

Nemo Link®

Environmental Statement Volume I

Environmental Statement
and Figures

February 2013

UK Environmental Statement

The Nemo Link

February 2013

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Abbreviations

1DV	One-dimensional vertical
μT	Microtesla
AC	Alternating current
AD	Anno Domini
AIS	Automatic Identification System
AONB	Area of Outstanding Natural Beauty
BAI	Broad Areas of Interest
BC	Before Christ
BGS	British Geological Society
BP	Before Present
BT	British Telecom
CALDOVREP	CNIS Mandatory Reporting System
CD	Capital Dredgings
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CLBs	Cable Lay Barges
CLV	Cable Laying Vessel
CNIS	Channel Navigation Information Service
COLREGS	International Regulations for Preventing Collisions at Sea, 1972 (as amended)
dB re 1μPa	Decibels relative to one micropascal
DAS	Days at sea
DC	Direct current
DECC	Department for Energy and Climate Change
dMCZ	Draft Marine Conservation Zone
DoRIS	Department of Research and Information Services
E	East
EEC	European Economic Community
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic fields
EOD	Explosives and Ordnance Disposal
EQS	Environmental Quality Standards
ERCoP	Emergency Response Coordination Plan
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
FLO	Fisheries Liaison Officer
FOCI	Feature of Conservation Interest
GB	Great British
GT	Gross Tonnage
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HVAC	High Voltage Alternating Current
HVDC	High voltage direct current
IBA	Important Bird Area
IFA	UK-France Interconnector

IMO	International Maritime Organisation
IRC	Integrated Return Conductor
JNCC	Joint Nature Conservation Committee
ICES	International Council for the Exploration of the Sea
KESFC	Kent and Essex Sea Fisheries Committee
KISCA	Kingfisher Cable Awareness Charts
km	Kilometres
KWT	Kent Wildlife Trust
LAT	Lowest Astronomical Tide
LNR	Local Nature Reserve
m	metres
MAGIC	Multi Agency Geographical Information for the Countryside
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MD	Maintenance Dredgings
MESH	Mapping European Seabed Habitats
MGN	Marine Guidance Note
MHWS	Mean High Water Spring
MI	Mass Impregnated
MLW	Mean Low Water
MLWS	Mean Low Water Spring
MMO	Marine Management Organisation
MPA	Marine Protected Area
ms	Milli-seconds
MUMM	Management Unit of the North Sea Mathematical Models
N	North
NAVTEX	Navigational Telex Reports
NE	North East
NEQ	Net Explosive Quantity
NM	Nautical Miles
NMR	National Monuments Record
NNR	National Nature Reserve
OFTO	Offshore Transmission Operator
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PLB	Post Lay Burial
PLGR	Pre-lay Grapnel Run
PMSS	Project Management Support Services Limited
PSA	Particle Size Analysis
RAF	Royal Air Force
ROEP	Rise of Earth Potential
ROV	Remote Operated Vehicle
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SPA	Special Protected Area
SSS	Side-scan Sonar
SSSI	Site of Special Scientific Interest
SW	South West
TAC	Total allowable catch
TFA	Thanet Fishermen's Association

THLS	Trinity House Lighthouse Service
TJP	Transition Jointing Pit
TSHD	Trailer suction hopper dredgers
TSS	Traffic Separation Scheme
TTS	Temporary threshold shift
UK	United Kingdom
UKCPC	UK Cable Protection Committee
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded Ordnance
VHF	Very High Frequency Radio
VMS	Vessel Monitoring System
VTS	Vessel Traffic Services
WFD	Water Framework Directive
WWI	World War I
WWII	World War II
XLPE	Cross Linked Polyethylene

1. Introduction

1.1. Purpose of this report

This Environmental Statement has been produced to support the consent applications for the UK marine aspects of the Nemo Link.

1.2. Project overview

The Nemo Link (the Project) is a proposed electrical interconnector, with an approximate capacity of 1000 MW, which will allow transfer of electrical power between the high voltage grid systems of Belgium and the United Kingdom. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. The proposed cable route would run from Richborough in Kent in the UK to Zeebrugge in Belgium, passing through English, French and Belgian waters. Figures A and B in Appendix 2 – Route Position List provide an overview of the location of the proposed cable route and the landfall location.

1.2.1. Scheme promoters

The Nemo Link is being developed by a consortium made up of National Grid Nemo Link Ltd and Elia Asset S.A., which is part of the national transmission company in Belgium. The companies are jointly referred to in this Environmental Statement as “the Nemo Consortium”.

1.3. Environmental Statement objectives

This Environmental Statement covers the UK marine cable elements of the Project, from the mean high water spring (MHWS) tide mark at Pegwell Bay in Kent out to the median line between England and France. 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). Therefore it does not constitute EIA (EIA) development under the relevant UK regulations (The Marine Works (EIA) Regulations 2007). This was confirmed by the Marine Management Organisation in response to a request for a joint screening and scoping opinion (Appendix 3). However, the Nemo Consortium has 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 detailed in Section 3 below.

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 the Environmental Statement has been collated to both inform the applications for the required consents and/or to allow the United Kingdom regulators (primarily the Marine Management Organisation (MMO)) to satisfy their statutory obligations.

The objectives of this document are therefore to:

- Enable the Nemo Consortium to comply with best environmental practice by delivering voluntary Environmental Impact Assessment (EIA) to a high standard
- Provide environmental information and data to inform the relevant consent applications as required by law and to allow the United Kingdom regulators to satisfy their obligations under European law (in particular in respect of the requirements for Appropriate Assessment under the Habitats Directive)

1.3.1. Other elements of the Project

In addition to the UK marine components which are the subject of this Environmental Statement, the Project includes the following elements:

- The UK onshore elements: the construction of an electricity converter station and substation on the site of the former Richborough power station, comprising buildings, outdoor electrical equipment and internal access roads, and the installation of underground electricity cables from low water at Pegwell Bay to the converter station.
- The Belgian onshore elements: the construction of an electricity converter station and substation at Zeebrugge, comprising buildings, outdoor electrical equipment and internal access roads, and the installation of underground electricity cables from low water to the converter station.
- The offshore elements in French and Belgian waters: the installation of a marine electricity cable from the median line between England and France to the landfall at Zeebrugge.

The appropriate consents for these other elements of the Project will be sought independently of, but in parallel to, the UK marine components, and Environmental Impact Assessments have been undertaken in respect of each element.

The likely significant effects of the other elements of the Project are summarised in section 10.

1.4. Environmental Statement structure

The structure of this report is as follows:-

Section	Title
Volume I: Environmental Statement	
1	Introduction
2	Project Background
3	Legislative Framework
4	Description of Proposed Development
5	EIA Method
6	Physical Environment
6.1	Geology and Bathymetry
6.2	Sediment transport and bedload
6.3	Water quality and suspended sediments
7	Biological environment
7.1	Conservation designations
7.2	Ornithology
7.3	Marine mammals
7.4	Benthic and intertidal ecology
7.5	Fish and shellfish ecology

8	Human environment
8.1	Commercial fisheries
8.2	Shipping and navigation
8.3	Archaeology and cultural heritage
8.4	Cables and pipelines
8.5	Military and other sea users
8.6	UXO
8.7	Tourism, recreation and amenity
9	Cumulative Effects
10	Effects of other Project elements
11	Conclusions
Appendix 1	Figures
Volume II: Technical Appendix	
Appendix 1	Route Position List
Appendix 2	Scoping Response Matrix
Appendix 3	MMO Scoping Response Letter
Appendix 4	Legislative Framework
Appendix 5	Habitats Regulations Assessment Signposting
Appendix 6	Assessment of Impact Significance
Appendix 7	HR Wallingford Technical Report
Appendix 8	Winter Bird Survey
Appendix 9	Inter-tidal sediment and invertebrate surveys
Appendix 10	Breeding Bird and Redshank Nesting Survey
Appendix 11	Benthic Survey Report
Appendix 12	Archaeological EIA
Appendix 13	Offshore French Non-Technical Summary
Appendix 14	Offshore Belgian Non-Technical Summary
Appendix 15	UK Onshore Non-Technical Summary
Appendix 16	Belgian Onshore Non-Technical Summary

1.5. References

- CEFAS (2004). Guidance notes for EIA in respect of FEPA/CPA requirements. (Version 2 - June 2004).
- HM Government et al, 2010 HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government (2010) Draft UK Marine Policy Statement: The Appraisal of Sustainability report <http://www.defra.gov.uk/corporate/consult/marine-policy/100721-marine-policy-appraisal-of-sustainability.pdf> [Accessed: 09/08/2010]
- Kalmijn, A. J. 1974. The detection of electric fields from inanimate and animate sources other than electric organs. In: Handbook of Sensory Physiology (Ed. by Fessard, A.), pp. 147-200. New York: Springer Verlag.
- Pals, N., Peters, R. C. & Schoenhage, A. A. C. 1982b. Local geo-electric fields at the bottom of the sea and their relevance for electrosensitive fish. Netherlands Journal of Zoology, 32, 495-512.

2. Project Background

2.1. Project justification

It is European Union (EU) policy to increase the transmission capacity between countries, with the stated wish to see each member state establish an interconnector capacity of around 10% of installed generation capacity. The reasons for this policy are to allow a more efficient energy market within the EU and facilitate the sustainable development of the electricity sector by increasing opportunities for clean and efficient generation and by making it easier to exploit intermittent renewable electricity resources in the UK and Continental Europe. The Nemo Link is consistent with these policy objectives.

Further information regarding the rationale behind the Project can be found on the project website available at the following link:

<http://www.nationalgrid.com/uk/Interconnectors/Belgium/Nemo+interconnector/>

2.2. Project definition process and alternatives considered

In order to identify an optimal project solution, the Nemo Consortium has undertaken a series of feasibility assessments and an ongoing route engineering study to address several connection and routing options.

2.2.1. Discussion of Belgian onshore options

Several onshore connection location options in Belgium were considered including Zeebrugge, Oostende and Koksijde. A connection point and landfall in Zeebrugge was selected for technical, economic and environmental reasons. A key reason for the selection of this landfall and connection point is that the Project will be able to make use of the increased grid capacity that will be offered by the Stevin project which will upgrade Elia's 380 kV electrical grid between Zomergem and Zeebrugge. The Stevin project is required to allow the planned offshore wind farms in Belgian waters to connect to the Belgian transmission system, facilitate the connection of this project and accommodate the increasing power requirements of the Port of Zeebrugge. Further details of the project can be found on the Elia website available at the following link:

<http://www.elia.be/en/projects/grid-projects/stevin>

The specific environmental reasons for selection of Zeebrugge for the onshore connection to the grid and the associated landfall are as follows:

- Reinforcement of the Belgian electricity transmission system to enable connection of the Project in Zeebrugge would need the least amount of overhead line in coastal areas in comparison to the other potential landfall locations
- The selection of Zeebrugge as the connection point for the Project minimises negative environmental effects on features such as visual amenity and ornithology.

2.2.2. UK Converter Station

The physical size of the converter station is dependent on a number of factors including the following examples:

- Power rating of the link;
- Operating voltage;
- Operating arrangements;

- Connection point on the transmission system; and
- Conversion technology

The initial study area in which the converter station was considered in the UK included a large area of land in southeast England in which the following parameters were identified:

- Possible onshore cables route from a cable landfall with a feasible and practical route offshore to the Belgian coast;
- A site where land was available and where a converter station could be deemed acceptable; and
- A potential connection to a robust connection point on the high voltage electricity transmission system.

With respect to the cable landfall and offshore cable route between the UK and Belgium a series of feasibility studies were undertaken (which are discussed further in Section 2.2.3). The initial feasibility work carried out highlighted Richborough to Zeebrugge as the preferable route following consideration of a number of environmental and technical factors such as:

- Other commercial offshore developments and sea users (e.g. offshore wind, aggregates, disposal sites, oil and gas, port development and dredging)
- Bathymetry and geology
- Military use
- Existing and potential conservation designations
- Fishing

In relation to the suitability of the onshore location, the following onshore factors were considered:

- Land availability in relation to the footprint of the converter station;
- Land designation and use (i.e. existing/planned use and setting as well as landscape, heritage and nature conservation designations);
- Feasibility of an appropriate AC connection to the grid system; and
- Environmental sensitivity of the site (e.g. existing visual amenity, noise, traffic levels etc.).

Ten locations were considered as potential converter stations, each having a direct current (DC) cable connection to a suitable subsea cable landfall area (Figure 2-1). The availability of land for a converter station, the suitability of planning policy and existing land uses, and the difficulty of the alternating current (AC) connection from the converter station to the transmission system, were all taken into account.

The following locations were investigated:

- Sizewell
- Bramford (near Ipswich)
- Bradwell
- Rayleigh (Essex)
- Shellhaven
- Grain
- Kemsley
- Cleve Hill
- Richborough
- Sellindge

The investigation into these options is presented in the report entitled Nemo Link: Development of an electricity interconnector between UK and Belgium - Review of Options which is available on the Project website following the link below:

<http://www.nemo-link.com/>

Initial investigations indicated that the most favoured sites were at Shellhaven, Kemsley and Richborough which were subject to further investigation. The site at Shellhaven became the 'Thames Gateway' development proposal which included dredging of the dock and plans to keep this and a channel to the open sea at appropriate depths with maintenance dredging if required. This precluded the location as a viable option due to the level of disturbance and potentially high risk of damage to the cables in that environment.

Detailed assessment and discussion with planning authorities, Environment Agency, Natural England and Kent Wildlife Trust focused on sites at Kemsley and the nearby Ridham Dock on the River Swale, Richborough and in the vicinity of Canterbury.

In relation to existing land use, Richborough Power Station was considered a strong candidate site as there have been long-held local aspirations for positive use of the dis-used station as a catalyst for clearance of the site. Kemsley and Ridham Dock also have a number of large industrial buildings in the vicinity, although there is also land with modern housing and other land held by housing developers. There is limited land available and concerns were expressed from consultation regarding the effects of development on the adjacent wildlife sites including European sites. Sites in the vicinity of Canterbury were generally deemed unsuitable for a converter station due to land conditions and possible effects on the setting of the World Heritage Site of the city.

The Richborough Power Station site for the converter station therefore offered the optimal balance between a feasible subsea cable route and a landfall to which a reasonable connection could be implemented, i.e. a suitable and available converter station site, and reasonable prospects for a connection to the high voltage transmission system without giving rise to unacceptable environmental effects (due to existing land use and a lower environmental sensitivity to this type of development in comparison to the other sites shortlisted).

No other offshore factors contributed to the siting of the converter station other than distance from a viable landfall option. However, the marine feasibility assessment involved an assessment of each of the possible marine routes based upon a comparative cost analysis and a review of environmental constraints and impacts and consent requirements. This assessment identified significant advantage (in terms of land availability, cable route length and permitting and consenting issues) of the route between Richborough and West Zeebrugge. A route between Richborough and West Zeebrugge is the shortest cable route option at 130 km and therefore minimises the extent and duration of environmental effects.

2.2.3. Preliminary Offshore cable route engineering study

Based upon the initial feasibility work a preliminary route engineering study was undertaken to assess alternatives and which identified the optimal offshore cable route between Richborough and Zeebrugge.

The following broad criteria were used to inform the route selection.

Category	Criteria
Physical environment	Available seabed sediment data were reviewed to assess the potential for successful burial of the cable. Where possible, areas of rock, boulder clay and sand waves were avoided as these factors could create difficulties in burying the cable.
Biological environment	The following designated conservation areas were considered in route development. Special Areas of Conservation

Category	Criteria
	<p>Special Protection Areas Ramsar Sites National Nature Reserves Sites of Special Scientific Interest Local Nature Reserves</p> <p>Marine development (including the laying and operation of submarine cables) is not prohibited in any of these sites and therefore protected sites were not considered "no go" areas for cable routing. Instead, the routing took into account available information on the designated sites. In the absence of available information on the precise locations of sensitivities within protected sites, the shortest route across these areas was taken where possible to minimise disturbance.</p>
Human Environment	<p>All anchorage areas, dredging areas, existing marine disposal areas, oil and gas infrastructure and existing offshore wind farms were avoided.</p> <p>An angle as close to 90° as possible was sought in making cable and pipeline crossings.</p> <p>Disused marine disposal sites and military practice areas were crossed with caution, taking into account available information on what they are used for.</p> <p>All known wrecks were avoided.</p>

Table 2-1: Route selection criteria

The specific marine, intertidal and coastal factors taken into account were as follows:

- Coastal geology
- Coastal processes
- Beach gradient
- Rivers and watercourses
- Existing infrastructure
- Access
- Proximity to residential areas
- Landing technique
- Conservation designations

A summary of the landfall areas near to Richborough considered is detailed below:

1. Service Station North – This is an area to the north of the petrol station located at the west of Pegwell Bay on the A256. The Thanet Offshore Wind Farm cable makes landfall in this area and therefore it is expected that installation of the cables is technically feasible using similar open cut trenching methods as used by the Thanet Project. This landfall location is slightly less sensitive in ecological terms than other areas of the bay as it would involve minimal crossing of saltmarsh. The area to the north, Cliff End Beach is important for a population of turnstone, the area to the south west has extensive areas of salt marsh, the area to the south of the river mouth – Sandwich Flats – has sensitivities including ancient dune pasture and is also a sand lizard re-introduction area. This landfall would however require crossing the Thanet Offshore Wind Farm cables both offshore and onshore.
2. Service Station South – This is an area to the south of the petrol station located at the west of Pegwell Bay on the A256. This location shares the benefits of the Service Station North landfall noted above. An offshore crossing of the Thanet Offshore Wind Farm cables would not be required for this option. It is understood however from anecdotal evidence (pers comm, Kent Wildlife Trust, 19 January 2011) that there may be hydrocarbon contamination in the area directly to the south of the service station that will need to be taken into account during

installation. This area is above mean high water and will therefore be addressed in more detail in the onshore Environmental Statement.

3. Cliff End Beach – This area is in the northern part of Pegwell Bay. Cable installation would require Horizontal Directional Drilling (HDD) through the cliffs at the back of the bay which may disturb a population of the protected bird species Turnstone (for which Thanet Coast and Sandwich Bay SPA is designated). An offshore crossing of the Thanet Offshore Wind Farm cables would also be required for this option.
4. Sandwich Flats – This landfall is located to the southern extent of the bay, south of the mouth of the River Stour. There are considerable disadvantages with this landfall owing to its remoteness, access issues, ecological sensitivities including the presence of ancient dune pasture and the adjacent sand lizard re-introduction area.
5. Country Park – This landfall is located in the southern extent of the bay, north of the mouth of the River Stour. It is understood that this area is a former landfill site for which records are incomplete. This option would present considerable engineering challenges to minimise any discharges from the landfall and may give the developers unacceptable levels of project and liability risk.
6. River Stour – This would involve installation of the cable in the mouth of the River Stour, making landfall at Richborough Port. The width of the river channel and estuarine environment present considerable risk to the environment and the project.

Based upon technical and environmental assessments of the alternatives detailed above, the proposed cable landfall is Service Station South. Due to a current lack of site specific topographic, geophysical and geotechnical data a landfall area (rather than a specific location) has been defined for this Environmental Statement and the associated consent and licence applications. The final cable route, within the intertidal zone, will be within this area. The extent of this 400m wide area is detailed in Figure 2-2.

In 2012, following the initial phase of feasibility work in 2006, a further study was undertaken to take account of further designations that had been put in place or potential designations such as the Marine Conservation Zones and Reference Areas. Additionally, there were further route options previously not considered, however these were deemed to be unacceptable on the grounds of constraints posed by technical or 3rd party and environmental factors (primarily designated sites that the routes crossed). Therefore the results of these feasibility studies were that the Richborough route with the Pegwell Bay landfall was the most environmentally and technically viable option.

2.3. Consultation

Consultation with stakeholders has been undertaken through the route selection and definition process, and comments were received from statutory and key consultees on the scope of EIA required for the proposed development via a Scoping Report circulated to consultees in October 2010. Appendix 2 – Scoping Response Matrix provides a summary of the responses received and the sections of this report that address these comments. Responses were received from the following organisations:

- The Marine Management Organisation
- Natural England
- English Heritage
- JNCC
- The Crown Estate

- The Maritime and Coastguard Agency
- The Royal Yachting Association
- Trinity House Lighthouse Service
- Port of Ramsgate
- Thanet District Council
- Kent Wildlife Trust

2.4. Sources of data and information

The following primary sources of data have been used to inform the project specific specialist studies and this Environmental Statement.

Survey/study	Extent of data	Data collected	Date of survey
Cable Route Geophysical Survey	Low water mark in the UK to low water mark in Belgium. 500m wide corridor surveyed.	Sidescan sonar, multibeam bathymetry, sub bottom profiler, magnetometer.	August 2010
Cable Route Benthic Survey	Low water mark in the UK to low water mark in Belgium.	Sidescan sonar and multibeam data examined to inform benthic sampling locations and locations for trawl survey.	September 2010
Cable Route Geotechnical survey	Low water mark in the UK to low water mark in Belgium.	Vibrocore samples taken to a depth of 5m and cone penetrometer tests undertaken.	September 2010
Wintering bird survey	Pegwell Bay	Details of the numbers and species of wintering birds present (see Section 7.2 – Ornithology for further details)	November 2008 – March 2009 and May 2009
Breeding bird survey	Pegwell Bay	Details of the numbers and species of breeding birds present (see Section 7.2 – Ornithology for further details)	May – June 2009
Invertebrate survey	Pegwell Bay	Sediment cores, biotope survey and survey of invertebrate communities and species abundance. Also includes a brief discussion on predator prey relationships especially in relation to bird species.	August 2009
Marine Archaeology Study	Marine cable route from high water mark in the UK to high water mark in Belgium	The archaeological consultants input to the scope of geophysical and geotechnical survey and reviewed all data to determine archaeological potential along the cable route.	July – December 2010
Sandwave and sediment modelling	Marine cable route from high water mark in the UK to high water mark in Belgium	The study drew upon the geophysical and geotechnical survey data to model the sediment mobility along the cable route to inform impact assessment and cable burial specification.	November 2010 – February 2011
Sediment plume dispersal modelling	Specific locations along the cable route selected to give an overview of the potential plume dispersal from installation along the cable route.	The study drew upon the geophysical and geotechnical survey data to model plume dispersal along the cable route to inform impact assessment and cable burial specification.	November 2010 – February 2011

Table 2-2 : Primary data sources and project specific studies undertaken to inform the Environmental Statement

3. Legislative Framework

As discussed above there is no specific legislative provision which requires the proposed development to undergo EIA. However, a number of policies and laws require decision makers to consider the environmental impacts of projects. The main relevant provisions are set out in the table at Appendix 4 – Legislative Framework.

It is understood that relevant licences, consents or permissions will be required under the following legislation for the proposed development:

- Marine and Coastal Access Act 2009
- Town and Country Planning Act 1990 (a separate Environmental Statement will be prepared for the UK onshore aspects of the Project covering all those aspects located above the mean low water spring (MLWS) tide mark)
- Environment Act 1995
- Land Drainage Act 1991
- Water Resources Act 1991

It should be noted that under the Marine and Coastal Access Act 2009, a licence is required for the following aspects of the proposed development:

- Laying and burial of cable from the Mean High Water Spring (MHWS) tide mark to 12 nautical miles (NM)
- Dredging and disposal required to pre-sweep sand waves
- Rock/concrete mattress placement in one location in the UK
- Horizontal directional drilling (HDD)

A Habitats Regulations Screening Assessment under The Conservation of Habitats and Species Regulations 2010 (as amended) is required for crossing both Special Area of Conservation (SAC) and Special Protection Area (SPA) designations at the cable landfall. (see The Nemo Link: Pegwell Bay – Assessment of Likely Significant Effects Report). Information relevant to this assessment within this Environmental Statement is highlighted within Appendix 5 – Habitats Regulations Assessment Signposting.

4. Description of Proposed Development

4.1. Introduction

This section presents the details of the UK marine elements of the Project which are the subject of this Environmental Statement. The installation, operation, maintenance and decommissioning phases are described in terms of the likely component options and their installation and use.

4.2. Project overview

The Nemo Link is a proposed electrical interconnector with an approximate capacity of 1000 MW, which will allow transfer of power between the high voltage grid systems of Belgium and the United Kingdom. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. The proposed cable route would run from Richborough in Kent in the UK to Zeebrugge in Belgium.

The use of High Voltage Direct Current (HVDC) provides the most efficient and effective means to transport electricity over this distance.

The high voltage grid systems in the UK and Belgium operate using high voltage alternating current (HVAC). To transport electricity from one country to the other first requires the HVAC to be converted to HVDC at the transmitting end and after traversing the seabeds of the UK, France and Belgium by means of HVDC cables then needs to be converted from HVDC to HVAC at the receiving end. This conversion process is carried out at converter stations which will be located at the former power station at Richborough in Kent and at Zeebrugge in Belgium.

A direct HVAC connection is not feasible due to inefficiencies resulting from the distances involved and from the fact that while both the UK and Belgium transmission systems operate at 50Hz an HVDC system allows for any discrepancies in synchronisation between the two systems.

The subsea cable system is jointed to its corresponding land cable in a joint pit located above mean high water mark and does not form part of this application. The consent for this will form part of the application for onshore consent.

4.3. Marine cable route description

4.3.1. Marine cable route

The route derived from preliminary cable route engineering and survey is shown in Figure A (Appendix 1). The description below outlines the key constraints that were considered in the cable route identification and selection. To aid this description, kilometre points have been assigned to the route running from Zeebrugge in Belgium to Richborough in the UK.

Route section	Key Constraints
Kilometre point 55 - 100	<p>Route continues on an east/west alignment taking a similar route to the Tangerine telecoms cable.</p> <p>Route crosses the Dover Straits traffic separation scheme and deep water route before continuing along the West Hinder Traffic Separation Scheme. The Tangerine telecoms cable takes a similar route in this area.</p> <p>Between KP 82 and 59 the cable route passes through French waters, before entering Belgian waters.</p>
Kilometre point 100	Crosses South Falls sand bank where water depth may be less than 10 m.

Route section	Key Constraints
	Bank is over 30 km long, meaning a substantial detour would be needed for the route to go around it.
Kilometre point 100 - 115	Local deviations to avoid known wreck locations. Hard ground may be encountered in this area. Project experience in this area suggests that burial in the chalk can be achieved with a rock cutting type plough. The alternative of protection through surface lay together with rock or mattress protection is likely to be more expensive and have a greater environmental impact. Further assessment of this will be undertaken based on survey data when available.
Kilometre point 115 - 124	Route crosses to the north of Goodwin Sands, an area of shallow water, shifting sands and known wrecks.
Kilometre point 124	Cable route avoids a marine spoil ground.
Kilometre point 128	Cable exits Pegwell Bay
Cable landfall UK/Intertidal Area (Richborough) Kilometre point 130	Port of Ramsgate to the north. Spoil ground and Cross Ledge Shoal to the south. <i>NB The marine approach of the cable route to Pegwell Bay has been confirmed via geophysical and geotechnical survey. Geophysical and geotechnical survey of the intertidal and associated landfall area (as indicated on Figure 4-1) was undertaken in August 2011. This data will be used to inform the precise alignment of the cable in the intertidal area.</i>

Table 4-1: Marine cable route high level description

4.4. Outline description of cable system

4.4.1. System options

As described in Section 4.2 the cable system will be HVDC. No decision has been taken to date on the type and voltage of submarine cable to be deployed, and this will be considered prior to any contract being awarded for cable design and installation. The cable will be rated at between 350 kV and 400 kV.

HVDC Interconnectors can be configured either as monopole or bipole systems.

4.4.1.1. Bipole system

Bipole systems transmit power via a closed circuit of two HVDC submarine cables installed alongside each other. Bipolar systems transmit power through two high voltage conductors of opposite polarity (e.g. +500 kV and — 500 kV).

Typically these are installed in a bundled configuration, with no separation between cables, however in some circumstances these cables may be installed in an unbundled format with cables installed in the same trench.

4.4.1.2. Monopole system

Monopole systems have a single high-voltage conductor, at either negative or positive polarity connected to a single converter at each end. The return path may be through the earth (and sea) itself or via a second cable. Using an earth return requires large copper electrodes to be placed near each

end of the link to feed the return current into the earth and sea. Although monopole interconnectors with earth returns operate successfully in a number of locations without adverse effects on local environments, concern has sometimes been expressed in respect of recent possible similar installations. These concerns generally relate to the effects on the marine environment of electrolysis products from the electrodes and the possible effects on metallic structures (such as pipelines) of stray currents.

Monopole systems may also use a metallic sheath around the main conductor as the return path.

4.4.2. Cable technology options

The Project is considering the use of one of two cable types available for HVDC application; Cross Linked Polyethylene (XLPE) and Mass Impregnated (MI).

4.4.2.1. XLPE cable

Extruded HVDC cables use XLPE for their insulation. The insulation is extruded over a copper or aluminium conductor (copper has a lower resistance and thus a higher power density, although it is heavier and more expensive than aluminium) and is covered with a water tight sheath, usually of extruded seamless lead for submarine cables or aluminium laminate for land cables, and a further protective plastic coating. Cables intended for submarine use have an additional layer of galvanised steel wire armour to increase the cable's tensile strength so it can better withstand the stresses of submarine installation. This is usually a single layer of wires, helically wound around the cable (although in deeper waters or over rocky sea beds this may be a double layer), and covered in a sleeve of bitumen impregnated polypropylene yarn to inhibit corrosion.

4.4.2.2. MI cable

MI type cable is a proven technology and has been widely used on major interconnector projects in service to date including but not limited to:-

- UK-France interconnector (IFA)
- BritNed, linking the UK and the Netherlands,
- Basslink, linking Australia with Tasmania
- NorNed, linking Norway with the Netherlands

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.

A typical section of an MI cable is shown in Figure 4-A below. 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 and to improve handling.



Figure 4-A : Mass Impregnated Cable

4.4.2.3. Cable oil and coating

The presence of oil in the cable and any possible consequences of this are avoided by using an MI or XLPE cable in which no liquid occurs. Some types of cable (oil filled cables) contain liquid oil that is used for electrical insulation. In the case of cable rupture, this oil could leak into the marine environment or into the ground. These types of cable are not being considered for the Nemo Link.

4.4.2.4. System assumed for the purposes of EIA

This Environmental Statement has been prepared on the basis that the cable configuration for the proposed 1000MW Nemo Link, will be a bipolar HVDC system, with a pair of single core, MI cables bundled together in the same trench.

4.5. Cable installation

The sections below give an outline description of operations involved in installing the cables.

4.5.1. Route preparation

Two significant preparation activities are likely to be undertaken prior to installation of the cable system. These are:

- Clearance of out-of-service telecommunications cables that cross the cable route using a grapnel hook dragged across the seabed to pick up the cables and cutting equipment to cut away the relevant section.
- Preparation and deposit of bridging and separation structures over any cables and pipelines that the Nemo Link cable route crosses. Typically crossing designs involve the placement of crushed rock on the seabed above the crossed asset by a specialist vessel, utilising a fall pipe that precisely guides the rock onto the seabed. The exact design will be agreed with the crossed party through a formal crossing agreement process and may, as an alternative, use concrete “link-lock” type mattresses.

It is also possible that areas of seabed where bed rock is present, likely to be chalk, may be prepared by the cutting of a trench that the cables will then be installed into. An alternative approach in these chalk areas, would be to use a specialist rock cutting plough, which may provide a more effective solution.

4.5.2. Cable route clearance

Prior to the start of marine operation it is essential to ensure the 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 be detrimental to the 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 detected and 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 specially designed hook, or grapnel, 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 1 m. The grapnel will have a maximum width of approximately 200 mm.

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 the 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.

4.5.3. Route preparation in sandwaves (pre-sweeping)

Sandwaves are known to be present on the sea bed along the cable route in the Eastern English Channel. They inhibit burial equipment and, if they are mobile, decrease the efficacy of burial.

Installation equipment can generally work on long inclines of up to 10-20°. However, sandwaves with crest lines on an oblique angle to the cable line can present major difficulties for both towed and self propelled machines.

Where sandwaves are mobile a cable buried into the upper part of a sandwave may become exposed if subsequently a trough moves through the location.

Pre-sweeping by dredging can be used to reduce the height of the sandwaves along the cables route and produce a flatter path for the installation equipment to move along. This also allows for greater control of the burial depth of the cables. It also makes the protection afforded by burial more resistant to sandwave mobility and therefore more durable over time.

Pre-sweeping is normally carried out by trailing suction hopper dredgers (TSHD) that shave off the crest lines of sandwaves and create a flatter path for a burial machine to move along. Path width will vary depending on the shape and size of each feature but may be 10m to 20m.

If adopted, pre-sweeping will be undertaken just a few days in advance of cable laying operations to ensure the dredged path remains open for the installation to take place. The TSHD would operate mainly as a discrete vessel detached from the cable laying spread, except if remedial work is considered necessary during cable laying. Dredgers are generally agile and not so restricted as a Cable Laying Vessel (CLV) or burial support vessel in their ability to manoeuvre.

The spoil volumes resulting from pre-sweeping are typical of dredging operations for channel or port maintenance and therefore relatively small. It is assumed that the spoil will be deposited back on the seabed in the immediate vicinity of the pre-sweeping activity.

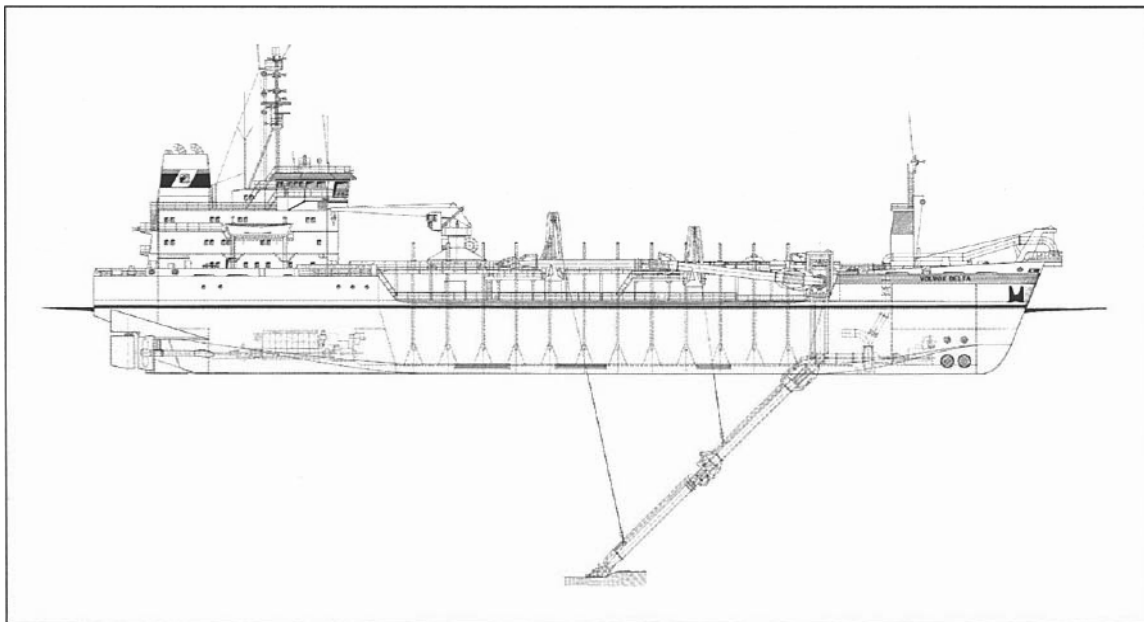


Figure 4-B : Trailing suction hopper dredger

The sediments along the UK route sector have been assessed relative to a 1:50 year storm event (i.e. a period which encompasses the expected engineering lifespan of the interconnector).

In addition to the pre-sweeping areas determined to allow target burial depths to be achieved, a number of locations have been identified where seabed slopes exceed the nominal 10-20° capability of burial machinery. These areas will require the local sediment slope angle to be modified to allow access for burial machinery. All locations where dredging of seabed slopes was identified coincide with the pre-sweeping areas as the sandwave crests tend to be the areas with the greatest slope angle. No further dredging areas were therefore identified as a result of the slope analysis. The table below presents the pre-sweeping locations and approximate volumes of material extracted, assuming a 40m pre-sweep corridor width (i.e. a 20m trench with sides of 1/5 gradient).

KP	Longitude	Latitude	Volume (m ³)	Purpose
26 - 29	2.77979	51.35257	38273	Mobility
29.25 - 29.35	2.75559	51.34716	743	Veneer
30.05 - 30.15	2.74507	51.34426	33	Veneer
31.5 - 34	2.70636	51.34514	10829	Mobility - Large Sandwave features, some presweep likely required
37.5 - 41.25	2.61177	51.34873	20479	Mobility
42.8 - 43	2.56172	51.35095	482	Veneer
54 - 57	2.40024	51.34705	27899	Mobility - Note cable crossing at 56.7
61.8 - 63	2.30903	51.32294	48491	Veneer
63 - 65.4	2.28503	51.31696	21330	Mobility
68.5 - 69.2	2.21952	51.32001	4593	Veneer
69.2 - 73.6	2.18433	51.32437	60249	Mobility
74.5 - 77.5	2.11854	51.32572	32614	Mobility - Assumes bedform type C is soft
82.3 - 87	1.99369	51.32529	24470	Mobility
99 - 100.75	1.77564	51.32706	93138	Mobility - South Falls sand bank
123 - 123.5	1.44542	51.30614	1170	Veneer

Table 4-2: Proposed pre-sweeping locations and approximate extraction dredging

4.5.4. Offshore operations

4.5.4.1. Offshore resources

The use of particular resources, CLVs or cable lay barges (CLBs), is dependent on the company that secures the installation contract and the availability of vessels. The present situation is that installation resources are in great demand and there is unlikely to be any decrease in this demand in the foreseeable future. It is impossible at this stage to make a forecast as to the available resources which could be deployed for the Project, since this is subject to market forces. The following presents a description of resources presently being deployed or proposed for installations of the size and character required for the Project.

The installation services typically being offered in the market for offshore work are based on either long standing installation resources such as the CLVs “Team Oman” and the “Giulio Verne” or relatively new entrants such as the CLVs “Stemat Spirit”, “NorthOcean 102”, the CLB “Atalanti” or the new build CLV “Aker Connector”. Available pictures of these vessels are provided in Figure 4-C below.



Team Oman



Stemat Spirit



North Ocean 102



Aker Connector



Giulio Verne

Figure 4-C : Cable laying vessels in the market

All the vessels mentioned are, in principle, capable of deploying burial equipment for simultaneous lay and burial and could therefore install all of the system between the 10 m depth contours on each side. The “Team Oman”, “Stemat Spirit” and the “Atalanti” also have some capability in waters shallower than 10m.

There may be limitations with respect to the amount of cable that can be carried if a vessel also has to deploy cable burial equipment. These limitations might affect the length of cable that can be installed during a single campaign and therefore the number of campaigns needed to install the complete system.

The larger CLVs are not normally worked inshore of the 10m isobath but may do so dependent on the environmental conditions, tidal range, weather etc., and the willingness of the operators to take the vessel closer in.

4.5.4.2. Shallow water working

The water depths on the route determine to a large degree the installation vessels and planning.

If the main CLV cannot approach close enough to the beach to directly land the cables, i.e. within a maximum of around 2km, a separate shallow water spread may be needed to install the cables.

Shallow water spreads are normally based upon flat-top pontoon barges that are mobilised on an *ad hoc* basis for cable work. They will be fitted with all necessary cable storage and working gear and a four to six point mooring system, which is used to manoeuvre the barge during cable work. Occasionally two barges are combined into a single spread, with one providing storage and deck working space and another providing motive power by use of anchors or thrusters.

Figures 4-D and 4-E below show the shallow water spread used for the installation of a landfall section of cable.



Figure 4-D : BritNed inshore installation spread – the Fetsy L multi-role and Stemat 81 flat barge



Figure 4-E : Fetsy L multi-role barge

4.5.4.3. Operational footprint

The footprint of a cable installation spread will depend on whether there is to be simultaneous lay and burial or post-lay burial. In the former case the lay vessel may deploy the burial equipment or this may be deployed by another vessel navigating close behind, creating effectively a single large spread. In the latter case the post lay burial (PLB) vessel may be some physical distance, or indeed some days, behind the lay vessel, so there are two discrete operations separated physically and in time.

The physical foot print will be that of the vessel, or vessels if working in concert, and also the surrounding navigational precautionary zone, commensurate with being a “vessel restricted in its ability to manoeuvre”. Typically a large CLV will be up to 150 m in length and will sit within a 500 m radius precautionary zone. This radius will be larger (potentially up to 2km) if the CLV has anchors.

The temporal impact of the spread will be dependent on the slowest moving element, usually the burial spread, which will most likely be moving at less than half a knot. This, in terms of other shipping will appear to be effectively stationary.

The more significant impact of the spread with respect to interference with general navigation is the precautionary zone as other vessels may need to alter course or speed to avoid this zone. The greatest significance will be within traffic separation schemes (TSS) where vessels are already constrained to navigate in defined areas and directions.

The greatest impact will be in the situation where the lay vessel is closely trailed by a burial vessel. In this case the precautionary zones may link together creating a single zone 500m by 1000m.

Interaction with other shipping traffic is managed in the first instance by broadcasting information regarding the location, direction and speed of the spread through normal marine channels, such as “Notices to Mariners”, and on vhf radio. In the second instance guard vessels are deployed with the spread to monitor and, if necessary, intercept approaching shipping to avoid hazardous situations developing.

In shallow waters the footprint of the spread will also be dependent on whether anchors are used. The anchors may be placed hundreds of metres from the vessel. The same precautions are necessary with respect to the vessel and the anchor pattern although there is inherently less risk of interaction with large volumes of shipping traffic in shallow water. The anchor handling vessels will in this case normally also act as guard vessels for the spread.

Project activity	Area concerned	Footprint
Cable installation at landfall	From approximately the low water mark to the transition joint pit which will be located above the mean high water springs line at the back of the beach.	Cable installation trench will be approximately 1 – 2 m wide. The cable will be buried to a target depth of circa 2-3 m. Mechanical excavators will be used to bury the cable. Potential for use of coffer dam
Shallow water cable installation	From approximately the low water mark out to 10 m water depth.	<u>Seabed</u> Anchors may be used to maintain the position of the vessel during installation of the landfall and shallow water section of cable system. It is expected that four anchors would be required and they would be approximately 100 m from the vessel. The cable will be buried to a target depth of circa 2 -3m Based on current burial technology it is estimated that the maximum footprint of the burial machine will be 10m and the footprint of the trench will be between 1 – 5 m. <u>Sea surface</u> The cable lay barge (CLB) will sit within a 500 m radius precautionary zone. If the lay vessel is closely trailed by a burial vessel the precautionary zones may link together creating a single zone 500 m by 1000 m. This radius will be larger (potentially up to 2 km) if the CLB has anchors.
Deep water cable installation	Water depths greater than 10 m	The cable will be buried to a target depth of circa 2 -3m. Based on current burial technology it is estimated that the maximum footprint of the burial machine will be 10 m and the footprint of the trench will be between 1 – 5 m. Pre-sweeping path width will vary depending the shape and size of each feature but may be 10 m to 20 m. <u>Sea surface</u> Typically a large Cable Lay Vessel (CLV) will be up to 150 m in length and will sit within a 500 m radius precautionary zone. If the lay vessel is closely trailed by a burial vessel the precautionary zones may link together creating a single zone 500 m by 1000 m. This radius will be larger (potentially up to 2 km) if the CLV has anchors.

Table 4-3 : Project installation footprint

4.5.5. Cable installation methods

A number of alternative methods are available for cable burial; however, the options are determined by the characteristics of the seabed into which the cables are to be buried.

The cables will be buried into the seabed either by a plough or trenching machine deployed by the main laying vessel directly or by a support vessel following behind. To ensure cable protection is immediate, operations may be simultaneous with burial equipment being deployed by either the cable layer or the support vessel. Alternatively cables may be buried in a 'post-lay burial' (PLB) operation, where a burial machine may be deployed days or even weeks later by a separate vessel.

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

- ploughs (towed),
- jetting machines (towed, free swimming or tracked)
- mechanical trenchers (tracked).

Ploughs

Ploughs are towed machines generally used for simultaneous lay and burial operations where the cable vessel controls cable laying speed to match plough performance and residual tension targets.

Although they are essentially passive, ploughs can be steered, and plough penetration (and hence cable depth) is 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 an auxiliary vessel moving along closely behind the cable vessel.

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 rock. The trench may be back filled by the use of back fill blades at the rear of the machine or left to backfill naturally.

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

The action of the displacement plough causes a relatively large amount of ground disturbance, because, as the name suggests sea bed material is displaced and piled up at either side of the produced trench. The sea bed footprint is greater than that of other machines and the spread footprint on the sea surface may be large owing to the size of vessel needed to pull this large equipment.

Non-displacement ploughs

This type of plough is the one most commonly used for the installation of telecommunications cables and is also used for power cables, umbilicals and other flexible products.



Figure 4-F : Modular Cable Plough in use on Isle of Man interconnector

A non-displacement plough uses a thin blade-like share that slices through sedimentary seabed material without creating an open trench. This type of plough often causes minimal disturbance to the seabed surface and the passage line can sometimes be difficult to detect during subsequent surveys. The cable runs through the heel of the share and is installed below soil that is relatively un-weakened by the process. Pulling forces for this type of plough are generally less than for the displacement plough but can still be in the order of 150 to 200 tonnes.

The footprint of the plough is typically 5 - 10 m wide depending on the size of the equipment.

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, thereby overcoming some of the effects of friction. The jetting plough has good performance in all sediment types including sand and requires less bollard pull to achieve the same burial depth as a conventional plough.

Non-displacement plough design has advanced over recent years and machines have been produced with capability in very hard materials including high strength clays, i.e. London Clay, and also chalk. These are typically called "rock ripping" ploughs and have similar operational characteristics to other non-displacement ploughs.

Another development of the non-displacement plough type is the vibro-plough which utilises vibration to reduce friction on the share. It has been shown to be particularly effective in glacial till ('boulder clay'). This type of plough is generally only available for inshore works and is usually mounted directly on a barge or tracked vehicle. Although very effective in the inter-tidal area this type of equipment has not so far been developed for use on large cables in greater water depths. The footprint of the plough is 3 - 4 m.

Jet trenchers

Jet trenching machines use water jets to fluidise the seabed underneath the cable, forming a trench full of fluidised material.



Figure 4-G : Canyon T750 tracked jet trencher

The cable sinks into the trench through the fluidised material under its own weight or is directed into it by a stinger or depressor. 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. The trench created may be partially or completely filled by reconsolidation of the fluidised material with the previous seabed level recovering over time through natural sedimentation.

Open sword jetting machines may be deployed directly behind the cable vessel or onto a cable that has been laid previously. Those with a cable depressor or stinger can only be deployed in simultaneous mode for the first pass on a cable. Figure 4-H shows the Prysmian Hydroplow jetting machine with stinger, currently being offered in the European market.



Figure 4-H : Prysmian Hydroplow jetting machine

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),
- increase of organic content (peat) and;
- increase of particle size (gravel, cobbles)

Mechanical trenchers

Mechanical trenchers are usually mounted on tracked vehicles and use chain saws or wheels armed with tungsten carbide teeth to cut a defined trench. These machines can work in virtually all sediments, including those with high shear strength and even bedrock. These are often large machines and work in very soft mud or loose ground conditions, though it can be difficult in mobile sands. They may also have difficulty in certain types of rock (eg chalk with flints) or in glacial till or “boulder clays” (where the loose cobbles may cause problems with teeth/additional wear).



Figure 4-1 : Canyon i-Trencher (BritNed)

Some spoil is ejected from the trench by the cutting action and the cable is guided into the trench base by a depressor arm. The mechanical action may be augmented in some cases by water jetting and/or by eductors that suck disrupted material out of the trench and deposit it to the side.

The trench opened during mechanical trenching can be back filled or left to refill naturally. A mechanical trencher will make trench of 0.5 m to 1.0 m in width and the footprint of a mechanical trencher will be 5 to 10 m, depending on the particular machine.

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

sections. They normally cannot be used for a second pass on an already buried cable as the cable cannot be located and loaded into the machine.

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 very high. This is because of the complexity of these machines, which have many moving parts, high wear rates and relatively slow installation speeds. These factors can potentially result in higher costs and possible delays during installation.

4.5.6. Cable joints

As a cable lay vessel or barge cannot carry the entire quantity of cable required for the marine cable route, it will be necessary to install the cable in several sections. Joints will be required to join each section of cable. It is expected that up to five offshore joints will be required for the Project however it will not be possible to determine the precise number or location of cable joints until an installation contractor has been appointed. Appointment of an installation contractor will not take place until consents for installation and operation of the project have been secured.

Cable joints will be made on board the cable lay vessel or barge and will take up to a week to complete. In this time the vessel is likely to anchor to maintain position. Once the cable joint has been made on board the vessel the cable lay will continue as normal.

4.5.7. Cable and pipeline crossings

Crossing agreements will be made with parties owning cables and pipelines which the project will cross in line with UK Cable Protection Committee (UKCPC) guidance. All parties have been informed about the potential for a cable crossing. These agreements detail the physical design of the crossing, and outline the rights and responsibilities of both parties to ensure the ongoing integrity of the assets. Indicative diagrams of typical methods of cable crossing are shown in Figures 4-J and 4-K. The footprint of cable crossings will be circa 100 m (rock or concrete mattress along the Nemo Interconnector cable) by 30 m (width of bridge over existing cable).

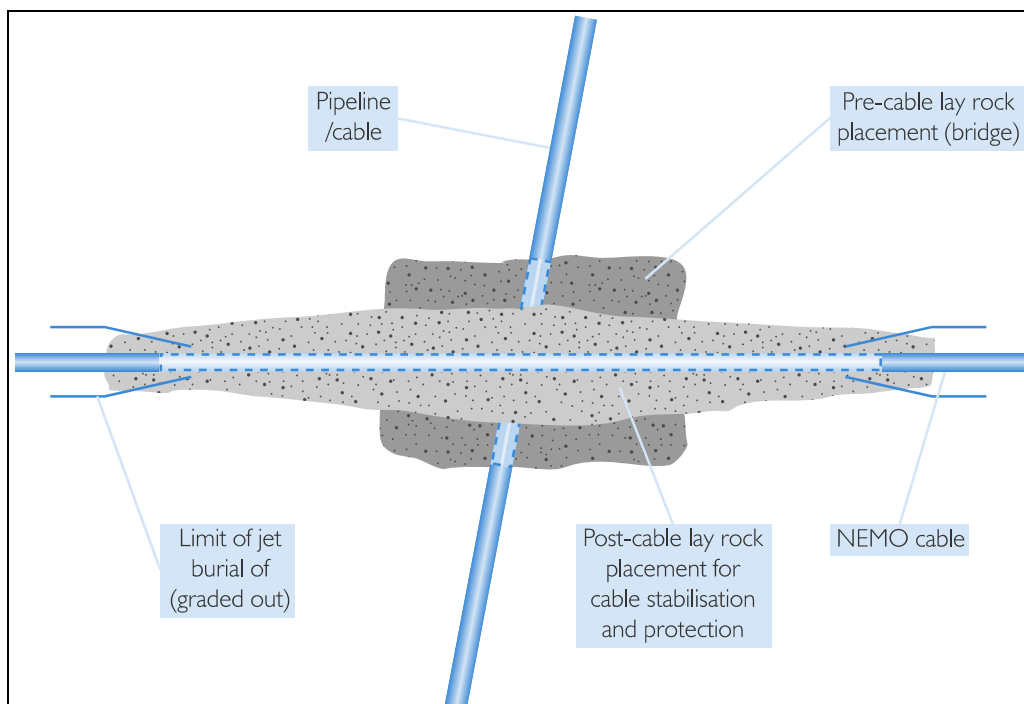


Figure 4-J : Cable crossing over buried/semi buried infrastructure

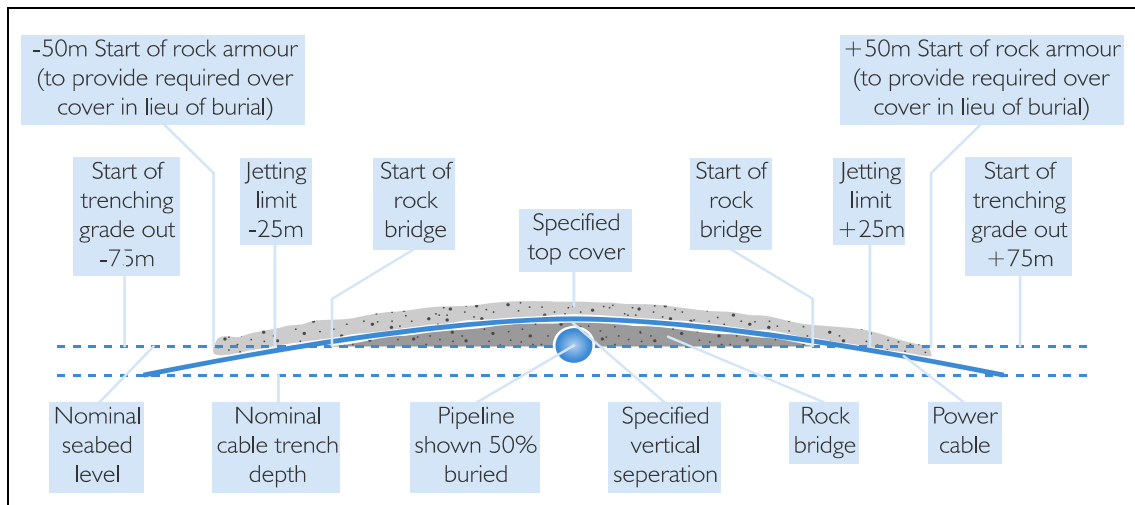


Figure 4-K : Cable crossing over buried/semi buried infrastructure – elevation

4.5.8. Landfall installation

In the case of Richborough, consideration of the Thanet Offshore Wind Farm operations suggests that marine burial of the cable will be possible between 1.5 km and 2.0 km from the beach. Inshore of this, the Thanet cables were mostly buried using the land based spider plough, with the last 100 m to 200 m being trenched with tracked excavators.

The landfall installation work relates to the construction of the Transition Jointing Pit (TJP) and the intertidal cable installation. The TJP will contain the joint between marine and land cables. The TJP, which will be described in the corresponding onshore planning application, will be constructed from reinforced-concrete and will be situated below ground level. It must be completed well in advance of the cable landing to avoid any delays to the landing operation. It will be necessary to agree temporary access routes to areas such as the beach for installation work to be completed. It is expected that the installation will use similar methods to those used for the Thanet Offshore Wind Farm cables as outlined above.

For the Nemo Link the proposed installation is via open cut trenching, possibly with the requirement for a cofferdam, which is similar to open cut but with sheet piling used to support the trench walls

For open trenching, a trench will be constructed using a conventional excavator and rollers will be used in the base of the trench to pull the cable along it. The trench will be approximately 1 – 2 m wide and the cables will be buried at a target depth of 2-3 m. Mechanical excavators will then be used to bury the cable. Some soil conditions may dictate that the cable should be laid on sand (or another suitable backfill) for protection. Top soil and subsoil from the trench will be removed and stored separately. In some areas it may also be necessary to provide protection to the topsoil in the surrounding work area through the use of wooden 'bog-mats' or possibly by removing the topsoil and storing it away from the construction area. Some conditions may require the use of cofferdams and in some open areas, such as the beach, it will be necessary to fence off the trench area in advance of installation.

A temporary working area of approximately 30m x 30m will be established as a works compound. The working assumption for this is the lay-by adjacent to the Service Station at Pegwell Bay.

4.5.9. Hours of work

As marine operations are dependent on weather conditions, installation work will be conducted on a 24-hour basis.

For inter-tidal cable work, site preparation work will be undertaken between 07:00 and 19:00 hrs Monday to Friday and 07:00 to 13:00 hrs on a Saturday. Within these times, one hour at either end of the working day has been allowed for start-up and shut down procedures. These hours of work may vary in extraordinary circumstances. Since the cable installation work is linked to offshore working, the installation work may require 24-hour working.

4.6. Installation programme

Cable installation schedules are dependent on a number of factors such as the delivery of cable, the availability of cable and the other commitments of the installer.

The Project route is relatively straightforward with approximately 20km of shallow water (< 10mCD) on the UK side, a deep water (> 10mCD) section of some 100 km (that crosses UK, French and Belgian waters) and a shallow water section at the Belgian end of approximately 10 km.

Figure 4-L below provides an indication of the installation programme for the marine aspects of the project. The programme for the commencement of installation has not yet been agreed but it is likely that installation will begin between 2014 and 2016. In general, installations in European waters are undertaken in the summer season, broadly between April and October. This period is determined primarily by the high probability of adverse weather occurring outside of this period. The schedule will also be affected by factors such as the requirement for ecological mitigation, cable delivery and the availability of vessels.

Activity	Description	Month				
		1	2	3	4	5
C1a UK shore end installation	Route clearance, laying and post lay burial of cable	■	■			
C1b Belgian shore end installation	Route clearance, laying and post lay burial of cable		■			
C2 Offshore installation UK	Pre-sweeping of sand waves, route clearance, cable jointing, simultaneous lay and burial of cable		■	■		
C3 Offshore installation France and Belgium	Pre-sweeping of sand waves, route clearance, cable jointing, simultaneous lay and burial of cable				■	■

Figure 4-L : Installation programme for the marine aspects of the project

Installation work in the intertidal areas in the UK and Belgium is expected to take less than one week. It is expected that up to five marine cable joints will be required on the entire cable system and each jointing operation will take approximately five days.

4.7. Cable operation

4.7.1. Overview

Following installation, routine maintenance work to the cables is not anticipated. However, some work may be required to maintain the burial of the cable to protect it from adverse interactions with other sea users and marine processes which might damage it. The cable and its installation will be designed to minimise any maintenance requirements.

4.7.2. In-service survey operations

Routine survey of a correctly installed and protected marine cable is not normally required as the subsea cables will be designed to require minimum maintenance. However, in areas of high seabed mobility, or if post-installation changes in the natural or manmade environment are perceived to have occurred (for example through an increase in adjacent dredging activity), survey of specific areas of the Nemo Link cables may be initiated. 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.

If required, a survey in shallow waters, 10m depth or less, will be carried out by divers or an ROV using cable tracking and video equipment and operating from a barge or small vessel. A survey in deeper water, 10m or more, will be carried out from a survey vessel using side-scan sonar (SSS) and ROV deployed instruments, such as cable trackers and video cameras.

4.7.3. Emissions from operating cable

There are a number of emissions which may occur to varying degrees during installation or operation of the interconnector. Such emissions include:

- electric and magnetic fields
- heat
- noise
- stray currents
- rise of earth potential (ROEP)

Several studies are referred to in order to assess the impact of the Nemo Link:

Study	Author
Electrotechnical studies and effects on the marine ecosystem for the BritNed connector (June 2003)	SwedPower
Seabed temperature profiles (September 2003)	KEMA
Two Part Report: Heating and magnetic issues and specific magnetic conditions within the Port of London (October 2003)	SwedPower
Magnetic and electric field strengths around HVDC cable (December 2003)	SwedPower

Table 4-4 : Operating cable emissions studies

4.7.3.1. Electric and magnetic field (EMF)

Background magnetic and electric fields

The geo-magnetic field forms the background which man-made magnetic fields interact with and against which they can be assessed. A desk study undertaken specifically for the BritNed interconnector estimated the geo-magnetic field in the vicinity of the marine section of the cables to be approximately 48 μ T (Swedpower, 2003a). This is assumed to be similar to that for the Nemo Link. This is supported by data from the world magnetic model. There are however likely to be very small local variations in the geo-magnetic field, which exist due to differences in the magnetic characteristics of the underlying geology from place to place.

The geo-magnetic field is thought to play a part in the navigation of marine fauna and is also used by man to navigate, by the use of the magnetic compass. The magnetic field has both magnitude and direction, which vary from place to place. Ships' compasses are adjusted to compensate for the difference between magnetic and true north, the declination.

Electric fields are induced in the sea water as it passes through the geo-magnetic field. The strength of these fields is dependent on the geo-magnetic field strength and also sea water chemistry, viscosity and its flow velocity and direction relative to the lines of magnetic flux.

Naturally occurring induced electric fields have been estimated for the North Sea and have been measured at $35 \mu\text{V}/\text{cm}$ (Pals *et al.*, 1982). In 1974, Kalmijn estimated electric fields in the English Channel to reach $25 \mu\text{V}/\text{cm}$ twice a day. However, the strength of the electric field in the sea varies continuously because of the varying speeds and directions of the water flow that are consequences of the tides and weather conditions, but it is essentially a static field.

Some species of marine fauna are known to utilize electric fields to detect prey and mates. It is also thought that some species are able to utilize the background electric field to orientate themselves and to navigate.

Magnetic fields associated with the marine cables

The system will produce a static magnetic field with a low-level time-varying magnetic field superimposed on to it.

The predicted line current on the Nemo Link produces a static magnetic field of a magnitude that is substantially the same as the geo-magnetic field. In theory, a cable type called the Integrated Return Conductor (IRC) will have a greatly diminished, or even no, magnetic field as both conductors are centred on the same axis of the cable. This type of cable may be considered ideal in respect of its magnetic signature and has been used for a twin monopole HVDC link between Scotland and Northern Ireland. However, the IRC cable type is not currently available for transmitting the level of power proposed for the Nemo Link, which will use instead a bipole system with two cables of opposite electrical polarity.

The Nemo Link cables will be installed in a bundled configuration, with nominal separation of 0.2 m. The resultant magnetic fields will be very low due to mutual cancellation of the positive and negative poles, and the time-varying component has been calculated to be insignificant.

Electric fields associated with marine cables

The HVDC voltage on the conductors of the Nemo Link cables produces a static electric field. The marine environment is shielded from this electric field by the lead sheath and other external metallic components of the cables, which are bonded to earth. For this reason, electric fields directly caused by the cable conductor voltages external to the cable will be insignificant.

Static and low-level, time-varying, electric fields are produced in the sea water around the cables by induction, principally by the sea water passing through the cables' static magnetic field in the same way as it does through the geo-magnetic field.

Very small electric fields are also produced in the water by the time-varying magnetic field resulting from the electrical 'noise' on the cables. The effects of these low-level fields are not considered to be significant.

The electric field situation is complex as the field strength around the cables is dependent on the cables' magnetic field strength and orientation, in absolute terms and relative to the geo-magnetic field, and time variable environmental factors such as water chemistry, viscosity and flow velocities. The time-varying fields will also serve to influence, however minimally, the resultant strength of the field.

The electric field produced in the cable's magnetic field will also be influenced by the natural electric field induced in the water by virtue of the earth's magnetic field at the same location. It is not possible

to accurately describe the electric field strength at a given location without a full understanding of the local environmental conditions. A study to estimate electric fields produced by the BritNed (SwedPower, December 2003) cable system (a similar system to the Nemo Link) was based on a maximal water flow parallel to a surface laid cable, which produces the greatest induction, and ignores any interactions with natural fields. The estimated field strengths are therefore based on ideal conditions for induction, which may rarely be achieved in the natural environment. Furthermore, these figures are for cables laid on the seabed. The magnetic field strength at the seabed will be reduced for the buried cables and the maximum possible electric fields strengths will be reduced proportionally.

The Nemo Link cable design eliminates direct electric field generation and, by minimizing the magnetic field generated by the Interconnector, the system configuration also minimizes electric fields induced in the marine environment.

Estimated magnetic and electric field strengths

Expected electric and magnetic fields from the Nemo Link have been confirmed by calculation as similar to those from BritNed, which were modelled for several different cable configurations (SwedPower, December 2003). The results of this work are summarized in Table 4-5. As can be seen from the table, both electric and magnetic fields are substantially reduced by bundling the cables together. Bundling is the “base case” cable configuration. Information on electric and magnetic field strengths are also given for 2m separation of cables, for comparison, although it is very unlikely that this cable configuration will be used. Absolute field strengths at 1m and 5m horizontal distance from the central axis of the cables along the seabed are presented for each cable configuration.

Cable configuration	Electric field strength ($\mu\text{V}/\text{m}$)		Magnetic field strength (μT)	
	1 m from cable	5 m from cable	1 m from cable	5 m from cable
Bundled (0.2 m separation)	61	1.9	72	2.2
Separated (2 m separation)	260	18	310	21

Table 4-5 : Electric and magnetic fields from BritNed.
Source: Swepower, December 2003

Note: The values above are calculated to be the maximum possible electric and magnetic fields to be produced by BritNed. Calculations are based on a sea water current speed of 0.85m/s, and a cable electrical current of 1,320 A.

Consideration has been given to the distance from the cables that the electric and magnetic fields generated by the cables can no longer be detected against the natural background fields. The electric and magnetic field contributions from each conductor decay by a factor equal to the reciprocal of the distance from the conductor. The net magnetic field at each point is the sum of magnetic field contributions from each conductor and the background earth’s geomagnetic field. For example, for the “base case” option (bundled cables), the magnetic field strength reduces to 0.5 μT at 8 m from the cables, representing only 1% of the typical strength of the earth’s magnetic field. This figure is for cables laid on the seabed; however, the magnetic field strength at the seabed will reduce proportionately as the cables are buried to greater depths.

Cable configuration	Electric field strength ($\mu\text{V}/\text{m}$)		Magnetic field strength (μT)	
	1 m from cable	5 m from cable	1 m from cable	5 m from cable
Bundled (0.2 m separation)	53	2.0	62	2.4
Separated (2 m separation)	266	21	313	25

Table 4-6 : Expected maximum electric and magnetic fields from the Nemo Link submarine cable.

Note: The values above are calculated to be the maximum possible electric and magnetic fields to be produced by the Nemo Link submarine cable. Calculations are based on a sea water current speed of 0.85m/s, 1 GW power transfer, +320 kV positive pole voltage, -320 kV negative pole voltage, a cable electrical current of 1,563 A, a burial depth of 1m and a seabed relative permeability of unity.

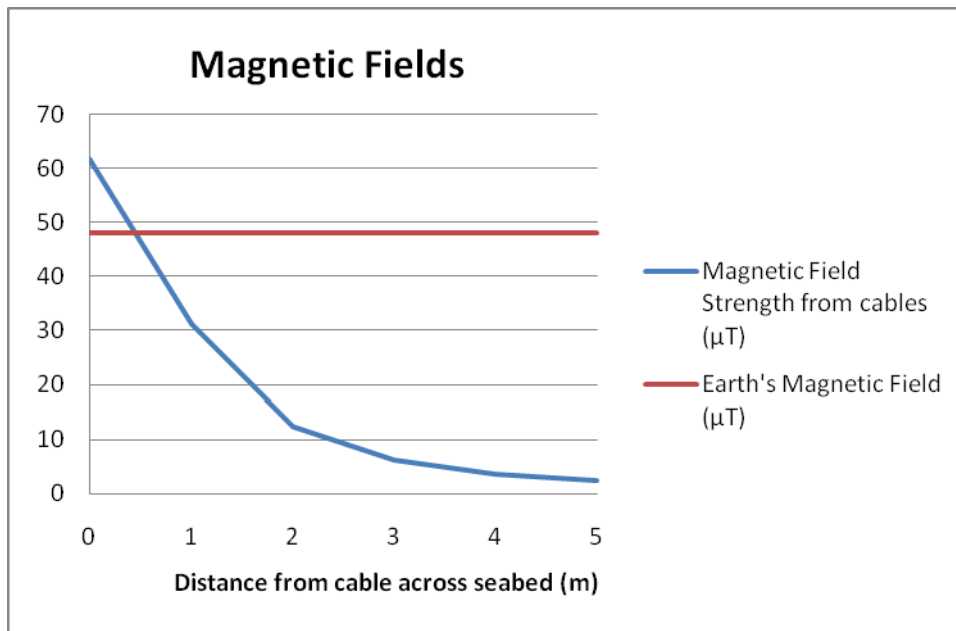


Figure 4-M : Maximum magnetic fields at seabed versus distance from the Nemo Link cable

4.7.3.2. Heat

In transporting DC electrical energy, losses occur as a consequence of the internal resistance in the conductor. This resistance is proportional to the length of the cables and inversely proportional to the cross-sectional area of the conductor (i.e. in this case the copper cable core). The energy that is lost is converted primarily into heat.

A study for the Nemo Link was undertaken in 2011 which uses thermal resistivity data collected during geotechnical survey of the cables route to calculate the impact of cable operation on the seabed temperature. In doing this, the following basic assumptions were used:

- Two bundled cables with a conductor cross-sectional area of 1440mm²;
- The temperature of the seabed is 17°C in the summer and 5°C in the winter;
- The heat production of the cables amounts to 70W/m in summer (with a conductor temperature of 70°C) and 66W/m in winter (with a conductor temperature of 55°C);
- Cable burial depth of 2.5m.

The calculations indicate the following:

- At a depth of 30cm below the seabed, localized heating directly above the cables amounts to a rise of 1.2 °C,
- At a depth of 10cm below the seabed, localized heating directly above the cables amounts to a rise of 0.7°C,

The 2.5m burial values detailed above could equate to a local rise in the seabed temperature in the topmost 30cm of sediment to a maximum of 18.2°C in the summer and 6.2°C in the winter. This is compared with a background summer maximum of approximately 17°C and a winter maximum of approximately 5°C. This heating effect would be very localised, only occurring in the sediment immediately surrounding the buried cables, and furthermore the seawater would be at background temperatures very close to the seabed surface.

4.7.3.3. Noise

No noise will be produced during operation of the cables; however, there are three main elements of the marine cable installation which will involve a degree of noise production. These are the offshore installation, shallow water installation and the land fall installation operations, where the cables are pulled ashore.

Offshore marine installation

The offshore installation spread is likely to comprise two vessels – one laying the cables and the second burying the cables. The offshore spread will typically be moving at a rate of 300m/hour on a 24 hour basis; therefore the noise caused by the installation at any one location will generally be transient and temporary. However, at joint locations the installation spread could be stationary for between 1 and 2 weeks. It is not possible at this stage to specify jointing locations but they are all expected to be some distance offshore.

A study into the noise emitted during subsea power cable installation was commissioned by COWRIE in 2003. During the installation of the cables at North Hoyle Offshore Wind Farm, measurements were made of the noise levels created by trenching of cables into the seabed. Levels were recorded at a range of 160 m from the trenching with the hydrophone at 2 m depth; this was necessary because, at the time the measurements were being made, the work was being undertaken in very shallow water. The sound pressure level of this recording was 123 dB re 1 mPa. The trenching noise was found to be a mixture of broadband noise, tonal machinery noise and transients which were probably associated with rock breakage. It was noted at the time of the survey that the noise was highly variable, and apparently dependent on the physical properties of the particular area of seabed that was being cut at the time. Analysis of the data indicates that if a Transmission Loss of 22 log (R) is assumed, a Source Level of 178 dB re 1 mPa @ 1 m results. Noise modelling undertaken using this source then indicates that, for distances up to 5km from the source, all of the measurements are below 70 dBht (with one isolated exception), and hence below the level at which a behavioural reaction would be expected. It is therefore expected that the impacts from cable laying noise will not be significant.

There are no anticipated emissions to air as a result of the cable laying operation.

Shallow water operation

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 in Pegwell Bay.

Background noise context

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.

Landfall installation

The landfall installation will be relatively static in its nature and is likely to take place in two phases: site preparation and the shore end cable installation.

The site preparation works will include the construction of a jointing pit to house the connection between the marine and land cables west of the sea defences and the drilling of two conduits under the sea defences. These operations will involve the use of various equipment including a horizontal directional drilling machine and excavation machines/vehicles and will take approximately three weeks in total to complete.

The shore end cable installation could take place any time after completion of the site preparation and conduit installation works and will involve the hauling ashore of the marine cables. This operation will involve the use of excavation machines, tracked vehicles and winches and could take up to two weeks to complete including preparation and remediation. The actual cable pull, where the cable vessel will

be laying relatively close to the shore, may take one or two days depending on factors such as weather and tidal conditions.

Noise associated with the landing will be largely confined to the vicinity of the sea defences, will be short term and generally occur during normal working hours. It is not anticipated that the installation operation will involve 24 hour working. However, it is possible that the pulling of the conduits into the bores drilled under the sea defences could run over one 24 hour period as this operation, once commenced, cannot be interrupted. Also the cable pull ashore may run over into a 24 hour period to take advantage of optimum weather and tidal conditions windows.

The operations will produce construction noise at, and close to, the sea defences and ship's machinery noise for a short period inshore and a longer period further offshore. In all cases the noise levels will not increase background levels significantly offshore and only to a limited extent for a short period onshore.

4.7.4. Rise of Earth Potential (ROEP)

Faults on cables (both sea and land) may occur when the insulation around the HV conductor fails due to internal breakdown or damage from external sources. Although faults are very rare, when the insulation does break down, a fault current flows and returns to the converter station earth mat, which is a metallic grid embedded in the ground under the converter station.

It should be noted the ROEP is a very short-term phenomenon which will disappear rapidly when the system shuts the link down after 150 milli-seconds (ms).

Most of the fault current flow will return from the point of damage to the earth mat via the cable lead sheath and steel armouring (which are bonded to the earth mat at the converter station). The remaining current flow will flow into the sea mass or the ground surrounding the cable fault, and return via the sea or seabed.

Calculations show that the temporary rise in the converter station earth mat potential may reach 800V (SwedPower, 2003b). However, for a member of the public to experience a shock it would be necessary for him to physically "bridge" the distance from a location external to the converter station and touch the earth mat (or connected apparatus). This is highly improbable, and therefore the public would not be at risk from faults occurring on the buried sea or land cables that cause to a transient ROEP. If any planned maintenance work is to be carried out on adjacent infrastructure on land, the placement of suitable earths will limit the spread of any transferred voltage and the use of insulating personal protective equipment will further reduce any risk.

If the ROEP area extends over adjacent infrastructure, such as pipelines, voltages up to 230V may be transferred to the infrastructure. However, touch and step potentials will not prove harmful if the minimum separation between cable and pipeline is maintained at greater than 1.7m (KEMA, 2003).

Stray electrical currents

For bipolar systems which do not utilize sea electrodes, and instead use 2 pole cables, the only situation in which stray currents could possibly occur is in the event of a cable rupture. In such an event the very high line voltage and currents will cause the fault to break down and a rapidly increasing fault current to flow. Any fault currents above 3 amps will be detected and cause a shut down within 150 ms (SwedPower, 2003b). This precludes the possibility of the prolonged circulation of low level fault currents.

4.7.5. Cable repairs

Cable repairs to correctly installed and protected submarine cables are infrequent but require operations which temporarily impact upon 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 third parties, typically caused by trawlers or commercial ships' anchors. Such damage may be localised or widespread depending on the energy of the interaction and the cable may be locally affected, mauled (where something is dragged with force along the cable for a distance) or dragged from the seabed.

A repair may be carried out by a single vessel. A shallow water repair, in less than 10 m of water, will typically be performed using an anchored barge. In deeper water, a dynamically positioned cable ship or barge 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 operational details and the exact configuration of a repair spread will depend on the type of repair and the contractors' facilities.

Typically the phases of a repair operation are as follows:

- loading of spare cable to the repair vessel;
- location of the damage;
- cable retrieval;
- cutting the cable
- cable recovery to the surface;
- repair of the cables;
- re-deployment onto the sea bed and re-burial.

Spare marine cable will normally be stored at the premises of the nominated repair contractor or a nearby port facility.

A repair invariably requires the insertion of additional cable 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.

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 that both cables might need to be repaired as a precaution against undetected damage. Alternatively the bundle would need to be recovered.

The extra length of a repaired short cable section means that the repaired cable cannot be returned to its exact previous position and alignment on the seabed. The excess cables will be laid on the seabed in a loop located to one side of the original route. The excess cables and first joint of a longer repair section can be laid 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. These operations are similar to those described above,

A cable repair operation will be expected to have a duration of several weeks or months, depending on the type and extent of damage and operational constraints.

4.8. Decommissioning

4.8.1. Introduction

The Nemo Consortium 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.

At the end of the cable's life the options for decommissioning will be evaluated. 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.

4.8.2. Extent of decommissioning

The objectives of the Nemo Consortium during the decommissioning process will be to minimize both the short and long term effects on the environment whilst making the sea safe for others to navigate. Based on current regulations and available technology, the Nemo Consortium proposes to perform the following level of decommissioning:

- Cable System – to be either removed or to be left safely in-situ, buried to below the natural seabed level
- Mattresses – to be left in-situ
- Scour protection material – to be left in-situ

The decommissioning aspects of the onshore works will be described in the relevant section of the onshore Environmental Statement for the project.

4.8.3. Retrieval of buried cables

Should cables be required to be removed from the seabed, the following operation is typical.

The first stage of the operation would be to expose a section of buried cable to either attach a gripper directly onto the cable or to install a cable “under roller” to de-bury the full length of the cable. This local cable de-burial operation would be undertaken using either a jetting device to expose a short section of cable or to use a grapnel tool to raise the cable to the surface. Various grapnel types are available, including de-trenching grapnels (the most likely form to be employed) and other more sophisticated cut and hold grapnels.

Once a section of the cable is exposed, there are then two alternative methods to de-bury the full length of cable. Providing cable “peel out” forces are not too excessive, a gripper could be attached to the cable to then lift a cable end back to the cable recovery vessel. Cable recovery could then proceed directly. Alternatively, a cable under roller could be used to run the full length of the buried cable. This device would be connected back to a vessel by a steel wire and raises the cable back to seabed level. Both schemes would ensure that a cable end is recovered back onto the cable recovery vessel. Cable recovery would then commence for the full cable length, or lengths would be cut and stored separately. The cable recovery process would essentially be the reverse of a cable laying operation, with the cable handling equipment working in reverse gear and the cable either being coiled into tanks on the vessel or guillotined into sections approximately 1.5m long immediately as it is recovered. These short sections of cable would be then stored in skips or open containers on board the vessel for later disposal through appropriate routes for material reuse, recycle or disposal.

When back in port, the cable recovery vessel would unload the cable onto the quayside.

The survey route would be surveyed to ensure that all cable had been removed. This survey would be provided as proof of removal.

4.8.4. Disposal / re-use of components

During the decommissioning of the assets wastes must be handled, stored and disposed of according to the following:

- UK waste management legislation

- Environmental best practice (i.e. the Waste Hierarchy)

The Waste Hierarchy is the nationally recognised approach to waste management and forms the basis of the UK Government's approach to waste management. The hierarchy is as follows in order of most-favoured to least-favoured option:

- Reduce
- Re-use
- Recycle
- Recover energy through incineration or from landfills
- Landfill without energy recovery

The three Rs below represent the most important waste options in the hierarchy:

- REDUCE Reducing waste saves both materials and energy, and removes the need and expense of disposal
- RE-USE Re-using minimises the need to buy new items, thereby saving resources
- RECYCLE This saves valuable raw materials and cuts down on waste collection and disposal costs.

At the time of decommissioning a waste management protocol will be drafted addressing the treatment of waste and its minimisation, re-use and recycling where possible, to reduce environmental damage, risks to health and safety, and address economic concerns.

4.8.5. Decommissioning programme

The decommissioning programme is expected to be similar to that during installation, and involve similar vessels and timescales to the installation phase.

4.8.6. Ongoing monitoring

No post-decommissioning monitoring of the seabed is proposed for this project.

5. Environmental Assessment Methodology

This section outlines the methodology that has been used to deliver the EIA of the proposed development and the subsequent Environmental Statement.

5.1. "Rochdale" approach to impact assessment

As with many large infrastructure projects, it is often impractical to provide full details of installation activities and the full specification of equipment at the time of the EIA. Such detail is dependent on a procurement of engineering options which will only commence once consent has been granted.

The 'Rochdale Envelope' provides a solution where there are good reasons why the details of the whole project are unavailable before consent is granted. Such an approach has been used under other consenting regimes (the Town and Country Planning Act 1990 and the Electricity Act 1989) where an application has been made at a time when the level of certainty as to the details of a project, have not been resolved. It has been successfully applied to most marine renewable energy projects, including all of the UK's Round 2 wind farms. However when the project details are deemed insufficient they potentially give rise to an impact greater than that which has been assessed. This was the situation considered in the cases of *R v Rochdale Metropolitan Borough Council ex p Milne* (2000) and *R v Rochdale Metropolitan Borough Council ex p Tew* (1999).

The approach is based on assessing the potential impacts of a "realistic worst case scenario", under which the assessment of the project is defined by an "envelope" of theoretical constraints. For example, although the burial equipment for cable cannot yet be specified, its "envelope" can be defined by a maximum footprint in respect to disturbance of the seabed (e.g. width of burial machine, width of burial trench and depth of burial). In this way the design of the project can vary within these maximum parameters without rendering the EIA findings invalid. Any subsequent consent would incorporate these parameters into its conditions, thereby ensuring that the scheme consented is that which has been assessed.

Where details of the proposed development cannot be finalised ahead of the submission of the Environmental Statement the Rochdale principle has been applied. The key aspects of the envelope are detailed below:

- A pre-lay grapnel run will take place prior to cable installation.
- Two cables will be installed, bundled in a single trench in the offshore and intertidal area.
- The cables will be installed by either a ploughing or jetting machine.
- Some pre-sweeping will be required to level the seabed prior to cable installation, estimated maximum quantities have been used to inform this EIA.
- Trenching (as opposed to directional drilling) will be used to install the cables in the intertidal area.

5.2. Impact assessment process and guidance

The sections below outline the method used to undertake the study and reporting of the EIA.

The impact assessment has been carried out taking into account the guidance provided by the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS) in 2004 - CEFAS (2004). Guidance notes for EIA in respect of FEPA/CPA requirements. (Version 2 - June 2004). Although the project does not constitute EIA development the explanatory memorandum to The Marine Works (EIA) Regulations 2007 No. 1518 prepared and issued by DEFRA has also been taken into account as appropriate.

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

5.3. Baseline environment

The baseline environment for each topic considered will be described within the Environmental Statement based on available data and information. Section 2.4 above details the primary data collected.

The data collected has been supplemented with relevant available information and literature from public bodies (e.g. CEFAS, JNCC and Natural England), government initiatives (e.g. the offshore Strategic EIAs), similar and proximate projects (e.g. Thanet Offshore Wind Farm and the BritNed project) and other relevant literature. The Appraisal of Sustainability associated with the Marine Policy Statement will also be taken into account in describing the baseline environment as appropriate (HM Government *et al*, 2011).

5.4. Identification of environmental impacts

The scoping report and associated consultee responses identified all anticipated environmental impacts. The impacts described in Chapters 6 to 8 of this ES have been identified based on a review of the likely interactions between the proposed development activities and the physical, biological and human environment.

5.5. Assessment of environmental impacts

This section describes the method of EIA used to determine the significance of the effects of the installation and operation of the marine cable system.

Each potential impact and associated receptor identified during the EIA scoping exercise has been assessed in an impact assessment matrix that takes into account the assessment method details below. The matrix can be found in Appendix 6 – Assessment of Impact Significance.

5.5.1. Nature of effect

The magnitude of the effect has been assessed using the following criteria:

- 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 from baseline conditions taking into account known information on natural variation
- Duration – the length of time over which the impact may occur

Effect Factor	Classification	Definition	Score
Likelihood	Certain	Will occur as a result of the project	100
	Possible	Likely to occur	10
	Unlikely	Not likely to occur	1
Spatial Extent	Regional	Regional to national/international (e.g. entire English Channel)	100
	Local	Within range (few km) of the source of impact	10

Effect Factor	Classification	Definition	Score
	Immediate vicinity	At source of impact only	1
Level Change of	High	Large change compared to natural variations in baseline	100
	Medium	Change will or may be noticeable/measurable against the natural variation in the baseline	10
	Low	Change will not be noticeable/measurable against natural variation in baseline	1
Duration	Long-term	Effect will occur for >5 years	100
	Medium-term	Effect will occur for between 6 months and 5 years	10
	Short-term	Effect will occur up to 6 months	1

Table 5-1 : Effect factor classification and definition

Using the criteria above an impact has been given a value of magnitude using the scoring system below. For example, for a long term effect that will definitely occur, at a regional scale with a large change from the baseline the score is 400. The Magnitude (Severe, Moderate or Low) of the effect has been determined using the thresholds below (:

Magnitude of Effect	Score Threshold
Severe	400 - 211
Moderate	202 - 22
Low	13 - 4

Table 5-2 : Magnitude of effect score thresholds

5.5.2. Description of receptor

In order to identify the level of impact on each receptor or feature the following has been described:

- Sensitivity – the sensitivity or tolerance of the receptor to the effect
- Recoverability – how rapidly the receptor recovers to baseline state following effect
- Importance – Receptor's importance in terms of its occurrence in the UK, its national/international significance and its conservation or commercial value

Receptor Aspect	Classification	Definition
Sensitivity	High	Receptor or feature is highly sensitive to effect and will be detrimentally damaged (in ecological terms killed/destroyed) by effect
	Moderate	Some damage may occur to the receptor or feature
	Low	Some minor damage to receptor or feature
Recoverability	Low	No recovery
	Moderate	Recovery to baseline conditions within years

Receptor Aspect	Classification	Definition
	High	Recovery to baseline conditions within weeks or months
Importance	High	Receptor is either rare, and/or significant in conservation or commercial terms
	Moderate	Feature is significant but not rare
	Low	Receptor is neither rare or significant in conservation or commercial terms

Table 5-3 : Receptor aspect classification and definition

Using the general criteria above a Receptor Value can be determined. The definition of Value (High, Moderate, Low) will vary between topics, and these criteria have been defined specifically in each relevant topic section. An example is given below for recreation and tourism.

Receptor Value	Definition
High	Damage or loss of an area of national or international importance for tourism, recreational activity or amenity. The area will not recover.
Medium	Damage or loss of an area of regional importance for tourism, recreational activity or amenity, the area may not recover. Temporary disturbance to sites of national or international importance.
Low	Small-scale, temporary disturbance to sites identified as being of regional, national or international importance to tourism. The area will recover.

Table 5-4 : Receptor value definition

5.5.3. Impact assessment

The impact significance is a function of the Magnitude of the effect and the Value of the receptor, as illustrated below.

		Value of Receptor		
		Sensitivity	High	Medium
Magnitude of effect	High	Significant	Significant	Moderate
	Moderate	Significant	Moderate	Minor
	Low	Moderate	Minor	Negligible

Table 5-5 : Determination of impact significance

Where an impact cannot be fully quantified due to its complexity or subjective nature, a subjective scale based on professional judgement has been used. Where this is the case the basis for this judgement has been outlined.

The significance of each impact is assessed as being minor, moderate or major. Impacts of 'major' or 'moderate' significance are considered to be 'significant' in EIA terms. Potential impacts may be positive (beneficial) or negative (adverse).

5.5.4. Cumulative impacts

Cumulative impacts with other cable projects and of the proposed development with other regulated human activities in the marine environment are assessed and reported on in Section 9.

6. Physical Environment

6.1. Geology

This section describes the geology along the potential cable route, and the potential impacts of the proposed development upon geological issues.

6.1.1. Baseline data sources

The information used for describing the geological environment was obtained from a variety of sources. These included:

- British Geological Survey United Kingdom Offshore Regional Report 1992. The Geology of the southern North Sea.
- British Geological Survey (BGS) data on surface sediments, supplied by SeaZone as GIS layers
- BGS reports on the geology of the North Sea (Cameron *et al.*, 1992)
- Futurecoast (2002) which includes geological information for the UK coastline
- Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI) citation
- Sediment data from geophysical survey carried out by MMT between August and October 2010
- Royal Haskoning (2005) Thanet Offshore Windfarm Environmental Statement
- Several journal papers and reports provide evidence about geology of the area surrounding the proposed cable route (see references).

6.1.2. Baseline

6.1.2.1. Geology description

The southern North Sea is a shallow shelf sea that is dominated by a deep channel in the west, connected to the Strait of Dover, flowing into the English Channel that eventually connects with the Atlantic Ocean in the south. Holocene sediments in the North Sea are generally present as a thin veneer of mainly sand and gravels, which cover earlier Pleistocene (or older) sediment formations (Cameron *et al.*, 1992). However, in the area of the proposed cable route, there are sediment accumulations in the form of tidal sand ridges (sandbanks) where the Holocene sediments can be up to 30 m in thickness (see Figure 6-1-1). Other exceptions to this, elsewhere in the North Sea, are scour hollows/palaeovalleys.

Sand ribbons, sandbanks and sand waves are common features in the southern North Sea. Although the water is shallow enough for wave-induced currents with sufficient strength to move bottom sediments, these are considered to be of minor importance when compared to the stronger and more regular tidal streams (Cameron *et al.*, 1992). Sand ribbons and sandbanks are longitudinal bedforms parallel or subparallel to the dominant flow, whereas sand waves are flow-transverse bedforms.

The offshore sandbanks are considered to have formed relatively early in the Holocene period as the sea transgressed through the Dover Strait. The Goodwin Sands are believed to be banner period sandbanks formed in the lee of the headland of North Foreland. Sandy sediments dominate over much of the offshore area and much of the sand is mobile under current hydrodynamic conditions and therefore its distribution relates to modern sand-transport processes.

The preferred proposed UK landfall area lies in the embayment of Pegwell Bay, just to the south of Ramsgate, Kent. The sediments in this area are composed of superficial Pleistocene sand and gravel

deposits, which are overlain by marine and estuarine alluvium. The marine alluvium comprises fine grained grey and brown sands with local silty clays and abundant marine shells. The depression which underlies Pegwell Bay may have been initiated by drainage from the Thames estuary into the English Channel during a period of lower sea levels in the early Holocene (Futurecoast, 2002).

To the north of the landfall location, the Thanet Sand Formation is exposed at the cliff face (Pegwell Bay cliffs) with an overlaying layer of Head Brickearth. The Thanet Sand Formation contains a diversity of fish fossils, representing the assemblage of species which were destroyed by volcanic action in the North Sea area, when ash fall caused an extinction event. These fossils consist of disarticulated fish debris, including a diversity of identifiable shark teeth. They are considered in the Sandwich and Hacklinge Marsh SSSI citation as being of “very great significance”.

The citation for Sandwich and Hacklinge Marsh SSSI says “Pegwell Bay is also the most important site for loess studies in Britain. The section shows up to 4 m of Devensian loess overlying Upper Chalk and Thanet Beds. The loess, an accumulation of wind-blown dust produced under periglacial conditions during the Ice Age is probably thicker here than at any other site in Britain, and is certainly the most closely studied example. Although leached in its upper part, the loess is calcareous below, with rootlet tubes and small concretions. Where the loess rests on the Chalk, there is often a highly frost-shattered zone with well developed involutions. In one part of the section where an infilled channel is cut into the frost-shattered chalk, the loess overlies chalky-flinty gravels and loams produced by solifluction. Pegwell Bay provides the best exposures of true loess deposits in Britain. They are exceptional in having escaped modification by solifluction; no other site provides such useful sections in highly calcareous loess that has not been reworked.”

The geology of Pegwell Bay to the south of the preferred landfall location is characterised by marine beach deposits and tidal flats. Inland, the surface deposits are marine and estuarine alluvium, comprising mainly of silty clay, which overlay the Thanet Sand Formation, which in turn overlies chalk.

The proposed cable route runs approximately east-west from Pegwell Bay to Zeebrugge, Belgium. Immediately east of Pegwell Bay, the surface sediments consist of sands and muds, followed by a chalk exposure area between The Brakes. The proposed route then passes through a sandy area to the north of Goodwin Sands. Further east the surface sediments are gravels, sands or sandy gravel. Some of these gravel areas consist of a silty chalk formation, that was clarified during the geophysical survey carried out by MMT between August and October 2010. South Falls is a linear sand bank/ridge approximately 28 km east of Pegwell Bay. To the east of this bank, numerous small sediment features are present and the sediments consist of sands and gravels and include a further area of silty chalk.

Published marine surface sediment types are shown in Figure 6-1-2 on the following page.

6.1.2.2. Seismic activity

In the UK the understanding of seismic events has predominantly been based on historic data due to the low rate of earthquake occurrence. Musson (1996) identified the area of the Dover Strait as being significant since two of the UK’s largest earthquakes occurred there in 1382 and 1580 (Richter local magnitude $\approx 5.8 M_L$). Musson suggests that the area may be structurally continuous with a zone of activity running east through Belgium and therefore, stress in this region has been released further east. Musson also considers that there may well be another large event in the future.

Seismic activity offshore in the North Sea has been linked with graben (a downthrown block between two parallel faults) systems and structure. Musson *et al.* (1997) reported on studies carried out in 1992. These studies suggest that for the whole North Sea area the likely return period for earthquakes with a magnitude of $4 M_L$ is around two years and for magnitude $5 M_L$, every fourteen years. For larger period return events there is more uncertainty, although $6 M_L$ return period events are predicted at around 130 year intervals. However, historical records show only three events in the last 900 years (Musson *et al.*, 1997). This may be due to missing data, a decrease in the frequency in the return period of $6 M_L$ events, or that such events represent a near maximum magnitude for events in this

area and thus the magnitude-frequency curve is tapering off. This latter explanation is considered the most likely explanation (Musson *et al.*, 1997).

EQE International (2002) state that in the southern North Sea the peak ground acceleration hazard is less than that in the northern North Sea where the analysis shows the highest value. These values were obtained from a map of seismic hazard offshore, which was generated using a seismic hazard computation on a regular spatial grid of individual sites, with an approximate mesh size of 50 km x 50 km. The 10^{-4} /yr exceedance peak ground acceleration can reach values of almost 25%g (2.5m/s^2) in the southern North Sea (EQE International, 2002).

6.1.3. Description of potential impacts

The table below shows how sensitivity, recoverability and importance of the geology crossed by the cable route have been considered in determining significance of effect.

Receptor Value	Definition
High	Area with unique, unusual or rare geological interest, that contributes to the scientific understanding of geological processes. If damaged, there will be a permanent loss to the integrity of the geology.
Medium	Area with uncommon geological interest, that contributes to the scientific understanding of geological processes. Extensive enough that damage will only impact a small percentage, such that the integrity of the geology will be preserved.
Low	Area of commonly encountered geology. Changes will not result in any loss to the scientific understanding of geological processes or any loss to geological integrity.

Table 6-1-1 : Definition of receptor value

6.1.3.1. Cable Installation

The most sensitive geological feature in the vicinity of the proposed cable route is the landfall location in Pegwell Bay on the UK coast. The geological interest features listed in the Sandwich Bay to Hacklinge Marshes SSSI citation are identified in the impact assessment matrix as being of high value and that there is potential for severe impact, in the worst case scenario. Should the cliffs at this location be trenched through, during cable installation, it is considered that irreversible damage would be caused.

Various sandbanks along the route will also be impacted as their crests will be dredged during the pre-sweeping operation. It is proposed that the dredge trench will vary depending on the shape and size of the features to be crossed. The greatest width of the trench is anticipated to be 20 m wide at the base, with side slopes of 10 m width on either side and an overall depth of 2 m. Studies have been carried out to determine whether these features would be altered or how long the trench will persist after dredging (see Appendix 7). The studies revealed that the features would not suffer any permanent alteration and that the trench would infill within a matter of weeks. This impact is therefore considered to be **minor**. Further information regarding these studies and a discussion of these features, is contained within the Chapter 6.2 - Bathymetry and Seabed Processes.

6.1.3.2. Cable Operation

The cabling through the landfall route will be buried at a nominal depth of 2 m. It will be insulated and protected with steel armouring in the cable design to ensure that maintenance requirements are reduced and kept to a minimum wherever possible. Should maintenance works be required, then local and temporary disturbance would occur, but these would be kept within the original installation area as far as possible. Therefore, **no impacts** to underlying geology are anticipated during the operation phase of the new cable.

6.1.3.3. Decommissioning

Should the cable system require removal at the end of its operational life, it will be removed through the same soils and sediments disturbed during installation. It is anticipated that the working areas for removal will also be restricted to the area used for installation. Therefore, **no impacts** to the underlying geology are anticipated during the decommissioning phase.

6.1.4. Mitigation

Six options for the landfall location were considered prior to the scoping stage, with only two being taken forward into the scoping assessment report. Discussions with Kent Wildlife Trust, who are considered to be the stewards of the Pegwell Bay area, and responses to the scoping report by the relevant consultees (see Appendix 2), indicated that the favoured landfall route will follow a similar course to the Thanet Offshore Wind Farm electricity export cable. It is therefore considered that the area of disturbance through the geology will be minimised. This location also avoids the indicated area of high geological interest, cited in the Sandwich and Hacklinge Marshes SSSI documentation.

An installation methodology that ensures the geological exposures of interest are not affected will be used during all installation activities to minimise impacts wherever possible. The working area of the cable route will be demarcated with fencing to ensure that installation, construction plant movements and any storage is kept away from the SSSI.

6.1.5. Residual impact

The choice of installation route close to the area utilised by the Thanet Offshore Wind Farm electricity export cable, will reduce the impacts on the geology to a **minor** level, as the highly sensitive and important geological exposure identified in the Sandwich Bay and Hacklinge Marshes SSSI citation will be avoided. The geological sensitivity of the subsea portion of the proposed cable route is low and mobile sandbank features are predicted to recover quickly, resulting in a **negligible** impact. **Minor** impacts are predicted in the areas where the cable goes through chalk outcrops, as the impact is very localised and the receptor value is low.

6.1.6. References

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6.2. Bathymetry and Seabed Processes

This section describes the bathymetry and sea bed processes along the cable route, and the potential impacts of the project upon sea bed processes.

6.2.1. Baseline data sources

The information used for describing the baseline bathymetry and sea bed environment was obtained from a variety of sources. These included:

- Marine hydrographic data from Seazone describing the bathymetry of the southern North Sea based upon surveys between 2009-2011.
- Bathymetry data from a geophysical survey carried out by MMT between August and October 2010 (see Appendix 7)
- Marine hydrographic data from the UK Hydrographic Office
- FutureCoast (2002), which describes sediment transport pathways along the UK coast and some distance offshore
- Isle of Grain to South Foreland Shoreline Management Plan (South East Coastal Group, 2007), which contains descriptions of sediment transport processes around the UK landfall
- The Southern North Sea Sediment Transport Study (HR Wallingford, 2002), which provides modelled sediment transport pathways in the southern North Sea
- The MAREBASSE reports (Van Lancker *et al.*, 2007), which provides modelling results of sediment transport for the Belgium Continental Shelf
- Several journal papers provide evidence relating to sediment movement and sand waves, especially on the Flemish Banks (see references)

6.2.2. Baseline

6.2.2.1. Bathymetry

The marine cable route proposed between Richborough and Zeebrugge is described in terms of its bathymetry from the proposed landfall area in the embayment of Pegwell Bay, south of Ramsgate, across to the median line between the UK and France (see Figure 6-1-1).

The proposed route crosses north of the shoals at Cross Ledge before crossing the Gull Stream channel (approximately 14 m water depth), and onwards to a shallow area to the north of Goodwin Knoll (4 – 8 m depth). The Goodwin Sands are highly mobile and the 2009-2011 surveys undertaken by the UK Hydrographic Office (UKHO), demonstrate that the bathymetry of this area has altered significantly in the last six years. East of the Goodwin Knoll, the seabed drops rapidly to a maximum depth of around 55 m, before rising to approximately 10 m at the South Falls bank. The South Falls bank potential sand mobility poses more of a risk to commercial navigation than the Goodwin Sands and for this reason is surveyed by UKHO annually. East of South Falls, the depth falls to an average of around 30 m for the next 50 km. This area is not smooth and contains several sandbanks, varying in height between 3 and 10 m along the proposed cable route. □

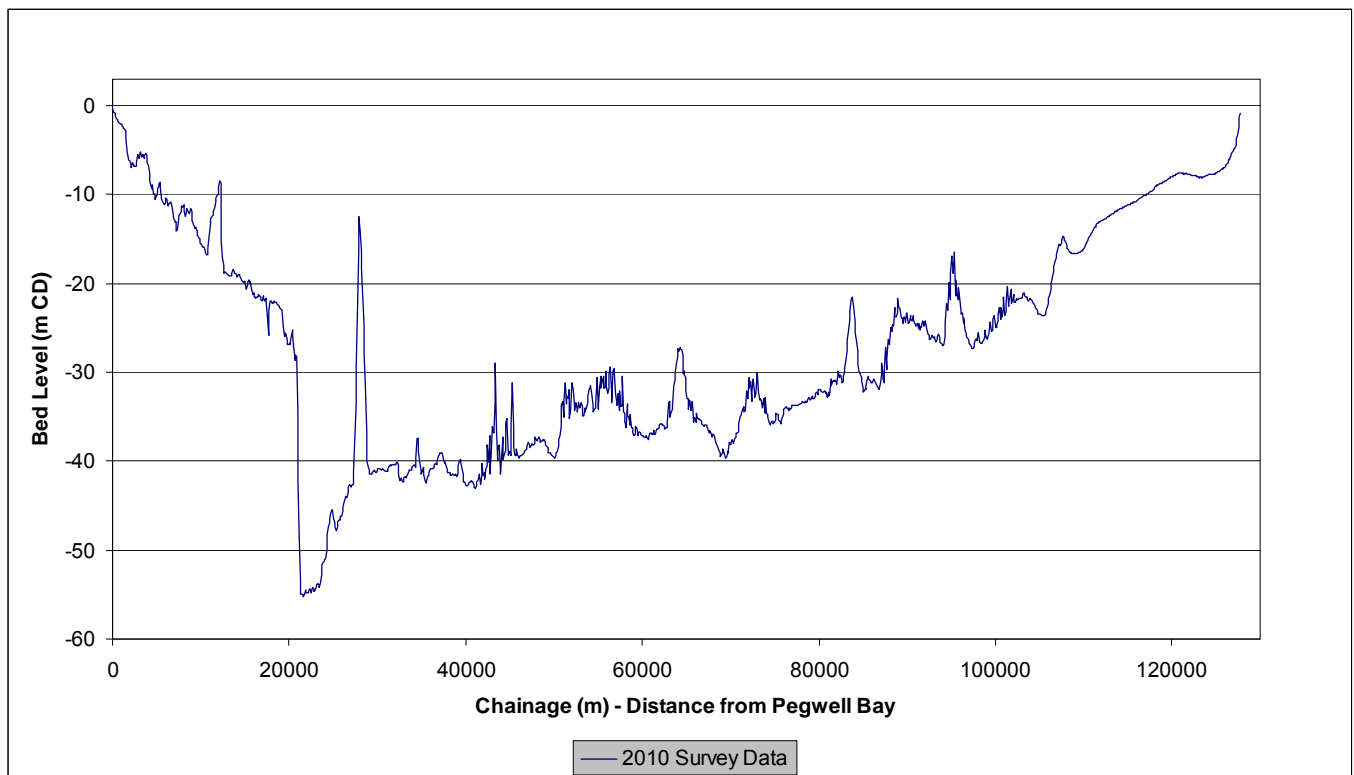


Figure 6-2-A : Profile of cable route interpolated from detailed bathymetry collected during the geophysical survey

A full bathymetric survey of the route was carried out by MMT as part of the overall geophysical survey. High-resolution bathymetric data was collected using a Kongsberg EM3002D Multibeam echo sounder, with data recorded using Kongsberg SIS software. Sound velocity profiles were measured using Valeport SVP SVX2 at regular intervals when needed, to maintain correct depth measurements. This high-resolution data revealed several sand wave fields, each stretching across several kilometres of the survey path. The path of the surveyed route is shown in Figure 6-1-1.

6.2.2.2. Metocean conditions

Hydrographic and meteorological conditions are important for determining sediment transport in the marine environment. Across the continental shelf, tidal currents are primarily responsible for the movement of sediments. However, during storm events, waves may be large enough to have an impact on sediment transport, through the effect of waves (stirring sand from the bottom) acting in combination with tidal currents. Even in deeper water, storm wave action will tend to flatten bedforms. At the proposed landfall locations, waves may also be significant due to the shallower depth which enables wave effects throughout the water column. This can cause changes in sediment transport, leading to beach profile and volume changes and the resuspension of muddier sediments.

Tidal range in this part of the North Sea is approximately 4.8 m on spring tides, reducing to approximately 2.7 m on neaps. Peak current velocities reach between 1 m/s and 1.5 m/s in the proposed cable route area of the North Sea (ABPmer, 2007; MUMM GIS data). This reduces towards both coasts, with typical coastal values of 0.75 m/s to 1 m/s. Pegwell Bay is relatively sheltered from tidal currents and the peak spring flow experienced at this location is less than 0.5 m/s (ABPmer, 2007). The HR Wallingford flow model of the North Sea shows good agreement with these peak velocities (Figure 6-2-B, which shows flow direction vectors and is colour coded for current speed).

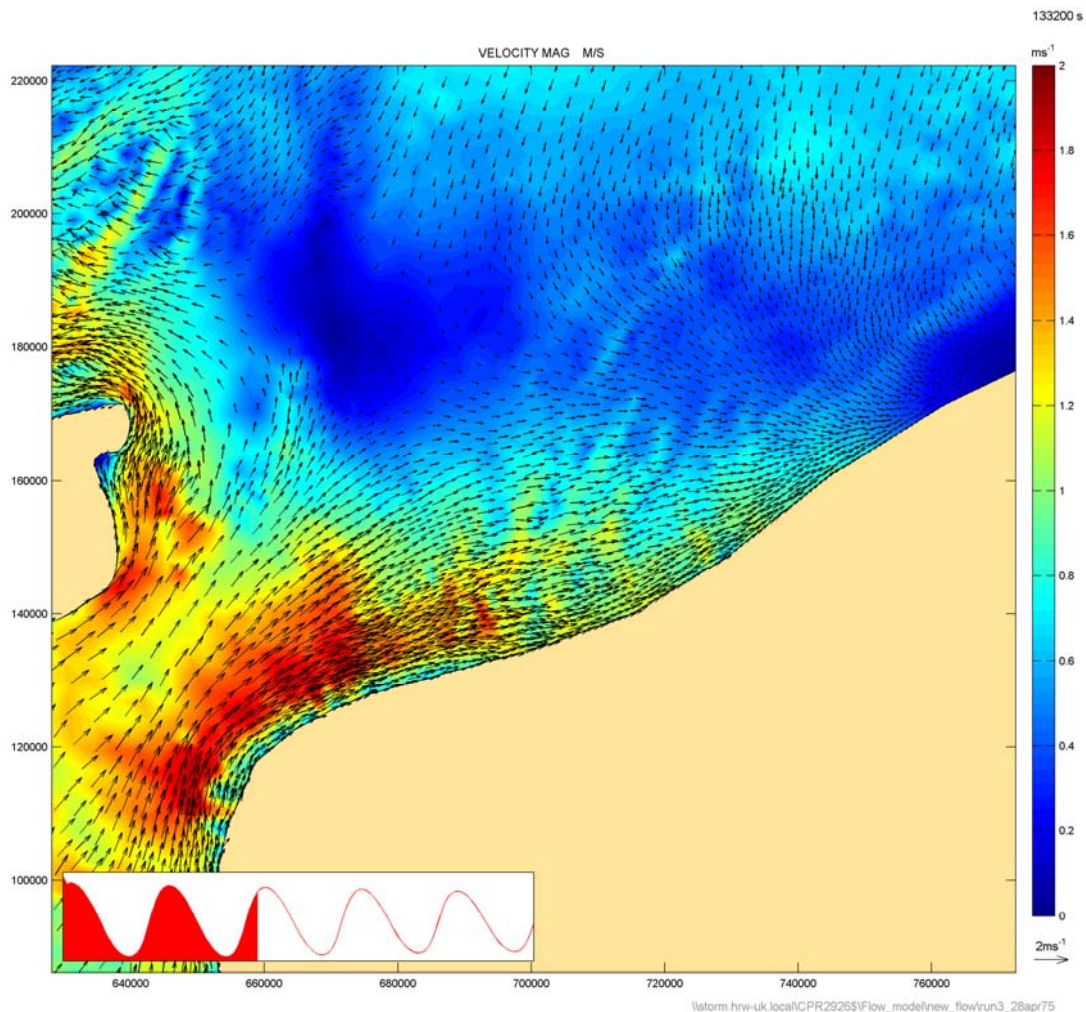


Figure 6-2-B : Flood tide current velocities from HR Wallingford North Sea flow model

Current velocities around the Flemish Banks have been studied by Lanckneus and De Moor (1990, 1995) and Williams *et al.* (1996). At Kwintebank, the tidal currents recorded were 0.7-0.8 m/s on springs and 0.5-0.6 m/s on neap tides (Lanckneus and De Moor, 1990). At Middelkerke Bank, currents along the crest were reported to be up to 0.8 m/s, and up to 0.6 m/s in the troughs.

ABPmer (2007) quotes a mean annual wave height of 1.25-1.5 m offshore from the UK coastline. This decreases to less than 0.75 m in Pegwell Bay. FutureCoast (2002) suggests that over a ten year period, around 10% of waves exceed 1 m in height at Sandwich Bay, just south of the UK landfall. Wave periods recorded at this location were generally between 4 and 6 m/s.

At Middelkerke Bank, less than 10% of wind waves generated produced significant wave heights exceeding 2 m (Williams *et al.*, 1996). During poor weather conditions, wave heights of up to 5 m, with a period of 9 s, were measured. Swell waves were not observed for much of the study period, but occasionally long period (20 s) /low amplitude (0.75 m) or short period (10 s)/ high amplitude (2 m) swell waves were recorded (Williams *et al.*, 1996).

ABPmer (2007) quotes a mean annual wind speed of 9-9.5 m/s offshore. This decreases to 7.5-8 m/s close to the coast. HR Wallingford (2002) used westerly winds of 10 m/s to represent the winter wind conditions in model set up for the North Sea and the Southern North Sea Sediment Transport Studies. At Middelkerke Bank, winds are predominantly from the south to west and peak speeds of more than 36 m/s have been observed from this direction (Williams *et al.*, 1996).

6.2.2.3. Seabed processes

The presence of sand banks along the proposed cable route generates complex sediment transport pathways in certain regions. Sand waves are found on the sandbanks and in the swales, indicating active sediment transport across much of the seabed. Some of these have been studied in detail so that locally, sediment transport patterns are well described. Sandbanks located off the north Kent coast are believed to influence coastal processes and sediment transport patterns, and sand from these banks feeds onshore, naturally replenishing the sand beaches along the Thanet coast. On the east coast sandbanks are believed to exert a key control on the wave climate and sediment pathways. Goodwin Sands, located between 4 and 12 km offshore Deal, is the most notable for these effects. The series of natural shallow sandbanks are maintained by the tidal currents of the area (Deal to Kingsdown Strategy Study, 2001) and serve as a division between the offshore wave climate and the inshore wave climate.

Modelling studies (e.g. HR Wallingford, 2002; FutureCoast, 2002; Van Lancker *et al.*, 2007) suggest that sediment transport is generally northward along both the UK coast and the French/Belgium coast, but is directed southward in the deeper water through the Straits of Dover. Sediment transport along the UK coastline is directed southward to the north of Pegwell Bay and northward to the south, resulting in a drift convergence at the UK landfall site (South East Coastal Group, 2007). As a result of this drift convergence, fine sediment tends to accumulate at Pegwell Bay as transport of sediments slows. Sediment transport is northward between Pegwell Bay and Goodwin Sands, turning eastward over the shoal and directed south further offshore (HR Wallingford, 2002; FutureCoast, 2002).

To further assess the potential sediment transport patterns in the vicinity of the cable route, several sediment transport simulations were carried out. Potential sediment transport rates are the rates that would occur in the case of abundant availability of sediment of the considered median grain size. Actual sediment transport rates may be reduced due to limited availability or in the case of sediment mixtures where finer fractions are sheltered by coarser fractions. Hence, in the absence of detailed particle size distribution information throughout the model domain, and of suitable data to calibrate the model predictions against, the model results should be seen as indicative and, in particular regarding predicted quantities, should be interpreted whilst keeping these uncertainties in mind. A full report of the modelling can be found in Appendix 7.

For these sediment transport simulations it was considered that the simplifying assumption of a uniform median grain size (d_{50}) of 400 μm would be justified for the purpose of demonstrating typical sediment transport patterns in the study area. In addition, a sensitivity test was conducted with a smaller median grain size of 250 μm . Given that the median sediment grain size along the European mainland coastline is generally smaller than that in the deeper areas and along the English coast, the results of the simulations with the smaller grain size of 250 μm could be more representative in that area, whereas the model results based on the coarser 400 μm sand would be a better indication for potential sediment transport along the shallow area of the English coast. The fact that coarser gravels are indicated to be present in this area would suggest transport rates would be smaller than those presented.

The model used to provide these simulations was SANDFLOW, which is the non-cohesive sediment transport model developed by HR Wallingford for use with the TELEMAC system. SANDFLOW uses the flows calculated by TELEMAC-2D to study the transport, deposition and erosion of non-cohesive (sandy) sediment and thereby identify areas of potential siltation and erosion. The model (Figure 6-2-C) was driven with tidal flows resulting from simulations made with the tidal flow model, which was used to simulate tidal flows over a neap-spring-neap cycle. In addition, a sensitivity test was conducted for a representative case with moderate waves approaching the study area from the northeast. A wave model was set-up for this purpose, using the same model mesh and bathymetry as the flow model. The wave orbital velocities resulting from the wave model were then input, together with the tidal flow fields, into the sediment transport model. Strong orbital velocities will stir up sediment which is subsequently advected by the ambient tidal current.

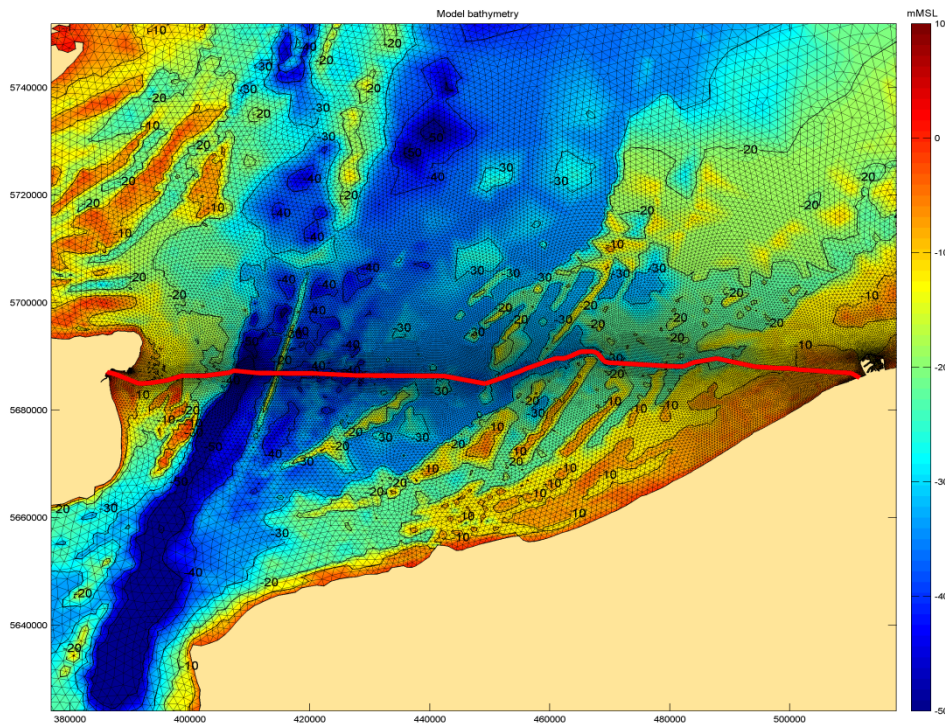


Figure 6-2-C : SANDFLOW Model bathymetry and mesh – near cable route

The resulting instantaneous sediment transport patterns, assuming abundant, uniform 400 μm sand at the same points in time, suggest that the largest potential transport rates occur off the English coast to the south of the cable route, gradually reducing to the north. During peak spring ebb the predicted potential transport rates decrease towards the European mainland coastline, whereas during peak spring flood there is less transport capacity north of the cable route near the English coast and increased rates along the French and Belgian coastline. The model predictions for spring tides, when the maximum potential transport patterns were observed, are shown in Figures 6-2-D and 6-2-E. The plots show the vector of transport and are colour coded to show the predicted magnitude.

The potential transport patterns predicted for a median grain size of 250 μm are similar to those predicted for 400 μm sand, but the magnitude of the fluxes is increased. The smaller grain size material is more easily entrained by the imposed flow conditions and therefore leads to an increase in potential transport. Comparison of the model output patterns to those showing the residual fluxes for the coarser material confirm the previously mentioned increase in potential transport magnitude along similar patterns. The model predictions for spring tides, when the maximum potential transport patterns were observed, are shown in Figures 6-2-F and 6-2-G.

In addition to the instantaneous transport patterns, the predicted sediment fluxes were integrated over a full tidal cycle to produce residual transport patterns for both grain sizes. Figures 6-2-H to 6-2-I indicate a net southward potential transport along the deeper central area toward Dover Strait and net northward and eastward fluxes along the English and European mainland coastline, respectively, over the spring tide. Over the neap tide the residual fluxes are northward throughout, and are much smaller and limited to the area in the vicinity of Dover Strait.

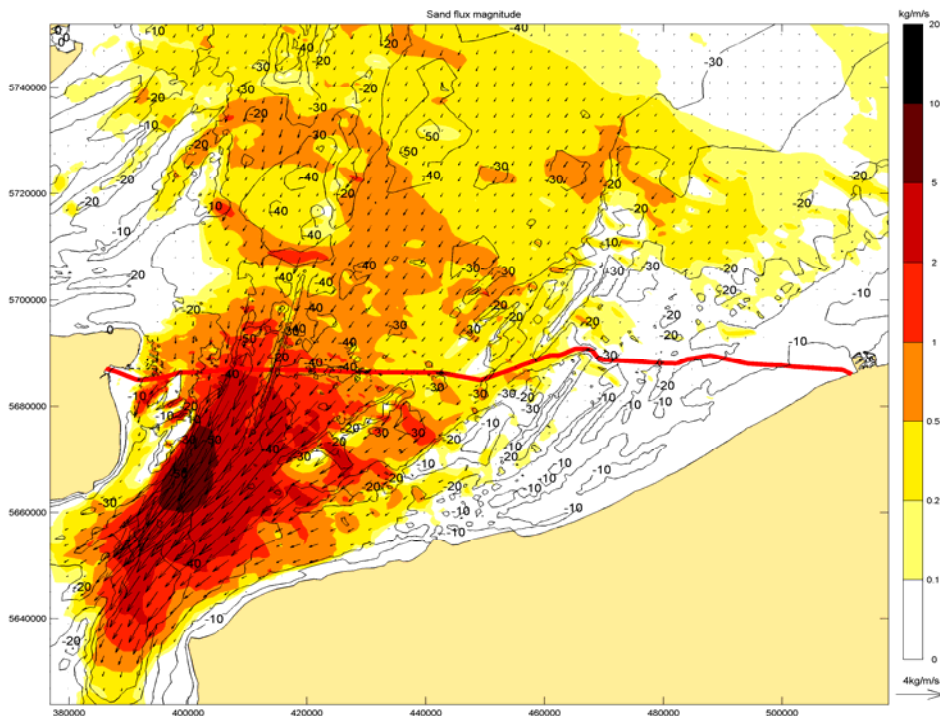


Figure 6-2-D : Peak ebb sand transport rates – Spring tide, 400 µm sand

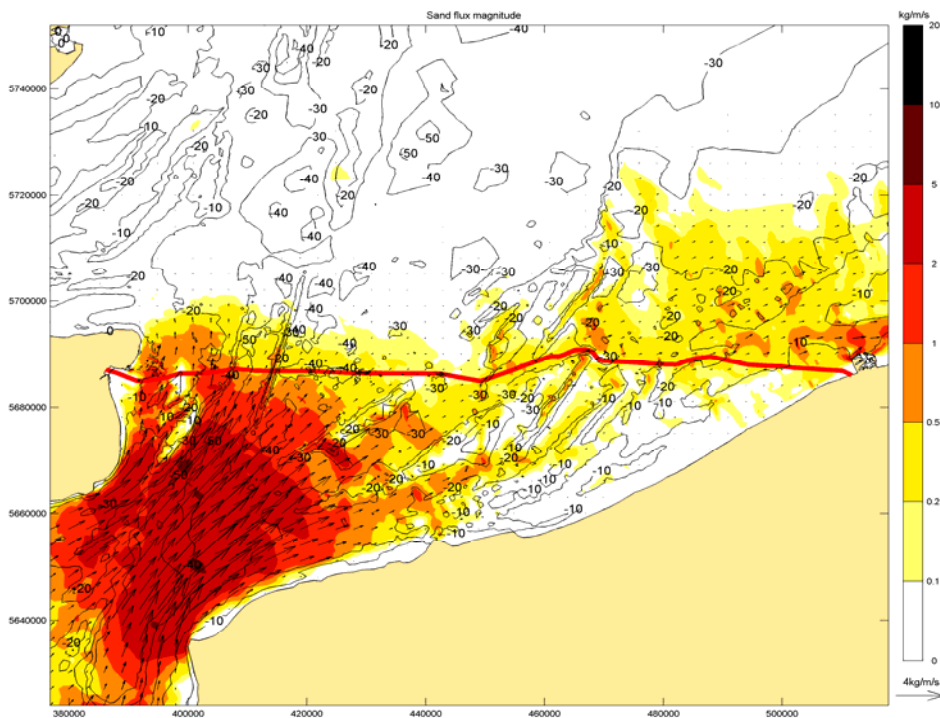


Figure 6-2-E : Peak flood sand transport rates – Spring tide, 400 µm sand

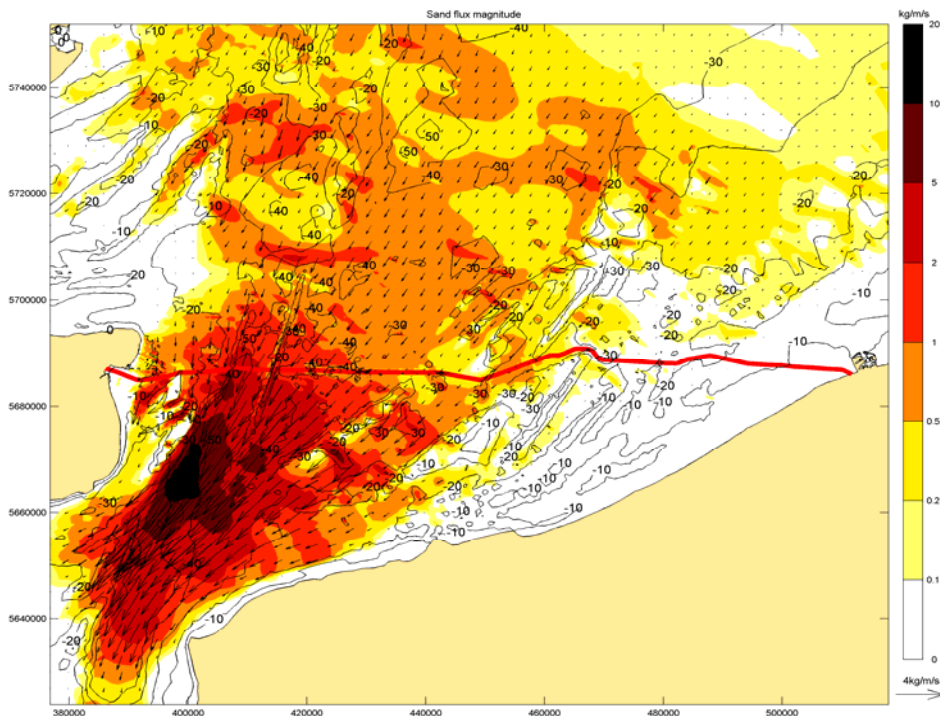


Figure 6-2-F : Peak ebb sand transport rates – Spring tide, 250 µm sand

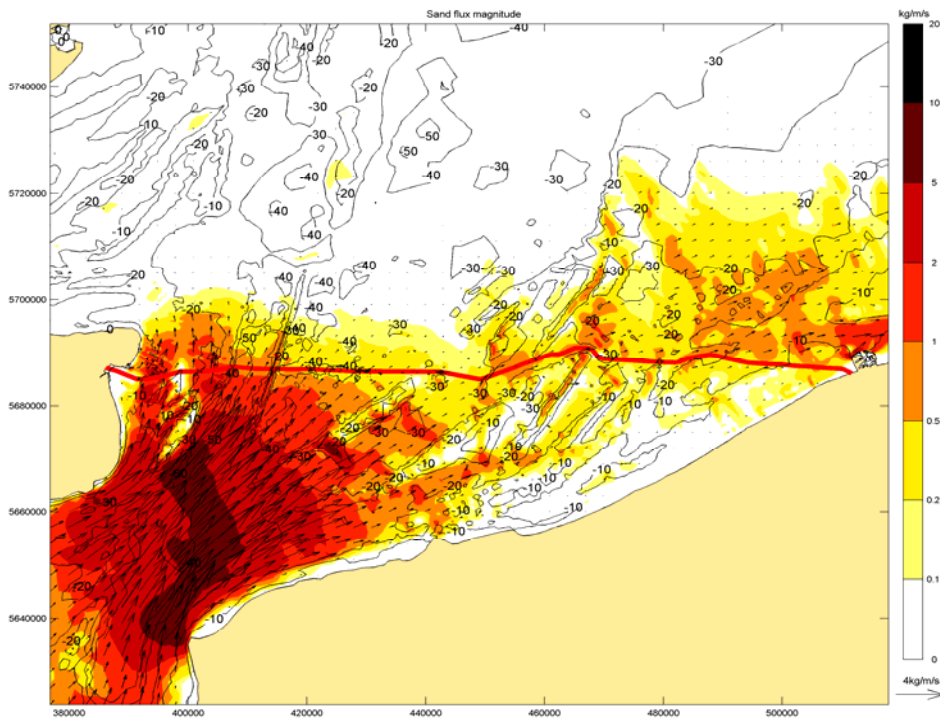


Figure 6-2-G : Peak flood sand transport rates – Spring tide, 250 µm sand

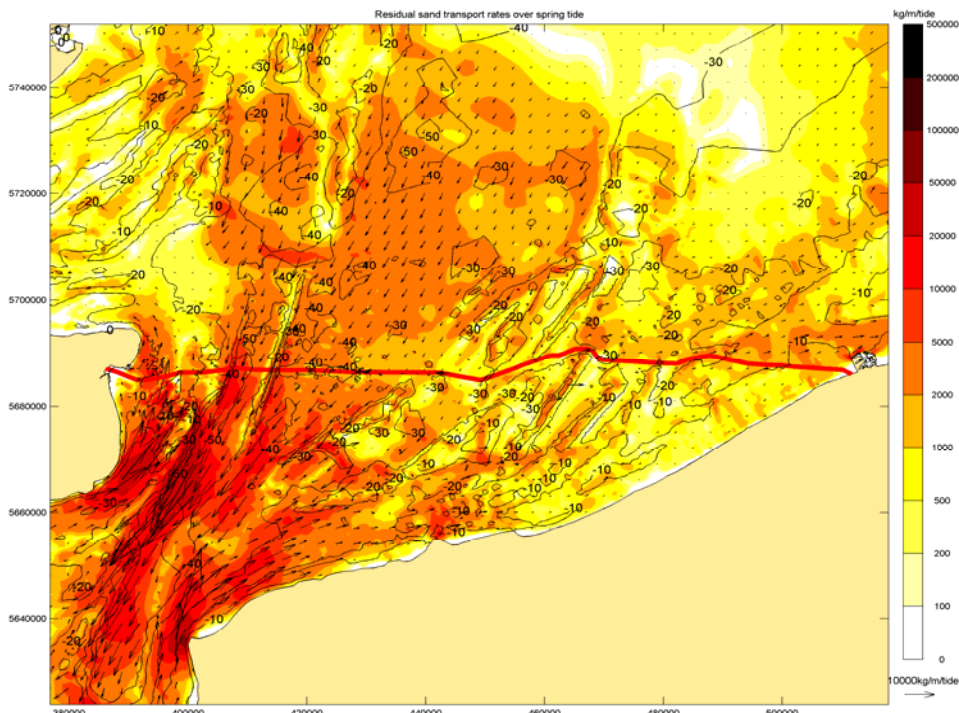


Figure 6-2-H : Residual sand transport rates over Spring tide – 400 µm sand

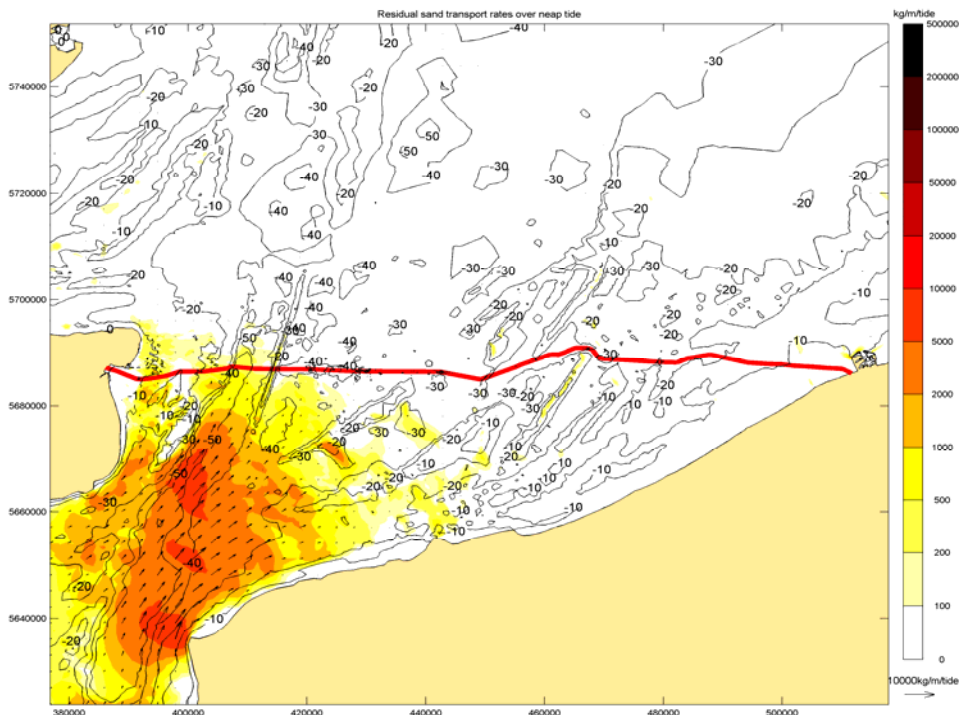


Figure 6-2-I : Residual sand transport rates over Neap tide – 400 µm sand

As stated previously, these results are indicative of the potential sediment transport patterns. Limited availability of the sediment simulated would reduce the expected transport rates. Given that the largest sediment fluxes are predicted in areas where the available sedimentological information indicates the presence of gravel and sandy gravel, it would be likely that actual transport is (much) lower than that predicted by the model. Similarly, if finer material than simulated is available and this finer fraction is not being sheltered by coarser fractions, rates could be larger in the coastal areas, where muds and silts exist. Keeping the uncertainties of the horizontal distribution of available mobile sediment and the inherent uncertainties associated with state-of-the-art sediment transport modelling,

the presented model results provide, in a qualitative way, an indication of the likely sediment transport patterns under the imposed flow conditions.

Given that the median sediment grain size along the European mainland coastline is generally smaller than that in the deeper areas and that along the English coast, the results of the simulations with the smaller grain size of 250 µm could be more representative in that area, whereas the model results based on the coarser 400 µm sand would be a better indication for potential sediment transport along the English coast.

Between South Falls and Sandettié the net sediment transport direction is south-southwest, with South Falls orientated slightly anticlockwise to the dominant tidal flow and Sandettié orientated clockwise (Kenyon *et al.*, 1981). The banks are steeper on the side away from the dominant flow and this causes some local reversal to tidal currents on the down drift side. This results in sediment transport that is generally towards the crest of the sandbank. The sand wave field at the southern tail of South Falls is observed to be highly stable (Wright, 1992). Sand waves were observed to move by up to 25 m/year, but tended to oscillate back and forth, therefore maintaining approximately the same position. Sand wave heights were more variable, but no overall pattern to these changes was discerned.

6.2.3. Description of potential impacts

The tables below show how sensitivity, recoverability and importance of the bathymetry and seabed processes have been considered in determining significance of effect. Table 6-2-1 outlines receptor value associated with bathymetry and Table 6-2-2 relates to the receptor value associated with seabed processes.

Receptor Value	Definition
High	Changes to bathymetry result in changed coastal processes, tidal flows and/or sediment characteristics which are considered adverse, widespread and long term.
Medium	Changes to bathymetry result in changed coastal processes, tidal flows and/or sediment characteristics which are undesirable, local and persist in the medium term, although may recover in the long term
Low	Changes to bathymetry do not result in changes to coastal processes, tidal flows and/or sediment characteristics, or any changes are transient and recover in the short term.

Table 6-2-1 : Definition of bathymetry receptor value

Receptor Value	Definition
High	Seabed processes which contribute significantly to supporting scarce ecological value and ecosystem functions, to the extent that changes to the seabed processes will result in permanent loss or impairment.
Medium	Seabed processes which contribute to supporting ecological value and ecosystem function, to the extent that changes to the seabed processes will result in changes that can recover, to the original state or result in impairment of a limited area.
Low	Seabed processes where changes do not result in changes to the ecological value and ecosystem function of an area.

Table 6-2-2 : Definition of seabed processes receptor value

6.2.3.1. Cable Installation

In shallow seas with sandy seabeds such as the southern North Sea, rhythmic bedform patterns are abundant. These bedform patterns can exist at a range of scales and have been shown to migrate. Dorst (2009) presents typical migration rates for different scales of bedforms along with their typical heights and wavelengths. Table 6-2-3 presents these characteristic features:

Bedform	Wavelength (m)	Height (m)	Migration rate
Ripple	1	0.01	1 m/hour
Megaripple	10	0.1	1 m/day
Sandwave	1500	5	10 m/year
Sandbank	6000	10	1 m/year

Table 6-2-3 : Migration rates of seabed features

The migration of bedforms such as sand waves may cause the cable to become exposed or develop free spans (Whitehouse *et al.*, 2000). Conversely, sand wave migration could cause over burial of the cable which may be an issue for thermal performance or if access is needed for any reason. Literature regarding sand waves at South Falls suggests that large sand waves, with heights between 0.5 m and 5 m, are stable in position, and tend to oscillate back and forth, reflecting the alternating dominance of ebb and flood directional strengths in the spring and neap tidal cycle, rather than migrating (Wright, 1992; Lanckneus and De Moor, 1990; Lanckneus and De Moor, 1995).

To minimise effects on the cable from migration of sand waves, or to allow the cable installation equipment to work effectively, it is proposed that a trailing suction hopper dredger (TSHD) will be used to “pre-sweep” sand waves and sandbanks. It is proposed that the dredge trench will vary depending on the shape and size of the features to be crossed. However, the greatest width of the trench is anticipated to be 20 m wide at the base, with side slopes of 10 m width on either side and an overall depth of 2 m. Following the bathymetry survey, areas to be dredged have been identified and an exercise carried out to quantify how much material will require removal by dredging. Only the crests of sandbanks and sand waves will be removed, so the locations shown in Figure 6-2-K contain many smaller areas, rather than being contiguous dredging. The quantities calculated are shown in Table 6-2-4

KP (km from Belgian landfall)	Longitude (E)	Latitude (N)	Easting	Northing	Volume (m³)	Purpose
26 - 29	2.77979	51.35257	484,665	5,689,057	38,273	Protect cable from sand wave mobility
29.25 - 29.35	2.75559	51.34716	482,978	5,688,460	743	Allow effective installation
30.05 - 30.15	2.74507	51.34426	482,245	5,688,140	33	Allow effective installation
31.5 - 34	2.70636	51.34514	479,549	5,688,248	10,829	Protect cable from sand wave mobility
37.5 - 41.25	2.61177	51.34873	472,963	5,688,678	20,479	Protect cable from sand wave mobility
42.8 - 43	2.56172	51.35095	469,479	5,688,944	482	Allow effective installation
54 - 57	2.40024	51.34705	458,230	5,688,590	27,899	Protect cable from sand wave mobility
61.8 - 63	2.30903	51.32294	451,852	5,685,965	48,491	Allow effective installation
63 - 65.4	2.28503	51.31696	450,174	5,685,316	21,330	Protect cable from sand wave mobility
68.5 - 69.2	2.21952	51.32001	445,612	5,685,702	4,593	Allow effective installation
69.2 - 73.6	2.18433	51.32437	443,165	5,686,213	60,249	Protect cable from sand wave mobility
74.5 - 77.5	2.11854	51.32572	438,583	5,686,417	32,614	Protect cable from sand wave mobility
82.3 - 87	1.99369	51.32529	429,883	5,686,480	24,470	Protect cable from sand wave mobility
99 - 100.75	1.77564	51.32706	414,694	5,686,908	93,138	Protect cable from sand wave mobility
123 - 123.5	1.44542	51.30614	391,638	5,685,017	1,170	Allow effective installation
Total quantity of dredging required					384,794	

Table 6-2-4 : Locations and quantity of sediments to be dredged from each location.

The approximate locations of areas containing features to be dredged in pre-sweeping operations are shown in Figure 6-2-1.

Disposal Site	Month of Disposal	2000	2001	2002	2003	2004		2005		2006		2007		2008		2009	2010
		CD	CD	MD	MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	MD	MD	MD
TH070	January		113227		68560		0	0	0	0	0	0	0	0	0	113952	0
	February		146529		0		344512	0		0	0	0	0	2950	0	0	0
	March		86586		0		0	0		0	0	0	0	0	0	0	0
	April		0		0		0	0		0		0	0	1872	0	0	0
	May	0	0		0		0	0	7000	0		0	0	0	0	0	0
	June	0	0		0		0	0	0	1400		0	0	0	0	0	0
	July	0	0		0		0	0	0	0	0	0	297750		0	0	0
	August	66950	0		0		0	0	0	0	0	0	0		0	0	0
	September	0	0		0		0	0	114335	0	0	0	0		0	0	89502
	October	0	0		0		0	0	0	0	0	0	0		0	0	0
	November	0			0		0	0	0	0	0	0	0		0	0	0
	December	0		0	0	0	0	0	0	0	0	0	0		0	0	0
Grand Total		66950	346342	0	68560	0	344512	0	121335	1400	0	0	297750	4822	0	113952	89502

Table 6-2-5 : Table of dry tonnes of licensed dredged material disposed at South Falls over the last ten years (CD-Capital Dredgings, MD-Maintenance Dredgings)

No figures in the cells indicate that no active licence was in force for disposal at the site.

Disposal of the material dredged in the pre-sweeping operation has been considered, with a licensed disposal site, TH070 South Falls identified as a potential area to receive the dredged material arising. Information on previous disposal operations at TH070 South Falls was provided by Cefas (D. Bastreri *pers.comm*). Disposal operations over the last ten years are shown in Table 6-2-5.

It can be seen that TH070 South Falls has not been utilised for the type of quantities liable to arise from the pre-sweeping activities. Disposing of material at pre-existing licensed sites has a number of additional drawbacks, including:

- extending the duration of dredging operations, with long periods of travel for the dredger between operational area and disposal site;
- decreasing the dredging efficiency whilst increasing overflow requirements to fill the hopper adequately for travel to disposal sites;
- increasing the carbon footprint of the dredging operation by increasing the travelling distances; and,
- removing the sediments from the local sedimentary budget.

It is therefore proposed that sediment arising from pre-sweeping dredging operations should be disposed in the vicinity (up to 1.5 km away from the dredging sites) of the dredging works, similar to the methodology employed by the installation of the BritNed interconnector cable. This allows the sediment to remain within the local sedimentary budget and local seabed processes, increases the dredging efficiency and reduces the carbon footprint of the dredging operation.

Dredging will necessarily alter the sedimentary bedforms and therefore, modelling was undertaken to establish whether these bedforms would re-establish and if so, what sort of time frame was expected. The computational sediment transport model SEDFLUX has been developed at HR Wallingford over a number of years (HR Wallingford, 2007). It predicts the magnitudes and directions of bedload, suspended load and total load transport rates for sand or shingle, together with suspended sediment concentrations at specified heights. SEDFLUX has been updated in successive stages during its development, namely up to its current version, SEDFLUX2010. A full report of the modelling can be found in Appendix 7.

SEDFLUX2010 includes:

- the method of calculating the bottom orbital velocity under combined waves and currents;
- the effect of a rippled bed, based on explicit predictions of ripple geometry and roughness;
- the effect of a bed sloping in an arbitrary direction relative to a current, combined with a wave in an arbitrary direction relative to the current; and,
- contributions of wave asymmetry to the sediment transport.

SEDFLUX2010 has been tested against benchmark observations of suspended concentrations collated for the EC Projects SEDMOC and SANDPIT. For the case of a current alone (e.g. rivers) reasonable agreement was found with the widely-used methods of Ackers and White, and Engelund and Hansen. A set of “saturation tests” of the model has been performed for a range of coastal conditions, based on a standard set of input values of sediment, water, currents and waves originally produced by van Rijn (1993). SEDFLUX2010 gives results that are generally similar to those produced by van Rijn’s own method.

SEDFLUX is ideally suited to analyse the sediment transport on the continental shelf, and allows for the analysis of the impact of a trench on that transport. For this purpose the transport rates at a location far away from the trench with the transport rates on the slopes of the trench were calculated. The differences in the transport then determine the infill rate of the trench.

Infill rates were calculated in kg/day and in m³/day. The infill rate was calculated at water levels: 20 m and 40 m, with maximum tidal velocities set at 0.75 m/s, 1.1 m/s and 1.5 m/s, respectively. A 0.1 m/s residual current was assumed and waves varied with heights of 0.5 m, 1 m and 2 m. The sediment sizes varied between 0.2 mm and 0.5 mm. An assumption was made that the trench would be at 45° to the dominant tidal currents. The results are shown in Figures 6-2-J AND 6-2-K.

The SEDFLUX calculations give the initial trench infill rates. These values are only valid for the duration that the slopes and depths at the reference points are unaltered. As long as the cumulative infill is less than 10 to 20 % of the initial trench depth, this condition can be assumed to be met. If the cumulative infill exceeds this threshold, the infill rates will drop significantly. This implies that for some of the cases considered, the initial estimates are no longer reached after the first day. Therefore, the infill rates, and in particular the higher valued ones, should be considered as indications of the expected rate of infill and not as a precise prediction.

For all conditions the infill rates are high enough to fill the trench within a few weeks. The higher depth averaged tidal velocities in the deeper parts result in higher infill rates for these depths. The impacts of pre-sweeping sand waves and cable burial are therefore considered to be **minor**.

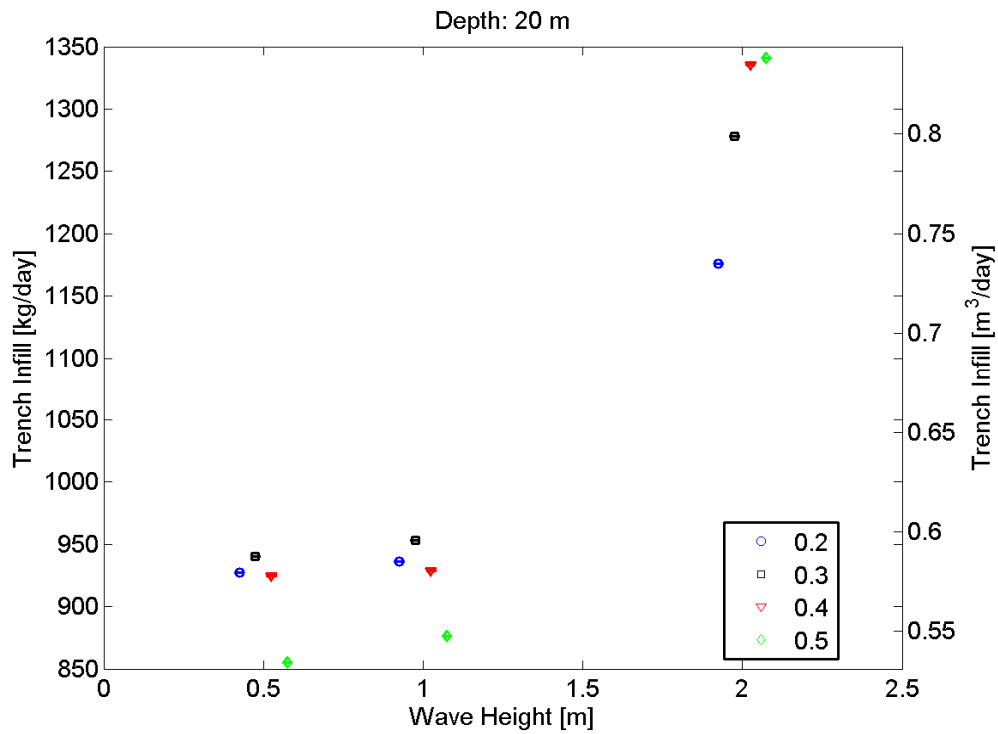


Figure 6-2-J : Infill rates per metre run of trench at 20 m water depth, for a range of sediment sizes (range from 0.2 mm to 0.5 mm)

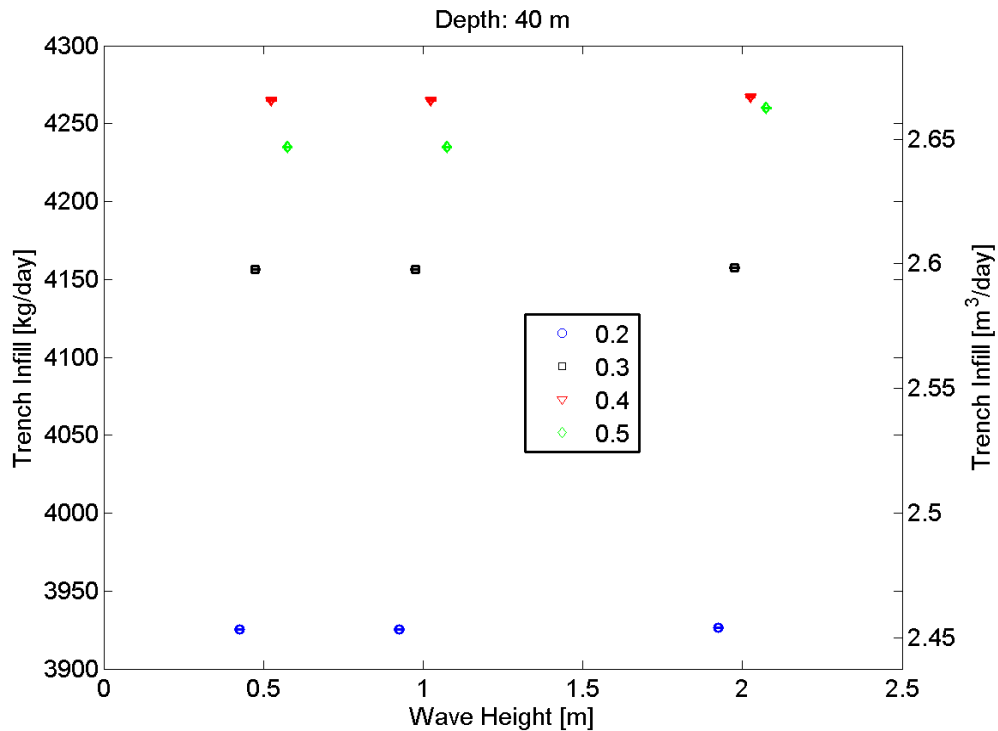


Figure 6-2-K : Infill rates per metre run of trench at 40 m water depth, for a range of sediment sizes (range from 0.2 mm to 0.5 mm)

The displacement of sediments due to dredging and installation of the cable can therefore be expected to be of a localised and temporary nature. Consequently, the predicted impacts are of minor significance. Since the dredged material sediments will be placed near to the cable route and hence remain within the system and contribute to the re-establishment of the sand wave regime, the impact of the disposal operations on bathymetry and seabed processes is considered to be **minor**.

6.2.3.2. Operation

The design of route and installation method has been carefully prepared to minimise the likelihood of cable exposure. Should cables become exposed however, there may be a requirement to provide external cable protection. Various methods are available to protect cables, such as rock placement, concrete mattresses and frond mattresses. These methods may occasionally be combined, e.g. concrete mattresses plus frond mattresses. These methods will all interrupt seabed processes on a local scale and thus only **minor** impact is predicted.

6.2.3.3. Decommissioning

If the cable is to be removed upon the cessation of operations, it will be recovered through the same seabed features that existed during installation, as these features are predicted to recover rapidly following installation. The same rapid recovery is anticipated following the disturbance to the seabed through decommissioning and therefore the impact is considered to be **minor**.

6.2.4. Mitigation

The pre-sweeping operations have been designed to trench only where judged necessary through the seabed features, which minimises sediment disturbance and resuspension. The dredged trench will be kept to the minimum possible length, width and depth, which will ensure that the cable burial will proceed effectively and result in a stable burial depth. Installing the cable to a stable burial depth will minimise the requirement for external cable protection and disturbance.

6.2.5. Residual impact

The impacts predicted are of **minor** significance, as all changes predicted will be reversible, transient and confined to a comparatively local area. They will remain minor after mitigation measures.

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6.3. Water Quality

This section describes the water quality along the proposed cable route, and the potential impacts of the project upon water quality issues.

6.3.1. Baseline data sources

Various sources of information have been used to inform this assessment, including:

- European Commission Environment Water Information System for Europe.
- Environment Agency What's In Your Backyard?
- Southern North Sea Sediment Transport Study (HR Wallingford, 2002), which contains a summary of CEFAS data on suspended sediments
- CEFAS report on temperature and salinity around UK coastlines (Joyce, 2006)
- Ramsgate West Rocks Development. Siltation in proposed shipping channel and turning area. HR Wallingford Report EX855, November 1978
- Thanet Offshore Wind Farm EIA. Coastal and Seabed processes. HR Wallingford Report EX5171, September 2005
- Management Unit of the North Sea Mathematical Models (MUMM), which has data on many aspects of the North Sea, including temperature, salinity and chemical concentrations
- Sediment data from the geophysical survey carried out by MMT between August and October 2010.

6.3.2. Baseline

Water quality monitoring is generally carried out in coastal locations with respect to EC Directives on Bathing Water quality (76/160/EEC and 2006/7/EC) and Shellfish Water quality (79/923/EEC and [2006/113/EC](#)). These existing water quality monitoring programmes are gradually being harmonised and co-ordinated across EC countries, to protect the fresh and coastal water environment, under the auspices of the Water Framework Directive (2000/60/EC). Marine territorial waters are to be regulated for sustainability under the Marine Strategy Framework Directive (2008/56/EC), to provide coherence with the Water Framework Directive. Under this Directive (transposed into UK law by the Marine Strategy Regulations 2010), an assessment of the current state of UK seas, upon which the monitoring programme will be based, is being carried out which will be completed by July 2012.

6.3.2.1. Water Framework Directive

The Water Framework Directive (WFD) ('Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy') establishes a framework for the protection of European waters, including inland surface waters, transitional waters, coastal waters and groundwater. Its environmental objectives are, *inter alia*:

- a) the prevention of further deterioration of the present status of all surface and ground water bodies;
- b) a good chemical and good ecological status for all surface and ground water bodies within
- c) 15 years (2015). This includes:
 - (i) coastal waters (1 nm): good ecological status;
 - (ii) territorial waters (12 nm): good chemical status;
- d) a good chemical status and maximum ecological potential for all artificial and "heavily modified water bodies" within 15 years (2015);
- e) a progressive reduction of emissions, discharges and losses of "Priority Substances";
- f) the phasing out of emissions, discharges and losses of "Priority Hazardous Substances";
- g) the progressive reduction of pollution of ground water and prevention of its further pollution;

- h) to achieve compliance with any standards and objectives for protected areas established under Community legislation by 2015; and
- i) several less stringent objectives or time schedules in specific cases.

The WFD's objective of a "good chemical status" is defined in terms of compliance with all the quality standards established for chemical substances at European level. The Directive also provides a mechanism for renewing these standards and establishing new ones by means of a prioritisation mechanism for hazardous chemicals. This will ensure at least a minimum chemical quality, particularly in relation to very toxic substances.

The WFD's objective of a "good ecological status" also requires certain chemical conditions. The chemical requirements include the achievement of environmental quality objectives for discharged priority substances and for any other substances liable to cause pollution and identified as being discharged in significant quantities.

The South East River Basin Management Plan (Environment Agency, 2009) has been drafted as a requirement of the Water Framework Directive. It indicates that the ecological status of Pegwell Bay is moderate and the chemical status is good.

6.3.2.2. The Marine Strategy Framework Directive

Directive 2008/56/EC of the European Parliament and of the Council of 15th July 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) aims to achieve "good environmental status" of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The Directive calls for the development of a marine strategy by each Member State. By July 2012, they must provide a comprehensive assessment of the state of the environment, identifying the main pressures on their respective marine regions, and defining targets and monitoring indicators. The UK Government and Devolved Administrations launched consultation on the 27th March 2012, ending 18th June 2012. By 2015, they will have to develop coherent and coordinated programmes of measures. To reach the 2020 target, they will have to achieve efficient communication and close cooperation, notably through regional sea conventions.

Good Environmental Status must be determined at the level of marine regions or sub regions, on the basis of 11 qualitative descriptors of the marine environment specified in the Marine Strategy Framework Directive.

1. Biological Diversity
2. Non-indigenous Species
3. Commercial Fishing
4. Food Webs
5. Eutrophication
6. Seafloor Integrity
7. Hydrographical Conditions
8. Contamination
9. Seafood Contamination
10. Marine Litter
11. Noise

The marine strategies to be developed by each Member State must contain a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level and the establishment of clear environmental targets and monitoring programmes. Water quality would fall within the contamination descriptor. No targets have yet been implemented.

6.3.2.3. Bathing waters

There are two designated bathing waters in the vicinity of the proposed cable route at the UK coast; these are at Sandwich Bay and at Ramsgate Western Undercliffe. A third bathing water, Ramsgate Sands, is situated to the north of Ramsgate Harbour and is included following scoping comments from the Environment Agency. The Environment Agency is responsible for monitoring water quality at these locations and regularly reports data collected against Environmental Quality Standards (EQS), which are designed to protect both the environment and human health. These standards were originally provided in the original EC Bathing Waters Directive (76/160/EEC), adopted by the Council of the European Communities in 1976. The standards were transposed into UK law for England and Wales to form The Bathing Waters (Classification) Regulations 1991. There were two types of microbiological standards set out, namely the mandatory standards and the more stringent guideline standards.

The mandatory microbiological standards are:

- 10,000 total coliforms per 100 ml of water in 95% of samples collected within a bathing season (15th May to 30th September); and
- 2,000 faecal coliforms per 100 ml of water in 95% of samples collected within a bathing season (15th May to 30th September).

The guideline microbiological standards are:

- 500 total coliforms per 100 ml of water in 80% of samples collected within a bathing season (15th May to 30th September);
- 100 faecal coliforms per 100 ml of water in 80% of samples collected within a bathing season (15th May to 30th September); and
- 100 faecal streptococci per 100 ml of water in 90% of samples collected within a bathing season (15th May to 30th September).

Water quality is classified as Excellent (E) if the guideline standards have been met, Good (G) if mandatory standards have been met and Poor (P) if the minimum mandatory standards have not been met. The achieved water quality for the relevant bathing waters is given in Table 6-3-1.

Bathing Water	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ramsgate Western Undercliffe	E	G	G	G	G	E	E	G	G	G	E	E	E	G	E
Ramsgate Sands	E	E	E	G	G	E	E	G	G	G	E	E	E	G	E
Sandwich Bay	E	E	E	G	G	E	E	G	E	E	E	E	E	E	E

Table 6-3-1 : Classification of monitored UK Bathing Waters from 1997 to 2011

These standards are being tightened, following the new Bathing Waters Directive (2006/7/EC) of the European Parliament and of the Council of 15 February 2006, concerning the management of bathing water quality, and repealing the original Directive 76/160/EEC as a gradual process to conclude in 2014. These were transposed into UK law for England and Wales to form The Bathing Waters (Classification) Regulations 2008. This sets out new standards to be met and in May 2012 monitoring began for a four year classification of bathing waters to be in place by 2015.

Parameter	Excellent quality	Good quality	Sufficient
Intestinal enterococci (cfu/100 ml)	100 (*)	200 (*)	185 (**)
Escherichia coli (cfu/100 ml)	250 (*)	500 (*)	500 (**)

cfu – colony forming units.
 (*) Based upon a 95 percentile evaluation.
 (**) Based upon a 90 percentile evaluation.

There are also additional criteria to be taken into account. These are a description of the physical, geographical and hydrological characteristics of the bathing water, identification and assessment of causes of pollution and assessments of the potential for proliferation of cyanobacteria, macro-algae and phytoplankton. Poor quality continues to be the classification given if standards are not met.

6.3.2.4. Shellfish Waters

There is a designated shellfish water in Pegwell Bay. This has complied with the mandatory standards since its designation in 2004.

The original Directive 'Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters as amended by Council Directive 91/692/EEC (further amended by Council Regulation 1882/2003/EC)', known as the Shellfish Waters Directive, was designed to protect the aquatic habitat of bivalve and gastropod molluscan species of shellfish. It sets out standards for various parameters that should be monitored in designated shellfish areas. It has since been superseded by 'Directive [2006/113/EC](#) of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters'.

The Directive establishes parameters applicable to designated shellfish waters, as well as indicative values, mandatory values, reference methods of analysis and the minimum frequency for taking samples and measurements. These parameters are set for pH, temperature, salinity and the presence or concentration of certain substances (dissolved oxygen, hydrocarbons, metals, organohalogenated substances, etc.).

The competent authorities for each Member State must take samples from the waters to verify their conformity with the criteria set by the Directive. The following proportions of samples must conform to the established values:

- 100% of the samples for the parameters 'organohalogenated substances' and 'metals';
- 95% of the samples for the parameters 'salinity' and 'dissolved oxygen';
- 75% of the samples for the other parameters; and
- No evidence of harm to the shellfish from organohalogenated compounds.

Additionally, the Directive stipulates that a discharge should not cause increase of suspended solids to exceed 30% above background levels, as shellfish can be adversely affected by the smothering effects of sediment settling.

6.3.2.5. Suspended sediments

Suspended sediments enter the southern North Sea from the English Channel, via the Strait of Dover. Estuaries such as the Thames, Scheldt and Rhine also contribute to the suspended sediment load. Suspended sediment concentrations are generally low in the North Sea during the summer but these may double during the winter. Away from the coast, summer concentrations of 0-4 mg/l are typical, with winter concentrations of up to 16 mg/l (HR Wallingford, 2002). Along the UK coastline, suspended sediment concentrations are higher, and may exceed 60 mg/l during winter months (HR Wallingford, 2002; Fettweis *et al.*, 2007).

Net suspended sediment transport is generally northward from the Strait of Dover along the UK coastline area and net transport fluxes peak in winter (Van Lancker *et al.*, 2007). Sediment transport

along the UK coastline is directed southward to the north of Pegwell Bay and northward to the south, resulting in a drift convergence at the UK landfall site, with fine sediment tending to accumulate at Pegwell Bay as transport of sediments slows.

6.3.2.6. In situ sediments

Sediment core samples taken along the UK landfall area of the cable route during the geotechnical investigations were analysed for contaminants. The locations of these sediment core sampling sites are shown in Figure 6-3-A and the results of the contaminant analyses are presented in Table 6-3-2.

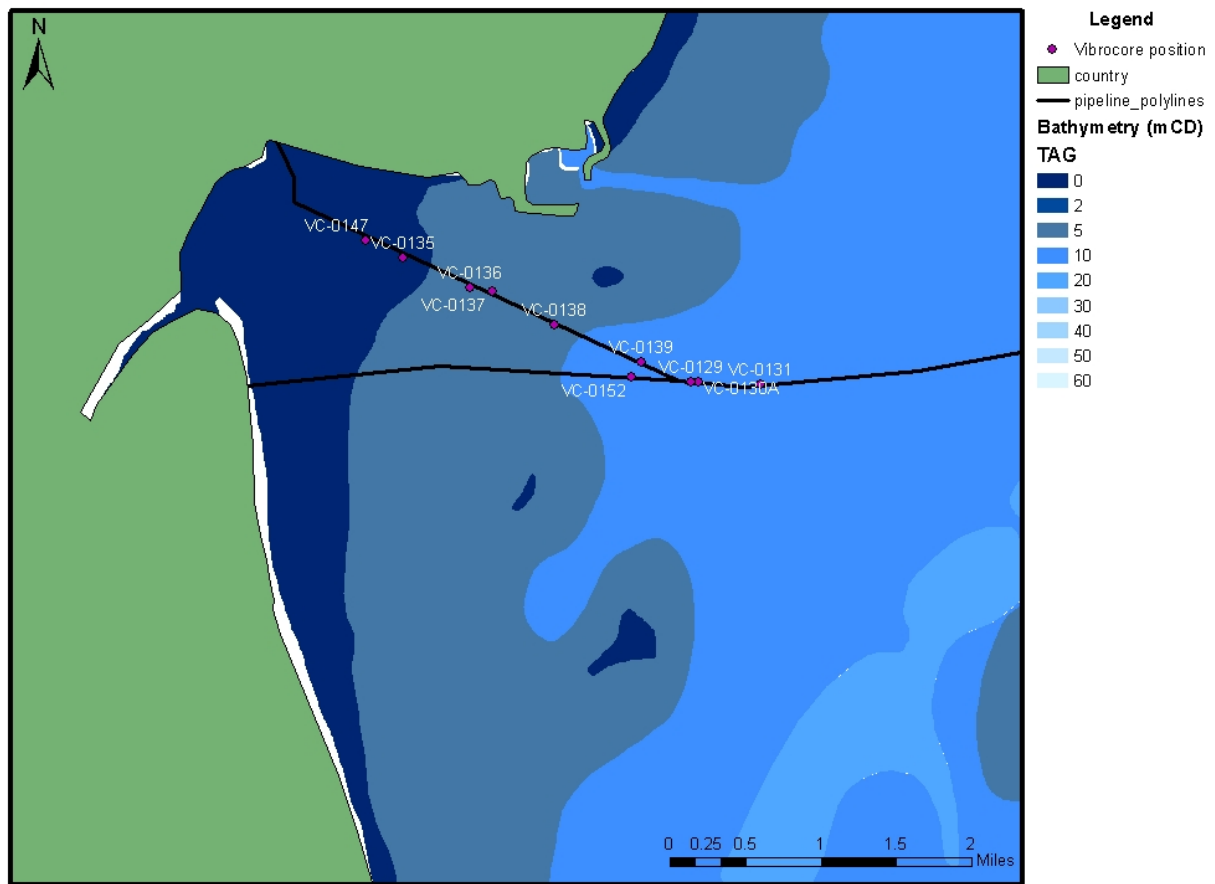


Figure 6-3-A : Location of vibrocore sites sampled for sediment contaminant analyses

Determinand	Unit	Sample No.																
		129 (0.4 – 0.8)	129 (1.85 – 2.05)	130A (0.6 – 0.9)	131 (0.5 – 0.85)	131 (1.9 – 2.0)	135 (0.4 – 0.85)	135 (1.8 – 2.2)	136 (0.7 – 0.95)	137 (0.6 – 0.95)	138 (0.55 – 0.85)	138 (1.6 – 2.0)	139 (0.45 – 0.9)	139 (1.9 – 2.25)	147 (0.5 – 0.95)	147 (1.95 – 2.1)	152 (0.5 – 0.85)	152 (1.35 – 1.7)
Sum of PCBs	mg/kg dw	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	
PAH L	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	
PAH M	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	
PAH H	mg/kg dw	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	
EOX	mg/kg dw	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Monobutyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Dibutyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	2.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Tributyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Triphenyltin	µg/kg dw	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Arsenic	mg/kg dw	31	28	4.3	17	21	8.6	11	3.6	28	25	13	21	12	11	15	18	
Barium	mg/kg dw	5.7	6.7	30	4.6	5.6	20	27	9.3	6.0	4.5	14	7.9	8.8	33	26	6.5	
Lead	mg/kg dw	6.7	6.1	6.3	4.9	3.8	9.1	7.6	3.6	6.8	5.0	8.9	4.3	5.7	22	6.3	4.9	
Cadmium	mg/kg dw	0.31	0.25	<0.24	<0.22	0.22	<0.24	<0.27	<0.24	0.26	0.24	0.24	<0.22	0.21	<0.24	<0.24	<0.21	
Cobalt	mg/kg dw	5.2	4.7	5.5	3.0	3.7	2.4	5.0	3.2	4.8	3.9	4.1	2.6	3.6	4.3	4.1	2.8	
Copper	mg/kg dw	<0.52	0.53	6.8	0.9	0.53	1.5	5.6	4.5	0.54	0.69	3.5	0.76	0.85	9.1	3.1	0.7	
Chromium	mg/kg dw	4.4	4.7	21	5.2	4.5	8.2	15	20	5.7	4.5	9.1	6.6	5.9	16	13	5.3	
Mercury	mg/kg dw	<0.05	<0.05	<0.05	<0.05	<0.05	0.053	<0.05	<0.05	<0.05	<0.05	0.066	<0.05	<0.05	0.22	<0.05	<0.05	
Nickel	mg/kg dw	3.8	37	14	3.4	3.0	3.2	11	9.7	4.0	3.6	7.0	3.9	3.8	8.6	7.6	3.4	
Vanadium	mg/kg dw	27	25	12	16	20	15	29	15	25	23	16	14	20	26	25	15	
Zinc	mg/kg dw	23	20	31	17	13	21	32	19	23	17	27	16	19	50	25	16	
Sulphur	mg/kg dw	450	380	220	380	380	650	4100	5700	340	260	1200	350	320	2700	2600	360	
pH		9	8.9	9.1	8.9	9.1	8.75	8.7	8.77	9.09	9.31	8.9	9.06	9.32	8.61	8.75	9.07	
Calcium	% dw	10	7.0		7.8	6.2	5.3	7.8	2	2.2	5.6	6.7	4.2	4.8	5.9	5.6	3.9	
Loss on ignition	% dw	1.5	1.3	2.5	1.6	1.2	2.8	4.4	2.4	0.97	0.96	2.7	1.1	1.2	3.3	2.5	1.2	
Dry weight	%	86.4	88.7	76.2	82	89.8	75.7	65.7	75.2	88.1	92.9	78.9	83.1	94	73.6	76.4	85.5	

Table 6-3-2 : Results of chemical contaminant analyses of vibrocore samples

There are no Environmental Quality Standards for *in situ* sediments in the UK, unlike for water quality. In the absence of any standards an initial assessment of whether organisms are at risk from concentrations of toxic contaminants can be undertaken by comparing data with the CEFAS guideline action levels for the disposal of dredged material.

CEFAS's guideline action levels for the disposal of dredged material are not statutory contaminant standards for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material to sea. The action levels are presented in Table 6-3-3. [The action levels are not pass/fail criteria, but triggers for further assessment. Accordingly, if concentrations are below action level 1, then refusal of disposal at sea on grounds of contamination is unlikely. If concentrations fall between levels 1 and 2, then further assessment is required. If concentrations exceed level 2, then the dredged material may not be acceptable for disposal at sea.]

	Action Level 1	Action Level 2
Contaminant / Compound	mg/kg Dry Weight (ppm)	mg/kg Dry Weight (ppm)
Arsenic	20	100
Mercury	0.3	3
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Lead	50	500
Zinc	130	800
Organotins; TBT DBT MBT	0.1	1
PCB's, sum of ICES 7	0.01	none
PCB's, sum of 25 congeners	0.02	0.2

Table 6-3-3 : CEFAS guideline action levels for the disposal of dredged material

A comparison of the results gained shows that only arsenic displays some elevation above CEFAS Action Level 1 and in only some locations. Also arsenic concentrations did not exceed Action Level 2. It also shows that TBT and its derivatives were not detected in most cases, with the exception of the surface sample at station 135. This result does not exceed Action Level 1 and is considered to be a local hotspot, possibly as the result of a paint flake within the sediment matrix, rather than indicative of contamination over a wider geographic spread.

6.3.2.7. Offshore water quality

Very little water quality monitoring has been or is currently undertaken in the offshore environment for the proposed cable route and the vast majority of the cable installation will be in areas where little to no water quality information currently exists. Water quality is linked to sediment quality, as certain contaminants tend to move between water and sediments. Certain types of contaminants are generally associated with fine and cohesive sediments, as they are adsorbed to the surface of mud particles. Disturbance of the seabed can mobilise sediments, lead to temporary increases in suspended sediment concentrations and has the potential to cause the release of contaminants from the sediment into the water column. Chapman (1992) suggests that the North Sea sediments away from point sources are likely to be unpolluted and thus it is thought that water quality is liable to be good. The silt/clay content of the surface sediments along the UK section of the proposed cable route tends to be low as revealed by the geotechnical investigation carried out by MMT between August and

October 2010. This would also suggest that little accumulation of contaminants in the sediments is likely and hence water quality is liable to be good.

6.3.3. Description of potential impacts

The table below shows how sensitivity, recoverability and importance of the water body crossed by the cable route have been considered in determining significance of effect.

Receptor Value	Definition
High	Water body is of high quality, would not recover from impact and its ongoing quality status is of national importance
Medium	Water body is of high or good quality, would recover from impact slowly and its ongoing quality status is of regional importance
Low	Water body is of good or acceptable quality, would recover from impact quickly and its ongoing quality status is of local importance

Table 6-3-4 : Definition of receptor value

In order to consider the potential effects of sediment suspension from the cable laying operations of pre-sweep dredging and ploughing on the surrounding water environment, HR Wallingford carried out plume modelling. The plume dispersion model used to simulate the dispersion of fine sediment from ploughing and trailer dredging is the SEDPLUME-RW model developed by HR Wallingford. A description of the model and full modelling report is in Appendix 7. The model was run using the hydrodynamic output from the flow model and the assumption of a logarithmic velocity profile through the water column to track the three dimensional movement of sediment particles.

Dispersal in the direction of flow in the model is provided by the shear action of differential speeds through the water column while turbulent dispersion is modelled using a random walk technique. The deposition and resuspension of particles are modelled by establishing critical shear stresses for erosion and deposition. Erosion of deposited material occurs when the bed shear stress exceeds the critical shear stress for erosion while deposition of suspended material occurs when the bed shear stress falls below the critical shear stress for deposition.

For simulation of the fine sediment plumes arising from trailer dredging HR Wallingford has developed a specially adapted form of the SEDPLUME-RW code which allows the representation of the moving sources and of the near-field mixing that occurs with trailer suction hopper dredgers (TSHD) (Spearman *et al*, 2003). The overflow discharge of sediment was calculated using the TASS overflow model developed at HR Wallingford (Aarninkhof *et al*, 2010). This model calculates the sediment transport processes in the hopper using a one-dimensional vertical (1DV) model and calculates the magnitude and particle size distribution of the sediment flux out of the hopper in the overflow discharge.

Five scenarios were investigated:

- Scenario 1 - Ploughing sand near *Sabellaria* area
- Scenario 2 - Ploughing chalk
- Scenario 3 - Ploughing sand at Goodwin Knoll
- Scenario 4 - Pre-sweeping by TSHD at South Falls
- Scenario 5 – Jetting sand in UK waters

The assumptions made for the model in each case are contained in the technical modelling report at Appendix 7.

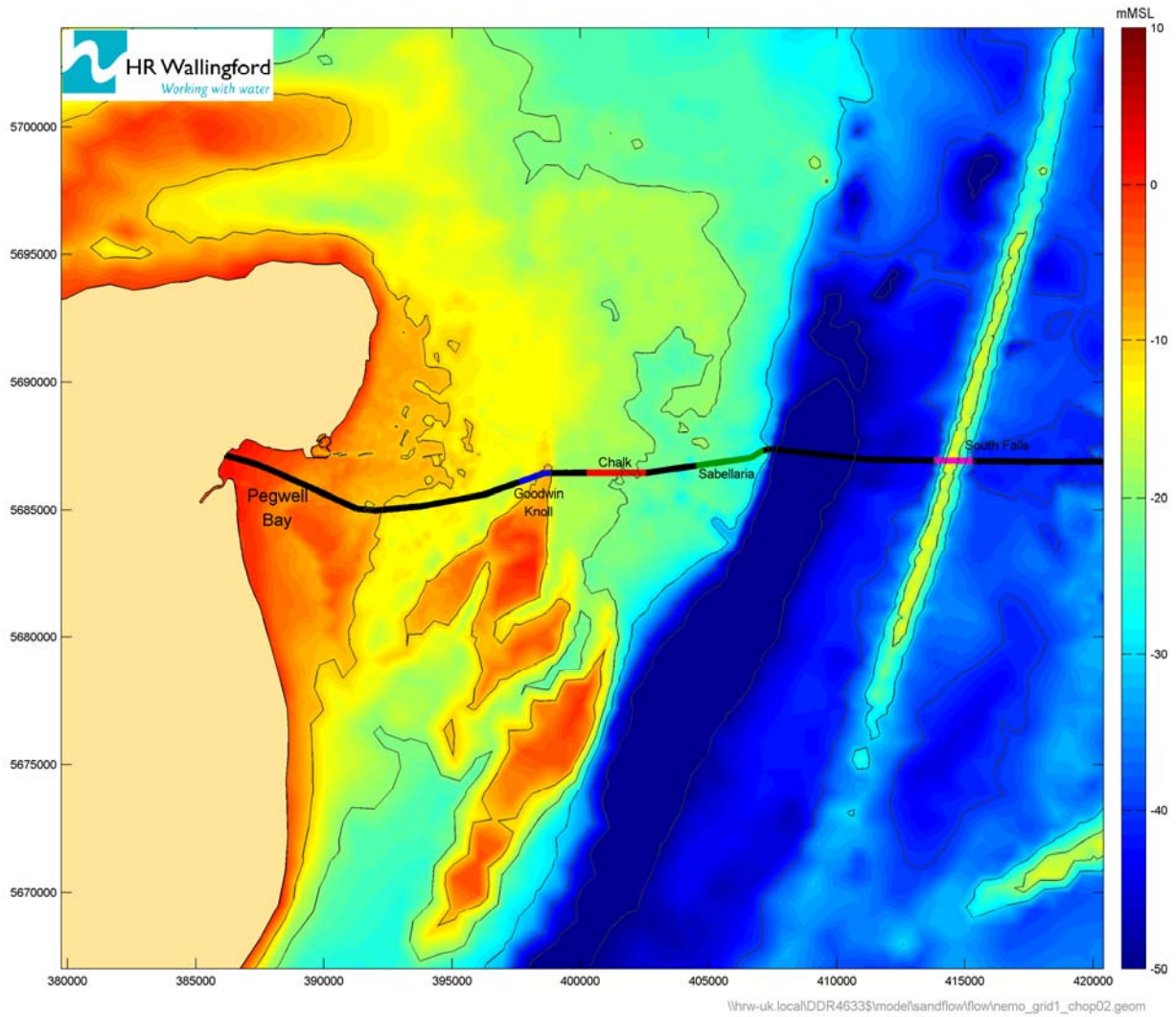


Figure 6-3-B : Location of proposed cable route in UK waters and cable laying sections for which plume dispersion simulations have been undertaken.

6.3.3.1. Scenario 1 - Ploughing sand near Sabellaria area

The scenario of ploughing sand with 3% fines content is predicted to produce depth-averaged and near bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. These levels are of an order of magnitude less than the natural variation range of suspended sediments. On this basis the potential effects of sediment suspension from ploughing near the *Sabellaria spinulosa* reef are considered to be **negligible**.

6.3.3.2. Scenario 2 - Ploughing chalk

Figures 6-3-C and 6-3-D show the *envelope* of predicted increases in near bed (Figure 6-3-C) and depth-averaged (Figure 6-3-D) suspended sediment concentrations above background during the simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation (one tidal cycle in this case). This style of figure is informative for showing the footprint of effect but tends to over-emphasise the size of the plume at any particular instant.

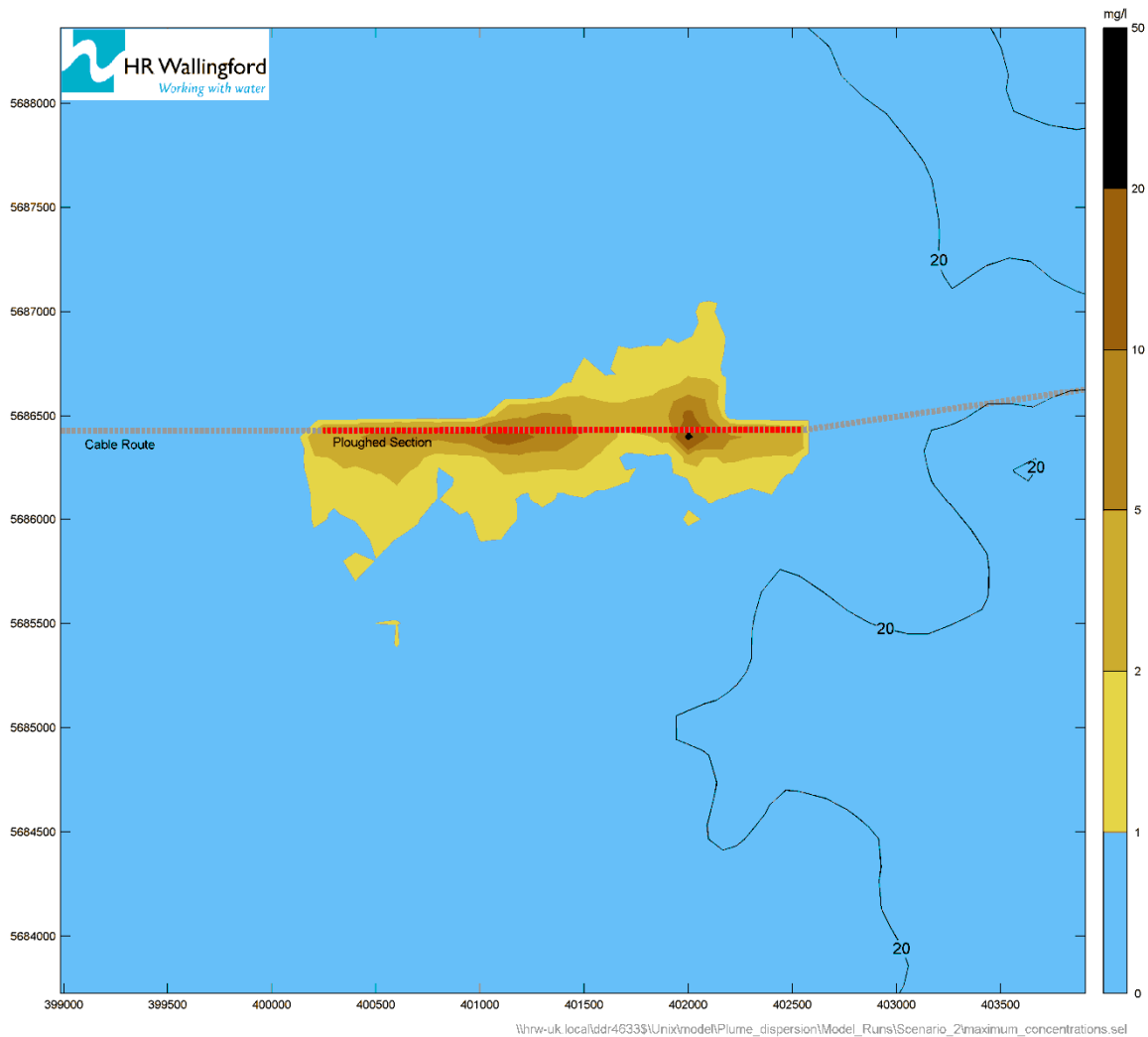


Figure 6-3-C : Predicted increase in near bed suspended sediment concentration above background, Scenario 2, ploughing chalk

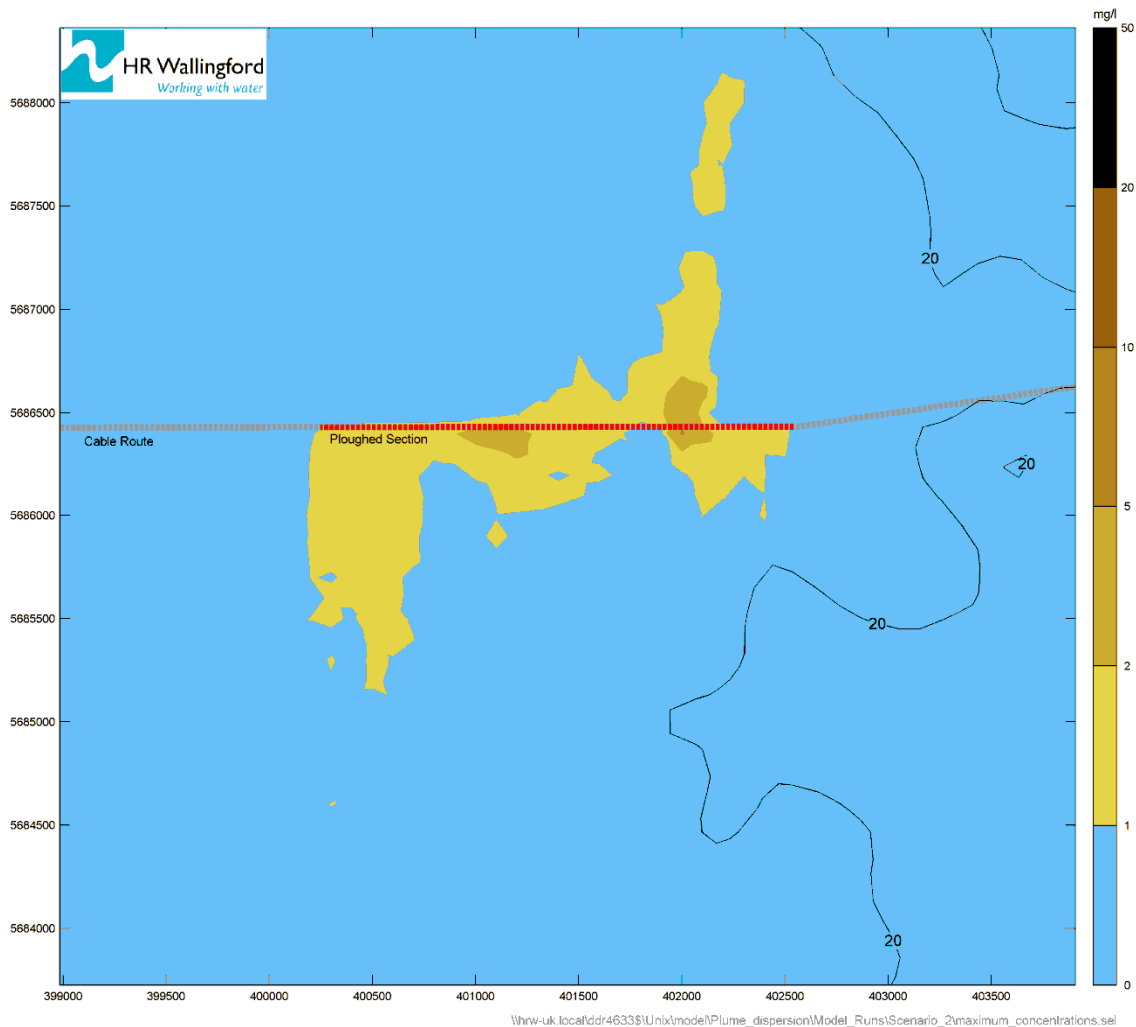


Figure 6-3-D : Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 2, ploughing chalk

The figures show that the footprint of impact extends up to 700 m from the cable route but that at these distances, the predicted increases in suspended concentration are less than 1 mg/l above background. Background suspended loads vary from typical summer values of 16 – 30 mg/l to typical winter values of up to 60 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable path. The peak predicted increase in concentration is about 20 mg/l. Deposition of fine sediment is predicted to be **negligible**.

This plume may provide some aesthetic impact, as suspended chalk particles are extremely visible, even in comparatively low concentrations. Concerns with regard to such impacts were raised as part of the Thanet Offshore Wind Farm development and Royal Haskoning provided an aerial survey of the plume caused by experimental ploughing when establishing best methodology for installing the export cable. This demonstrated that despite the visibility of the plume, it was similar to natural sediment suspension, or the effect of vessels moving through the coastal environment off Ramsgate Harbour. The water quality value in this offshore area is considered to be low (as defined in the receptor value table above), would recover very quickly and the changes are localised. The predicted impact of the chalk plume on water quality is therefore considered to be **minor**.

6.3.3.3. Scenario 3 - Ploughing sand at Goodwin Knoll

As for Scenario 1, the scenario with ploughing sand with 3% fines content is predicted to produce depth-averaged and near bed concentration increases of less than 0.5 mg/l above background and deposition of less than 0.1 mm. On this basis the effect of ploughing over Goodwin Knoll on sediment suspension levels is considered to be **negligible**.

6.3.3.4. Scenario 4 – Trailer dredging at South Falls

Figures 6-3-E and 6-3-F show the *envelope* of predicted increases in near bed (Figure 6-3-E) and depth-averaged (Figure 6-3-F) suspended sediment concentration above background during the pre-sweep simulation. These figures do not show the actual plume at any time but rather the peak values attained at each location over the course of the simulation (in this case 24 hours). The plume footprint is mainly due to the presence of fine material at the extremities of the plume. Closer to the point of release, the majority of the plume will be coarser, sandy material.

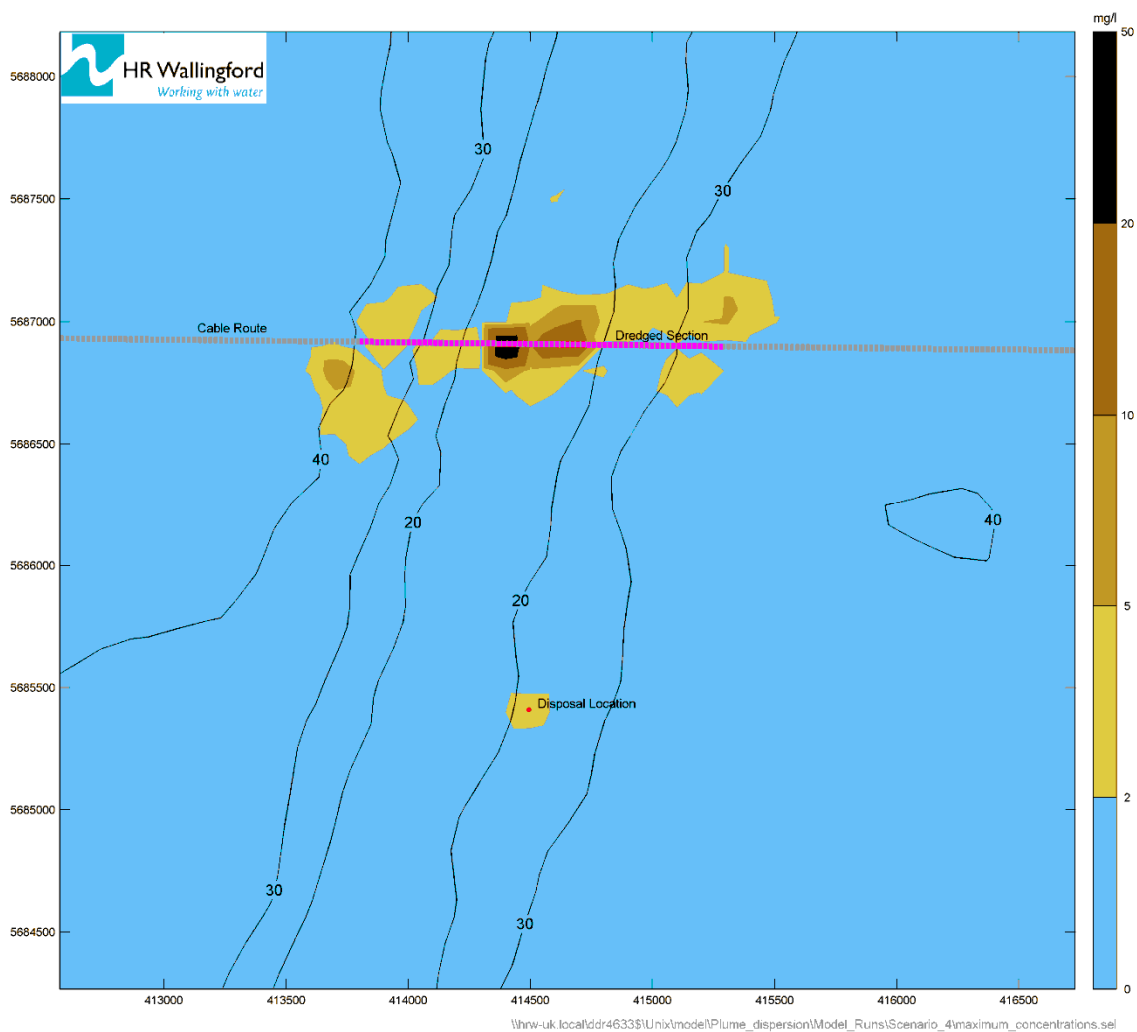


Figure 6-3-E : Predicted increase in near bed suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south

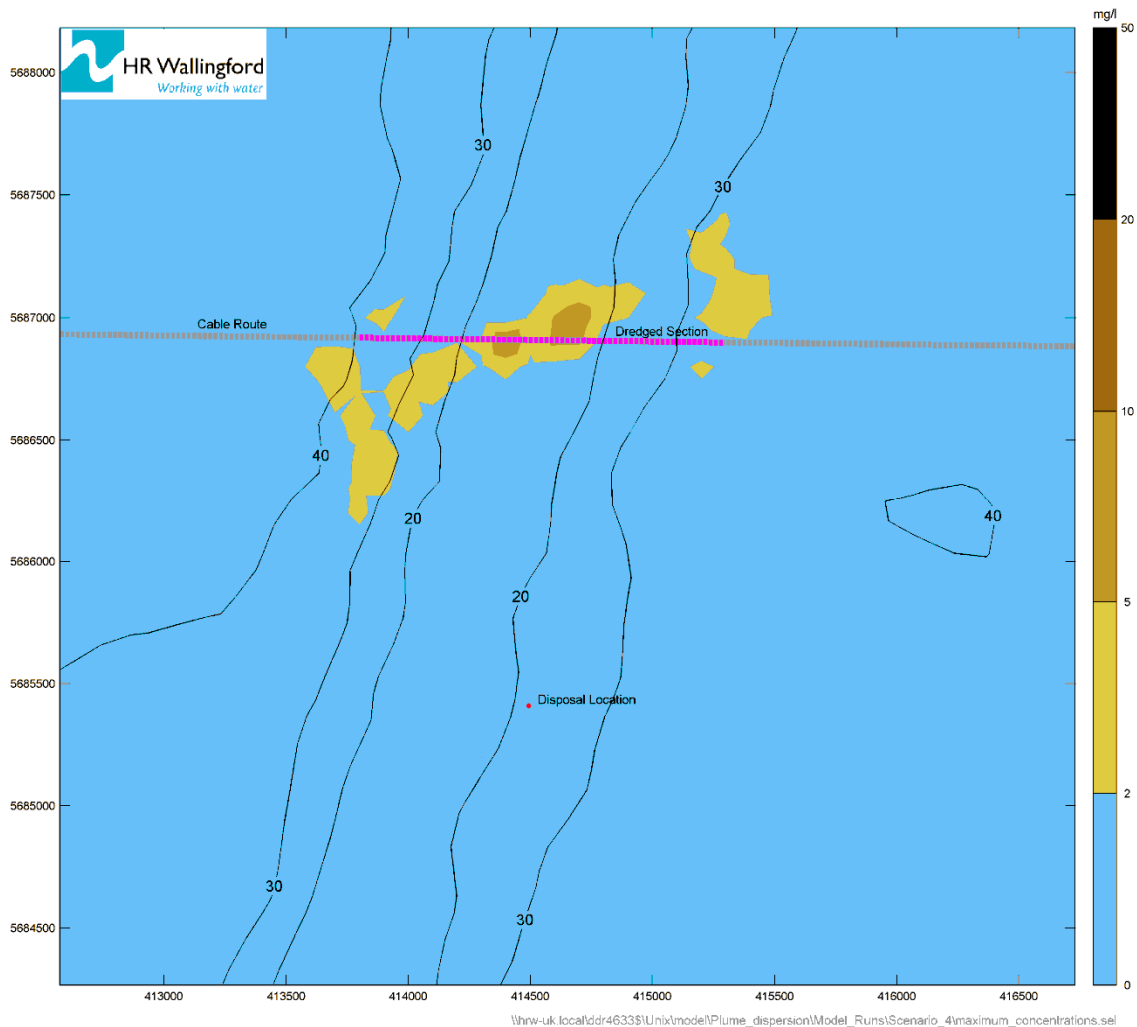


Figure 6-3-F : Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south

The figures show that the footprint of impact extends up to 500 m from the cable route but that at these distances the predicted increases in suspended concentration are less than 1 mg/l above background. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 250 m of the cable route. The peak predicted increase in concentration is about 30 mg/l.

Figures 6-3-E and 6-3-F also show that the plume of fine material arising from disposal produces concentration increases of around 2 mg/l of fine material (< 63 µm) owing to the small amount of fines released. There will however be considerably more coarse sediment released than fine sediment and concentration increases will be of the order of 1000s mg/l within one hundred metres of the point of disposal over a period of around ten minutes while these coarser particles settle to the bed.

Deposition of fine sediment is predicted to be less than 0.1 mm and so is considered to be **negligible**. Any sandy sediment released from the dredger is estimated to fall to the bed within 200-400 m of the cable route and within 100 m of the point of disposal.

Increased turbidity from suspended sediments during dredging and disposal are therefore considered to cause potential **minor** impacts on water quality.

6.3.3.5. Scenario 5 – Jetting sand in UK waters

The release rate corresponding to jetting in the sandy conditions of UK waters, is about 2 kg/s or less. The release rate is much lower for these sandy substrates compared to muddy conditions, because of the low fines content (i.e. the small proportion of particles less than 63 µm in diameter) of the sand. A release rate of 2 kg/s corresponds roughly with the release rate resulting from ploughing of chalk. The predicted deposition arising from fine sediment plumes with such a low release rate can be deduced to be **negligible** on the basis of the simulations undertaken in this study. On this basis we used the result from simulation of chalk ploughing (Scenario 2) to give reasonable approximation of the increase in suspended sediment concentrations from fine sediment plumes caused by dredging sand.

6.3.3.6. Contaminants

Most contaminant levels in the vibrocore samples at the UK landfall area are relatively low, with the exception of some elevations of arsenic and a singular hotspot of organotin compounds. Arsenic is a naturally occurring chemical element that is normally found in small amounts. Arsenic concentrations in estuarine sediments from England and Wales range over three orders of magnitude. Enrichment of arsenic can occur either from natural biogeochemical processes or due to anthropogenic sources (e.g. mining activities). The arsenic levels found are only slightly above CEFAS's guideline Action Level 1 for arsenic (20 mg/kg dry weight) and well below Action Level 2 (100 mg/kg dry weight) for the disposal of dredged material. Ploughing or jetting will resuspend sediments in a localised area. However, the resuspension will be local and for a very short period of time during the cable installation phase or potentially during the decommissioning, should the cable be removed from the seabed. Natural biogeochemical reactions can result in the release of arsenic to the water column when redox conditions are altered (from the presence of oxygen for example) and, if released, the speciation of arsenic will then be an important factor related to its toxic and mobile behaviour. It is not possible to quantify the release due to the dynamic nature of the marine environment, i.e. a number of parameters which fluctuate, such as salinity, iron content and redox potential. Considering these points on the behaviour of arsenic and the fact that the levels are elevated for only some of the locations, it is considered that the ploughing or jetting process will not release significant contamination into the local environment. Organotin compounds decay upon prolonged exposure to elevated temperature and light, when in aerobic conditions and thus the resuspension of one small area of contamination will affect only the immediate locale and will not persist. The impact of contaminants on water quality in the coastal area is therefore considered to be of **minor** significance. As discussed in the baseline section, it is considered that sediments further offshore are unlikely to contain significant levels of contamination and therefore the impact of contaminants on water quality in the offshore area is predicted to be **negligible**.

6.3.3.7. Heat emissions

Operation of the cables will result in some heat being emitted from the cable. Such losses as heat reduce the efficiency of the cable system; the cable design will be optimised to maximise the efficiency of the cable system thereby reducing heat emissions. Any heating effects will be very local to the cable and the sediment surrounding it. Transmission of heat through to the marine environment will be minimal and the presence of sea water will aid the dissipation of any heat produced. Elevated temperatures will therefore be very localised and during the operation of the cable, impacts on water quality are considered to be **minor**.

6.3.3.8. Accidental contamination

Accidental contamination is a risk to the project, however, with good practice and observation of MARPOL regulations, this risk should be managed to be as low as reasonably practical (ALARP), during the installation, operation and decommissioning phases. It is therefore not considered within potential impacts, but is noted here in order to provide completeness of consideration.

6.3.4. Mitigation

The pre-sweeping operations have been designed to trench only through the seabed features where judged necessary, which minimises disturbance and resuspension of sediments and any associated contaminants from dredging and disposal.

The cable will be designed for maximum efficiency and therefore minimise any excessive heat losses.

6.3.5. Residual impact

The impacts predicted are of minor significance, as the water quality is expected to be impacted only in localised low value receptor areas, will recover quickly and high value receptors will not be affected. Impacts are also predicted to remain **minor** after mitigation measures.

This chapter has aimed to determine the potential impacts in relation to water quality caused by the development and disturbance to the seabed sediments. Once the contract has been awarded for the installation work and the full engineering design has been undertaken and finalised, an assessment will be completed in relation to the potential effects on ecological and chemical status in Pegwell Bay (as covered within the South East River Basin Management Plan). This will be undertaken in line with the parameters set out in the Environment Agency Guidance (Clearing the Waters: Marine Dredging and the Water Framework Directive Stage Two, the Scoping Process – April 2010).

6.3.6. References

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7. Biological Environment

7.1. Conservation Designations

The Project has the potential to affect areas designated for nature conservation in terms of habitat and the species protected within them in the following ways:

- Direct impacts on species through location and installation of landfall, onshore and offshore works;
- Direct impacts on habitat/species from offshore and onshore cabling;
- Indirect impacts of disturbance or habitat loss associated with installation work and operation; and
- In-combination effects with other developments.

The following section provides information on sites that are protected under European Directives or British legislation, that are located near to or could be directly or indirectly affected by the scheme. This also includes potential cumulative effects from other schemes. It should be noted however that this section only concerns biological designations and has not considered areas prioritised for their landscape or amenity value (such as Areas of Outstanding Natural Beauty). Habitats Regulations Assessment signposting can be found in Appendix 5.

7.1.1. Baseline Data Sources

Data to inform the conservation designations section has been sourced from the following locations:

- Joint Nature Conservation Committee (JNCC) website (<http://www.jncc.gov.uk>);
- Natural England's Nature on the Map Website (<http://www.natureonthemap.gov.uk>);
- Multi Agency Geographical Information for the Countryside (MAGIC) database (<http://www.magic.gov.uk>);
- Balanced Seas Project;
- Natural England;
- Ramsar Website (<http://www.ramsar.org.uk>) and;
- Kent Wildlife Trust (KWT).

7.1.2. Baseline

There are a range of international and national statutory designations that vary in their level of importance and protection located in the Project area. Statutory and non statutory local designations have also been considered based on the available information. The designated areas that have been considered are defined and summarised below and shown in Figure 7-1-1.

7.1.2.1. Special Areas of Conservation

Special Areas of Conservation (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 in Annexes I and II of the Habitats Directive. If an activity has the potential to have a significant adverse impact on the conservation features for which the SAC 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'.

There are two SACs located within the study area, Sandwich Bay and Thanet Coast, details of which are shown in Table 7-1-1.

7.1.2.2. Special Protection Area

A Special Protection Area (SPA) is site of international conservation importance for birdlife designated under the EC Birds Directive (79/409/EEC). The requirement for Appropriate Assessment, briefly described above, also applies to SPAs. 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, both SPAs in close proximity to the proposed project site and those SPAs designated for target species whose foraging ranges overlap with the site have been included in the table.

There is one SPA that could potentially be impacted by the Project, Thanet Coast and Sandwich SPA, which is listed in Table 7-1-2 and considered in detail in Chapter 7.2 – Ornithology.

7.1.2.3. Ramsar Sites

Ramsar sites are designated under the Convention of Wetlands, which requires member states to designate wetlands that meet the criteria for inclusion on the List of Wetlands of International Importance (Ramsar list). The only Ramsar site that has the potential to be affected by the Project is Thanet Coast and Sandwich Bay Ramsar Site, details of which are shown in Table 7-1-1.

7.1.2.4. Sites of Special Scientific Interest

A Site of Special Scientific Interest (SSSI) is an area of land or water designated 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. In the majority of cases the seaward boundary of coastal SSSIs have been demarcated by Mean Low Water (MLW), although some have been notified with boundaries which extend seawards of MLW. Although there are SSSIs in the vicinity of the proposed project, in particular Sandwich Bay to Hacklinge Marshes SSSI, there are none that extend below MLW or include submerged habitats.

The SPA and SACs discussed above are also underpinned through designation as SSSIs. In the area of the Project the relevant SSSI is Sandwich Bay to Hacklinge Marshes SSSI. This site has been designated for the most important sand dune system and sandy coastal grassland in South East England. It includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. It also supports outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded.

It is also an important landfall for migrating birds and also supports large wintering populations of waders, some of which regularly reach levels of national importance.

7.1.2.5. National Nature Reserve

A National Nature Reserve (NNR) is a nationally important area designated under the National Parks and Access to the Countryside Act 1949, or under the Wildlife and Countryside Act of 1981. NNRs are set up to conserve and allow people access to the fauna, flora, or geological features of special interest.

There is one NNR located within the project area, Sandwich and Pegwell Bay NNR that has been designated for its habitats. These include eroding chalk cliffs and wave cut platforms to the north of Pegwell Bay, intertidal mudflats, developing beaches, sand dunes and saltmarsh. Semi-natural habitats include ancient dune pasture and coastal scrubland while the re-created grassland of the Pegwell Bay Country Park, along with ponds, dykes and ditches are artificial habitats.

The intertidal mudflats support nationally and internationally important numbers of waders and wildfowl, both on migration and over-winter. The sand dunes and ancient dune pasture contain large numbers of southern marsh orchid, marsh helleborine, pyramidal orchid and the occasional lizard orchid.

7.1.2.6. Local Nature Reserve

A Local Nature Reserve (LNR) is a statutory designation made under Section 21 of the National Parks and Access to the Countryside Act 1949 by principal local authorities. LNRs protect habitats and species and help forge partnerships between the local authority, nature conservation organisations and the community. The nearest LNR to the project is Prince's Beachlands LNR.

It should be noted that this section only concerns biological designations and has not considered areas prioritised for their landscape or amenity value (such as Areas of Outstanding Natural Beauty (AONB)).

7.1.2.7. Marine Conservation Zones

A Marine Conservation Zone (MCZ) is a protected area created under the Marine and Coastal Access Act 2009 that will protect inshore and offshore areas to complement existing Marine Protected Areas such as SACs and SPAs. The purpose of the MCZs is to protect nationally important marine wildlife, geology and geomorphology. The bodies responsible for MCZs within the project area are Natural England and the Joint Nature Conservation Committee, who in turn seek guidance from Balanced Seas, a regional body created to make recommendations specifically for the waters off the South East England.

Originally, the Balanced Seas project put forward a list of draft Marine Conservation Zones (dMCZ) and, within these draft Reference Areas (dRAs). Consultation was completed in respect of the dMCZs and a revised list of 31 recommended MCZs (rMCZ) and recommended Reference Areas (rRAs) have now been put forward. Impact Assessments have been ongoing since October 2011 and Natural England and the JNCC collated the outputs. It is important to note that rMCZ status does not necessarily mean that the site will become an MCZ (and likewise with rRAs). Furthermore, MCZ status will not automatically preclude development in a given area. Rather the development must not disturb the designated species or habitat. However, Reference Area status would include a blanket ban on all development within its boundaries.

There are four rMCZs in proximity to the Project, one of which lies across the cable route (Goodwin Sands rMCZ). The Project does not fall within any areas currently put forward as rRAs; the only rRA in close proximity to the Project is the Goodwin Knoll rRA (within the Goodwin Sands rMCZ), which lies approximately 1 km to the south of the Project. Figure 7-1-1 shows all rMCZs and rRAs that are in close proximity to the Project and Table 7-1-1 provides further detail.

Site Name	Grid Reference	Area (ha)	Approximate Proximity to Project (km)	Qualifying Interest
Goodwin Sands (rMCZ 8)	ETRS89 N51 15' 23.836" E1 35' 11.227" N51 15.397' E1 35.187'	27691	Project overlaps with the northern extent of the rMCZ.	Broad-scale habitat types present qualifying for designation within Goodwin Sands are: Moderate energy infralittoral rock, moderate energy circalittoral rock, sub-tidal coarse sediment, and sub-tidal sand. Habitat FOCI are blue mussel beds and rosworm (<i>Sabellaria spinulosa</i>) reef.
Goodwin Knoll (rRA6)	ETRS89 N51 16' 47.126" E1	2318	1 km	Qualifying broad-scale habitat types present within Goodwin Knoll are sub-tidal coarse sediment and sub-tidal

Site Name	Grid Reference	Area (ha)	Approximate Proximity to Project (km)	Qualifying Interest
	32' 33.767" N51 16.785' E1 32.563'			sand. It is important as a haul-out area for seals and a foraging ground for birds.
Thanet Coast (rMCZ 7)	ETRS89 N51 22' 40.556" E1 22' 44.002" N51 22.676' E1 22.733'	6279	2 km	Features proposed for designation are broad-scale habitat types: moderate energy infralittoral rock, moderate energy circilittoral rock, sub-tidal coarse sediment, sub-tidal sand and sub-tidal mixed sediments. Habitats of conservation interest are; blue mussel beds, peat and clay exposures, rosworm (<i>Sabellaria spinulosa</i>), sub-tidal chalk and sub-tidal sands and gravels. Species of conservation interest are: St John's jellyfish and Kaleidoscope jellyfish.
Offshore Foreland (rMCZ 9)	ETRS89 N51 7' 43.961" E1 41' 9.693" N51 7.733' E1 41.162'	25249	4 km	Broad-scale habitat types present within Offshore Foreland qualifying for rMCZ are: high energy infralittoral rock, high energy ciralittoral rock, moderate energy circalittoral rock, sub-tidal coarse sediment and sub-tidal sands.
Dover to Deal (rMCZ 11)	ETRS89 N51 9' 21.617" E1 23' 32.638" N51 9.360' E1 23.544'	1040	12 km	Features proposed for designation are: broad-scale habitats; moderate energy intertidal rock, intertidal coarse sediment, intertidal mud, high energy infralittoral rock, moderate energy infralittoral rock, sub-tidal coarse sediments and sub-tidal mixed sediments. Habitat FOCI in this area are blue mussel beds, intertidal underboulder communities, littoral chalk communities, subtidal chalk and rosworm (<i>Sabellaria spinulosa</i>) reef.

Table 7-1-1 : rMCZs and rRAs in the vicinity of the cable route

The areas described above, rMCZs and rRAs, are assessed within Chapter 7.4 - Benthic and Intertidal Ecology along with Annex I Habitats

A summary of the designated areas with the potential to be affected by the proposal are listed in Table 7-1-2.

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Thanet Coast and Sandwich SPA (UK9012071)	634735E 161127N	1870.16	28/07/94	The site supports an important wintering population of turnstone (<i>Arenaria interpres</i>), 940 individuals representing at least 1.3% of the wintering Western Palearctic - wintering population (5 year peak mean 1991/2 - 1995/6). Also supports a wintering population of golden plover (<i>Pluvialis apricaria</i>) and breeding colony of little terns (<i>Sterna albifrons</i>). The SPA also has supports the following habitats; mesophile grassland, tidal rivers, estuaries, sand flats, lagoons, coastal sand dunes, shingle, sea cliffs and improved grassland.

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Sandwich Bay SAC (UK0013077)	635450E 161750N	1137.87	08/01/96	<p>Primary reason for designation of the site is the presence of several types of marine habitat detailed under Annex I of the Habitats Directive – Embryonic shifting dunes, shifting dunes along the shoreline with <i>Ammophila arenaria</i> (“white dunes”), fixed dunes with herbaceous vegetation (“grey dunes”), and dunes with <i>Salix repens</i> ssp. <i>argentea</i> (<i>Salicion arenariae</i>).</p> <p>The Annex I Habitat humid dune slacks is also a qualifying feature of the site.</p>
Thanet Coast SAC (UK0013107)	634288E 170421N	2,803.84	14/10/96	<p>Thanet Coast SAC Designated due to the presence of two types of marine habitat detailed under Annex I of the Habitats Directive – reefs and submerged or partially submerged sea caves.</p>
Thanet Coast and Sandwich Bay Ramsar Site (Ramsar Site No. UK11070)	635667E 161632N	2,169.23	28/07/94	<p>A coastal site, consisting of a long rocky shore, adjoining estuary, dune, maritime grassland, saltmarsh, and grazing marsh. The site supports internationally important numbers of wintering turnstone (<i>Arenaria interpres</i>), and four waders occurring at nationally important levels: ringed plover, golden plover, gray plover and sanderling. Large numbers of migratory birds use the site for staging. Large numbers of nationally scarce invertebrate species occur at the site (supports up to fifteen British Red Data Book wetland invertebrates. Human activities include recreation, bait collection, agriculture, livestock grazing, fishing, and hunting.</p>
Sandwich Bay to Hacklinge Marshes SSSI	635350E 158550N	1756.5	1951	<p>The SSSI contains the most important sand dune system and sandy coastal grassland in South East England.</p> <p>Includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland.</p> <p>Outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded.</p> <p>Invertebrates are also of interest with recent records including 19 nationally rare, and 149 nationally scarce species.</p> <p>Important landfall for migrating birds and also supports large wintering populations of waders, some of which regularly reach levels of national importance.</p> <p>Cliffs at Pegwell Bay are of geological interest.</p>

Site Name	Grid Reference	Area (ha)	Date Designated	Qualifying Interest
Sandwich and Pegwell Bay NNR	635490E 163517N	629.31	Not Known	Natural habitats include: eroding chalk cliffs and wave cut platforms to the north of Pegwell Bay, intertidal mudflats, developing beaches, sand dunes and saltmarsh. Semi-natural habitats include; ancient dune pasture and coastal scrubland while the re-created grassland of the Pegwell Bay Country Park, along with ponds, dykes and ditches are artificial habitats. The intertidal mudflats support nationally and internationally important numbers of waders and wildfowl, both during migration and over-winter. The sand dunes and ancient dune pasture contain large numbers of southern marsh orchid, marsh helleborine, pyramidal orchid and the occasional lizard orchid.
Prince's Beachlands LNR	635190E 161729N	6.15	Not Known	No information regarding this designated area has been received from Dover District Council.

Table 7-1-2 : Conservation Designations

7.1.3. Description of potential impacts

The potential impacts on the receptors identified in this section, the designated sites, are listed below for all phases of the proposed development; installation, operation and decommissioning. A detailed impact assessment is included in Appendix 6 with a summary shown below.

The definition of receptor values is shown in Table 7-1-3 below. These values take into account sensitivity, recoverability and importance.

Receptor Value	Definition
High	A site of international importance such as a SPA, SAC or Ramsar site. By definition the sites or qualifying features are considered to be of the highest sensitivity and rarity and could be destroyed or irreversibly damaged by the effect. Effects on the sites and their qualifying features could be irreversible and/or take considerable time to recover.
Medium	A site of national importance such as a SSSI or NNR. By definition the sites or qualifying features are considered to be sensitive but are likely to be less susceptible to damage and irreversible effects. Effects on the sites and their qualifying features could be significant but are likely to recover with time.
Low	A site of local importance such as a LNR. By definition the sites or qualifying features are considered to be less sensitive and effects are less likely to result in significant damage and irreversible effects. Effects on the sites and their qualifying features are likely to be tolerable and less likely to be significant. Site will recover.

Table 7-1-3: Receptor Value Definitions

7.1.3.1. Cable Installation

The main impacts associated with the installation phase will be those direct impacts associated with the laying of cables and open trenching works that could destroy or displace habitats and flora and fauna that are qualifying features of the designations. The cable trench in the intertidal area is expected to be 1-2 m wide and approximately 2-3 m deep. The cable laying process however, is temporary in nature and likely to take approximately 2 months to complete (within British waters)

although the potential effects as a result of habitat and species disturbance will be longer lasting due to the removal of vegetation.

Based on this information it is predicted that the cable installation could have a **moderate** impact on internationally and nationally designated sites, prior to application of mitigation. This has been based on a review of the sensitivity of the habitats, which are designated as internationally and nationally important areas for the flora and fauna they support. However, it is also considered that the habitats affected, mud and sand flats are likely to recover quickly following disturbance and these effects are temporary and short term in nature. Mitigation is available to reduce the impact and this is discussed in Section 7.1.4 below.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2 - Ornithology.

7.1.3.2. Cable Operation

Whilst there will be maintenance requirements for the cable and at the landfall location it is considered that these will be temporary in nature and will be localised to the areas in question. Maintenance works are likely to last a matter of days for ongoing surveys to monitor the cable with any remedial or repair works taking no more than a couple of weeks. It is considered that these will result in very moderate or minor impacts (depending on the status of the designation) on all designated areas and are therefore considered **not significant**.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2.

7.1.3.3. Decommissioning

The degree of impact for decommissioning will depend on the level of works required; complete removal of the cable will result in a higher magnitude of impact than leaving the cable insitu. Based on a worst case full removal of the cable the level of impact will be similar to that of the installation phase; a **moderate** impact on internationally designated sites and **minor** impact on nationally and locally designated areas. This has been based on the fact that the internationally designated areas are of the highest sensitivity based on its qualifying features whilst the nationally designated areas are less sensitive. It is considered that the habitats will take longer to recover if the cables were removed during decommissioning rather than left in situ.

The potential impacts to the ornithological interests and qualifying features of the designated features will be considered within Chapter 7.2.

7.1.4. Mitigation

7.1.4.1. Installation

Avoidance of the most sensitive habitats, such as high quality saltmarsh (discussed in the terrestrial conservation designations chapter) has been used to minimise the magnitude of impact. The landfall selected is located at the Service Station area, close to the landfall for the Thanet Offshore Wind Farm which is not located within a designated area.

Installation in the intertidal areas in the bird nesting and wintering periods will occur outside of the most sensitive periods where practical to ensure impacts upon ornithology are reduced as far as possible.

7.1.4.2. Cable Operation

Maintenance activities during the operational phase should take into account the qualifying features of the designations and works should be planned to minimise disturbance and damage. This should also include indirect effects caused by the vehicles and plant (such as access and generation of noise emissions).

7.1.4.3. Decommissioning

It is recommended that decommissioning of the project allows for the cable to be de-energised and remain in situ to minimise the level of disturbance on designated areas.

7.1.5. Residual impact

7.1.5.1. Installation

The cable route has been located away from the most sensitive areas based on the qualifying features of the designations, namely the high quality saltmarsh and ornithological interests. The likelihood, therefore, of potential impacts on the sites is reduced. In the case of disturbance to SPAs and SACs, the impact on internationally designated areas will be of **minor** significance (in terms of the EIA regulations) due to the limited extent and duration of the works and the fact that the cable route avoids the most sensitive habitats and features of the site. This is supported by the positive consent determination for the Thanet Offshore Wind Farm cable installation and anecdotal evidence regarding recovery of the local area.

7.1.5.2. Decommissioning

If the cable remains in situ in the intertidal area, it is likely to have **no impact** on the qualifying features of the designations.

7.2. Ornithology

7.2.1. Data, information and guidance

The following sources of data and information have been used to inform the baseline summary in this report.

- JNCC website for details of Special Protection Areas (SPAs) including site information and designation details
- Kent Wildlife Trust (KWT) - Consultation meeting with KWT provided information on ecological sensitivities at Sandwich and Pegwell Bay National Nature Reserve (NNR), Thanet Coast and Sandwich Bay SPA and Ramsar site, Sandwich Bay Special Area for Conservation (SAC) and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI)
- The UK Offshore Energy Strategic Environmental Assessment (Department for Energy and Climate Change (DECC), 2009)
- The Wetland Bird Survey (Holt *et al*, 2009)
- The Joint Nature Conservation Committee (JNCC) atlas of seabird distribution in north-west European waters (Stone *et al*, 1995) and
- A wintering bird survey undertaken to for the project to inform cable routeing and EIA (Appendix 8).
- Pegwell Bay inter-tidal sediment and invertebrate surveys (Appendix 9)
- Pegwell Bay breeding bird and redshank nesting survey (Appendix 10)
- Thanet Offshore Wind Farm Environmental Statement (2005)
- JNCC Seabirds at Sea database

It is understood that Kent Wildlife Trust and Natural England have been carrying out surveys to determine potential causes of disturbance to the local bird populations at Pegwell Bay, with surveys carried out each month. Although this study was not concluded in time for inclusion in the Environmental Statement, interim results and species data were available. A local ornithological group “Planet Thanet” also undertakes regular informal surveys of the area and produces annual reports.

7.2.2. Baseline overview

7.2.2.1. Intertidal Bird Species

The area surrounding Pegwell Bay is used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn. These include nationally important numbers of ringed plover (*Charadrius hiaticula*) and greenshank (*Tringa nebularia*) during their migration and red-throated diver (*Gavia stellata*) during the winter period. The area is also of importance for several other species including wintering populations of dunlin (*Calidris alpina*), curlew (*Numenius arquata*), oystercatcher (*Haematopus ostralegus*), redshank (*Tringa tetanus*), sanderling (*Calidris alba*) and grey plover (*Pluvialis squatarola*) as well as breeding populations of shelduck (*Tadorna tadorna*), redshank (*Tringa tetanus*) and oystercatcher (*Haematopus ostralegus*).

The proposed location of the cable landfall area is protected by several conservation designations (as detailed in Chapter 7.1 – Conservation Designations). In relation to ornithology, it is designated as an SPA and a Ramsar site and it is also classified as an Important Bird Area (IBA). There is a level of overlap between the birds covered under different designations, however the SPA and Ramsar sites note all nationally important bird species.

Thanet Coast and Sandwich Bay SPA

Thanet Coast and Sandwich Bay SPA consists of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (JNCC, 2001). Specifically the area is designated for supporting over-wintering populations of European importance of turnstone (*Arenaria interpres*) and golden plover (*P. apricaria*), and a breeding population of little tern (*Sterna albifrons*) as shown in Table 7-2-1 below (JNCC, 2006).

Thanet Coast and Sandwich Bay Ramsar Site

Thanet Coast and Sandwich Bay Ramsar site covers a similar area to the SPA, covering 2169 hectares. The wetland habitats support 15 British Red Data Book invertebrates, as well as a large number of nationally scarce species (Bratton, 1991). The site attracts nationally important numbers overwintering bird populations including Lapland buntings (*Calcarius lapponicus*) and several wader species; ringed plover, golden plover, grey plover and sanderling. The site is used by large numbers of migratory birds. The following species occur at levels of national importance during migration periods in spring and autumn (JNCC, 2008):

- Ringed plover, 649 individuals representing 2% of the Great British (GB) population
- Common greenshank, 35 individuals representing 5.8% of the GB population.

The following species occur at nationally important levels in winter (JNCC, 2008):

- Red-throated diver, 57 individuals, representing an average of 1.1% of the GB population
- Great crested grebe (*Podiceps cristatus cristatus*), 218 individuals, representing an average of 1.3% of the GB population
- European golden plover, 4190 individuals, representing an average of 1.6% of the GB population
- Sanderling 598 individuals, representing an average of 2.9% of the GB population.

Species	Period of use	Numbers at SPA	Percentage of population	Qualification
Turnstone (<i>Arenaria interpres</i>)	Winter	940 individuals	1.4% of wintering Western Palearctic population	Article 4.2 (79/409/EEC)
Golden Plover (<i>Pluvialis apricaria</i>)	Winter	411 individuals	0.2% of British Population	Article 4.1 (79/409/EEC)
Little Terns (<i>Sterna albifrons</i>)	Breeding season	6 breeding pairs	0.3% of British population	Article 4.1 (79/409/EEC)

Table 7-2-1 : Annex I bird species regularly occurring at Thanet Coast and Sandwich Bay SPA (JNCC, 2006)

The most numerous bird species recorded during the winter bird survey, carried out in 2008 and 2009, included lapwing and golden plover followed by dunlin and oystercatcher (TEP, 2010). The survey identified a number of specific areas within Pegwell Bay that are used regularly by certain wader and wildfowl species for roosting or feeding. These areas are listed below and shown on Figure 7-2-1:

- The mudflats near the north bank of the River Stour
- The large area of saltmarsh immediately to the east of Stonelees
- Shellness
- Saltmarsh and grazing marsh on the south bank of the River Stour
- The mudflats at the south-east end of Pegwell Bay.

It is likely that the distribution of wader species is dictated by the abundance of invertebrate prey species. The Inter-tidal Sediment and Invertebrate Survey (Appendix 9) recorded 42 different invertebrate taxa and distinct areas of Pegwell Bay could be identified based on the invertebrate

species identified there. However, certain species had widespread distributions within the bay including annelid species and the common cockle (*Cerastoderma edule*), which was found to be widespread and abundant, and they are considered important prey for several wader species. Pegwell Bay and Stonelees are also considered to have local importance for breeding birds with 34 bird species observed during the 2009 breeding bird survey (Appendix 10). The table below summarises species information for birds that occur at nationally or internationally important levels at the SPA and Ramsar sites discussed above.

Bird Species	Species Information
Little Tern	Little tern traditionally nest at Shell Ness in Pegwell Bay approximately 800m south of the cable route. They tend to nest in small, single-species colonies on areas of shingle and sand. It has been observed through the ongoing surveys undertaken by KWT and other groups that numbers of little terns have been decreasing dramatically in recent years and this is thought to be largely as a result of increased disturbance (not solely due to recreation but this has triggered the introduction of control measures). Little terns are not present in the UK during the winter months as they overwinter off the coast of Africa, however a survey visit was undertaken in May to include the spring migration period. In addition to their breeding grounds little tern feed in the shallow coastal waters on small fish (e.g. sand eel, pipefish, and gobies) and crustaceans (shrimps, prawns and crabs). When the tide is in, feeding activity occurs in the Sandwich and Pegwell Bay area and in the lower reaches of the River Stour (Dover District Council, 2010).
Turnstone	Turnstone feed on sandy beaches and rocky shores along the north-east Kent coast particularly in areas of loose stones or seaweeds. Their preferred food includes peeler crabs, small crustaceans such as shrimps, and barnacles, as well as marine molluscs such as periwinkles. They may continue to forage at high tide on areas of washed up weed at the tideline. Roosting within the SPA occurs from Swalecliffe to Pegwell Bay mainly on areas of sand and shingle but also on man-made structures such as the sea wall. Additionally, some birds roost on fields at the top of the cliffs and other areas of open space landward of the boundary of the SPA (Dover District Council, 2010).
Golden Plover	Golden plover overwinter on land around Sandwich Bay. In recent years golden plover have taken to roosting in large numbers on the intertidal mudflats of the bay itself. It is likely that, whilst there, some feeding takes place but this is not their prime feeding habitat. Their main feeding habitat is arable fields and grazing marsh located inland of the dunes of Sandwich Bay. Mudflats and sandflats in Pegwell Bay and Sandwich Bay provide roosting grounds for golden plover (Dover District Council, 2010).
Ringed Plover	Ringed Plover breed and overwinter on beaches around the British coast line. In Pegwell Bay significant numbers of ringed plover pass through during migratory periods travelling to and from Canada and Greenland (RSPB, 2011). Over winter they are not observed in high numbers in the Bay but when they were seen, they appear to feed near the mouth of the River Stour (Appendix 8). They eat spiders and flies as well as marine worms, crustaceans and molluscs.
Greenshank	Migrating greenshank can be found in Pegwell Bay mostly in April and May and between July and September while travelling to and from African wintering grounds (RSPB, 2011). They are rarely seen in the bay in winter and were not observed during the Winter Bird Survey (Appendix 8). Greenshank tend to feed on worms, snails and fish (RSPB, 2011).
Red-throated Diver	Red-throated divers are known to breed mainly on the Shetland Islands, Orkney, the northern Scottish coastline and the Outer Hebrides (RSPB, 2011). Outside of the breeding season they are numerous along the East coast of Britain and they are known to over winter in Pegwell Bay. Only four individuals were observed during the TEP Winter Bird Survey (2010a) and these were seen towards the middle of the bay, swimming south. They feed on a wide range of fish species.
Great Crested Grebe	Numbers of great crested grebe peak within the Thanet Coast and Sandwich Bay Ramsar site during winter, however, no individuals were observed in Pegwell Bay during the Winter Bird Survey suggesting individuals tend to reside elsewhere within the Ramsar site (Appendix 8). Great crested grebe dive to catch fish as well as to escape, tending to prefer this to flying.
Sanderling	Sanderling breed in the Arctic but overwinter in the UK in places such as Pegwell Bay. Over 100 individuals were observed in Pegwell Bay during the Winter Bird Survey (Appendix 8). The birds were observed in various locations, appearing not to be restricted to certain areas of the bay. They feed on small marine worms, crustaceans and molluscs (RSPB, 2011).

Table 7-2-2 : Species information for Nationally and internationally important bird species

7.2.2.2. Current Disturbance of Intertidal Bird Species

KWT is currently undertaking a disturbance study in Pegwell Bay investigating factors that disturb waders and wildfowl in the bay. A sample of raw data that spanned 2010 was obtained and analysed by PMSS as the study has yet to be fully concluded. It was observed that on average motor boats caused the greatest disturbance to birds, tending to cause birds to fly more than 50m away from their original position or abandon the study area entirely. Predators, in the form of birds of prey and foxes, also caused a high level of disturbance, tending to cause birds to walk or fly short distances. When considering the most serious disturbance events, where birds have flown to a different position in the bay or abandoned it, it was found that the cause of many of these events was unknown however, of those disturbances where the cause was identified the majority (65%) appeared to be caused by walkers or walkers with dogs.

7.2.2.3. Offshore Bird Species

Areas further offshore are important as feeding and loafing areas, and migration routes. The JNCC Atlas of Seabird Distribution in northwest European Waters and the DECC Offshore Energy SEA (2009) indicate that the following species have been observed in the vicinity of the cable route.

Species	Likely period present
Red Throated Diver	October - March
Fulmar	All year
Gannet	All year but predominant in February to November, moving to the Channel over winter
Cormorants	All year
Velvet Scoter	January – April, October – December. Tend to be coastal species occasionally recorded offshore.
Red Breasted Merganser	November - April
Arctic Skua	August - October
Great Skua	All year
Little Gull	March – May, August to February
Black Headed Gull	All year
Common Gull	All year
Lesser Black Backed Gull	All year
Kittiwake	All year
Sandwich Tern	March – August. High densities found at coastal breeding sites in this period but some birds feed offshore. Birds become widely distributed outside of this period.
Guillemot	March – June, August, September - February. Guillemots are widespread in winter but generally at higher densities further north than the cable route.
Razorbill	October - June
Little auk	November - February

Source: JNCC atlas of seabird distribution in north-west European waters and DECC Offshore Energy SEA (2009)
Table 7-2-3 : Bird species potentially present along the cable route

7.2.3. Description of potential impacts

The table below provides details of how receptor value has been defined for the purposes of the impact assessment. The likely impacts on birds have been identified as:

- Disturbance to birds during the intertidal works
- Habitat contamination or loss

The section below assesses the level of impact before mitigation and the following sections discuss potential mitigation of the residual impact. A detailed description of the potential impacts is included in Appendix 6. The table below details how receptor sensitivity, recoverability and importance have been taken into account in determining significance of effect.

Receptor Value	Definition
High	Populations of national or international importance that are highly sensitive to the potential impact. The population will not return to its former level within several generations.
Medium	Populations of regional importance that are moderately effected by potential impact in terms of decline in abundance or change in distribution above that experienced under natural conditions, but does not threaten the integrity of the population(s). The population(s) will return to former levels within a few generations.
Low	Populations of local importance where the potential impact only causes small-scale or short term disturbances and no long term noticeable effects above the levels of natural variation. The impacts are not sufficient to be observed at population level.

Table 7-2-4 : Definition of receptor value

7.2.3.1. Cable Installation

Although there will be seabirds feeding offshore in the area of cable installation, it is not likely that the proposed cable installation will have a substantially greater impact on these bird species than the existing shipping already present in this area. It is predicted that the most likely impacts on bird species will occur in the intertidal area in Pegwell Bay and these impacts are discussed below.

Disturbance to Wader and Waterfowl Species in the Intertidal Area

Cable installation in the intertidal area will be undertaken by trenching across Pegwell Bay to a location just south of the service station (Figure 7-2-1). It is expected that the intertidal works will take approximately less than one week. Pegwell Bay forms part of Thanet Coast and Sandwich Bay SPA and Ramsar sites which are designated for nationally important numbers of ringed plover and greenshank as well as nationally or internationally important populations of over wintering golden plover, little tern, turnstone, red-throated diver and sanderling. The winter bird survey (Appendix 8) noted that the most numerous species feeding and roosting in Pegwell Bay were lapwing and golden plover, followed by dunlin and oystercatcher. The survey also identified a number of specific areas within Pegwell Bay that are likely to be particularly sensitive however, these are all located in the south of Pegwell Bay near the course of the River Stour which is approximately 900m from the cable route. As birds were found across the bay, the intertidal works will almost certainly cause some level of disturbance. This will most likely affect the birds in the immediate vicinity of the works and will only occur for the short period of time that the installation works are taking place in the bay (expected to be less than a week). The works will likely constitute a low level of change for birds considering that other activities such as dog walking and bait digging are also common in the bay. The receptor value has been defined as moderate due to the fact that Pegwell Bay forms part of Thanet Coast and Sandwich Bay SPA and Ramsar sites which support nationally and internationally important numbers of wader and waterfowl species and that these birds are sensitive to disturbance although they are likely to recover quickly. Based on this assessment, it is anticipated that the installation will have an impact of **minor** significance.

Pegwell Bay Country Park is believed to be of local importance for breeding bird species including redshank and whitethroat. The Breeding Bird and Nesting Redshank Survey (Appendix 10) identified a total of 34 bird species during the survey although it was noted that some species may not have been breeding in the survey area. The vast majority of nesting and breeding behaviours occur above

the high water mark and are more likely to be impacted by the onshore works and so will be discussed further in the onshore Environmental Statement. There is the possibility that the offshore works very near to the landfall could cause disturbance to nesting birds if completed during the breeding season. There were three redshank nesting areas identified by the survey in Pegwell Bay and one of these is located near to the landfall. At the closest point it will be just under 100m from the intertidal works. It is possible that the intertidal works may cause some disturbance to breeding birds for a very short period of time when the works are taking place in this area. Although the breeding birds will be very sensitive to disturbance, it is expected that the impact of the works taking place during the breeding season, will be of **minor** significance.

Loss of Prey Species

It is considered that the distribution of wader species is dictated by the abundance of invertebrate prey species. The Intertidal Sediment and Invertebrate Survey (Appendix 9) identified four distinct areas of Pegwell Bay based on the invertebrate species range and abundance. The cable route will pass through three of these areas. Certain species, including annelid species and the common cockle which are important prey for many wader species, were found to be abundant in several areas of the bay. The cable route will only disturb a very small proportion of the total prey species in the bay. The trench across the intertidal area is expected to be 1–2m wide and 2-3m deep. Furthermore, visual observations of the area where the Thanet Offshore Wind Farm cable was installed (also in Pegwell Bay) suggest that the area recovers well (meeting/pers comms with Natural England, March 2011) and so the loss of prey will only result in a low level of change and occur for a short period of time. Overall, it is expected that the magnitude of change will be low. Although, bird numbers of national and international importance visit the site, the loss of prey will account for only a small area of the bay and therefore bird species are unlikely to be sensitive to it and will have high recoverability. Based on this information it is expected that the impact on prey species is likely to be of **negligible** significance.

Habitat Contamination or Loss

As discussed above it is likely that any habitat loss will be highly localised and temporary in nature. There is, however, the possibility for accidental contamination of habitat by vessels or equipment associated with the installation. In such a situation, the incidence will be localised, infrequent and likely to dissipate or be neutralised by construction workers in a short period of time. Although, bird numbers of national and international importance are observed in the area and will be sensitive to habitat contamination, they are likely to have high recoverability. It has been assessed that the receptor value is moderate and it is likely that the overall impact will be of **minor** significance.

7.2.3.2. Cable Operation

Habitat Contamination or Loss

As discussed above it is likely that any habitat loss will be highly localised and temporary in nature. It is expected that the cable will be relatively benign during operation and have no impact on habitat. There is, however, the possibility for accidental contamination of habitat or individuals by associated vessels or equipment, including failure of the integrity of the cable. However, it is likely that any contaminations will be localised and likely to dissipate or be neutralised by maintenance workers in a short period of time. On this basis, it is likely that any impact will be of minor significance.

7.2.3.3. Decommissioning

In the event that the cable is removed, it is likely that any impacts during decommissioning will be similar to those experienced during installation. Once the project is in operation decommissioning options will be periodically re-evaluated via a decommissioning plan.

7.2.4. Mitigation

Disturbance to Wader and Waterfowl Species in the Intertidal Area

The Winter Bird Survey (Appendix 8) states that Pegwell Bay bird populations will be most sensitive to disturbance during the periods from October to February (lapwing, golden plover, turnstone and grey plover) and in May (turnstone, sanderling and grey plover). Therefore, if practicable, installation activities in the intertidal area will be timed to avoid these periods. The installation works in the intertidal area will be completed in as short a period as possible to further reduce disturbance to birds.

Disturbance to breeding birds

The Environmental Management Plan (EMP) that will be produced prior to installation commencement will detail sensitive areas that will be fenced off to avoid installation work accidentally entering them and causing unnecessary disturbance to birds. The main breeding period for redshank is from mid April to July. If practicable, the intertidal works will avoid this period and if it is not practical, the Project will then attempt to avoid the most sensitive periods within the breeding season.

Habitat Contamination or Loss

Standard construction and environmental best practice will be used to minimise the likelihood of contaminants being released. This will be documented in an EMP that will be issued to the Contractor prior to the commencement of the installation phase. The contents of the EMP will be strictly adhered to by the Contractor to ensure that contaminants are not released but should, in the unlikely event, a pollution event occur a robust response plan will be initiated.

7.2.5. Residual Impact

Disturbance to Wader and Waterfowl Species in the Intertidal Area

If installation activities can be restricted to periods when overwintering birds are not frequently present in the bay, it becomes unlikely that the installation works will affect these species of national and international importance. Although there may be other birds present, the most sensitive species will be unlikely to be impacted upon by the installation and therefore the significance of the impact is reduced to minor.

Disturbance to Breeding Birds

Although the mitigation measures discussed above may reduce the likelihood of disturbance to birds, the significance of the impact will remain minor as the receptor value is moderate.

Habitat Contamination or Loss

By ensuring strict adherence to the EMP, the likelihood of an accidental contamination event and duration will be reduced. It is likely that the significance of the impact will remain minor.

7.2.6. References

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3. JNCC (2001). SPA Description: Thanet Coast and Sandwich Bay. [online] JNCC; Peterborough. Available at: [<http://www.jncc.gov.uk/default.aspx?page=2045>] Accessed 16/03/2011

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5. JNCC (2008) Information Sheet on Ramsar Wetlands (RIS): Thanet Coast and Sandwich Bay. JNCC; Peterborough
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7. TEP (2010a) UK-Belgium interconnector project Nemo; winter bird survey. National Grid Ltd; Warwick (Ref TEP 1430.01.024 r1)
8. TEP (2010b) UK-Belgium interconnector project Nemo; intertidal sediment and invertebrate surveys. National Grid Ltd; Warwick (Ref TEP 1430.01.027 r1)
9. TEP (2010c) UK-Belgium interconnector project Nemo; breeding bird survey and redshank nesting survey. National Grid Ltd; Warwick (Ref TEP 1430.01.025 r1)
10. DECC (2009) Offshore Energy SEA. DECC; London.

7.3. Marine Mammals

7.3.1. Introduction

Cetaceans and pinnipeds (seals) are protected under various laws, including the Habitats Directive, which is transposed into UK law by the Conservation of Habitats and Species Regulations 2010, and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007.

Marine mammals are particularly sensitive to noise, primarily because they rely heavily on sound for communication, navigation and locating prey. The impact of noise on marine mammals has been taken into account below, drawing upon available data on the noise created during cable installation from other projects and the sensitivity of marine mammals to this type of marine installation.

In response to the scoping report, Natural England noted that this chapter should determine what marine mammal species are likely to be present in the area and whether the development is likely to cause disturbance or injury to them. They suggest that work undertaken by Southall and colleagues (2007) on effects of noise on marine mammals should be used to help inform this process. Kent Wildlife Trust also noted that sea mammal numbers are often underestimated in the area and suggested referring to a study commissioned by Kent Mammal Group investigating haul out sites of common and grey seals on the north Kent coast.

7.3.2. Baseline data sources

The key data sources that have been taken into account in relation to the distribution of marine mammals in the vicinity of the cable route are detailed below:

- JNCC Atlas of Cetacean Distribution in Northwest European Waters - Data compiled from a number of sources detailing the distribution of the 28 cetacean species known to have occurred within the waters of northwest Europe in the last 25 years. It provides an historic account of recorded sightings of cetaceans around the British Isles, potentially providing a more accurate record than observations taken over a limited period of time.
- JNCC Atlas of Cetacean Distribution in Northwest European Waters; Online monthly distribution maps
- DECC (2009) UK Offshore Energy Strategic Environmental Assessment - Strategic Environmental Assessment of the waters around the UK undertaken, in part, to enable Round 3 wind farm leasing. This is a good overview of existing marine mammal data including SCANS (Small Cetaceans in the European Atlantic and North Sea) II survey data.
- National Biodiversity Network website - Provides biodiversity data for the UK, including otter sightings and distribution.
- Multi Agency Geographic Information for the Countryside - Interactive mapping system showing data from UK conservation agencies and organisations. Specifically, in relation to this section of the report, it provides seal data collected by the Sea Mammal Research Unit (SMRU).
- SCANS II data - Cetacean population estimates and distribution obtained from SMRU in the form of the SCANS-II (Small Cetaceans in the European Atlantic and North Sea) final report (SCANS-II 2008) Kent Mammal Group pilot study on seal haul out sites on the North Kent Coast (Bramley Associates, 2004).
- Southall and colleagues (2007) Marine mammal noise exposure criteria: initial scientific recommendations.

7.3.3. Baseline

The southern North Sea is of relatively low importance for cetacean and seal populations when compared with other parts of the United Kingdom. Only two species of cetacean are periodically sighted within the area surrounding the cable route and no species is highly abundant (Reid *et al.*, 2003). There are also grey and common seals within the area and these, as well as cetaceans, are discussed in more detail below.

7.3.3.1. Cetaceans

Cetacean species diversity and abundance is believed to be low in the area of the cable route compared to other areas in the North Sea (SMRU, 2005). The only frequently occurring species in this southern area of the North Sea is the harbour porpoise. This is the most frequently observed cetacean in European waters in both inshore and offshore waters thus the proportion of the total population that frequents the area near the cable route is very small (Reid *et al.*, 2003). The seasonal movements of the Harbour Porpoise are difficult to infer as survey data is often patchy (Reid *et al.*, 2003). The highest levels of sightings in the south eastern North Sea occur from January to April. The harbour porpoise has an extended breeding season occurring mainly between May and August, although some can be as early as March. The diet of the harbour porpoise comprises of a wide variety of small fish species (Reid *et al.*, 2003). This includes young herring, sprat, sand-eel, whiting, saithe and pollock. Southall and colleagues (2007) surmise that harbour porpoises fall within the high frequency cetacean hearing group with an estimated auditory bandwidth of 0.2 kHz to 180 kHz.

The Cetacean Atlas indicates that common bottlenose dolphin and white-beaked dolphin are also occasionally present in the area along the cable route (Reid *et al.*, 2003). In UK waters, the white-beaked dolphin occurs predominantly in waters surrounding the western coast of Scotland and Northern Ireland. Distribution of white-beaked dolphin is generally restricted to the northern half of UK waters, sightings are rare below 54°N in the North Sea (DECC, 2009). They tend to be present on the continental shelf year-round but in nearshore water the species is observed more frequently between June and October. The white-beaked dolphin diet consists of a wide variety of fish (including cod, sand-eels and flatfishes) and some invertebrate species such as octopus and snow crab. They are believed to breed mainly between May and August but breeding may also extend to September and October (TOW, 2005). Southall and colleagues (2007) suggest that bottlenose dolphin have a mid-frequency cetacean hearing range between 0.15 kHz and 160 kHz. Thus different noise frequencies may affect bottlenose dolphins compared to harbour porpoises which fall within the high frequency cetacean hearing group.

The common bottlenose dolphin is an inshore species, in UK waters it is most frequently sighted within 10km of land. Their numbers in UK waters appear to peak between July and October. However, most sightings in the South East of England are in spring (Reid *et al.*, 2003). They feed on a wide variety of benthic and pelagic fish as well as cephalopods and shellfish. Southall and colleagues (2007) surmise that the white-beaked dolphin also have a mid frequency hearing range with an estimated auditory broad bandwidth between 0.15 kHz and 160 kHz.

7.3.3.2. Pinnipeds

Two species of seal breed in British Waters: the harbour seal (also known as the common seal) and the grey seal. Both these seal species are listed under Annex II of the Habitats Directive. The abundance of pinniped species is very low in comparison to other areas in the North Sea. However, Kent Wildlife Trust noted that marine mammal numbers in the area are often under estimated (see Appendix 2 Scoping Response Matrix). Both harbour and grey seals occur in the area, according to count data collected by the Sea Mammal Research Unit (SMRU) in the period August 1996 to 1997 (SMRU, 1997). SMRU breeding colony data from 2005 (SMRU, 2005) also indicates that there is a minor Grey Seal breeding colony located off Ramsgate, approximately 1.5 km from the cable route. There are believed to be 50 common seals in the Stour Estuary and 20 on Goodwin Knoll

approximately 1.9 km south of the cable route. The Kent Mammal Group completed a survey in 2004 of haul out sites in the region of the cable route. Goodwin Sands complex was identified as an area of locally important haul out sites. The survey counted 60 harbour seals and 21 grey seals on the Goodwin Sands complex on a single survey day. The distribution of the seals across the sand bank complex is shown below in Table 7-3-1 and the location of the sand banks can be found in Figure 7-3-1.

Sandbank	Harbour Seal	Grey Seal
North Sand	25	20
Keellet Gut Bank	1	1
Central Goodwin	34	0

Table 7-3-1: Kent Mammal Group commissioned pilot survey of seals on Goodwin Sands Complex.

Common Seals

The UK population represents approximately 5 % of the global population of harbour seals. Harbour seals often haul out onto tidally exposed sandbanks to rest, moult and suckle their young. Harbour seals tend to breed near their haul out sites but may feed long distances from these locations (Brasseur and Fedak, 2003). They are more frequently observed at haul out sites from June to September. Pupping tends to occur in August and September (Hammond et al, 2003). Harbour seals are generalist feeders that take a wide variety of fish, cephalopods, and crustaceans obtained from surface, mid-water, and benthic habitats (Thompson & Härkönen, 2008). Pinniped species have an estimated auditory band width of 0.75 kHz to 75 kHz when in water, while out of water their auditory range is believed to be between 0.75 kHz and 20 kHz (Southall et al, 2007).

Grey Seals

Grey seals haul out on land between foraging trips and for breeding. Pupping tends to occur in January in the southern North Sea followed by moulting in February and March (Hammond *et al*, 2002). Grey seals are largely demersal or benthic feeders with sandeels, cod and Dover sole shown to make up the majority of the grey seal diet in the UK. Grey seals also eat a variety of flat fish species (Thompson & Härkönen, 2008).

7.3.4. Description of potential impacts

The potential impacts on the receptors identified in this section are listed in the following sections for all phases of the proposed development; installation, operation and decommissioning. A detailed impact assessment is included in Appendix 6.

The definition of receptor values is shown in below. These values take into account sensitivity, recoverability and importance. Receptor value has been taken into account

Receptor Value	Definition
High	Permanent decline in abundance and/or change in distribution above that experienced under natural conditions. The population will not return to its former level within several generations.
Medium	Temporary decline in abundance or change in distribution above that experienced under natural conditions, but does not threaten the integrity of the population(s). The population(s) will return to former levels within a few generations.
Low	Small-scale or short term disturbance to habitats or species and no long term noticeable effects above the levels of natural variation. The impacts are not sufficient to be observed at population level.

Table 7-3-2 – Definition of receptor value

7.3.4.1. Cable Installation

Neither the cable route nor the landfall site of the Project is within an area of particular importance or sensitivity for cetaceans or pinnipeds (SMRU, 2005). These species are particularly sensitive to impacts from marine noise, because they use noise for communication, navigation and prey location. There are considered to be three types of noise that can disturb or injure marine mammals. Single pulses, such as those caused by a single explosion, multiple pulses, such as pile striking, or nonpulses caused by events such as drilling (Southall et al, 2007). The main sources of noise during cable installation will be nonpulse noise, likely to be associated with the excavation of the cable trench, pre-sweeping and from the presence of cable laying vessels.

Impacts resulting from vessel noise

Vessel noise may have an effect on both seals and cetacean species. For harbour seals, the noise from construction vessels is likely to be audible up to 15 to 20 km from source, and 1 to 3 km from source for harbour porpoises depending on the noise frequency (Thompson *et al*, 2006). The noise impact from the vessels therefore is likely to affect the local area. Thompson and colleagues did not expect temporary threshold shift (TTS)¹ from shipping noise except at exceptionally close distances. Thus it is expected that the majority of marine mammals will not be sensitive to the noise or they will have a high recoverability from noise disturbance. The area of the cable installation is also not of high importance for marine mammal species and based on this information it is predicted that the receptor value will be low. The main effect of shipping noise will be disturbance of marine mammals in the area. The likelihood and degree of such disturbances will vary between auditory groups but, even when taking these into account, it is difficult to predict accurately due to the high degree of variation in the results obtained by different noise disturbance studies (reviewed by Southall et al, 2007). It is important to note that the area surrounding the cable route is regularly used by large commercial shipping vessels that travel to and from the Port of Ramsgate as well as shipping lanes that navigate around the Goodwin Sands complex thus the level of change compared to back ground shipping will be low (See Chapter 8.2 – Shipping and Navigation).

The seals observed on Goodwin Sands (less than 2km from the cable route) may also be temporarily disturbed by the installation activities in the local area. Brasseur and Fedak (2003) observed that seals at haul out sites would leave their site when powerboats passed over a kilometre away. Evidence appears to suggest that seals are able to habituate to anthropogenic noise. Therefore, whilst any marine mammals present in the vicinity of cable installation activities may experience local and temporary disturbance by cable installation vessels, their sensitivity to the effect is low and recoverability is expected to be high. Overall it is considered that there is a possibility of this impacting on pinnipeds and cetaceans. It is likely that this will be only a minor change from baseline shipping traffic in the area and any effect will be in the local area only and short in duration, the impact is therefore expected to be of minor significance.

Impacts resulting from burial of cables

There are two main sources of noise generated during the cable burial process itself; the first is during cable trenching and the second can be generated if rock placement is required to protect the cable. Although rock placement had a slightly greater noise level than trenching (Nedwell, 2004), its use will be highly localised to the area of cable crossing. Trenching noise was found to be a mixture of broad band noise, tonal machinery noise and transient noise, most likely associated with rock breakage (Nedwell, 2004). It was also noted that the noise was highly variable probably due to the specific physical properties of the sea bed being cut at the time. When noise levels at different distances were compared to species specific hearing sensitivities in certain marine mammals (dB_{HT} levels) it was found that no significant behavioural reactions, such as fleeing the area, will occur over 100m from source (Nedwell et al, 2003). There was some evidence to suggest minor behavioural reactions may occur in harbour porpoises at distances of less than 1000m. Based on this it has been determined that sensitivity to the effect is low and recoverability is expected to be high. It is predicted that noise

¹ Temporary threshold shift is the term for temporary hearing loss often induced by a loud noise

associated with excavation of the cable trench may disturb marine mammals in the local area on a temporary basis and therefore the impact significance of this is expected to be minor.

There is potential for disturbance of seals within the intertidal works area as there are believed to be 50 common seals in the Stour estuary. The intertidal works will be highly localised, taking place approximately 800m from the Stour estuary. Considering the works will be temporary (expected to last approximately one week) and will cause a low level of change for seals in the immediate area, it is expected that the impact to seals will be of negligible significance.

Accidental contamination

Contamination of habitats could occur from any accidental spills from installation vessels and equipment. Such an occurrence has the potential to cause significant damage. The Project will undertake risk assessments and produce contingency plans as a matter of course to ensure this risk is reduced to be as low as reasonably manageable.

7.3.4.2. Cable Operation

Electric and magnetic fields

There is some evidence that suggests that cetaceans are able to sense magnetic fields. Cetaceans species appear sensitive to variations in the Earth's magnetic field (Klinowska, 1990). For example, they are thought to be sensitive to changes in the geomagnetic field of 30-60 nT, and probably employ much finer levels of discrimination (CMACS, 2003). Consideration has therefore been given to whether cetacean migrations might be affected by electromagnetic fields generated from the Nemo Link cable.

There is no apparent evidence that existing interconnector cables have influenced migration of cetaceans. Migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operational subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration patterns (NSR Environmental Consultants, 2001). The area of the Nemo Link cable route in UK waters is not of particular importance for cetaceans. The most frequently observed species in nearshore waters are the harbour porpoise and bottlenose dolphin (both of which are listed in Annex II of the Habitats Directive). These species are however rare in the region. There have been no reported impacts on the migration of harbour porpoise over existing interconnector cables in the Baltic Sea. The magnetic fields generated are expected to be perceived by cetaceans as a new localised addition to the heterogeneous pattern of geomagnetic anomalies of the North Sea, and no significant impact on cetaceans is therefore expected as a result of magnetic fields produced during operation of the cable.

With respect to pinnipeds, there is currently no evidence that they are influenced by, or use, electromagnetic fields. It is likely that there will be no significant impact on harbour or grey seals as a result of magnetic fields produced during operation of the cable.

Noise

Noise generated by maintenance vessels is likely to be similar to that generated by installation vessels although it is likely to be more localised and shorter in duration therefore it is predicted that the impact will be of negligible significance.

Accidental contamination

Similar to installation activity, contamination of habitats or individuals animals could occur from any accidental spills from installation vessels and equipment. Such an occurrence has the potential to cause significant damage. It is likely that the level of change will be small and impact the local area only. Furthermore, any incident will be dealt with rapidly by the operators and thus it is expected that the impact of this will be of **minor** significance.

7.3.4.3. Decommissioning

If the cable is retrieved, there may be an impact of minor significance in relation to disruption and accidental contamination in the decommissioning phase, similar to that experienced during installation. However, it is often the practice to leave cables on the seabed after they are no longer in service as this action often causes the least environmental disruption.

7.3.5. Mitigation

Based on the low level of impact expected and the existing baseline of ongoing shipping activity in the area of interest no mitigation is proposed.

7.3.6. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

7.3.7. References

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7.4. Benthic and Intertidal Ecology

7.4.1. Baseline data sources

This chapter details the benthic and intertidal habitats and communities within the study area. Baseline conditions have been determined in order to conduct an assessment of the impacts associated with the installation, operation and decommissioning of the proposed Nemo Link high voltage direct current (HVDC) interconnector cable.

Substantial data on the region already exist in the public domain, with much of the literature published on benthic communities of the Thanet coast and south-east seas relating to the area's numerous existing and potential conservation designations.

As part of the planned network of Marine Protected Areas (MPAs) required by the Marine and Coastal Access Act (2009) regional projects have been conducted to identify Marine Conservation Zones (MCZs). The MPA network includes sites of national, European and international importance. The MCZ Project is led by Natural England (NE) and the Joint Nature Conservation Committee (JNCC) and it has identified broad-scale habitats and features of conservation interest (FOCI) to be included in and represented by MCZs (Natural England and the JNCC, 2010). The regional MCZ project responsible for the south-east seas, known as Balanced Seas, has identified and mapped several broad-scale habitats and FOCI that may occur within the area. Balanced Seas' area covers the UK waters of the English Channel and adjacent areas from north of the Suffolk/Essex border to the Hampshire/Dorset border, and includes the Solent and the Thames Estuary. The Balanced Seas website has been a valuable resource for information on the region, along with conservation authorities including the JNCC and Natural England.

Existing information has been used to support the description of the environment along with more detailed geophysical and marine benthic studies along the cable route (MMT, 2010a; 2010b). Intertidal data collected during surveys by English Nature (Tittley et al., 1998; Tittley et al., 2002) and a survey for the Thanet Offshore Wind Farm (TOWF) project (Royal Haskoning, 2005) have been used to establish baseline conditions within the nearshore part of the survey area and proposed landfall site. Impacts have been assessed using available literature and review of scientific data, including that referred to in the similar BritNed interconnector cable development (Metoc, 2004a).

Other information sources have included the Marine Habitat Classification for Britain and Ireland (Connor et al., 2004), the EUNIS Biodiversity database (European Environment Agency; EEA, 2011), the Mapping European Seabed Habitats website (MESH, 2011) and the UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).

7.4.1.1. Intertidal survey

The Thanet OWF intertidal survey (Royal Haskoning, 2005) was carried out in May 2005, across the intertidal flats of Pegwell Bay. A total of 38 stations were investigated, with box core samples sieved over 1mm mesh size and 0.25m² quadrats used on rocky substrata, to obtain baseline counts of organisms in the intertidal environment. Data were described using the Marine Nature Conservations Review (MNCR) SACFOR scale, a widely accepted method for recording faunal abundance, presented in Table 7-4-1.

% cover	Growth Form		Size of individuals/colonies				Density	Number
	Crust/ meadow	Massive/turf	<1cm	1-3cm	3-15cm	>15cm		
>80	S		S				>1/0.001m ² (1x1cm)	>10,000/m ²
40-79	A	S	A	S			1-9/0.001m ²	1000-9999/m ²
20-39	C	A	C	A	S		1-9/0.01m ² (10x10cm)	100-999/m ²
10-19	F	C	F	C	A	S	1-9/0.1m ²	10-99/m ²
5-9	O	F	O	F	C	A	1-9/m ²	
1-5	R	O	R	O	F	C	1-9/10m ² (3.16x3.16m)	
<1		R		R	O	F	1-9/100m ² (10x10m)	
					R	O	1-9/1000m ² (31.6x31.6m)	
						R	<1/1000m ²	

S=superabundant; A=abundant; C=common, F=frequent; O=occasional; R=rare

Table 7-4-1 : SACFOR abundance scale

7.4.1.2. Subtidal survey

The sub-tidal benthic survey was carried out between the 22nd September- 2nd October-2010. Within UK waters, twenty stations were investigated with a drop-down digital stills camera with a freshwater lens and video system. Two camera cross transects were carried out over two stations where potentially sensitive biogenic reef habitat was identified, to determine the nature and extent of any reef structures. Sediment sampling was conducted using a 0.1m² Day Grab, with samples sieved over a 1mm mesh. Three grab samples were collected from each station, where possible, and retained for faunal analysis. A 500ml sediment sample was retained from one grab for particle size analysis (PSA). Details of the survey methodology and the target and actual positions of each sample are provided in the Environmental Survey Report (MMT, 2010b; Appendix 11). The positions of the twenty environmental survey stations in UK waters are presented in Figure 7-4-1.

Fauna identified from video analysis was quantified using the SACFOR abundance scale (Table 7-4-1) while fauna captured in still photographs and grab samples were enumerated as individuals per m² and percentage cover for colonial species during analysis.

7.4.1.3. Subtidal epibenthic survey

Epibenthic trawling was carried out at four trawl locations using a 2m beam trawl to investigate megafauna (>1cm) abundance and distribution. Three trawls were conducted over a distance of 600m, with the fourth over a distance of 1200m. Samples were washed over a 5mm mesh sieve prior to sorting and field identification. Details of the survey methodology and the positions of each trawl are provided in the Environmental Survey Report (MMT, 2010b; Appendix 11). The positions of the trawl locations in UK waters are presented in Figure 7-4-1 and presented in more detail in Chapter 7.5 – Fish and Shellfish Ecology.

7.4.2. Baseline Environment

7.4.2.1. Intertidal communities

The intertidal area of the landfall region has previously been described by the Thanet OWF Environmental Statement, after an extensive survey of the intertidal flats of Pegwell Bay in May 2005. Much of the data for the intertidal communities have been sourced from the Marine Ecology chapter of the Thanet OWF Environmental Statement (Royal Haskoning, 2005).

Pegwell Bay is a sheltered muddy sand bay, which is exposed over a wide area of approximately 542 hectares at low tide. Low chalk cliffs mark the northern edge of the Bay, which extends westwards into marshland and southwards into an area of mudflats.

The preferred cable route is to cross the intertidal flats of Pegwell Bay and make landfall to the south of the Service Station in the centre of the bay. This location is already used as landfall for the Thanet OWF export cables.

Pegwell Bay holds a number of conservation designations due to its importance to local and national biodiversity:

- Sandwich Bay and Hacklinge Marsh Site of Special Scientific Interest (SSSI)
- Sandwich and Pegwell Bay National Nature Reserve (NNR)
- Thanet Coast and Sandwich Bay Special Protection Area (SPA);
- Thanet Coast and Sandwich Bay Ramsar Wetland of International Importance (Ramsar); and
- Thanet Coast and Sandwich Bay candidate Special Areas of Conservation (cSAC);
- The preferred landfall site would also require the proposed cable route to cross intertidal mudflat and coastal saltmarsh Biodiversity Action Plan (BAP) priority habitats.

The Joint Nature Conservation Committee have identified a number of Annex I marine habitats along the Thanet coast. These Annex I habitats have been pivotal in the recommendation of the Thanet coast as an SAC. Annex I habitats that occur within the area of Pegwell Bay where the UK cable landfall will be located include:

- Sandbanks which are slightly covered by sea water all the time
- Mudflats and sandflats not covered by seawater at low tide
- Reefs
- Coastal saltmarsh
- Coastal lagoons
- Submerged or partially submerged sea caves

The Thanet intertidal survey (Royal Haskoning, 2005) identified four main habitat types with their associated faunal communities. These comprised:

- Wave-cut chalk platforms at the base of the chalk cliffs and sea defences;
- Upper midshore boulders and reefs;
- Midshore muddy sandflats; and
- Saltmarsh and associated mudflats

Wave-cut chalk platforms and upper midshore boulders

Chalk platforms are characteristic of areas where vertical rocky cliff faces abut a wave-eroded foreshore creating soft chalk reef susceptible to erosion. These wave-cut chalk platforms support unique faunal assemblages, characterised by resilient and opportunistic species, such as rock-boring piddocks (Family Pholadidae) and *Polydora* sp. and ephemeral algal species adapted to the soft-rock environment (OSPAR, 2009a; Tittley *et al.*, 1998). Algae and lichens can become established well above the high water mark due to the porous nature of the chalk, developing unique and specialised communities scarcely found elsewhere (Fowler and Tittley, 1993). Extensive sublittoral chalk reefs have been documented along the Thanet coast, covering most of the nearshore and extending into

the littoral zone, representing 12% of the UK's coastal chalk (Jones *et al.*, 2004). The area has thus been selected as a candidate Special Area of Conservation (cSAC), with conservation objectives including maintenance of the intertidal chalk cliff algal and lichen communities found in the chalk reef and submerged sea cave habitats (Tittley *et al.*, 2002). The Thanet cSAC is thought to well represent the biotopes that occur on British chalk shores, with intrinsically low species diversity on the chalk platforms reflecting the harsh tidal swept environment (Tittley *et al.*, 1998). As with the Thanet export cable, the proposed Nemo Link cable route avoids these sensitive wave-cut chalk platforms to the north of Pegwell Bay.

These chalk platforms have been well documented by numerous intertidal surveys along the coast from Pegwell village to the port of Ramsgate (Tittley *et al.*, 1998; 2002; Royal Haskoning, 2005). An extensive intertidal study conducted by English Nature in 2005 determined the presence of four biotopes (Connor *et al.*, 1997) which translate to current EUNIS classifications of: 'A1.441 Chrysophyceae and Haptophyceae on vertical upper littoral fringe soft rock'; 'A2.72 Littoral mussel beds on sediment'; 'A1.452 *Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock'; and 'A2.431 Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata' (Tittley *et al.*, 2002).

Extensive sampling along the Pegwell Bay chalk platforms during the Thanet OWF intertidal survey recorded an abundance of common mussel *Mytilus edulis*, sand mason worm *Lanice conchilega* and acorn barnacles *Semibalanus balanoides* and *Elminius modestus*, with common limpet *Patella vulgata*, rough periwinkle *Littorina saxatilis*, common periwinkle *Littorina littorea*, edible oysters *Crassostrea* sp. and gobies *Pomatoschistus* sp. also commonly recorded (Royal Haskoning, 2005). The *Mytilus/Lanice* community dominate much of the midshore chalk reef, demonstrating a high tolerance to siltation and exposure to air (Royal Haskoning, 2005), although *M. edulis* has shown intolerance to smothering from dredging operations (Rosenberg, 1977). During the Thanet intertidal survey, it was felt that the *Mytilus* reef and associated faunal assemblage was unique enough in the study area to be considered of local conservation importance (Royal Haskoning, 2005). The proposed Nemo Link cable route is estimated to pass at least 250m from the wave-cut chalk platforms and mussel beds identified during the previous surveys.

Intertidal muddy sandflats

Intertidal mudflats and sandflats commonly support communities characterised by polychaetes, oligochaetes and bivalves, which can provide important food sources for juvenile fish, wading birds and wildfowl. Intertidal mudflats and sandflats can be characterised by biota which reflect the established physical conditions, such as salinity and the proportion of sand. In mudflats of lower salinity, typical fauna can include the Baltic tellin *Macoma balthica*, common cockle *Cerastoderma edule*, sand-hopper *Corophium volutator* and laver spire shell *Hydrobia ulvae*. With an increase in the proportion of sand, the lugworm *Arenicola marina* and the catworm *Nephtys hombergii* can dominate (Maddock, 2008).

At high tide, mudflats can provide important nursery areas for flatfish such as sole *Solea solea*, dab *Limanda limanda*, flounder *Platichthys flesus* and plaice *Pleuronectes platessa*. In the summer months, juvenile plaice and dab move over the flats at high tide to feed on mobile epifauna and sedentary infauna (OSPAR, 2009b). Because of this conservation significance, mudflats and sandflats not covered by seawater at low tide can be designated as Annex I habitat of the Habitats Directive. Intertidal mudflats are also included on the OSPAR List of threatened and/or declining species and habitats (OSPAR Agreement 2008-6). As such, the presence of these mudflats in part prompted the designation of the area as the Sandwich Bay to Hacklinge Marshes SSSI. Intertidal mudflats are also designated as a UK Biodiversity Action Plan (BAP) Priority Habitat.

Intertidal muddy sands dominate a large portion of Pegwell Bay, with this habitat extending from the lower wave-cut chalk platform at mid-tide level to mean low water. The Thanet OWF intertidal survey recorded infauna dominated by species typical for this habitat. Two marginally different biotopes were identified, with the lugworm *A. marina*, laver spire shell *H. ulvae* and bivalves including the edible cockle *C. edule* and the Baltic tellin *M. balthica* dominating the muddy sand flats closer to the coast. *Arenicola marina*, *C. edule* and the sandmason worm *L. conchilega*, a species common to the UK

coast, were pre-dominant over much of the mid to lower shore area, with *L. conchilega* particularly abundant in the north of Pegwell Bay.

Species recorded during the Thanet survey are typical for muddy sandflat environments (Maddock, 2008; Royal Haskoning, 2005). Such intertidal species are adapted to mobile nearshore sediments, and thus capable of tolerating physical disturbance and high levels of suspended solids.

Coastal saltmarshes and associated mudflats

Coastal saltmarshes are vegetated areas found in sheltered coastal locations, the development of which is dependant on the presence of intertidal mudflats. Saltmarshes have been assigned as a Biodiversity Action Plan (BAP) habitat action plan (UK BAP, 2009).

The Pegwell Bay saltmarsh comprises a diversity of characteristic plants, dominated by saltmarsh grasses such as *Puccinellia maritima* and common cord-grass *Spartina anglica*, with other abundant species such as sea purslane *Halimione portulacoides*, sea aster *Aster tripolium*, sea lavender *Limonium vulgare* and the nationally scarce golden samphire *Inula crithmoides* (Natural England, 1994). Saltmarshes can also be important nursery sites for fish species. The Thanet OWF intertidal survey recorded emergent patchy *Spartina* saltmarsh to the north of the disused hoverport site in the north-west of the Bay, and surrounding the proposed landfall site. A more well-developed and diverse *Spartina* marsh community was recorded to the south of the River Stour. This more mature community can be considered of greater ecological importance to the region. This area of more mature saltmarsh habitat is estimated at over 150m from the proposed northern landfall site, and is not within the path of the proposed cable route.

Dense patches of the green algae *Enteromorpha intestinalis* were also recorded, along with the burrowing amphipod crustacean *Corophium volutator*, the small gastropod mud snail *Hydrobia ulvae* and the ragworm *Hediste diversicolor*. Other common species identified in this habitat included the edible cockle *C. edule* and the Baltic tellin *M. balthica*. *Enteromorpha* and the bladder wrack *Fucus vesiculosus* were also found as part of a dense algal assemblage colonising the concrete skirt of the disused hoverport. The range and abundance of infaunal species found in the saltmarsh and associated mudflats can provide an important food source for wading birds.

Dominant species within the intertidal zone comprised both active suspension and surface deposit feeders. The sand mason worm, *L. conchilega* is capable of both active suspension and surface deposit feeding, and is generally found in fully marine areas, thus is more common in the lower and midshore (Elliot et al., 1998). Suspension feeders can be particularly vulnerable to the impacts of developments such as cable-laying and dredging, which increase the amount of suspended sediments in the water column. Fauna identified within the intertidal mudflats, chalk platforms and saltmarsh at the proposed northern landfall are typical of the region with no rare, scarce or protected species under national or international legislation recorded in the area. They do however provide an important food resource for a range of wading birds, wildfowl and juvenile fish in the region.

7.4.2.2. Benthic communities

The area along the proposed cable route is characterised by softer substrates, with the seabed dominated by mixed sands and gravels, and offshore sandbanks arising up to 26m from the seabed. Sand formations such as sand waves and ripples interrupt the predominantly smooth bathymetry along much of the route. Between KP 82.3 and KP 87, the sand and gravelly sediment was visible in sand wave formations, which reach 2 to 6 metres height above the surrounding seabed. Between KP 99.2 and KP 100.8, the proposed route passes across the South Falls sandbank, which reaches approximately 26m height, at the top of which the water depth is approximately 12m LAT. These sandbanks provide important habitats for benthic invertebrates as well as spawning and nursery grounds for several fish species. Each sandbank is unique with its own characteristic community; the deeper and more stable sandbanks tend to be more species-rich than the more mobile, shallow and thus exposed sandbanks. 'Sandbanks which are slightly covered by sea water all the time' are defined in Annex I of the Habitats Directive.

Subtidal sandbanks are high-energy environments, subject to physical disturbance through strong tidal currents. Such sandbanks are characterised by low faunal diversity, with a lack of sedentary taxa such as bivalve molluscs. Fauna recorded on the crests of such sandbanks tend to be restricted to those species associated with sandy habitats, and are characteristically dominated by agile swimmers such as burrowing haustoriid amphipods and isopods; species which typically have a short lifespan and are tolerant of sediment disturbance (Elliot *et al.*, 1998).

Bedrock is rarely evident at the seabed, with visible bedrock generally exposed as chalk (Jones *et al.*, 2004). Submerged chalk platforms are also present off the east Kent coast (Jones *et al.*, 2004) and have been identified in the intertidal zone (Royal Haskoning, 2005). There is no exposed chalk within the subtidal area surveyed for the proposed cable route; however underlying chalk was detected close to the surface from KP 87 to KP 108, covered only by a thin layer of sand and gravel. Along much of the route between KP 108 and KP 114.5, the chalk unit is only covered by a thin veneer of sand. Bedrock was present at or near the surface along the westernmost parts of the route beyond KP114.5, close to the UK coastline.

7.4.2.3. EUNIS Habitat Classification

Habitat classification is used to identify different habitats and biotopes based on the biotic and abiotic features of the seabed. Habitat and biotope classification was conducted on the benthic survey data, adhering to protocols within the European Union Nature Identification System (EUNIS). The system was developed between 1996 and 2001 by the European Environment Agency (EEA) in collaboration with European experts. A marine habitat classification system for Britain, Ireland and the North-east Atlantic was developed by the JNCC (Connor *et al.*, 2004) and has been fully incorporated into EUNIS.

Table 7-4-2 shows the five EUNIS levels to describe the marine environment in Britain:

Level	Detail Covered (EUNIS / JNCC Classification)
1. Environment	Marine (A)
2. Broad habitats	Sublittoral Sediment (A5 / SS)
3. Main habitats	Sublittoral biogenic reefs on sediment (A5.6 / SS.SBR)
4. Biotope complexes	Polychaete worm reefs (A5.61 / SS.SBR.PoR)
5. Biotopes	Sabellaria spinulosa on stable circalittoral mixed sediment (A5.611 / SS.SBR.PoR.SspiM)

Table 7-4-2 : Example EUNIS Marine Classification Levels

Development of the EUNIS classification comes from both a top-down and a bottom-up approach. Top-down classification differentiates between rock and sediment habitats, and between those habitats on the shore (intertidal) and those in the subtidal or offshore (deep) areas. These high-level divisions can be further subdivided on the basis of different types of sediment (e.g. gravel, mud), different degrees of wave exposure on rocky coasts (exposed, sheltered) and varying depth bands below the low water mark (e.g. shallow water where light penetrates, deeper water with little light). Such broad-scale differences in habitat character are readily understood by non-specialists and provide classification types that are easily mapped. They also have ecological relevance as they reflect major changes in habitat character upon which species distribution depend (Connor *et al.*, 2004).

Bottom-up classification differentiates between places with different species communities. Relative species composition, diversity and abundance vary from place to place and are dependent both on environmental characteristics and upon interactions between species. Surveyed sites with similar environmental characteristics, such as sediment type and depth, show certain levels of similarity in their species communities. Multivariate analysis of the data from field surveys (e.g. grabs and trawls) groups these data into clusters that have a similar character. These clusters form the basis of defining the types at the lower end of the EUNIS classification.

The top-down and bottom-up approaches have been merged together into the single hierarchical EUNIS classification, which enables broad-scale application in management and mapping, and fine-scale application for detailed survey, monitoring and scientific study.

Based on depth, PSA, fauna data and seabed imagery (following the approach given by Connor *et al.*, 2004) the benthic survey stations were classified to EUNIS levels. The identification of the main habitat (EUNIS Level 3) is mainly based on depth and sediment type. The EUNIS classification hierarchy to biotope complex (Level 4) and biotopes (Level 5) includes the use of faunal data, where available. Given the fact that faunal data were not always available to provide added insight into baseline conditions, some stations could only be classified to EUNIS level 3 (main habitat).

Eleven distinct EUNIS sublittoral sediment habitats were identified along the proposed cable route, with seven of these habitats present in UK waters. The most abundant habitat identified within the survey corridor was 'A5.25 Circalittoral fine sand' found along much of the eastern and central parts of the UK route between KP 82.27 and KP 87, and between KP 102.3 and KP 118. This classification describes clean fine sands with less than 5% fines (silt and clay <63µm) in deeper water with a diverse community (Connor *et al.*, 2004). This habitat was generally dominated by polychaetes and crustaceans with fewer species found in the UK part of the route than in French or Belgian waters.

Between KP 87 and KP 99.5, the sediment generally comprised tide-swept circalittoral coarse sands and gravel. At EUNIS biotope level, this part of the survey area varied between 'A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' and 'A5.145 *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel'. The *P. triqueter* habitat was characterised by cobbles with tubes of Serpularidae and the sea urchin *Psammechinus miliaris* and anemones Actinaria common. The *B. lanceolatum* habitat was characterised by the lancelet, along with Nematoda and the polychaetes *Polycirrus medusa* and *Notomastus latericeus*.

The area surrounding the South Falls sandbank between approximately KP 99.5 and KP 100.8 was described as tide-swept infralittoral clean sands. The slopes of the sandbank were classified as 'A5.23 Infralittoral fine sand' with an abundance of the polychaete *Ophelia borealis* and the crustacean *Urothoe brevicornis*. The top of the sandbank was classified as 'A5.231 Infralittoral mobile clean sand with sparse fauna' due to the lower faunal diversity and abundance caused by the more mobile substratum. Typical biota in these habitats include opportunistic populations of infaunal amphipods, with recorded taxa including the crustacean *Urothoe* spp. and low numbers of the polychaete *Nephtys cirrosa*.

Between KP 100.8 and KP 115.7, the sediment was dominated by alternating extents of 'A5.25 Circalittoral fine sand' and 'A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles'. Two areas of potential *Sabellaria spinulosa* reef were identified around KP 108.5 and KP 110.3. These areas were delineated using available data (described in more detail in Section 7.4.2.5) and classified 'A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment'. These areas were inhabited by a higher diversity of species in comparison to their surroundings, with associated species including long-clawed porcelain crab *Pisidia longicornis*, brittle stars Ophiuroida and *Amphipholus squamata*, starfish *Leptasterias muelleri* and *Asterias rubens*, mussels *Abra prismatica* and *A. nitida*, snails *Odostomia unidentata*, cnidarians Actinaria and fish *Gaidropsarus* spp.

From approximately KP 115.7, the proposed cable route entered the nearshore area and into Pegwell Bay, along which water depths were generally less than 10m. Along this part of the survey area were alternating bands of the aforementioned 'A5.23 Infralittoral fine sand', 'A5.25 Circalittoral fine sand' and 'A5.231 Infralittoral mobile clean sand with sparse fauna', as well as 'A5.43 Infralittoral mixed sediments' which consisted mostly of gravel with an abundance of the bivalve Mytilidae. At the most coastal point, the sediment was described as 'A5.24 Infralittoral muddy sand'; with an abundance of the polychaete *N. latericeus*, the bivalves *Nucula nitidosa* and *Abra* spp., the crustacean *Gammaridae* spp. and the brittle star *A. squamata*, and the sea spider *Anoplodactylus petiolatus* commonly recorded in this area..

The most diverse infaunal habitat along the proposed cable route was the 'A5.24 Infralittoral muddy sand' biotope in UK waters; with 74 species identified in one grab sample. The *Sabellaria spinulosa* reef habitat was also diverse with 46 species recorded.

7.4.2.4. Features of Conservation Importance

Recommended Marine Conservation Zones (rMCZs) have been selected to ensure the MPA network protects:

- Habitats representing the range of biodiversity in UK seas (Broad-scale habitats);
- Habitats and species that are rare, threatened or declining in UK waters (Features of Conservation Importance; FOCI).

There are four rMCZs in proximity to the Project, one of which lies across the cable route (Goodwin Sands rMCZ). The Project does not fall within any areas currently put forward as recommended Reference Areas (rRAs); the only rRA in close proximity to the Project is the Goodwin Knoll rRA (within the Goodwin Sands rMCZ), which lies approximately 1 km to the south of the Project.

Analysis of the habitats and species identified by Balanced Seas (2011) and the data obtained during the Nemo Link benthic survey, Thanet intertidal survey (Royal Haskoning, 2005) and English Nature (Tittley *et al.*, 2002) intertidal survey indicate the presence of at least eight broad-scale habitats within the survey area. The intertidal broad-scale habitats cannot be considered certain, as the classifications have been interpolated from previous data sets. The identified broad-scale habitats are detailed in Table 7-4-3 and data from the Balanced Seas (2011) website is presented in Figure 7-4-A.

Broad-scale habitat types	EUNIS Level 3 habitat code
Intertidal habitats identified during previous surveys	
Moderate energy infralittoral rock	A3.2
Moderate energy circalittoral rock	A4.2
Intertidal sand and muddy sand	A2.2
Intertidal mud	A2.3
Intertidal mixed sediments	A2.4
Coastal saltmarshes and saline reedbeds	A2.5
Subtidal habitats identified during benthic survey	
Subtidal coarse sediment	A5.1
Subtidal sand	A5.2
Subtidal mud	A5.3
Subtidal mixed sediments	A5.4
Subtidal biogenic reefs	A5.6

*Intertidal habitats were identified during previous studies conducted by English Nature (Tittley *et al.*, 2002), calculated for this report from data collected during previous surveys (Tittley *et al.*, 1998; Royal Haskoning, 2005), or extrapolated from the Balanced Seas website (2011).*

Subtidal habitats were recorded during the Nemo Link benthic survey (MMT, 2010b).

Habitats in bold are likely to be encountered within the proposed route installation corridor.

Table 7-4-3 : Broad-scale habitats within Pegwell Bay and the Nemo Link benthic survey area

MCZ Project Interactive Map



BalancedSeas



Source: Balanced Seas website, 2011

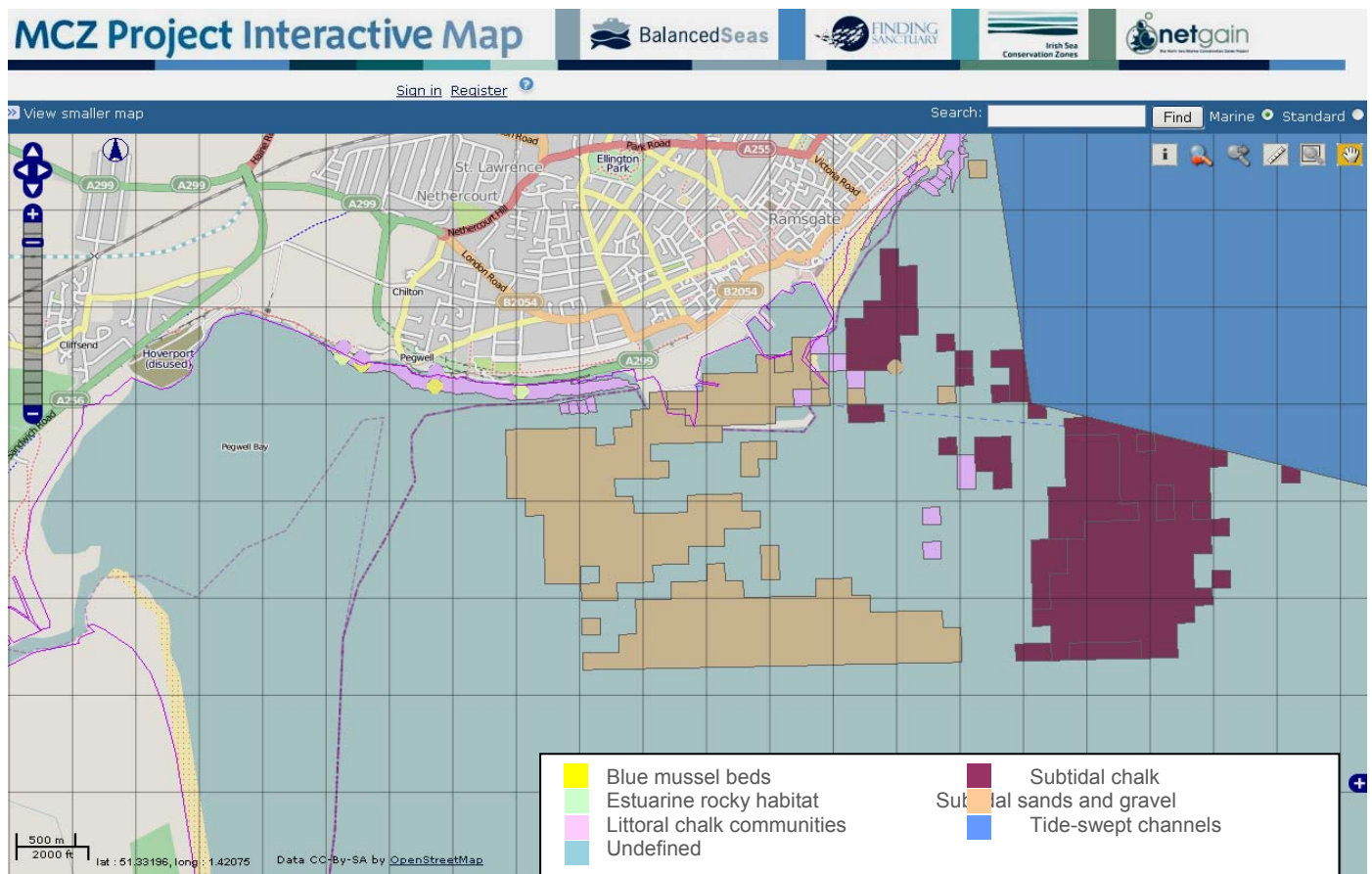
Figure 7-4-A : Broad-scale habitats within Pegwell Bay and the surrounding area

Analysis of the data obtained during the Nemo Link benthic survey and habitats identified by Balanced Seas (2011) indicate the presence of four (possibly five) habitat FOCI within the survey area. These habitat FOCI are presented in Table 7-4-4, with data from the Balanced Seas (2011) website presented in Figure 7-4-B. No species FOCI were identified within the UK section of the proposed development.

Habitats of conservation importance (Habitat FOCI)	Intertidal	Subtidal
Littoral chalk communities	X	
Ross worm (<i>Sabellaria spinulosa</i>) reefs		X
Subtidal chalk		X
Subtidal sands and gravels		X
Tide-swept channels		X

Habitat FOCI in italics were extrapolated from the Balanced Seas website (2011) and expected to predominantly fall outside the proposed cable development.

Table 7-4-4 : Features of conservation interest within the Nemo Link survey area



Source: Balanced Seas website, 2011

Figure 7-4-B : Habitat FOCI within Pegwell Bay and the surrounding area

7.4.2.5. Sabellaria spinulosa

Aggregations of the tube-building riss worm, *Sabellaria spinulosa*, are well documented within the region, occasionally dense enough to form biogenic reef structures (Jones *et al.*, 2004; Royal Haskoning, 2005). *S. spinulosa* is a filter feeding polychaete, which constructs and inhabits a hard tube formed from sand grains collected while feeding. The planktonic larvae are strongly stimulated to metamorphose and settle by the presence of the cement secretions from other *S. spinulosa* or dead shells. Individuals may occur solitary or in dense aggregations and have been reported to stand up to 60cm proud of the seabed and persist for several years. Dense aggregations of *S. spinulosa* exert considerable influence on the benthic community structure, stabilising mobile sediments and increasing the structural complexity of the seabed. As a result, these forms support a rich and diverse range of associated infauna and epifauna (Holt *et al.*, 1998).

S. spinulosa requires a good supply of suspended sediment for feeding and tube formation. As such, reef communities only occur in turbid areas where sand is placed in suspension by water movements (Holt *et al.*, 1998). While bedrock may not be required for settlement, a somewhat firm substratum is necessary. It has also been suggested that, once established, a colony may increase in size by addition to itself, removing the need for additional hard substratum. This raises the possibility of relatively large aggregations occurring on predominantly sandy bottoms. Foster-Smith and White (2001) suggested that favorable conditions for *S. spinulosa* were silty sand and cobbles and large shells on areas where sand supply is high, such as edges of sand banks and where there are sand waves.

Examination of the sidescan sonar data and the drop camera still photographs collected during the Nemo Link benthic survey in 2010 identified two areas of possible *S. spinulosa* reef; example

photographs are provided in Figure 7-4-C. Grab samples collected from these sites indicated the presence of several *S. spinulosa* tubes attached to stones at Station B03_040, while a large number (>900 individuals per 0.2m²) were identified at Station B03_039. The elevation of *S. spinulosa* tubes measured in the Day grab was approximately 7cm. There was also a vast increase in faunal diversity at Station B03_039, with dominant species including the long-clawed porcelain crab *P. longicornis*, brittle stars Ophiuroidea and *A. squamata*, starfish *Leptasterias muelleri* and *Asterias rubens*, mussels *Abra prismatica* and *A. nitida*, snails *Odostomia unidentata*, fish *Gaidropsarus* spp. and cnidarians Actinaria. In addition, two camera cross transects were conducted over the two sites, with photographs taken every 20m, in order to estimate the extent of any *S. spinulosa* reef.

The distinction between what is, or is not, a *Sabellaria* 'reef' is imprecise. To try to make the process of 'reef definition' more transparent and reproducible, Hendrick and Foster-Smith (2006) produced a scoring system based on a series of physical, biological and temporal characteristic reef features. Where possible, the Hendrick and Foster-Smith (2006) scoring system has been applied to the survey data in an attempt to define the 'reefiness' of the areas of *Sabellaria* colonies identified along the proposed pipeline route.

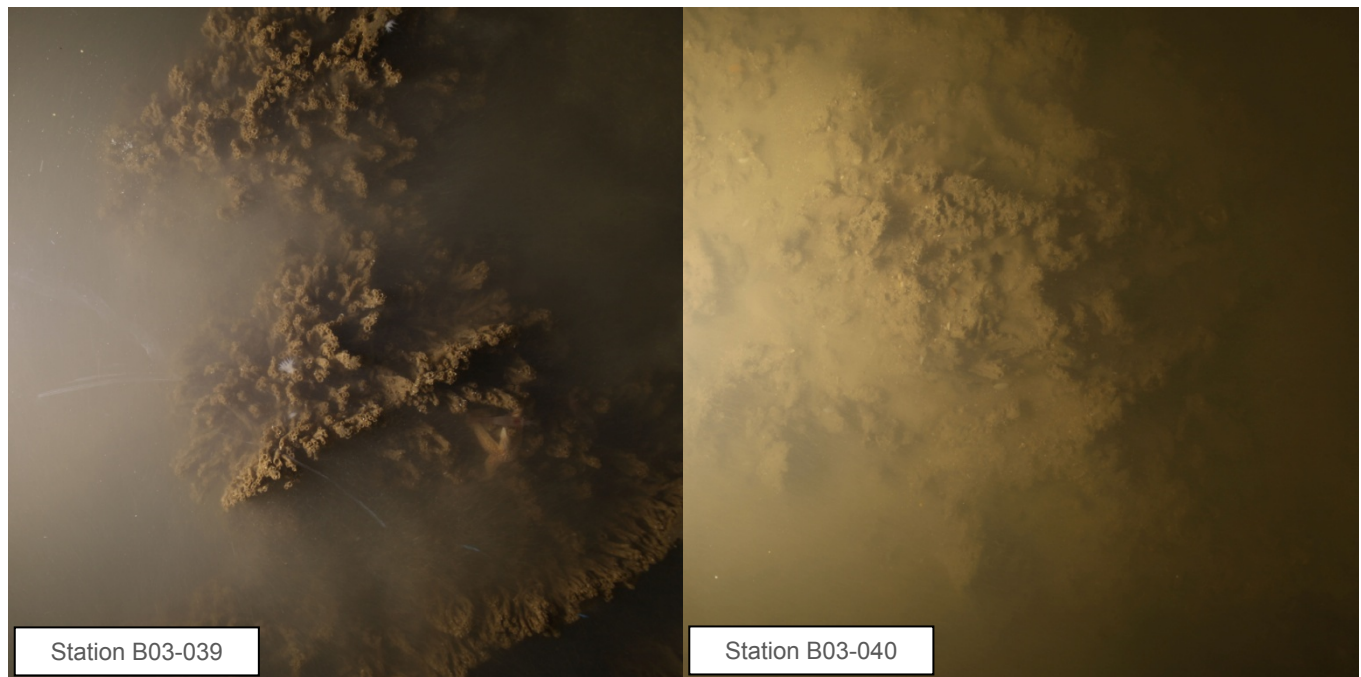


Figure 7-4-C : *Sabellaria spinulosa* reef

It has been possible to use only some of the scoring criteria, notably:

- Spatial Extent – Area (from the sidescan data) of possible extent of colonies;
- Patchiness – Percentage cover (from stills photographs);
- Elevation – Average height of tubes within colony(ies) (from photographs and grab samples);
- Consolidation – Degree that colony is consolidating the underlying sediment (from photographs and samples).

The 'reefiness' scale has been based largely on results of an inter agency workshop run by JNCC to help define and manage *S. spinulosa* reefs and reported in Gubbay (2007). During the workshop participants were asked, based on their experience, to indicate what they believed would be suitable cut off points for grading an area on a scale of low-medium-high for 'reefiness'. The best, but not unanimous, agreement, which could be reached on the day, is given in Table 7-4-5. It should be

emphasized that the figures presented are considered as a starting point for wider discussion rather than accepted and fully agreed thresholds for *S. spinulosa* reef identification.

Other scoring criteria, e.g. biodiversity and longevity scores, were not applied as they are reliant upon time series of data and detailed benthic community data being available. Whilst mainly subjective, the results have allowed a basic understanding of the *Sabellaria* colony composition of each area to be made, and a measure of its 'reefiness' to be arrived at.

Measure of reefiness	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m ²)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Source: Gubbay, 2007.

Table 7-4-5 : Proposed measure of 'Reefiness'

S. spinulosa reef was identified in several of the photographs of the sand and gravel habitat along Transects B03_039_001 and B03_039_002, with associated epifauna including starfish *A. rubens*, crustaceans *P. longicornis*, Paguridae, Galatheididae, Caridea, Portunidae spp., anemones Actinaria and sea urchins *Psammechinus miliaris* identified. *Sabellaria* tube height varied along the camera transects, with reef elevation between 0.05 and 0.15m (5-15cm). This area was classified using the seabed imagery to EUNIS biotope A5.611 '*Sabellaria spinulosa* on stable circalittoral mixed sediment', with the narrow habitat extending NW-SE over an area of approximately 424m by 59m. Figure 7-4-2 displays the area around Station B03-039 covered by *S. spinulosa* with example photographs, bathymetry and shaded relief of bathymetry, sonar mosaics and EUNIS habitat classification.

The sediment across Transects B03_040_001 and B03_040_002 comprised sand with gravel and some cobbles. Structures resembling *Sabellaria* reef were visible in the photographs, but due to the poor visual range in the turbid conditions, the density and elevation of the structures could not be determined as *Sabellaria* reef with absolute certainty. The potential reef across this area appears patchy and scattered, with the extent of potential reef identified as 26.8m by 31m using side scan sonar and confirmed using the camera transect ground truthing. Figure 7-4-3 displays the area around Station B03-040 covered by *S. spinulosa* with example photographs, bathymetry and shaded relief of bathymetry, sonar mosaics and EUNIS habitat classification.

Using the scoring criteria in Table 7-4-5 and data collected during the seabed imagery and sampling, the area of *Sabellaria* at Station B03_039 can be classified with a high degree of confidence as having a medium measure of reefiness, while Station B03_040 has a low measure with regard to reefiness.

There is little knowledge of the sensitivity of *S. spinulosa* to natural events; however, JNCC consider *S. spinulosa* to be particularly susceptible to trawling and dredging activities, particularly with prolonged disturbance, often leaving behind impoverished communities. Holt *et al.*, (1998) also documented that biogenic reef areas have almost certainly suffered widespread and long-lasting damage due to the activities of bottom fishing and that recovery is impossible while fishing activities in these areas persist.

7.4.2.6. Non-native species

Only one non-native species was identified during the subtidal benthic survey. The slipper limpet *Crepidula fornicata* was identified within the sample from Trawl B03-002. *C. fornicata* is a gastropod mollusc introduced to Europe in 1872, and has since spread throughout the south and southeast of the UK. The species is known to compete with other filter-feeding invertebrates for food and space, and in waters containing high suspended fines, it encourages deposition of mud (Eno *et al.*, 1997). For these reasons, *C. fornicata* is considered a pest on commercial oyster beds. Eleven individuals were recorded in the aforementioned trawl during the epibenthic survey, but there were no occurrences in the remaining trawls or the grab sampling.

The amphipod crustacean *Corophium* spp., and the molluscs *Ensis* spp. and *Mya* spp. were also identified, thus the presence of the non-native species *Corophium sextonae*, *Ensis americanus* and *Mya arenaria* could not be eliminated.

The common cord-grass *Spartina anglica*, identified around the proposed northern landfall side during the Thanet OWF intertidal survey, is a non-native hybrid species that arose from a crossing between the native small cord-grass *S. maritima* and the introduced smooth cord-grass *S. alterniflora*. *S. anglica* was planted in the past to aid the stabilisation of intertidal mudflats, but is generally considered to be a negative conservation feature and several attempts have been made to control its spread (JNCC, 2011).

7.4.3. Description of potential impacts

7.4.3.1. Introduction to assessment

The life of an offshore cable development can be divided into three separate phases:

- Pre-installation
- Installation
- Operation
- Decommissioning

Each of these phases will have potentially significant impacts on the existing environment, including benthic invertebrates, intertidal communities and fish, and may lead to the creation of new habitats and a change in species composition and communities. The table below takes into account sensitivity, recoverability and importance in order to determine a receptor value in assessing the significance of an effect.

Receptor Value	Definition
High	Receptor of national or international importance, that is highly sensitive to predicted impact and will not recover.
Medium	Receptor is either highly sensitive to predicted impact or will not recover. Receptor may be a species / habitat of regional or national importance.
Low	Receptor is not sensitive to predicted impact or will likely recover. Receptor is not a species / habitat of national or international importance.

Table 7-4-6 : Definition of receptor value

The table in Appendix 6 provides a detailed description of the impact assessment.

7.4.3.2. Pre-installation

Disturbance of habitats and species due to pre-lay grapnel run

A pre-lay grapnel run (PLGR) is likely to cause disturbance to and possible mortality of benthic fauna within the immediate vicinity of the grapnel hook. During the pre-lay grapnel run, out of service cables will be cut and removed using a grapnel. The level of change to the intertidal and subtidal faunal communities is unlikely to be noticeable and the impact will be only short-term. Benthic fauna is likely

to recover quickly through natural recruitment and migration from adjacent sediments, and hence the impact can be considered of negligible significance, even in the protected sites within Pegwell Bay.

The impact of a pre-lay grapnel run will be of greater significance should the hook be dragged across two areas of potential *Sabellaria spinulosa* reef identified during the benthic survey as close to and across the proposed route between KP108 and KP111. Biogenic reefs are designated a broad-scale habitat and *Sabellaria* reef is a habitat FOCl, thus areas of reef have been considered for protection during MCZ designation. Despite the small spatial extent of impact for a grapnel run, the high conservation importance of this habitat type means that any direct loss that damages the integrity of the reef structures or adversely affects their development would be considered as being moderately significant. *S. spinulosa* recruitment rates are high, so although the species is highly intolerant of substratum loss and moderately intolerant of physical disturbance, recoverability can be considered high (Jackson and Hiscock, 2008), resulting in a medium receptor value and a moderate impact significance. This impact on *Sabellaria* reef can be mitigated, as discussed in Section 7.4.4.

Disturbance of habitats and species due to pre-sweeping of sand waves

Pre-sweeping of sand waves is proposed at three points along the UK sector of the route, in order to reduce the height of the sand waves to aid the path of burial equipment and allow for greater control of the cable burial depth. No pre-sweeping will be required in the intertidal zone, thus no impacts are anticipated on intertidal habitats or communities.

Between KP82.3 and KP87, approximately 24470m³ of material is proposed for dredging, while between KP123 and KP123.5, an area of 1170m³ of sediment is proposed for removal. The area of the South Falls Sand Bank between KP99 and KP100.75 constitutes the largest area for pre-sweeping, with a proposed 93138m³ of material to be dredged. It has been proposed that a trailing suction hopper dredger (TSH) will be used with a total pre-sweeping corridor of 40m in width (20m either side of the cable centreline). These spoil volumes are considered typical of dredging operations for channel or port maintenance. The current proposal is for the dredged spoil to be deposited back on the seabed, in the immediate vicinity of the sandbank system from where it was derived, within 1500m of the point of dredging.

The impacts of pre-sweeping are two-fold: the removal of sediment from the areas to be dredged, and the deposition of the dredged sediment elsewhere. Removal of large amounts of sediment will have an influence on sediment transport as disturbance of the seabed will cause sediments to become re-suspended in the water column and deposited elsewhere. Sand and coarser sediment would only be dispersed over a short distance, while finer particles such as silt and chalk will be carried in suspension further from the disturbed area, as influenced by tidal currents. Further information on plume dispersal can be found in Chapter 2 – Project Background. Sandbanks are characterised by species which are adapted to the variable hydrographic conditions and mobile substrates (Elliot *et al.*, 1998), and many species can therefore be considered tolerant of disturbance.

Suspension and deposition of fine particles may have an effect on sessile filter feeders, through the blocking of feeding siphons, and may also affect reproductive processes of some species. The significance of these impacts relates directly to the sensitivity of the habitats and species in the affected area. Benthic communities in mobile sandy sediments are generally well adapted to regular disturbance, with low sensitivity to turbidity, increased suspended sediments and potential smothering, and often have rapid recovery rates. Several species identified during the subtidal benthic survey have been identified as having some intolerance to smothering, including the active suspension feeding polychaete worm *P. triqueter* (Hiscock *et al.*, 2005; Riley and Ballerstedt, 2005) and the deposit feeding crustacean *Urothoe* sp. (Hyslop *et al.*, 1997); hence the sensitivity and recoverability of the benthic community have been considered moderate. Neither of these species is considered rare or scarce within the UK, nor are they protected under UK or European legislation.

Plume concentrations and footprints of increased suspended sediment concentration above background levels have been calculated for the assessment of pre-sweeping and trenching impacts. This modelling, conducted by HR Wallingford, predicts increases in suspended sediment of more than 10mg l⁻¹ within 250m of the cable route, and the plume of fine material arising from disposal of dredged material from the South Falls sandbank to produce concentrations of around 2mg l⁻¹ above

background levels, due to the minimal amount of fines present and thus suspended from the sediment (HR Wallingford, 2011). The peak increase in suspended sediment concentration is not expected to exceed 30mg l^{-1} and deposition of fine material is predicted to be negligible, less than 0.1mm (HR Wallingford, 2011). Substantially more coarse sediment is expected to be released due to the nature of the seabed in the vicinity of the areas of pre-sweeping, with concentrations expected to increase to $>1000\text{mg l}^{-1}$ within 100m of the disposal site during the time it takes for the coarser particles to settle on the seabed; approximately ten minutes (HR Wallingford, 2011). Due to the limited spatial extent of the predicted impact, the lack of any rare or scarce species and the predominantly coarse sand found in the vicinity, the effects of suspended fine sediment and smothering on benthic communities can be considered of minor significance.

As with physical disturbance from a grapnel hook, *Sabellaria* is considered to have a medium receptor value with regard to disturbance from pre-sweeping. The two areas of existing *Sabellaria* reef identified during the benthic survey are over 8km from the areas of proposed pre-sweeping. The footprint of impact is not expected to extend beyond 500m from the proposed cable route (HR Wallingford, 2011), and thus the impacts of pre-sweeping on both the direct physical disturbance of, and smothering of, *Sabellaria* will be **minor**.

7.4.3.3. Cable Installation

Disturbance of habitats and species due to use of cable lay barges

Up to four anchors are proposed for use by each cable laying barge, and would be deployed up to 100m from the vessel. Anchors will only be used should the vessels be stationary for a lengthy period of time (days), or when cable jointing is taking place, which is expected to take up to five days per cable joint. Deployment of anchors may cause direct displacement of species on the seabed. This displacement and possible mortality of intertidal and subtidal benthic fauna will be localised at the point of anchor penetration and have no measurable effect on communities or habitats against natural variation in the baseline environment. This impact can be considered of minor significance.

The deployment of anchors could cause a significant impact on the two areas of *Sabellaria* reef should they be struck by an anchor. Although affecting only the immediate point of penetration, damage may be caused to part of the localised reef structure, which may take years to recover to baseline conditions. Thus the use of anchors could be considered of moderate impact significance on the existing *Sabellaria* reef within the installation corridor, although it will be possible to plan the works to avoid such damage.

Disturbance of habitats and species due to excavation of cable trench

Equipment used for excavation of the trench and burial of the cable will depend on the type of sediment encountered. Potential equipment to be used includes ploughs, jetting machines and mechanical trenchers, with land based spider ploughs for the intertidal installation, within the inshore zone - 1.5 to 2km from the beach. The last inshore 100 to 200m will require open cut trenching with tracked excavators, as for the landfall installation.

Disturbance of the seabed caused by excavation of the cable trench will lead to direct displacement and mortality of species located within the installation corridor, though only in the immediate vicinity of the burial path. Intertidal species are more tolerant of and well adapted to regular disturbance, and subsequent recovery of these fauna is expected to be very rapid as they are replaced by natural recruitment within a few weeks or months (Ager, 2008; Budd and Rayment, 2001; Jackson, 2000). There is little variation in the faunal community across the muddy sandflats of the intertidal area, with the exception of the *Lanice* dominated community in the mid-shore and the *Hydrobia/Macoma* community closer to the coast. The proposed cable route avoids the more sensitive wave-cut chalk platform to the north of Pegwell Bay and the mature saltmarsh communities to the south of the River Stour. The proposed cable landfall site is in the vicinity of an area of *Spartina* saltmarsh, though the patchy nature of this marsh suggests an emergent community (Royal Haskoning, 2005) and thus is unlikely to be of high conservation significance. Excavation of the cable trench is therefore likely to have only minor impact significance on intertidal communities. It should be noted that informal

discussion with Natural England and Kent Wildlife Trust has indicated that the intertidal habitat is recovering well following installation of the Thanet Offshore Wind Farm cables in 2010.

Benthic species within the subtidal zone would also have rapid recovery rates following disturbance and potential mortality. The impacts of excavation and burial will be one off occurrences; seabed species and habitats can begin recovery immediately after burial of the cable is completed. Although there is the potential for the intertidal and subtidal communities to be affected by the installation beyond the level of change which occurs with natural variation, the faunal community is predominantly of low conservation value and typical of these particular habitats and this region of the southern North Sea, thus the impact significance can be considered minor.

The effects of different burial equipment on direct disturbance of the seabed fauna are generally similar, although localised invertebrate mortality along the proposed cable route may be higher with jetting equipment than with ploughs, due to the greater amount of disturbance to the sediment. Smothering of sensitive species may occur, and buried species may be uncovered and exposed to predation. With burial by plough, impacts arise only from disturbance of the sediment by the plough itself. Displacement ploughs will create a v-shaped trench, while non-displacement ploughs shear through the sediment without creating an open trench, thus creating less disturbance to the seabed. Trenching would have the greatest impact on the seabed, while jetting would increase the re-suspension of sediments rather than increased direct physical disturbance of fauna. It is estimated that using the range of jetting and trenching burial technology suitable for the sediment type, the maximum footprint of the burial machine will be 10m and the footprint of the trench will be up to 5m.

Excavation of the sediment during installation will also have an impact on habitat FOCI that have been identified within the survey area. Sediment along the proposed route in UK waters was predominantly comprised of subtidal sands and gravels, with subtidal chalk also observed from the geophysical data along a large section of the route, covered by a veneer of sand and gravel, with the occasional small outcrop (MMT, 2010a). Considering the extent of these habitats across the survey area, and wider region, the disturbance of sediment within the cable installation corridor would be of minor significance. Data obtained from the Balanced Seas (2011) website indicates the prevalence of tide-swept channels within the survey area. Evidence has suggested that subtidal areas subject to strong tidal action may be host to diverse communities and robust fauna able to withstand such dynamic and changeable environments (Hill *et al.*, 2010; Hoare and Peattie, 1979).

The habitat FOCI of greatest concern with regard to disturbance caused by the proposed cable development is *Sabellaria spinulosa* reef. Installation of the cable has the potential to cause direct loss of the two areas of *S. spinulosa* that have been identified as being dense enough in aggregation to be considered as being potential reef structures. Excavation of the cable trench would remove any *Sabellaria* reef in the vicinity of the cable trench, up to 5m width, and within the footprint of the burial machine, up to 10m width. The high conservation importance of this habitat type means that any direct loss that damages the integrity or development of the reef structures would be considered as being significant. *Sabellaria* is generally ephemeral in nature, often being removed or damaged during winter storms. Data from other surveys have shown that rapid colonisation of existing reefs can begin almost immediately following cessation of such activities as aggregate dredging, with rapid growth within the first eighteen months and worms reaching adult body size within a year of settlement (Gubbay, 2007; Pearce *et al.*, 2007). Vorberg (2000) recorded average tube growth rates for in situ colonies of *S. alveolata* of 4.4mm per day after damage from trawling. Mature patches of *Sabellaria* in the area surrounding the Hastings Shingle Bank were estimated at three to five years of age (Pearce *et al.*, 2007). Therefore it is likely that the re-forming of *Sabellaria* reef and re-colonisation by associated species would occur within five years of completion of the cable installation. Due to the moderate magnitude of effect and the importance of *Sabellaria*, which has a medium receptor value, the impact of trench excavation will have moderate impact significance; though this impact can be mitigated.

Re-suspension of sediment into the water column

Excavation of the cable trench and burial of the cable may also have an influence on sediment transport, though only within the immediate vicinity of the cable trench. Disturbance of the seabed during excavation and cable burial will cause sediments to become re-suspended in the water column and potentially deposited elsewhere. Smothering from deposition of coarser suspended sediment due

to excavation of the sediment is only expected to have an effect on the immediate vicinity of the cable trench. This impact is localised and temporary and less significant for ploughing the cable trench than for jetting, where the sediment is fluidised for ease of cable burial. The indirect impacts of suspension of finer sediments extend beyond the installation corridor.

Plume dispersal was modelled for sandy sediment at a dry density of 1700kg m^{-3} , with the assumption that sandy material disturbed upon ploughing would fall to the seabed almost immediately, with only fines re-suspended and transported in the water column (HR Wallingford, 2011). Sandy sediment containing 2-3% fines ($<63\mu\text{m}$) was modelled, as this was the sediment recorded along much of the route, including the area surrounding the *Sabellaria*. A release rate of 0.05kg s^{-1} was calculated with such fines assumed to have a settling velocity of 1mm s^{-1} (HR Wallingford, 2011).

Benthic and intertidal communities in mobile sandy sediments are generally well adapted to regular disturbance, with low sensitivity to increased turbidity and suspended sediments. The dominant intertidal species are particularly well adapted to turbidity (Ager, 2008; Budd and Rayment, 2001; Tyler-Walters, 2008). At least two benthic species, *P. triqueter* (Hiscock *et al.*, 2005; Riley and Ballerstedt, 2005) and the deposit feeding crustacean *Urothoe* sp. (Hyslop *et al.*, 1997), have a higher intolerance to smothering, although these species are of low conservation value. Sediment dispersal modelling predicts that ploughing sand with 3% fines content would produce near seabed increases in suspended sediment concentration of less than 0.5mg l^{-3} above background levels and deposition of less than 0.1mm (HR Wallingford, 2011). The impact of such a small increase in suspended sediments on the benthic communities with a limited duration and spatial extent would be negligible, thus the predicted impacts of turbidity and smothering on the intertidal and subtidal communities can be considered of **negligible** significance.

Sabellaria spinulosa is also a filter feeding organism, requiring a good supply of suspended sediment for feeding and tube formation and, as such, *Sabellaria* reef communities generally occur in turbid areas where sand is readily placed in suspension (Holt *et al.*, 1998). It is expected that *Sabellaria*'s tolerance of turbidity and poor water quality (Holt *et al.*, 1998) would make the species more tolerant of increased sediment loads. It has even been suggested that an increased sediment load could have a positive impact on the development of *S. spinulosa* aggregations, as the worms could utilise the sediment in their tube building (Pearce *et al.*, 2007). *Sabellaria* may well be tolerant to smothering in the short term. Suspension of fine material during nearby activities such as dredging is not considered to have a detrimental effect, although long term smothering may affect feeding and growth (OSPAR QSR, 2010). As a protected Annex 1 habitat, the impact of long term smothering on *Sabellaria* would be of greater significance. However, *Sabellaria* is considered to be tolerant of increased suspended sediments and would likely have high recoverability following smothering for several weeks, once the population is able to recommence feeding and tube growth (Jackson and Hiscock, 2008). Suspended sediment concentration is predicted to increase to less than 0.5mg l^{-3} above background levels, with deposition of less than 0.1mm (HR Wallingford, 2011); at these levels and with the small spatial extent and short duration to which the *Sabellaria* reef will be exposed, the impact of sediment re-suspension can be considered **minor**.

Re-suspension of fine materials also has the potential to release sediment-bound contaminants into the water column, which would then be transported and potentially deposited on the seabed elsewhere. The Thanet OWF survey and results of MMT analysis of geotechnical samples reported metal and hydrocarbon concentrations in the intertidal sediments as within interim sediment quality guidelines, thus the effect of re-suspending these sediment-bound contaminants would likely have a **negligible** impact on intertidal communities (Royal Haskoning, 2005).

Disturbance of habitats and species due to chalk cutting

There is potentially the need for rock-cutting at some points along the proposed route between KP100 and KP115 where the underlying silty chalk substrate is close to the surface, covered only by a thin veneer of gravelly sandy sediment, and thus within the 2-3m depth intended for cable burial.

The two areas of *Sabellaria* reef are in proximity to the areas that may require chalk-cutting; therefore there is the potential for suspended silty chalk being transported to and deposited on the reef, along with other suspended fines. Plume dispersal of suspended sediments was modelled for chalk at a dry

density of 2000kg m^{-3} with 100% assumed to be released from ploughing, resulting in a release rate of 2kg s^{-1} and with chalk assumed to have a settling velocity of 0mm s^{-1} , deposition will be negligible (HR Wallingford, 2011). This would suggest only a minor impact of re-suspended chalk fines on the benthic communities within the area of chalk-cutting, while the fines may be transported along the predominant tidal direction. The predominant tidal direction and thus direction of sediment transport is north to south (HR Wallingford, 2011b), so it is likely that the chalk fines would be carried into the English Channel in the water column and dispersed, with minimal deposition. The impact on subbenthic fauna and *Sabellaria* within the survey area would be of **minor** significance.

Disturbance of habitats and species due to installation of external cable protection

External cable protection would be required where the proposed cable is required to cross an existing cable or pipeline. There is one potential cable crossing in UK waters: Global Crossing's Atlantic Crossing 1 telecom cable. The exact nature of external cable protection will be dependant upon crossing agreements with the parties owning the assets to be crossed. The footprint of the cable crossing will be approximately 100m of rock or concrete mattress along the Project cable, with approximately 30m of rock or concrete acting as a bridge over the existing cable.

The installation of this external cable protection will have an effect on the seabed, in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fauna and displacement of benthic habitat. This could effectively cause a long-term change in the faunal baseline at those immediate localities; however, the benthic faunal assemblage along the cable route can be considered typical of fauna in this region of the southern North Sea and is generally of low conservation value. Despite the use of external cable protection creating a potentially moderate impact significance in terms of substrate change, as a whole the spatial extent of effect is minimal and the provision of new hard substrate can create new habitat for colonisation, thus can be considered a positive impact rather than a negative one. The impact of installation the external cable protection will be of minor significance due to the small spatial extent and duration of any works, and the lack of any sensitive habitats or habitats of conservation importance in the area surrounding the cable crossing.

Only two areas of *Sabellaria* reef have been identified along the UK route, and neither of these occurs within 10km of the potential cable crossings and anticipated external cable protection. Thus there is no anticipated impact upon these dense *Sabellaria* aggregations.

Impacts from noise and vibration

Evidence suggests that several intertidal species present within Pegwell Bay, including *Hydrobia ulvae*, *Macoma balthica* and *Lanice concilega* are tolerant to noise (Ager, 2008; Budd and Rayment, 2001; Jackson, 2000). Monitoring studies conducted at the Horns Rev wind farm indicated that noise and vibration have not caused any detrimental effects to marine invertebrates within the survey area (Vella *et al.*, 2001). The noise and vibration associated with cable-laying operations would not therefore be produced at a high enough intensity to cause physical damage or disturbance to intertidal benthic species, thus can be considered of negligible impact significance.

Accidental contamination from associated vessels and equipment

During cable-laying operations, any use of associated vessels and equipment would have potential for accidental contamination of the sediment. Such contamination is unlikely given environmental procedures, but could have a minor impact on benthic communities in the local area and have a medium-term effect, depending on the type and spread of contamination. This impact could also potentially occur during the operational and decommissioning phases, should there be any maintenance activities required or if the cable is removed.

7.4.3.4. Cable Operation

Impacts due to changes in current regime

There is no anticipated impact of buried cables on the current regime in the intertidal area of Pegwell Bay or the subtidal region along the UK portion of the proposed cable route. The presence of external cable protection used around cable crossings may potentially cause minor localised alterations in current flow, resulting in localised turbulence during peak flow and increase the potential for scour to

occur around the structures. The impact of this given the small spatial size of external cable protection is expected to be negligible.

Disturbance of habitats and species due to external cable protection (scour and substrate change)

The use of rock or concrete as external cable protection will provide an additional hard substrate in a generally sandy environment, providing a new habitat for colonisation by a range of benthic invertebrates, with associated epifauna and fish communities over time. The extent of scour that would occur is dependant upon the type and size of structure installed and the seabed sediment type in the vicinity of the structure. Scour would have a short-term impact directly after initial installation of any external cable protection, and likely be negligible considering the structures would be readily re-colonised by an array of benthic fauna. Despite the use of external cable protection creating a potentially moderate magnitude of effect, it can be considered a minor positive impact.

Impacts due to maintenance activities

Routine maintenance work to the cables is not anticipated. Some unscheduled work may be required to maintain the burial of the cable to protect it following adverse interactions with other sea users or marine processes such as tidal scour. In the event of such maintenance work, it is likely that benthic species and habitats in the immediate vicinity of the area of works would be disturbed with some possible small scale mortality. Any such work would be localised to the immediate vicinity and be short in duration and therefore have an impact of negligible significance. Accidental contamination from associated vessels and equipment during maintenance works may also occur. Such contamination is unlikely given environmental procedures, but could have an effect on benthic communities in the local area and have a medium-term effect, depending on the type of contaminants.

Impacts due to operational noise and emissions

No noise will be produced during operation of the cables and thus is more relevant as a concern during the installation and decommissioning phases of the project.

As the cables are to be buried, the impact of heat from the operating cables at the seabed would be minimal, with temperatures expected to increase above background levels only in the 10-30cm immediately above the cables (Metoc, 2004a). Generated heat is absorbed and dissipated into the surrounding environment, thus the presence of sea water will aid the dissipation of any heat produced. Calculations from a study conducted for the BritNed interconnector cable development indicate that during summer the temperature may increase between 0.5°C and 5.5°C through localised heating directly above the cable, where the cable is buried at a depth of 1m, and from less than 0.5°C to 1.8°C where the cable is buried at a depth of 3m (Swedpower, 2003).

Cable Burial Depth	Predicted Temperature Increase							
	10cm (summer)		30cm (summer)		10cm (winter)		30cm (winter)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1m	0.5°C	1.5°C	1.5°C	5°C	0.5°C	2°C	1.5°C	5.5°C
3m	<0.5°C	N/A	0.5°C	1.8°C	<0.5°C	N/A	0.4°C	1.7°C

Data from Swedpower (2003) on behalf of BritNed.

Table 7-4-7 : Predicted temperature increase when cables are buried at 1 and 3 metres

Burial of the cables will reduce the level of magnetic and electric fields occurring at the seabed surface. It is expected that the electromagnetic field (EMF) created by the operation of the cables will be small and within the natural range occurring in the North Sea (Metoc, 2004a; 2004b). There is no evidence that benthic invertebrates are adversely affected by low levels of electric and magnetic fields. The impacts of operational noise and heat emissions on benthic fauna are expected to be **negligible**.

7.4.3.5. Decommissioning

There is a lack of clear guidance in legislation regarding the decommissioning of marine installations, such as cables. Subsea cables would be isolated offshore, with two alternatives, removing the cable or leaving it buried in situ.

The current proposal is for the external cable mattressing and any scour protection to be left in-situ, with the cable to either be left buried deep enough in-situ, or removed. If the cable is to be removed, then either a grapnel hook will be used to lift the cable from the seabed, or a jetting device will be used to expose a section of cable to allow removal. As such, an assessment of the impacts of decommissioning will be carried out prior to any decision being made on whether to recover the cables, and a survey of the seabed will need to be conducted to assess the species and habitats within the vicinity.

Cable recovery would have a variety of impacts, similar to installation, with disturbance to the immediate vicinity as the cables are removed, and sediment re-suspended into the water column, causing smothering and other potentially detrimental effects on suspension feeders. Consideration must also be given to the disposal of materials being removed from the seabed and the consequent effect on the habitat and colonising species.

Leaving the cable buried in-situ will be unlikely to have new impacts, especially as faunal communities will likely have “recovered” to their previous state or adapted to the presence of the cable and any external protection. Additional factors to consider in the presence of any external cable protection will be the degree of epifaunal colonisation that has taken place, including the presence of potentially sensitive *Sabellaria* and associated fish communities supported by the increased and varied diversity (Vella et al., 2001). Studies at the Horns Rev offshore wind farm in Denmark recorded considerable colonisation of the wind turbine foundation by numerous species, within only five months of construction being completed (Leonhard, 2000). Hisock et al. (2005) suggested that if wind farm foundations have supported productive artificial reef communities, it may be a more environmentally beneficial and cost-effective alternative to leave the foundations in place after decommissioning. The same should be considered of any external cable protection in place, such as rock or concrete mattressing.

7.4.4. Mitigation

The predicted impacts of the interconnector cable development are minimal, with the most significant impacts concerning the sensitive *Sabellaria spinulosa* reef habitat identified at two points along the UK cable route. Several mitigation measures have been identified in order to minimise impacts from the various phases of the cable development.

The original proposed route passed directly through one area identified as *Sabellaria spinulosa* reef from the geophysical data and the seabed imagery, and within 65m of a second, smaller, area of potential reef. To avoid these areas of *Sabellaria* reef, the proposed installation has been re-routed between KP107.5 and KP112 and to pass approximately 165m south of the original route at the point of the larger area of delineated reef. At its closest point, this revised route will pass approximately 90m from the larger reef and approximately 150m from the smaller area of potential reef. Both routes are displayed in Figure 7-4-1, and are shown in relation to the *S. spinulosa* reefs at Stations B03-039 and B03-040 in Figures 7-4-2 and 7-4-3 respectively. Delineation of the reef at Station B03-039 is shown in Figure 7-4-D in relation to the original and revised proposed routes. This re-routing to avoid *S. spinulosa* reef will provide adequate mitigation to eliminate any threat of direct disturbance or damage to this habitat from the pre-lay grapnel run, pre-sweeping of sand waves, the use of cable lay barges, excavation of the cable trench and burial of the cable. Avoidance of the areas of *Sabellaria* has been discussed with Natural England and it has been agreed that the revised cable route alignment will ensure that there are no impacts on the areas identified.

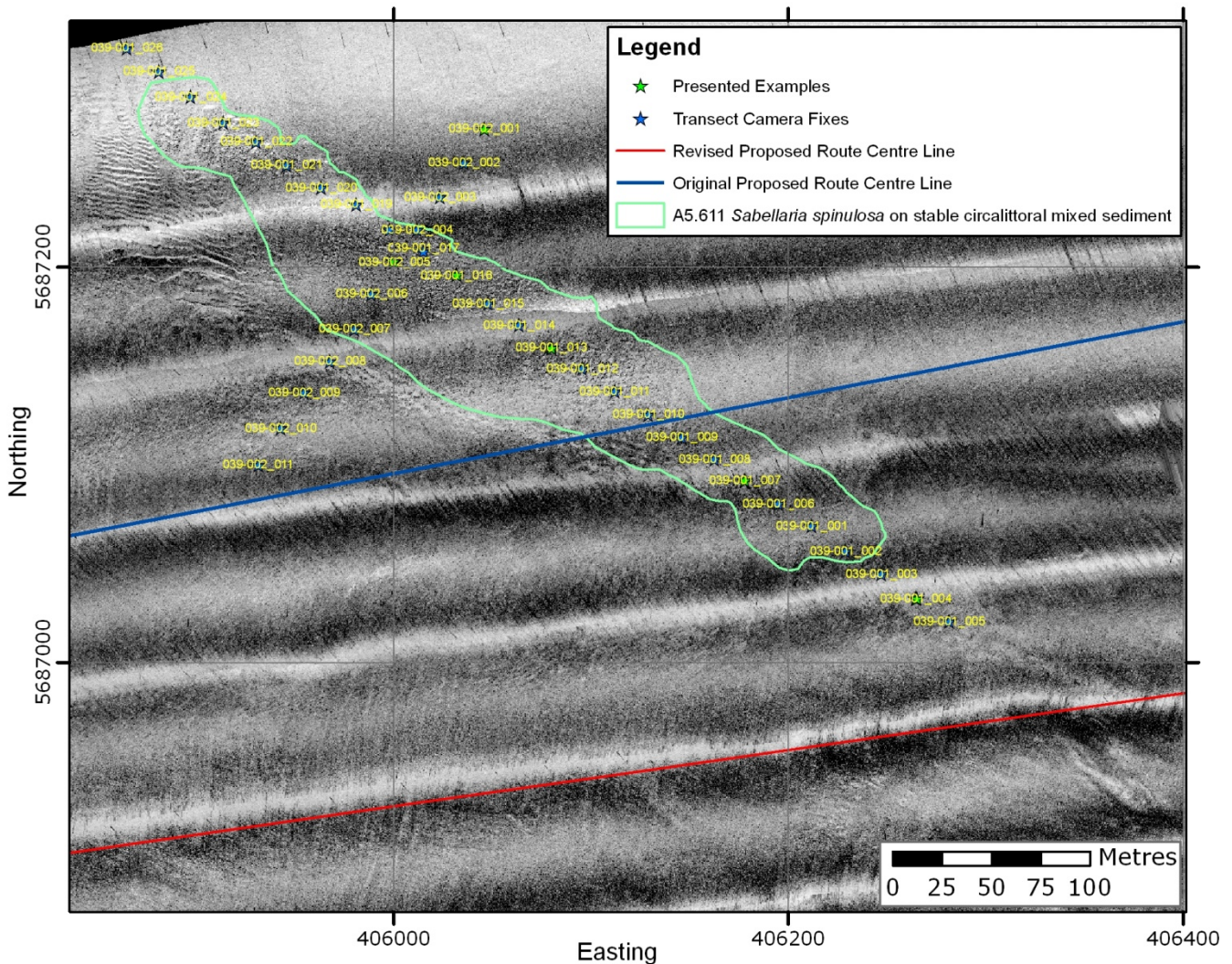


Figure 7-4-D : Delineation of Sabellaria reef – Station B03-039

Ploughing or jetting are the recommended methods to excavate the cable trench as they reduce the re-suspension of sediments and thus minimise impact on benthic communities. Jet trenchers result in more turbidity than non-displacement ploughs due to the use of water to fluidise the sediment. Bundling the cables together in one trench, rather than two separate trenches will also reduce the impact footprint of trench excavation and cable burial. Simultaneous lay and burial would also be recommended to minimise repeated impacts on the benthic community. The size and amount of external cable protection should also be minimised in order to mitigate the impact of the structures on current flow, and thus reduce scour. A smaller amount of external cable protection would also result in less disturbance to and loss of the seabed.

The current project plan includes the proposal to deposit the spoil removed from the seabed during pre-sweeping at least 1km from the area in which it was dredged. It will be ensured that this spoil is not deposited in the vicinity of the *Sabellaria* reefs to eliminate any further impact of sediment re-suspension and potential smothering.

It is currently recommended to leave the cable in-situ after decommissioning to avoid further impacts on the seabed, though this will likely require further impact assessment as conditions may change throughout the lifecycle of the development.

Strict environmental health and safety guidelines and spill procedures will be followed to minimise the risk of accidental contamination throughout the life of the project.

7.4.5. Residual impact

No rare or scarce species have been identified in the vicinity of the cable route. Impacts of cable installation are therefore expected to be **minor**, with the exception of potential impacts on the two areas of *Sabellaria* reef, which will have been mitigated for accordingly.

Following re-routing to avoid the areas of *Sabellaria spinulosa* reef, there are no anticipated significant impacts from the installation, operation and decommissioning phases of the cable development. Residual impacts are all considered to be of minor significance; however the presence of *Sabellaria* along the route means that the potential impacts of the pre-lay grapnel run, the use of cable lay barge anchors, excavation of the trench and cable burial may still have a **moderate** impact on this high value receptor.

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7.5. Fish and Shellfish Ecology

7.5.1. Baseline data sources

This chapter details the natural fish and shellfish resource within the study area. Baseline conditions have been determined in order to conduct an assessment of the impacts associated with the installation, operation and decommissioning of the proposed Nemo Link high voltage direct current (HVDC) interconnector cable. Impacts upon commercial fishing are assessed in Chapter 8.1 – Commercial Fisheries.

Substantial existing information has been used to support the description of the environment, with much of the published literature of the south-east seas relating to the area's numerous potential conservation designations. While no specifically commissioned fish surveys were conducted as part of the Environmental Impact Assessment (EIA) some datasets were provided by four trawls carried out for the subtidal epibenthic survey (MMT, 2010; Appendix 11 – Environmental Survey Report (ESR)). General descriptions of commercially and non-commercially important fish species in the area have been obtained from numerous sources, including English Nature's Marine Natural Area Profile (Jones *et al.*, 2004a and 2004b), and Environmental Statements from other offshore wind farm developments in the Outer Thames Estuary. This includes data collected during adult and juvenile fish surveys for the nearby Thanet Offshore Wind Farm project (Royal Haskoning, 2005).

Other information sources have included surveys conducted by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and the UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).

7.5.1.1. Subtidal benthic survey

The subtidal benthic survey was conducted between the 22nd September and 2nd October 2010. The benthic survey design and sampling strategy was conducted in accordance with existing survey guidance (ALSF, 2010; CEFAS, 2002; Davies *et al.*, 2001; JNCC, 2010) and consultation with Natural England (NE), the JNCC and the Environment Agency (EA). Within Block 3, UK waters, twenty stations were investigated with a drop down digital stills camera and video system, at two of these stations cross camera transects were carried out as potentially sensitive biogenic reef habitat was identified. Sediment sampling was conducted using a 0.1m² Day Grab. At each station three samples were collected and, where possible, these were sieved over a 1mm mesh to collect faunal samples for analysis. The positions of the twenty environmental survey stations are presented in Figure 7-4-1. Details of the survey methodology are provided in the ESR (MMT, 2010; Appendix 11). Description of the baseline marine benthic environment and a discussion of potential impacts of the interconnector cable upon this is made in Chapter 7.4 – Benthic and Intertidal Ecology.

7.5.1.2. Epibenthic trawl survey

The epibenthic 2m trawl survey was conducted on the 30th September 2010. The epibenthic survey was designed and implemented in accordance with existing survey guidance (CEFAS, 2002; Davies *et al.*, 2001) and consultation with Cefas. Epibenthic trawling was carried out at four locations in Block 3 using a 2m beam trawl to sample megafauna (>1cm). Three trawls were conducted over a distance of 600m, with the fourth over a distance of 1200m. Samples were washed over a 5mm mesh sieve prior to sorting and field identification. Details of the survey methodology and the positions of each trawl are provided in the ESR (MMT, 2010; Appendix 11). The positions of the trawl locations are presented in Figure 7-4-1.

7.5.2. Baseline Environment

7.5.2.1. Marine Fish

The southern North Sea is characterised by a sandy, flat, shallow seabed with substantial tidal mixing, it contains greater fish species diversity than either the central or northern North Sea (Callaway *et al.*, 2002), this diversity is most pronounced towards the west (Rogers *et al.*, 1998). The southern North Sea is characterised by a high abundance of small non-commercial demersal (bottom-dwelling) species (Callaway *et al.*, 2002) and also contains a number of important nursery and spawning grounds.

The area of the southern North Sea stretching between the English and Dutch coasts contains a distinctly different community comprising of pelagic species, in particular horse mackerel (*Trachurus trachurus*) and mackerel (*Scomber scombrus*) (Callaway *et al.*, 2002).

Fish identified during the Nemo Link epibenthic grab and trawl surveys are listed in Table 7-5-1. Trawl abundance reflects the total number of individuals recorded during the survey, while the grab abundance reflects the number of individuals captured per square metre of the survey area.

Latin Name	Common Name	Grab Abundance (number per m ²)	Trawl Abundance (number of individuals)
Actinopterygii		-	1
Amoglossus laterna	Mediterranean scaldfish	-	4
Callionymus lyra	Common dragonet	-	8
Gaidropsarus spp.	Rockling	10	-
Hyperoplus lanceolatus	Greater sand eel	-	3
Pleuronectes platessa	European plaice	-	17
Pomatoschistus spp.	Gobies	-	195
Solea solea	Common sole	-	7
Trachinus draco	Greater weever	-	22
Trachurus trachurus	Atlantic horse mackerel	-	1
Trisopterus minutus	Poor cod	-	2

Table 7-5-1 : Fish species recorded within the survey area

Demersal species

Demersal fish dwell at or near to the bottom of the water column and their lifecycle is closely associated with the seabed which is commonly used to forage, shelter and breed.. The flat sandy sediments found in the southern North Sea are well suited to demersal fish who are prevalent and use the region as both spawning and nursery grounds.

Atlantic cod (*Gadus morhua*) occurs ubiquitously around the UK coast and favour sandy sediments. The juveniles tend to inhabit the inshore waters while adults are generally found further offshore in deeper, cooler waters. Cod commonly school during the day at depths of 30-50m below the surface.

Cod occur throughout the North Sea, including the region of the proposed Nemo Link cable route, spawning is concentrated within several the central North Sea (Dogger Bank), the southern North Sea and the German Bight (CEFAS, 2001). Spawning generally occurs between January and April (Coull *et al.*, 1998) at temperatures ranging between 0-12°C, both eggs and larvae are pelagic and are dispersed over a wide area (Cohen *et al.*, 1990). North Sea cod stocks have been heavily impacted by the combined effects of overfishing and temperatures changes throughout the water column thus impacting on all life stages (Rindorf and Lewy, 2006). Only 2 cod were caught during the Thanet OWF spring fish survey (Royal Haskoning, 2005).

European plaice (*Pleuronectes platessa*) occurs throughout UK waters generally in association with sandy sediments, but is also found in areas of mud and gravel, plaice tend to inhabit depths of <50m. Plaice spawn in the south-eastern waters of the UK and shallower parts of the southern North Sea from December to March (Coull *et al.*, 1998). Plaice eggs have a temperature tolerance 0 -14°C (Rijnsdorp and van der Veer, 2008) but spawning occurs at around 6°C (CEFAS, 2001). Plaice eggs and larvae drift in the water column for 2-3 months (Rijnsdorp and van der Veer, 2008), enabling them to settle in the shallow, sandy bays of the east and south-east coasts of Britain. From these inshore nursery grounds the juveniles disperse offshore as they mature (Coull *et al.*, 1998; DECC, 2009). Plaice is one of the most commercially important European fish species. A total of 17 were caught during the 4 Nemo Link epibenthic trawls (MMT, 2010). During the Thanet OWF spring and summer fish surveys, 174 plaice were caught, 57 in spring and 117 in summer (Royal Haskoning, 2005).

Whiting (*Merlangius merlangus*) are found in deeper waters on sandy and gravelly sediments, where they feed predominantly on crustaceans, sand eels and other small fish. Whiting spawn offshore between February and June (Coull *et al.*, 1998), with eggs remaining in the water column (Cohen *et al.*, 1990) and juveniles living closer inshore in sheltered bays and estuaries (Coull *et al.*, 1998), migrating to the open sea at around a year old (Cohen *et al.*, 1990). Although temperature is believed to have an effect on the geographical distribution of whiting, the effects of temperature on spawning are likely to be minor as the species is so widespread in the North Sea (Loots *et al.*, 2010). During the Thanet OWF spring and summer fish surveys 58 whiting were caught, 28 in spring and 30 in summer (Royal Haskoning, 2005).

Poor cod (*Trisopterus minutus*) is common in UK waters, though less so in the southern North Sea (Kay and Dipper, 2009), it is an important food source for valuable commercial species such as cod. Poor cod spawn in the spring when the water has warmed to at least 8°C (Kay and Dipper, 2009), with eggs scattered and left unguarded on the seabed (Cohen *et al.*, 1990). The Nemo Link epibenthic trawl captured 2 poor cod (MMT, 2010). The Thanet spring and summer fish surveys captured 7 and 7 individuals respectively. (Royal Haskoning, 2005).

Common sole (*Solea solea*), sometimes referred to as Dover sole, is a coastal species, usually found on sandy and muddy seabeds and estuaries in depths of <70m. Sole spawn in shallow inshore areas and sandbanks of <30m deep between March and May (Coull *et al.*, 1998; DECC, 2009) at temperatures of 6-12°C (Quéro *et al.*, 1986). A literature review conducted by Wehner *et al.* (2003) suggests water temperatures influence spawning times with earlier peaks in spawning in warmer years and vice versa. The optimal temperature range for egg survival is 8-16°C. Larvae are pelagic for approximately 1 month, before metamorphosing into the demersal phase consequently shallow coastal nursery grounds are situated close to spawning areas (Coull *et al.*, 1998). The common sole is an important heavily exploited commercial species. During the Thanet OWF fish surveys, 6 sole were landed in spring and 47 in summer (Royal Haskoning, 2005).

Lemon sole (*Microstomus kitt*) inhabits coarser sediments than the common sole and deeper waters <200m. Spawning occurs in deep waters between April and September (Coull *et al.*, 1999; Kay and Dipper, 2009), little else is known of lemon sole spawning characteristics; however they are believed to spawn over a wide area (CEFAS, 2001). The Thanet OWF spring fish survey captured 3 lemon sole and the summer survey 26 individuals (Royal Haskoning, 2005).

The lesser sand eel (*Ammodytes tobianus*) is the commonest species of sand eel in the North Sea, it provided an important food source for fish e.g. herring and mackerel and seabirds such as puffins. The greater sand eel (*Hyperoplus lanceolatus*) was also recorded in the survey area, and is known to commonly associate with shoals of *Ammodytes* spp. Sand eel spawning generally occurs between November and February (Coull *et al.*, 1998), with demersal eggs laid in sticky clumps on sandy sediments (CEFAS, 2001). Upon hatching, larvae become planktonic resulting in a wide distribution, then return to being demersal between 2-5 months (CEFAS, 2001). There is little movement between spawning and feeding grounds (Coull *et al.*, 1998; DECC, 2009). Sand eels are also harvested as an important part of industrial fisheries.

Gobies (*Pomatoschistus* spp.) inhabit clean inshore sands throughout the UK's coastal waters. Gobies feed on a range of planktonic organisms and crustaceans, and themselves form an abundant food source for many demersal fish, including commercial species such as cod and flatfish. Various species of goby were recorded in the epibenthic trawls in quite high numbers.

Mediterranean scaldfish (*Arnoglossus laterna*) can be found all around the British Isles and is especially common in the southern North Sea, where it provides an important food for larger commercial fish. The scaldfish spawns in the spring and summer in the North Sea.

Common dragonet (*Callionymus lyra*) is the most abundant of three species of dragonet found around the British Isles. Dragonets inhabit shallow water with sand and muddy sands, they feed primarily on polychaete worms, crustaceans and molluscs. The common dragonet spawns between late winter and early spring, in depths of less than 50m (DECC, 2009).

Greater weever fish (*Trachinus draco*) and lesser weever fish (*Echiichthys vipera*) can both be found on sandy seabeds all around the British coasts, where they spawn during the summer months.

Other demersal species recorded during the Thanet OWF surveys included tub gurnard (*Trigla lucerna*), grey gurnard (*Eutrigla gurnardus*), dab (*Limanda limanda*), bib (*Trisopterus luscus*) and flounder (*Platichthys flesus*) (Royal Haskoning, 2005).

Pelagic species

There are several pelagic species that make extensive migrations through the southern North Sea.

Atlantic herring (*Clupea harengus*) are widespread in the North Sea, spending much of the year in feeding grounds in the northern North Sea, migrating south to spawn in shallow coastal regions, using coastal waters, estuaries and inlets as nursery grounds. Herring require coarse sands and gravels in depths of 15 to 40m, upon which to lay sticky adhesive eggs. This species is particularly sensitive to disturbance; egg mortality occurs as a result of predation, suffocation due to silting and, in intertidal areas, from exposure to air and wave action (Haegele and Schweigert, 1985). Herring spawning off the south-east coast occurs between November and January (Coull *et al.*, 1998). Young herring can be found in inshore waters, in dense mixed shoals with sprat (DECC, 2009). The Thanet OWF spring fish survey captured 5 herring (Royal Haskoning, 2005).

Sprat (*Sprattus sprattus*) prefer shallower coastal waters and estuaries and are widespread along the coasts of the southern North Sea. Sprat spawn through summer months in waters of 10-20m depths (Coull *et al.*, 1998; DECC, 2009). The eggs and larvae are pelagic and dispersed across wide areas (Kay and Dipper, 2009).

Mackerel (*Scomber scombrus*) are widely distributed around the UK and can be found in huge shoals, feeding on crustaceans, zooplankton and small fish. The North Sea mackerel stock spawns between May and August, with highest egg concentration in the central North Sea (Coull *et al.*, 1998). Mackerel are batch spawners meaning they cover a wide area (Kay and Dipper, 2009). A review of existing information on mackerel suggests that the primary limitation for the timing of spawning is temperature, with an optimal range of 10 -15°C (Johnson, 1977).

Horse mackerel (*Trachurus trachurus*) spend much of the year in the central North Sea, forming large shoals and migrating to the southern North Sea in the summer to feed on plankton and spawn in open water. Eggs and larvae are released into the water column and dispersed over a wide area (Kay and Dipper, 2009). In winter, horse mackerel move into deeper offshore waters to feed on bottom living invertebrates (Kay and Dipper, 2009). The optimal spawning temperature for horse mackerel is ~13°C, with a range of between 10-22°C (Eaton, 1983).

7.5.2.2. Spawning and nursery grounds

The area along the proposed cable route is characterised by offshore sandbanks, with sediment formations such as sand waves and ripples interrupting the predominantly smooth bathymetry along much of the route. Sandbanks provide important habitats for benthic invertebrates and thus provide an important food resource for a range of fish and seabirds, as well as being spawning and nursery grounds for many commercially important fish species.

The majority of fish species spawn in the water column (pelagic spawning), and remain there as larvae after hatching, feeding on microscopic organisms until they develop into adults. Some species rely more heavily on the seabed (demersal spawning) and a more specific set of conditions for spawning to occur. Herring is particularly sensitive with regard to spawning conditions, requiring well-sorted coarse sands and gravels in depths of 15 to 40m, elevated from the surrounding seabed and with exposure to the main flow of water to provide oxygenation of the sediments. Much of the sediment along the proposed route comprises such coarse sands and gravels, and with numerous sand ripples and sand waves, these areas are likely to host herring spawning grounds.

Juveniles require food sources and protection from predators both of which are provided by the seabed, whereas inhabiting the water column can be more risky. Nursery areas can host vast numbers of juvenile fish, sometimes together with older individuals, and even adult fish. Depending on the species, nursery areas can be found in shallow and productive coastal waters where there is an abundance of polychaetes and crustaceans (in the case of juvenile flatfish), and others in coastal reef environments (such as juvenile cod) or deeper offshore areas. Nursery areas are difficult to delineate as they can be affected by changing hydrographic and biological conditions, such as temperature, currents and food availability.

It is typical for juvenile fish of many species to remain in these nursery grounds which are sheltered from predators and provide an abundance of food. Within nursery and spawning grounds, fish aggregate in large numbers and so are particularly vulnerable to disturbance. The proposed offshore cable route is situated in an area used by several key commercial species as spawning and nursery grounds. Cod, herring, lemon sole, common sole, plaice, sand eel, sprat, horse mackerel and whiting use at least part of the area for spawning, while lemon sole, common sole, sand eel, cod, plaice, mackerel, herring, tope and whiting have been recorded using the area as a nursery ground.

An overview of the approximate spawning periods for each species is presented in Table 7.5.2. Overviews of potential spawning and nursery grounds for selected fish within the survey area are presented in Figure 7.5.1 and Figure 7.5.2, highlighting areas of high and low intensity. Areas of higher concentrations of juveniles (H) are considered to relate to more important nursery grounds (Coull *et al.*, 1998; Ellis *et al.*, 2010).

Species (stock)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herring (SE England)												
Common sole				*								
Lemon sole												
Plaice	*	*										
Sprat					*	*						
Sand eel												
Whiting												
Cod		*	*									
Mackerel (N Sea)						*	*					
Horse mackerel (N Sea)					*	*	*					

Table adapted from Coull *et al.*, 1998 and CEFAS GIS mapping data (Ellis *et al.*, 2010)

* Peak spawning

Table 7-5-2: Approximate spawning periods within the survey area

7.5.2.3. Diadromous fish

Diadromous species are those that migrate between fresh and salt water during different stages of their life cycle, many of which are of high conservation importance.

Anadromous species are those diadromous fish that live in salt water and migrate to fresh water specifically to breed. Atlantic salmon (*Salmo salar*) are known to spawn in rivers and estuaries of the south-east region of England (DECC, 2009) and are likely migrate over the proposed cable route to spawning grounds in the River Stour, Kent.

Sea trout (*Salmo trutta*) are found in streams, ponds, rivers and lakes and there is a recorded trout run into the River Stour (DECC, 2009) with individuals generally arriving in early June (Royal Haskoning, 2005).

Smelt (*Osmerus eperlanus*) are rarely found far from the shore, entering rivers for spawning between February and April (Barnes, 2008). Smelt have been recorded within the Thames Estuary (Royal Haskoning, 2005), thus it is likely that they also use the River Stour for spawning. Smelt can form an important food source for many birds.

The European eel (*Anguilla anguilla*) is a catadromous species, metamorphosing twice, with part of its life cycle spent in freshwater and part in estuarine or fully saline seawater (Whitehead *et al.*, 1986). Eels are a severely declining species, the IUCN red list classifies eels as critically endangered. Eels inhabit a range of fresh water and marine habitats, including: rivers, estuaries, low salinity pools, tidal pools, coastal and oceanic waters. They migrate an approximate 5000km to the Sargasso Sea in the West Atlantic to spawn during late winter and spring.

Adult eels have been recorded in the River Stour and will therefore pass over the proposed cable route as they migrate. Adults and juvenile eels (elvers) will also likely traverse the route on their return journey to the estuaries in April and May. The species has undergone a sharp decline in recruitment and population size, and is listed as critically endangered on the IUCN Red List of Threatened Species (Freyhof and Kottelat, 2008).

7.5.2.4. Elasmobranchs

Current knowledge of elasmobranch distribution around the UK is recognised as being very limited. Elasmobranchs are a subclass of cartilaginous fish, which includes the sharks, skates and rays. Shark species generally found within the coastal regions of the southern North Sea include nursehound, or greater-spotted dogfish, (*Scyliorhinus stellaris*), the small-spotted catshark, or lesser-spotted dogfish, (*Scyliorhinus canicula*), smoothhound (*Mustelus mustelus*), spurdog (*Squalus acanthias*) and tope (*Galeorhinus galeus*).

Ray and skate species include the thornback ray (*Raja clavata*), small-eyed ray (*Raja microocellata*) and endangered undulate ray (*Raja undulata*), with the endangered common skate (*Diptura batis*) present but rare (DECC, 2009). Large open water fish species such as porbeagle shark, blue shark, thresher shark and basking shark are occasionally sighted in coastal waters of the south east coast of England and English Channel (DECC, 2009), but there are no confirmed records within the proposed area of development. Available data on elasmobranchs is primarily based on catch and by-catch data (Gill *et al.*, 2001).

No elasmobranch species were recorded during the Nemo Link epibenthic survey (MMT, 2010). However *Raja* spp. (including a total of 58 thornback ray), 307 small-spotted catshark and 69 starry smoothhound were all recorded during the Thanet OWF fisheries surveys (Royal Haskoning, 2005). The small-spotted catshark is widely distributed in the shallow sublittoral zone around the UK coasts. This species has been recorded within the area of planned work around the Kent coastline by numerous surveys conducted by CEFAS (Marine Biological Association, 2008) and Seasearch Marine Surveys (Marine Conservation Society, 2010) between 1998 and 2010.

Dogfish display a wide but patchy distribution in the North Sea, feeding on crustaceans, cephalopods and fish (Ellis *et al.*, 1996) and are generally found living on the seabed. Breeding occurs between November and July, peaking in the summer months, and as with all elasmobranchs, is heavily associated with the sediment, as eggs are laid on the benthos.

The dependency of elasmobranchs on the seabed as a source of food, refuge and breeding ground makes them potentially vulnerable to consequences of alteration of the seabed e.g. cable laying, dredging and increased sediment mobility etc.

7.5.2.5. Cephalopods

A number of cephalopod (squid, cuttlefish and octopus species) occur in UK waters. The most frequently observed species include the long-finned squid (*Loligo forbesi*), bobtail squids and the octopus (*Eledone cirrhosa*) (DECC, 2009).

No cephalopods were recorded during the Nemo Link epibenthic trawls (MMT, 2010); however long-finned squid and common cuttlefish (*Sepia officinalis*) were both identified during the Thanet OWF fish surveys (Royal Haskoning, 2005).

The long-finned squid is the most commercially important squid species in the UK, and is generally recorded in shallow coastal waters and along the continental shelf (DECC, 2009).

The common cuttlefish is the largest cuttlefish species found in UK waters, and is widespread along British coasts, feeding on molluscs, crustaceans and small fish.

The little cuttlefish (*Sepia atlantica*) is also widespread along the British coasts, especially in England and Scotland. This small species can be found burrowing into sandy sediments, in the shallow subtidal zone often in rockpools, and further offshore. Seven individuals were recorded in the epibenthic trawls (MMT, 2010).

7.5.2.6. Shellfish

The Kent coast is important for various shellfish species, including cockles, scallops, oysters, mussels, whelks, lobster and crab. Pegwell Bay is designated as a Shellfish Water under the Shellfish Waters Directive; aimed at protecting the aquatic habitat of bivalve and gastropod molluscs, including oysters, mussels, cockles, scallops and clams. The Shellfish Waters Directive does not cover shellfish crustaceans such as crabs, crayfish and lobsters.

There are extensive shellfish fisheries within the vicinity of Pegwell Bay, most notably for cockles, scallops, oysters, whelks and lobster. It is understood from Kent and Essex Sea Fisheries Committee (now Kent and Essex IFCA), that fishing for whelks and lobster takes place along the cable route where it enters Pegwell Bay (pers. comm.). Wave-cut chalk platforms were identified along the northern coast of Pegwell Bay during the Thanet OWF survey (Royal Haskoning, 2005). Along these rocky reefs was recorded an abundance of common mussel (*Mytilus edulis*), in an assemblage considered unique enough to be of local conservation importance (Royal Haskoning, 2005). The outer extent of these chalk platforms and mussel beds is over 250m from the proposed cable route.

Shellfish identified during the Nemo Link epibenthic trawl survey are listed in Table 7.5.3. Trawl abundance reflects the total number of individuals recorded within the survey. Grab abundance reflects the number of individuals per square metre. Species include crabs, lobster, shrimp and molluscs and are not limited to only commercially important species. A full species list is presented in the benthic survey report (MMT, 2010).

Latin Name	Common Name	Grab Abundance (number per m ²)	Trawl Abundance (number of individuals)
MOLLUSCA			
<i>Aequipecten opercularis</i>	Queen scallop	-	8
<i>Buccinum undatum</i>	Common whelk	20	1
<i>Cryptonatica affinis</i>	Arctic moon snail	-	1
<i>Spisula elliptica</i>	Bivalve mollusc	110	1
CRUSTACEA			
<i>Liocarcinus holstatus</i>	Flying crab	-	9
<i>Liocarcinus marmoreus</i>	Marbled swimming crab	10	40
<i>Liocarcinus</i> spp.		10	-
<i>Pagurus bernhardus</i>	Hermit crab	10	84
<i>Pagurus</i> spp.		10	-
<i>Macropodia tenuirostris</i>	Slender spider crab	-	6
<i>Pisidia longicornis</i>	Long clawed porcelain crab	1650	6
<i>Galathea intermedia</i>	Squat lobster	20	2
<i>Galathea</i> spp.	Squat lobsters	10	4
<i>Crangon crangon</i>	Brown shrimp	-	84
<i>Crangon</i> spp.	Shrimp	-	81
Caridea	Shrimp	-	6
<i>Crangon allmanni</i>	Shrimp	-	2
<i>Pandalina</i> spp.	Shrimp	-	44
<i>Gastrosaccus spinifer</i>	Opossum shrimp	10	4

Table 7.5.3 Shellfish species recorded within the survey area

Common mussel reef and edible oysters (*Crassostrea* sp.) were identified along the wave-cut chalk platforms during the Thanet OWF intertidal survey (Royal Haskoning, 2005), this is to the north of the proposed cable route and therefore outside the expected area of impact.

Native oyster (*Ostrea edulis*) were not found within the survey area, and are believed to be mainly found in the Thames Estuary (Royal Haskoning, 2005).

Common cockle (*Cerastoderma edula*) are found in the muddy sandflats of Pegwell Bay but were not recorded in the Nemo Link benthic or epibenthic surveys, during which there was no intertidal sampling conducted. *Cerastoderma* were recorded within the intertidal muddy sand flats of Pegwell Bay during the Thanet OWF intertidal survey (Royal Haskoning, 2005).

Queen scallop (*Aequipecten opercularis*) is commercially fished in some areas, but was not recorded during the benthic or epibenthic surveys.

The common whelk (*Buccinum undatum*) is found throughout all UK coastlines, preferring subtidal muddy sands, gravels and rock (Barne *et al.*, 1995). One individual was identified during the epibenthic trawls, with an additional 20 identified in the grab samples from Station B03-050. Common whelks are commercially exploited in the UK and are a high value species.

The brown shrimp (*Crangon crangon*) is found on sandy and muddy seabeds around the British coast. The brown shrimp is an important food source for many species, including other crustaceans, fish and birds and is commercially exploited throughout northern Europe (Neal, K., 2008). Brown shrimp were recorded in both the Nemo Link epibenthic survey and Thanet OWF epibenthic survey (Royal Haskoning, 2005).

The European lobster (*Homarus gammarus*) was not recorded during the Nemo Link epibenthic survey, but was captured during the Thanet OWF fish survey (Royal Haskoning, 2005).

7.5.2.7. Species of conservation importance

No rare, scarce or protected species under national or international legislation were recorded in the survey area during the Nemo Link benthic and epibenthic surveys (MMT, 2010). Of the Annex II protected species, twaite and allis shad, river and sea lamprey were not found within the survey area. Given the distribution of these species and their preferred habitats, it is unlikely that these protected or threatened species could be present along the proposed cable route.

However as detailed in section 7.5.2.3 salmon are known to utilise the waters of south eastern England including the Kent Stour and despite not being captured during the survey work it is very likely that they will be migrating over the cable route. Salmon are

As well as being listed on the IUCN red list eels are also a CITIES appendix II species and are protected under EC provisions for species specific management plans. As with salmon the presence of eels was not recorded in the Nemo Link survey work however secondary data sources indicate it is likely that they inhabit the vicinity of the cable route.

The area along the route has been identified as a potential nursery ground for tope (*Galeorhinus galeus*), a species of shark classified as vulnerable by the IUCN; and the common skate (*Dipturus batis*) classified as endangered by the IUCN and protected as a UK BAP species is rarely recorded in the area. Neither species was recorded during the Thanet fish surveys (Royal Haskoning, 2008), but their presence in the survey area cannot be discounted with certainty.

7.5.3. Description of potential impacts

7.5.3.1. Introduction to assessment

The life of an offshore cable development can be divided into four separate phases:

- Pre-installation
- Installation
- Operation
- Decommissioning

Each of these phases will have potentially significant impacts on the existing environment, benthic invertebrates, intertidal communities and fish. Changes may occur in habitats and in turn changes in associated species composition and communities. The table below takes into account sensitivity, recoverability and importance in order to determine a receptor value in assessing the significance of an effect.

Receptor Value	Definition
High	Receptor is highly sensitive to predicted impact and will not recover. Receptor is a species / habitat of national or international importance.
Medium	Receptor is either highly sensitive to predicted impact or will not recover. Receptor may be a species / habitat of national or international importance.
Low	Receptor is not sensitive to predicted impact or will likely recover. Receptor is not a species / habitat of national or international importance.

Table 7.5.4: Definition of receptor value

The table in Appendix 6 provides a detailed description of the impact assessment.

7.5.3.2. Pre-installation

Disturbance of spawning and nursery grounds due to pre-installation activities

A pre-lay grapnel run is likely to cause disturbance of and possible mortality to benthic fauna within the immediate vicinity (the maximum width - 200m - and depth – 1m) of the grapnel hook. Potential removal of this benthic habitat and associated floral and faunal assemblages will be both localised and short-term. Disturbance to fish populations as a result of this activity would be difficult to measure against natural variations in abundance and distribution. As the impact will be of a short-term duration and highly localised it is considered of negligible significance.

Fish spawning and nursery grounds are likely to be more significantly impacted by sediment disturbance from vessels involved in the work as well as the grapnel hook movements. Fish are at their most vulnerable to anthropogenic impacts at larval and juvenile life stages. Species that rely on the seabed as a functional habitat (for breeding, feeding, shelter etc) are particularly vulnerable, especially to changes in its physical form in relation to substrate type, sediment movement and water depth. Any disturbance of the seabed could damage eggs already attached, remove or bury the suitable substrate on which fish deposit the eggs, or deter fish from spawning in the area; such impacts could be mitigated. A description of fish spawning and nursery grounds in the area is given in Section 7.5.2.2.

Sensitivity maps are available for many commercial fish species this data can be used to assess effects of activities such as cable trenching and laying. These maps, summarised in Figures 7-5-1 and 7-5-2, show that the proposed cable route (in UK waters) passes through spawning areas for sprat, plaice, sand eel, common sole, lemon sole, and herring. Cod, whiting and horse mackerel use part of the area for spawning, while nursery areas for mackerel, plaice, sand eel, cod, sole, lemon sole, herring, whiting and tope shark have been recorded (Coull et al., 1998; Ellis et al., 2010).

The most sensitive of these species with regard to spawning is herring, which has the potential to be impacted by the various pre-installation and installation works. Herring spawn in discrete areas on the seabed, and the eggs or larvae may therefore be affected by disturbance to the seabed during the pre-lay grapnel run, leading to measurable change against the baseline. The impact of the pre-lay grapnel run may therefore be considered of moderate impact significance with regard to herring spawning. It should be noted that due to the following factors the significance of effect on all but the most sensitive receptors (i.e. herring spawning) is expected to be minor, even without the application of mitigation:

- The limited spatial extent of the pre-lay grapnel run;
- Change in the fish community as a result of the impact is unlikely to be measurable against natural variation;
- The duration of the effect in any location will be short term (i.e. a matter of hours to days);
- The sensitivity, recoverability and importance of fish nursery grounds typically combines to give a medium receptor value.

Pre-sweeping of sand waves is proposed at three points along the UK sector of the route, in order to reduce the height of the sand waves to aid the path of burial equipment and allow for greater control of the cable burial depth. Between KP82.3 and KP87, an area of approximately 24470m² of material is proposed for dredging, while between KP123 and KP123.5, an area of 1170m² of sediment is proposed for removal. The area of the South Falls Sand Bank between KP99 and KP100.75 constitutes the largest area for pre-sweeping, with a proposed 93138m² of material to be dredged. The proposed trailing suction hopper dredger will be used with a total pre-sweeping corridor of 40m in width (20m either side of the cable centreline). These spoil volumes are considered typical of dredging operations for channel or port maintenance. The current proposal is for the dredged spoil to be deposited back on the seabed, in the immediate vicinity of the sandbank system, within 1500m of the area of dredging.

Sandbanks are characterised by species which are adapted to the variable hydrographic conditions and mobile substrates (Elliot *et al.*, 1998), and can therefore be considered somewhat tolerant of disturbance. These include epibenthic species and demersal fish including sand eels *Ammodytes* spp. Benthic species inhabit highly dynamic environments and as such are generally well adapted to regular disturbance therefore significant disturbance to food webs as a result of cable laying should be unlikely. Increased suspended sediment may however have a negative impact on sessile organisms through smothering and juvenile fish species by clogging gills. Pre-sweeping at the South Falls sandbank is expected to cause an increase in suspended sediment concentration of more than 10mg l⁻¹ within 250m of the proposed cable route, with a peak predicted increase of 30mg l⁻¹ and the footprint of impact extending up to 500m away (HR Wallingford, 2011). However, the sediment along this part of the proposed route is predominantly coarser sands, which settle quickly, rather than fines, which would be transported further when disturbed. Within 100m of the point of disposal of the dredged sediment, the coarser material will be suspended in concentrations reaching >1000mg l⁻¹; with these concentrations of suspended sediment lasting approximately ten minutes, before settling on the seabed (HR Wallingford, 2011).

The rate at which the coarser sediment will settle on the seabed, and the localised extent affected by the suspended sediments, would indicate that, for most fish spawning and nursery grounds, change would not be measurable against natural variation in the baseline. Thus pre-sweeping would have a low magnitude of impact and minor impact significance, even without the application of mitigation. However, as with the pre-lay grapnel run, given the sensitivity of species such as herring that rely on the seabed for spawning, a greater level of change would be noticeable; pre-sweeping would have a moderate magnitude of effect for these more sensitive species, resulting in **moderate** impact significance.

Disturbance of shellfish beds due to pre-installation activities

It is not anticipated that pre-installation activities will impact upon the intertidal shellfish beds to the north of Pegwell Bay where pre-sweeping is not required. The predicted footprint of pre-sweeping impacts is within 500m of the cable route (HR Wallingford, 2011), and the predominance of coarser sediment which settle quickly ensures that pre-sweeping will have a **negligible** impact on the intertidal zone. Fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries); however the impacts of these activities on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

7.5.3.3. Cable Installation

Disturbance of spawning and nursery grounds due to trench excavation and cable burial

Due to the mobile nature of fish communities, cable installation works will not have a direct impact on adult fish species that can be measurable against natural variation. Disturbance to and mortality of benthic species within the installation corridor will remove a food resource for fish communities, however this impact is very localised and short-term and hence can be considered of negligible significance.

The potential impacts of cable installation works on fish spawning and nursery grounds are of greater concern. The majority of fish species in the area are pelagic spawners, releasing eggs into the water column to be transported with the currents during development into larvae. These species would be largely unaffected by direct disturbance to the sediment during trench excavation and cable burial, with no measurable change beyond that of natural variation in abundance and distribution. The impact of trench excavation and cable burial on these species would have a low magnitude of effect and thus have minor impact significance. The significance of these impacts is greater on demersal spawners these more sensitive species, such as herring, utilise specific grounds for spawning the conditions they require are not prevalent across the entire survey area. Juvenile cod, sand eel and plaice also utilise the seabed and would also be impacted by the cable installation works; however their mobility makes them less sensitive to impacts than demersal eggs or larvae. The magnitude of effect on

herring spawning is moderate, resulting in moderate impact significance, although it will be possible to plan works to avoid the most sensitive period for demersal spawning fish.

Disturbance of shellfish beds due to trench excavation and cable burial

The impact of trench excavation, cable burial and use of cable-lay barges are expected to have only a minor impact on shellfish beds, as these beds are predominantly outside the survey area, within the intertidal zone to the north of Pegwell Bay. Fishing for lobster and whelk occurs along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries). The impacts on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

Re-suspension of sediment into the water column

Studies on the effects of increased suspended sediments on salmonids indicate that factors such as concentration, duration of exposure and the life stage of the fish determine the level of impact (Larkin *et al.*, 1998), these results also apply to other species. With low suspended sediment loads, subtle behavioural changes may be observed along with a reduction in feeding rate (Newcombe and Jensen, 1996). Higher sediment loading can kill fish directly through clogging or abrasion of the gills (Herbert and Merkins, 1961) and indirectly via smothering of fish eggs or larvae and habitat degradation, such as reduced porosity of spawning gravels.

The effect of coarser sediments suspended due to excavation of the seabed is only expected to affect the immediate vicinity of the cable trench, as these sediments are too heavy to travel far.. This impact is localised and temporary and less significant for ploughing the cable trench than for jetting, which fluidises sediment for cable burial. However, the indirect impacts of suspension of finer sediments extend beyond the installation corridor, with modelling data showing the release of fine material from ploughing over a 3km path (HR Wallingford, 2011). The re-suspension of sediment would cease upon completion of activities such as trench excavation, although the effects of turbidity, transport of sediment fines and potential smothering of eggs or larvae on the seabed may last beyond these works where the proportion of sediment fines is higher, with the corresponding impact on fish communities having a medium-term effect. HR Wallingford's (2011) modelling of sediment ploughing along the proposed route predicted a release rate of 0.05kg s^{-1} for sediments containing 3% fines, assumed to have a settling velocity of 1mm s^{-1} . The release of chalk from ploughing was modelled at a dry density of 2000kg m^{-3} with 100% assumed to be re-suspended; this model produced a release rate of 2kg s^{-1} and with chalk assumed to have a settling velocity of 0mm s^{-1} , deposition will be negligible (HR Wallingford, 2011).

The release of fine sediments into suspension and the resultant smothering of demersal eggs and larvae would produce a moderate magnitude of effect and have **moderate** impact significance on the more sensitive species, notably herring. The impact on other pelagic fish species, eggs and larvae would be of short duration, with no notable change outside natural variation; resulting in a low magnitude effect and thus the re-suspension of sediments will have **minor** impact significance on the less sensitive spawning and nursery grounds.

While mobile fish can move away from areas of increased sediment loads, suspension-feeding shellfish could be more detrimentally impacted by the re-suspension of sediments from marine anthropogenic activities. Research has suggested that cockles can initially benefit from the increased food availability associated with higher suspended sediment loads, but that this benefit reduces as suspension persists with durations of >5 days producing negative impacts (Hewitt *et al.*, 2008).. Growth rates of cockles can be adversely affected by high sediment loads, depending on the concentrations and duration of their exposure. Laboratory results have suggested that $>400\text{mg l}^{-1}$ for 14 days would decrease adult cockle condition (Hewitt *et al.*, 2008). Shellfish beds were identified in the intertidal zone, along the north coast of Pegwell Bay, outside the installation corridor and over 250m from the proposed cable route. Fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries).

The footprint of re-suspension of finer silts and clays in the intertidal zone will likely extend over an area similar in size to the ploughing of chalk, up to 700m from the cable route. Silt will likely settle

during periods of slack water, and be re-suspended during the following tide. The release of fine material would be east to west with the predominant tidal direction, and thus the suspended sediments could reach the wave-cut chalk platforms and mussel beds within Pegwell Bay, however at those distances the predicted increases in suspended sediment would likely be less than 1 mg l^{-1} above background (HR Wallingford, 2011). Modelling of sediment containing up to 60% fines was conducted for the Sheringham Shoal Offshore Wind Farm, with a predicted maximum rate of silt deposition of $<0.5\text{ mm}$, even under slack water conditions (Scira, 2006). Thus the impact of suspended sediments on shellfish beds can be considered of **minor** significance.

Disturbance of spawning and nursery grounds due to external cable protection

Installation of external cable protection would have moderate impact significance for demersal spawning grounds in the region, such as herring. Any eggs or larvae present on the seabed at the time of external cable protection installation would be removed or destroyed. This impact would be of minor significance to those species that spawn in the water column, as the eggs are unlikely to be damaged; the impact would be restricted to the area of work, and any displacement of spawning fish would be temporary.

Disturbance of shellfish beds due to external cable protection

There will be a negligible impact of the external cable protection on shellfish as the area of cable crossing will be well outside the intertidal area where shellfish beds have been recorded. However, fishing for lobster and whelk does occur along part of the proposed cable route (pers. comm., Kent and Essex Sea Fisheries); the impacts on commercial fisheries are assessed in Chapter 8.1 – Commercial Fisheries.

Substrate change due to installation of external cable protection

The installation of external cable protection around the area of the cable crossing will have an effect on the seabed, effectively replacing the sandy sediment with hard substrate. This will result in localised disturbance of any benthic fauna, causing a long-term though very localised change. In terms of the fish community, the hard substrate may create a new habitat for colonisation, in effect acting as an artificial reef. This habitat may then support a new range of benthic epifauna that prefer harder substrates, and a resulting fish community that may feed on them. Although this will have a severe magnitude of effect due to the long duration and high level of change given the removal of existing habitat, and thus have moderate impact significance for fish, the effect could be considered a positive one. However it is important to note that rather than changing the baseline by attracting new fish species to the area, it is more likely that existing fish in the area will be using the new habitat and feeding on newly colonising fauna.

Impacts from noise and vibration

The low frequency noise and vibration associated with cable-laying operations comes from a variety of sources, including shipping operations and the trenching, laying and burial of the cable. Given the level of shipping traffic that already exists in the region, the presence of the trenching and cable-laying barges is unlikely to have a significant impact on fish around the installation corridor. Measurements of suction and hopper dredgers and pipe laying vessels indicate a peak spectral source level of up to $177\text{ dB re } 1\mu\text{Pa}$ at 1 m between frequencies of 4 Hz and 1 KHz (Nedwell and Howell, 2004), in the range of that heard by most fish species.

Few measurements of sound produced during cable-laying are available in published media, although data from Richardson *et al.* (1995) and Nedwell *et al.* (2004) suggest that the source level of trenching noise from mechanical dredging operations could reach $185\text{ dB re } 1\mu\text{Pa}$ at 1 m . Modelling conducted for the Beatrice Offshore Windfarm Demonstrator predicts that at the same source level for umbilical-burying operations, the expected noise level salmon might receive (as a function of that species' sensitivity to noise) at a distance of 1 m , would be $90.8\text{ dB}_{\text{ht}}$, with the received sound level remaining above the 90 dB_{ht} (*species*) threshold at which avoidance behaviour is expected, within 5 m of the source (Talisman Energy, 2005).

Measurements from deep water pipe laying noise from the *Trenchsetter* in the Yell Sound near Shetland indicate that the expected noise level cod might receive at a distance of 1m from the trenching activity would be 75dB_{ht}, a level 5dB_{ht} above the threshold expected to produce a mild behavioural response (Nedwell and Howell, 2004), but below the suggested avoidance threshold of 90dB_{ht} (*species*) (Nedwell *et al.*, 2004). The data also indicate that salmon and dab might receive 50dB_{ht} at the same distance (Nedwell and Howell, 2004). Results from the North Hoyle offshore wind farm in Wales showed that during cable trenching at a source level of 178dB re 1µPa at 1m, cod, salmon and dab all had received levels of sound below the 70dB_{ht}(*species*) level, expected to elicit a mild behavioural response (Nedwell *et al.*, 2004). These received sound levels are summarised in Table 7-5-5.

Species	Received sound levels (dB _{ht} Species)		
	Pipe trenching at 1m (Nedwell and Howell, 2004)	Mechanical dredging 185dB re 1µPa at 1m (Richardson <i>et al.</i> , 1995; Talisman Energy, 2005)	Cable trenching 178dB re 1µPa at 1m (Nedwell <i>et al.</i> , 2004)
Cod <i>Gadus morhua</i>	75dB _{ht}	N/A	<70dB _{ht}
Dab <i>Limanda limanda</i>	50dB _{ht}	N/A	<70dB _{ht}
Salmon <i>Salmo salar</i>	50dB _{ht}	90.8dB _{ht}	<70dB _{ht}

Table 7-5-5 : Received trenching and dredging sound levels by fish species

Given that mechanical dredging and trenching for pipelines will cause considerably more noise than trenching to lay sub-sea cables, this suggests that noise produced by trenching activity could have a moderate impact, though only on fish at close range to activities. The zone in which the sound will be at a sufficiently high level to elicit a behavioural response will be very small, likely within 50m; therefore the number of fish that may be exposed to such levels will be low. 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.

Sound will also be produced during any rock dumping or pre-sweeping activities, but the lack of measurements and behaviour observations of fish during such activities make it difficult to draw any conclusions regarding the effects of such sound. However, the extent and duration of effects from rock placement will be limited.

Although an avoidance response to the sound produced during trenching is expected, with a moderate magnitude of effect, the short duration of the impact, moderate sensitivity and recoverability of the fish indicate the impact to be of **minor** significance.

Accidental contamination from associated vessels and equipment

During cable-laying operations, any use of associated vessels and equipment has potential for accidental contamination of the sediment. Such contamination is unlikely given standard environmental management procedures, but could have a medium-term impact on fish communities in the local area, with a knock-on effect on bioaccumulation in fish that consume contaminated fauna. Contaminants could adhere to the sediment and be transported outside the local area creating a moderate magnitude of effect. Despite the generally moderate sensitivity and high recoverability of fish to contaminants, the impact of accidental contamination of habitats and individuals would still have **minor** significance. This impact could also potentially occur during the operational and decommissioning phases, should there be any maintenance activities required or if the cable is removed.

7.5.3.4. Cable Operation

Disturbance of habitats and species due to external cable protection

Rock or concrete external cable protection will add hard substrate to a generally sandy environment, providing a potential new habitat for colonisation by a range of benthic invertebrates, associated epifauna and fish communities over time. There is evidence for the artificial reef effect to occur where turbine foundations have been constructed at offshore wind farms. Test fishing has been conducted before and after the construction of wind turbines at the Vindeby offshore wind farm in Denmark, indicating an increase in fish yields, attributable to the creation of artificial reef (Krohn, 2002). Turbine foundations can act as reefs, which can be colonised by bivalves and other epifauna, creating a habitat and food source for fish communities and potentially increasing localised biodiversity. Although aggregations of fish may be recorded around seabed structures, this may not signify an actual increase in fish biomass. Although the small amount of external cable protection that may be required during the Nemo Link development may have a noticeable effect on fish within the area, due to the substrate change, the effect will be localised and may be considered a positive impact and is of minor significance.

Impacts due to maintenance activities

Routine maintenance work to the cable is not anticipated. Some unscheduled work may be required to maintain the burial of the cable to protect it following adverse interactions with other sea users or marine processes such as tidal scour. In the event of such maintenance work, it is likely that fish species in the immediate vicinity of the area of works would be disturbed, however, any such work would be localised to the immediate vicinity and be short in duration so would likely only result in short-term displacement from the area. Maintenance work may be of more concern should it occur during fish spawning or nursery season, in a sensitive location, where eggs, larvae or juvenile fish might be disturbed. Due to the low receptor value, and short duration of impact caused by maintenance activities, the impact significance would be negligible. Accidental contamination from associated vessels and equipment during maintenance works may also occur. Such contamination is unlikely given environmental procedures, but could have an effect on faunal communities in the local area, and potentially have a medium-term effect on a fish feeding resource, or possible mortality of fish eggs or larvae on the sediment. As such, the impact of accidental contamination would have minor significance on fish communities.

Impacts due to operational noise from cables

The majority of previous research on the effects of noise on fish relates to seismic exploration, which is not really comparable to the operational noise of cables. No significant noise will be produced during operation of the cable (PMSS, 2010) and thus is more relevant as a concern during the installation and decommissioning phases of the project. It is likely that any low level of noise produced during operation of the interconnector cable will merely contribute to the background low frequency noise levels in the area, that result from shipping, fishing vessels and environmental noise such as wind and waves. As such the impact of operational noise on fish is expected to be of minor significance.

Impacts due to emission of electromagnetic fields from cables

Electromagnetic fields (EMF) created by power cables may affect fish feeding behaviour and navigation in elasmobranchs (sharks, skates and rays) and the migration routes of bony fish (including salmon and eels). Electromagnetic fields are composed of electric fields, shielded by and retained within the cable structure, and magnetic fields, which are detectable outside the cable (Gill et al., 2005). Electric fields are produced as a result of seawater passing through the earth's natural geo-magnetic field, and similarly when passing through the magnetic field surrounding a cable. The strength of such an electric field is dependent on the qualities of the seawater (such as velocity and direction of flow), the strength of the magnetic field produced by the cable and distance from the cable.

A desk study conducted for the BritNed interconnector cable route estimated the geo-magnetic field in the vicinity of the cable to be approximately 48 μ T, which along with a water current speed relative to the seabed of 0.85m s⁻¹, allowed the calculation of a maximum background electric field of between 39 μ V m⁻¹ and 42 μ V m⁻¹ depending on the direction of water flow (Swedpower, 2003a; Metoc, 2004b).

These background magnetic and electric field strengths can be considered applicable for background levels in the vicinity of the Nemo Link cable route.

The expected electric and magnetic fields from the BritNed interconnector system were modelled for the cables being bundled together at 0.2m separation, or in two trenches separated by 2m; these different cable configurations are similar to those proposed for the Nemo Link. These calculations can be considered the maximum possible electric and magnetic field strengths and are presented in Table 7-5-6.

Cable configuration	Electric field strength ($\mu\text{V m}^{-1}$)		Magnetic field strength (μT)	
	1m from cable	5m from cable	1m from cable	5m from cable
Bundled (0.2m separation)	61	1.9	72	2.2
Separated (2m separation)	260	18	310	21

Source: BritNed Interconnector system modelling (Swedpower, 2003a)

Table 7-5-6 Expected electric and magnetic field strength

Elasmobranch fish are known to be electroreceptive as they have receptor cells along the surface of the skin (Ampullae of Lorenzini) that can detect very weak voltage gradients in the environment around them. They use this detection of bio-electric fields to locate and catch burrowing prey. Electroreceptive elasmobranchs can also detect the induced electrical field, produced by the magnetic field, either passively or actively as an aid for navigation (Gill *et al.*, 2005). Laboratory tests have shown that dogfish (*Scyliorhinus canicula*) are attracted to a DC field of $10\mu\text{V m}^{-1}$ at 0.1m from source, similar to that produced by their prey, while they demonstrate avoidance behaviour to constant DC electric fields of $1000\mu\text{V m}^{-1}$ (Gill and Taylor, 2001). The same study demonstrated the minimum DC field strength eliciting a response from fish was $0.5\mu\text{V m}^{-1}$.

Teleost (bony) fish are also electrosensitive, though the method of detection is unclear as they do not possess specialised electrosensors. Teleost fish have not generally been recorded as reacting to electric field strengths of less than 6V m^{-1} (Uhlman, 1975), nor do they react to the type of permanent static electric field that would be produced by a DC cable such as the BritNed or Nemo interconnectors (Lamarque, 1990 cited in Metoc, 2004b, p. 8). This suggests that teleost fish are not susceptible to the types of electric field strengths that will be generated by the Nemo Link cable.

Other species are magnetosensitive, responding directly to geomagnetic or magnetic fields for navigation. Elasmobranchs use the Earth's magnetic field for navigation, with sharks known to induce an electric field (between 5 and $50\mu\text{V m}^{-1}$) around their bodies to allow them to detect their heading through the magnetic field, like using a compass (Metoc, 2004b). Some species of shark have demonstrated sensitivity to localised magnetic fields during behavioural experiments, indicating an ability to differentiate change in magnetic field emissions against the existing background geomagnetic field (Meyer *et al.*, 2004). Changes in the magnetic field surrounding the cable are therefore likely to have the same impact on elasmobranchs as described for changes to the electric fields.

The Earth's magnetic field is also used for navigation by a small number of teleost fish species; Atlantic salmon, sea trout and eel. Results of an experiment conducted by Swedpower (2003a), fitting sea trout and salmon with a transmitter that generated a magnetic field approximately twice the magnitude of the earth's magnetic field in the fishes' brains, indicated no effect on fish behaviour and movement. Research has also been conducted on the sensitivity of *A. anguilla* silver eels (those migrating back to the Sargasso Sea to spawn aged 6-12 for males and 9-20 for females), to changes in magnetic field strength. Silver eels have been observed swimming significantly lower around a 130kV AC subsea cable, suggesting that some subsea cables have an impact on behaviour, although conflicting information has been published on the effect of DC cables (Westerberg and Lagenfelt, 2008). Eels are often found close to or buried in the surficial sediment, and thus are more likely to be impacted by proximity to magnetic fields produced by the cable. Brown shrimp (*Crangon crangon*) have also been recorded demonstrating attraction to the magnetic fields of the magnitude expected from wind farms (ICES, 2003).

Some studies have suggested that exposure to electromagnetic fields may be disruptive to embryonic development in sea urchins and fish (Cameron *et al.*, 1993; Zimmerman *et al.*, 1990). COWRIE (Collaborative Offshore Wind Research into the Environment) funded a study (CMACS, 2003; Gill *et al.*, 2005) that determined cable burial does not provide sufficient mitigation against the effects of electromagnetic fields, although it is still not clear how significant the impacts of these fields are on potentially sensitive species.

Only two species recorded during the epibenthic survey in the area surrounding the proposed cable route can be considered sensitive to electric or magnetic fields; the electro-sensitive cod and the magneto-sensitive brown shrimp. However, other species known to be electro-sensitive and/or magneto-sensitive have been recorded in the region surrounding or adjacent to the proposed development. Plaice is known to be both electro-sensitive and magneto-sensitive, and is also found in the Thanet region (Royal Haskoning, 2005; DECC, 2009), while smaller-spotted catshark, starry smoothhound and thornback ray were abundant during the Thanet OWF survey (Royal Haskoning, 2005) and have been recorded in numerous locations off the coast of Kent (Marine Biological Association, 2008; Marine Conservation Society, 2010).

A direct current (DC) cable such as the proposed Nemo Link HVDC cable will produce less EMF than an alternating current (AC) cable due to the current passing in only one direction rather than both directions as with AC. Natural background electric fields are on average 130V m^{-1} at surface level in fair weather, increasing up to 3000V m^{-1} prior to storms, with background static geomagnetic fields increasing from approximately $35\mu\text{T}$ at the equator to $70\mu\text{T}$ at the poles when measured in air (WHO, 2006). The expected magnetic fields produced by bundled cables at only 1m depth (Table 6) are within natural background levels, while the electric field produced by the cables at 1m or 5m would be well within background levels. These factors indicate that EMF would have a low magnitude of effect on the behaviour of fish along the proposed cable route despite the long-term nature of the impact; which, despite the sensitivity of some species in the area, would mean the impact is of **minor** significance.

Impacts due to emission of heat from cables

Calculations from a study conducted for the BritNed interconnector cable development (Table 7-5-7) indicate that during summer the temperature may increase between 0.5°C - 5.5°C through localised heating directly above the cable, where the cable is buried at a depth of 1m, and from less than 0.5°C to 1.8°C where the cable is buried at a depth of 3m (Swedpower, 2003b).

Cable Burial Depth	Predicted Seasonal Temperature Increase (at 10cm and 30cm below seabed surface)							
	10cm (summer)		30cm (summer)		10cm (winter)		30cm (winter)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1m	0.5°C	1.5°C	1.5°C	5°C	0.5°C	2°C	1.5°C	5.5°C
3m	$<0.5^{\circ}\text{C}$	N/A	0.5°C	1.8°C	$<0.5^{\circ}\text{C}$	N/A	0.4°C	1.7°C

Data from Swedpower (2003b) on behalf of BritNed.

Table 7-5-7 : Expected temperature increase

As the cable is to be buried, the impact of heat from the operating cable at the seabed would be minimal, the generated heat should be dissipated by the presence of sea water and temperatures are expected to increase above background levels only in the 10-30cm immediately above the cable (Metoc, 2004a). Therefore the temperature at the seabed surface is expected to be the same as the water temperature and would not have an impact on fish species in the water column, on the seabed or eggs laid by some fish species on the seabed surface. Therefore the increase in temperature would have **minor** impact significance.

7.5.3.5. Decommissioning

The impacts of decommissioning are very similar to those associated with the installation phase of the development, with disturbance to the seabed such as use of grapnel hooks to lift the cable, and the resulting re-suspension of sediments. The current proposal is for the external cable mattresses and any scour protection to be left in-situ, with the cable to either be left in-situ, or removed. An assessment of the impacts of decommissioning should be carried out prior to any decision being made on whether to recover the cable, and a survey of the area will need to be conducted to assess any change in species and habitats within the vicinity.

Leaving the cable buried in-situ will be unlikely to have new impacts, especially as fish communities will likely have returned to baseline conditions. Once the cable is no longer operational, the impacts of heat, noise and electromagnetic fields on fish will cease, and fish will likely have adapted to the presence of the cable and any external protection. Epifaunal colonisation of external structures should be considered during this phase as fish communities will likely have been supported by the increased and varied diversity (Vella et al., 2001).

7.5.4. Mitigation

The impacts of installation, operation and decommissioning of the cable upon most fish populations are generally expected to be minor as the area of seabed affected is predominantly localised and the installation and decommissioning works are temporary.

The impacts of most concern relate to species that spawn on the seabed, or use the area as nursery grounds and localised populations of shellfish along the north coast of Pegwell Bay. Mitigation of potential impacts of the developmental phases on fish spawning and nursery grounds is possible. Knowledge of the most sensitive spawning periods by month can enable operators to plan their activities more efficiently. If peak times for nursery and spawning grounds can be avoided, this effectively removes the potential impact of each phase on this particular receptor. An examination of seasonal seismic sensitivity data compiled by Coull *et al.* (1998) and displayed in Table 8, shows that November to May is the most sensitive period for disturbance to fish spawning and nursery grounds. This data set does not include species of less concern due to their very wide spawning distributions, such as sprat and lemon sole.

For the purpose of the areas surrounding the proposed cable route, the most sensitive period is November to May. However, the majority of species spawn in the water column and have large spawning grounds across the wider area, thus do not require mitigation. The most sensitive species is the herring, which spawns in discrete areas on the seabed and is more vulnerable to disturbance and the mortality of eggs and larvae. Herring spawn in this region between November and January, thus works should be planned to avoid these months.

Month	Sensitivity				Species spawning
	HIGH Entire planned route	MODERATE Majority of planned route	LOW Outside planned route	NONE	
January		x			Herring, plaice, sand eel (cod nursery)
February		x			Plaice sand eel (cod nursery)
March	x				Plaice, common sole (cod nursery)
April	x				Lemon sole, common sole (cod nursery)
May	x				Lemon sole, common sole, Sprat (mackerel nursery)

Month	Sensitivity				Species spawning
	HIGH Entire planned route	MODERATE Majority of planned route	LOW Outside planned route	NONE	
June			x		Lemon sole, sprat (mackerel nursery)
July			x		Lemon sole, sprat (mackerel nursery)
August			x		Lemon sole, sprat (mackerel nursery)
September				x	Lemon sole
October				x	
November		x			Herring, sand eel
December		x			Herring, plaice, sand eel

Table adapted from seasonal seismic sensitivity data in Coull *et al.*, 1998.

Table 7-5-8 Seasonal sensitivity along the proposed cable route

Several additional actions can be taken to mitigate the severity of effects during installation and operation. Such mitigation measures include:

- The use of non-displacement ploughing equipment rather than jet trenchers to minimise the level of sediment re-suspension during cable installation, however this is dependent on ground conditions along the proposed route and available technology at the time of construction which may not allow much flexibility in the choice of installation methods;
- Burial of the cable to the maximum depth possible in the survey design to minimise the increase in temperature at the seabed surface;
- Bundling the cables together in one trench to minimise the footprint of electromagnetic fields generated during operation;
- Simultaneous cable lay and burial to minimise repeated impacts on fish in the area.

For the purpose of avoiding further impacts during the decommissioning phase, it is currently recommended to leave the cable in-situ, though this will likely require further impact assessment as conditions may change throughout the lifecycle of the development.

Strict environmental health and safety guidelines and spill procedures should be followed to minimise the risk of accidental contamination throughout the life of the project.

7.5.5. Residual impact

No rare or scarce species have been directly identified in the vicinity of the proposed cable route, although the presence of salmon, eel, tope and common skate cannot be discounted. Impacts of the cable development are generally expected to be minor, with a few exceptions, such as the potential impacts on the most sensitive fish spawning and nursery grounds, which will have been mitigated for accordingly.

The impact on fish communities of substrate change caused by the use of external cable protection can be considered **moderately** significant; however it is important to note that this may be considered a positive impact rather than a negative one, through the creation of new habitat.

7.5.6. References

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8. Human Environment

8.1. Commercial Fisheries

8.1.1. Introduction

In order to assess the impact of the installation, operation and decommissioning of the Nemo Link upon commercial fisheries, a fisheries assessment has been undertaken. This draws upon available data and consultation with fishing organisations to give an indication of:

- the quantity of commercially important species landed in the area surrounding the cable route;
- the types and intensity of fishing effort expended along the cable route;
- seasonal variation in commercial fishing activity;
- restrictions related to commercial fishing activity, and;
- the location of key fishing grounds in the vicinity of the cable route.

A large proportion of submarine cable faults are caused by fishing gear and the majority of these faults are caused by trawl gear and dredgers, however other types of fishing gear (e.g. long lines, gillnets) have also brought about cable faults. The intensity of bottom contact fishing methods and their potential interaction with the Project cable has been considered as part of the determination of the target cable burial depth of 2-3 m. This will help to minimise any impacts on commercial fishing activity.

The commercial fishing activities in the vicinity of the cable route fall into two specific categories; effort expended by local fishermen of Kent and Essex ports (which is generally concentrated within the 12 NM limit) and larger vessels of the national fleet which are restricted to areas outside of the 6 NM fisheries limit and tend to fish beyond the 12 NM territorial limit.

8.1.2. Baseline data sources

The key sources of data used to inform this impact assessment are vessel monitoring system (VMS) data and value, effort and landings data from the Marine Management Organisation (MMO). This data has been supplemented with data and information from the Thanet Offshore Wind Farm Environmental Statement, the COWRIE programme fish value report, discussion with Thanet Fishermen's Association (TFA) and Kent and Essex Sea Fisheries Committee (KESFC) (Now Kent and Essex IFCA).

Fisheries data including landings (weight and value of catch) and effort (days at sea) is aggregated by ICES (International Council for the Exploration of the Sea) rectangles which encompass one degree of latitude by 0.5 degrees (30 minutes) of longitude (see Figure 8-1-1). This fisheries data cannot be targeted along the cable route specifically, however, analysis of ICES rectangle data can provide an overview of gear types used, target species, seasonality of the fishery, landing quantities and catch values. Fisheries data by ICES rectangle were obtained from the MMO. The MMO data includes fishing effort from all UK fishing boats and foreign vessels that land their catch in the UK. The data indicates that there are low levels of fishing effort expended outside of the 12 NM limit (in ICES rectangle 32F2) but in reality further effort is expended beyond this point by foreign vessels, typically undertaking trawling. These data form the basis of the UK's annual fisheries reports which are the only widely available data from which to calculate fishing trends and are therefore useful in assessing relative differences between fishing effort and landings between ICES rectangles. ICES data has been acquired for the years 2007 to 2011. The cable route crosses ICES rectangles 31F1 and 31F2, in UK waters, and then 31F3 before landfall in Belgium (Figure 8-1-1).

Effort, landings and value data have been supplemented with MMO satellite VMS data for the year 2009. The positions of all vessels, over 15 metres in length, in UK waters are logged at 2 hour intervals. For each record in the database there are fields documenting the year, month, day, ICES rectangle, latitude and longitude, vessel nationality and the gear type used. The data also indicates whether the vessel is steaming or actively fishing. The data can be used to give an indication of the location of important fishing grounds. VMS data has been used to supplement the MMO ICES data for the area up to the median line.

8.1.3. Baseline

The Fish Value Report (ABPmer, 2009) and the Energy SEA (DECC, 2009) indicate that trawling and static gear (e.g. trammel nets and gill nets) are the main fishing methods used in the vicinity of the cable route in UK waters, probably targeting mainly sole, plaice, cod, bass and rays (DECC, 2009). Over recent years, fishing activities within the Thames Estuary have shifted towards shellfish, predominantly oyster, whelks and mussels (KEOWFE, 2011).

The MMO ICES rectangle data (2007-2011) shows that static gear (gillnets, trammel nets, pots) is typically deployed by small day boats (less than 10 m in length). These reports do not fully reflect the activities of other small fishing vessels operating out of local ports. The main fishing ports in Kent are Dungeness, Folkestone, Ramsgate and Whitstable and Leigh-on-Sea, West Mersea and Harwich in Essex. Some vessels also land fish onto the beaches at Herne Bay, Deal, Hythe and Dungeness (KEIFCA, 2012). MMO landing data show Ramsgate and Whitstable to be the key ports for landings in the area.

Just over three-quarters of the UK fleet comprises of vessels less than 10 m, a trend reflected in the Thames, although a few 10-15 m vessels do operate in the area. Lowestoft is the closest administrative port to the UK landing of the cable. It has 347 registered vessels the vast majority of which are less than 10 m vessels operated predominately by 581 regular, rather than part-time, fishermen. There are 275 licensed vessels within the KEIFCA District directly employing >300 people. The local fleet is dominated by vessels less than 10 m in length deploying a range of gear including trawling, pair trawling, drift and fixed netting, potting and scallop, oyster and cockle dredging. Over the past decade there has been a continual decline in fishing activity within the district accompanied by a decline in active vessels (KEIFCA, 2012).

The available information also suggests that significant effort is being deployed by foreign vessels in the area crossed by the cable. Typically foreign vessels are not allowed to fish within the 12 NM UK territorial limit. Belgium and France have historic fishing rights around south east England that allow them, in certain locations, to fish within the territorial limit. In recent years the numbers of foreign vessels fishing in the area have reduced due to increased fuel costs and days at sea restrictions (TOW, 2005).

A meeting with the executive committee of Thanet Fishermen's Association (TFA) indicated that the vast majority of vessels fishing in the area between the landfall and South Falls are based in Ramsgate. It was suggested that approximately 12 vessels could be disrupted by cable installation activities in summer months, based on the current situation. These vessels are operating fixed trammel and drift nets but there is also some lobster and whelk potting taking place in the Pegwell Bay Area, outside of the SSSI boundary.

Information on fishing activity along the proposed cable route is best described as that which takes place within the 12 NM limit, and that which takes place between the 12 NM limit and the median line with France. As detailed above, ICES data has been acquired for the years 2007 to 2011 for the rectangles surrounding the cable route. In UK waters the cable route crosses ICES rectangles 31F1 and 31F2 while, 31F3 is crossed in Belgian waters before landfall. A summary of fishing activity is presented below and an outline of fishing methods in the vicinity of the cable is also discussed. This is important information for both the assessment of possible impacts upon the fishing industry, and in understanding the potential interaction between fishing gear and the cables.

In comparison to the rest of the UK, 31F1 is important for demersal species, producing higher than average landings by weight and by value but is less important for pelagic fish and shellfish with below average landings (MMO, 2011). Sole is the main target species landed in 31F1 followed by bass, other key commercial species include mackerel, skate, cod and plaice. Netting is the predominant activity and key gears used are fixed and drift nets with some demersal trawling and cockle dredging also occurring. The key shellfish species are mussels, scallops, oysters, crab and whelk. Fishing activities are predominantly seasonal as are the prices for key species, sole and skate values peak in April, bass peaks in September and whelks and lobster remain high between May and September (KFOWFE, 2011). The COWRIE Fish Value Report (Dunstone, 2009) shows that, with the exception of trawling, fishing by boats greater than 15 m to be relatively limited in comparison to the rest of the UK. The Dunstone report, when investigating non-VMS data based on ICES rectangle fishing effort data, found high levels of dredging in the area surrounding the cable route and above average netting. Overall the level of fishing effort in the area is comparable with many areas of the UK (Dunstone, 2009).

Landings and effort expended within the 12 nautical mile limit

Figure 8-1-1 shows that ICES rectangle 31F1 is crossed by the cable route and falls within the 12 NM limit. In terms of effort (days at sea) between 2007-2011, 31F1 remains the most important of the ICES rectangles surrounding the cable route (31F1, 31F2, 31F3, 32F1, 32F2 and 32F3) to UK fishing vessels. Combined with 32F1, these two rectangles account for 98% of fishing effort by UK fishing vessels in the area surrounding the cable route (see Figures 8-1-A & 8-1-1). This suggests that the majority of UK fishing vessels fish within the 12 NM limit in this region.

Effort within 31F1 averages at 4449 days annually, the majority of which is undertaken using gillnets, and the average landing value recorded by MMO data between 2000-2009 for the rectangle is £2,276,858 (KEOWFE, 2011).

Analysis of the data indicates that:

- Within the 12 NM limit, a range of gears are used including: otter trawls, pots, drift nets, gillnets and trammel nets;
- Mechanised dredges are also used in rectangle 31F1 (however, discussions with Thanet Fishermen's Association indicate that shellfish dredging does not generally take place in the vicinity of the cable route, with the exception of Pegwell Bay in some seasons);
- Lobster, whelks, crabs, scallops, cockles, Pacific and native oysters are the most important invertebrate species groups in terms of both weight caught and commercial value within ICES rectangle 31F1.

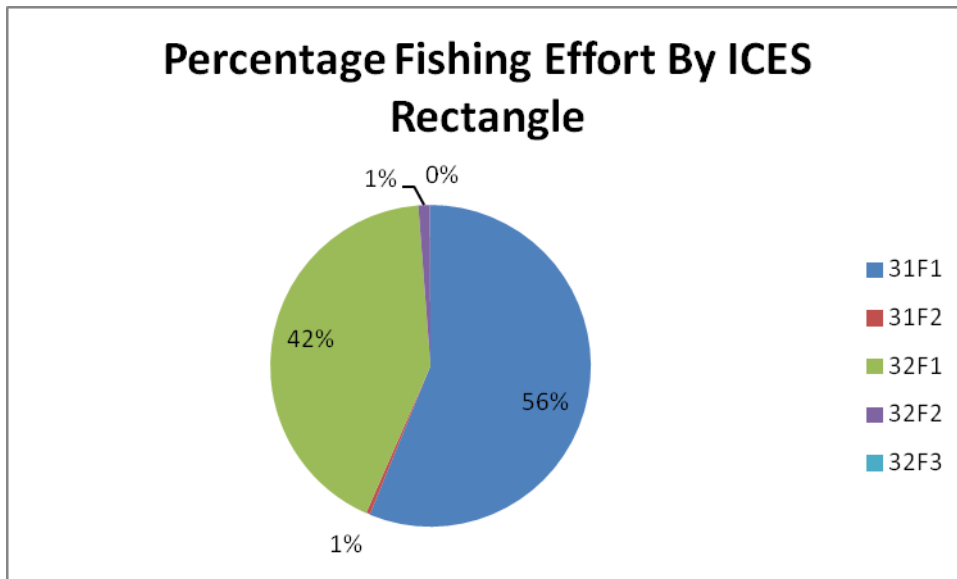


Figure 8-1-A: MMO data (2007-2011) showing the percentage of fishing effort (days at sea) expended in ICES rectangles surrounding the cable route

Between 2007-2011, sole remains the highest value species captured within ICES rectangle 31F1 (with an average of approximately £808,000). It is primarily targeted using otter trawls (bottom, twin or unspecified) or gillnets. Other high value species in this rectangle include bass, cod, lobsters, whelks and skates and rays. Figure 8-1-B shows the mean annual value of the top 15 most valuable catches in the ICES squares. It is important to note that this is reflective of the commercial value of the species rather than catch volume, as each species has a different monetary value associated with it. Figure 8-1-C below illustrates the highest quantities of catch by species.

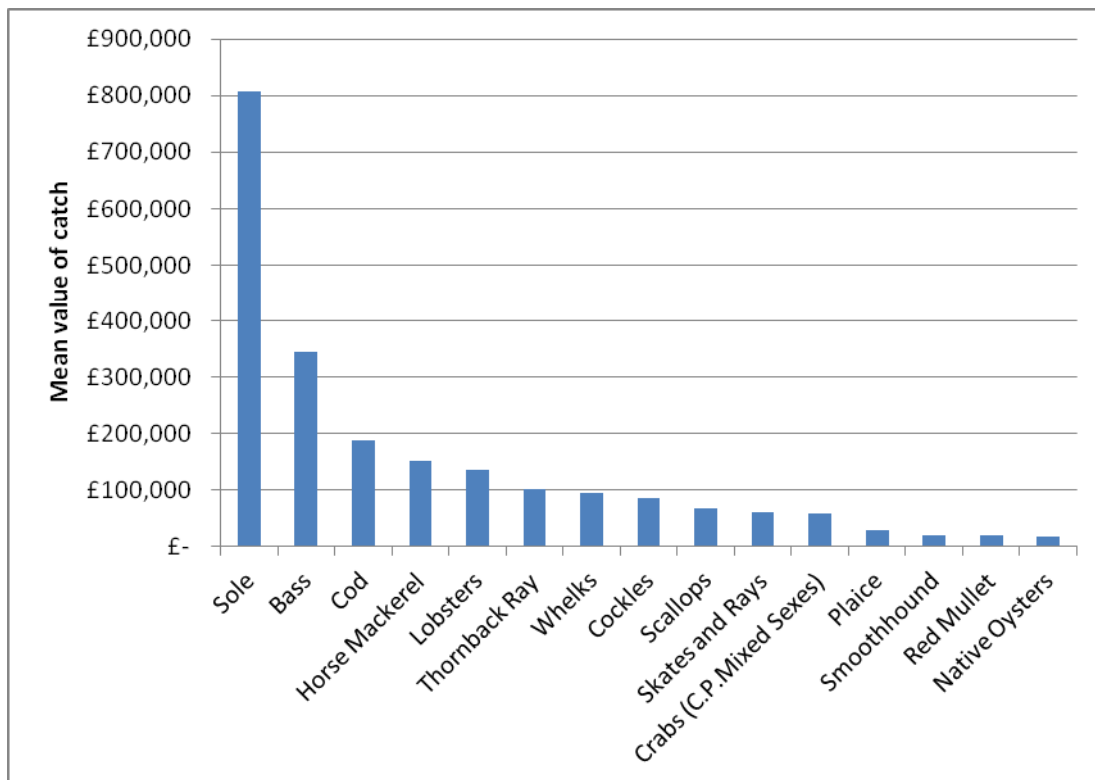


Figure 8-1-B: Mean annual value of the top 15 most valuable catches in ICES rectangle 31F1 (MMO, 2007-2011)

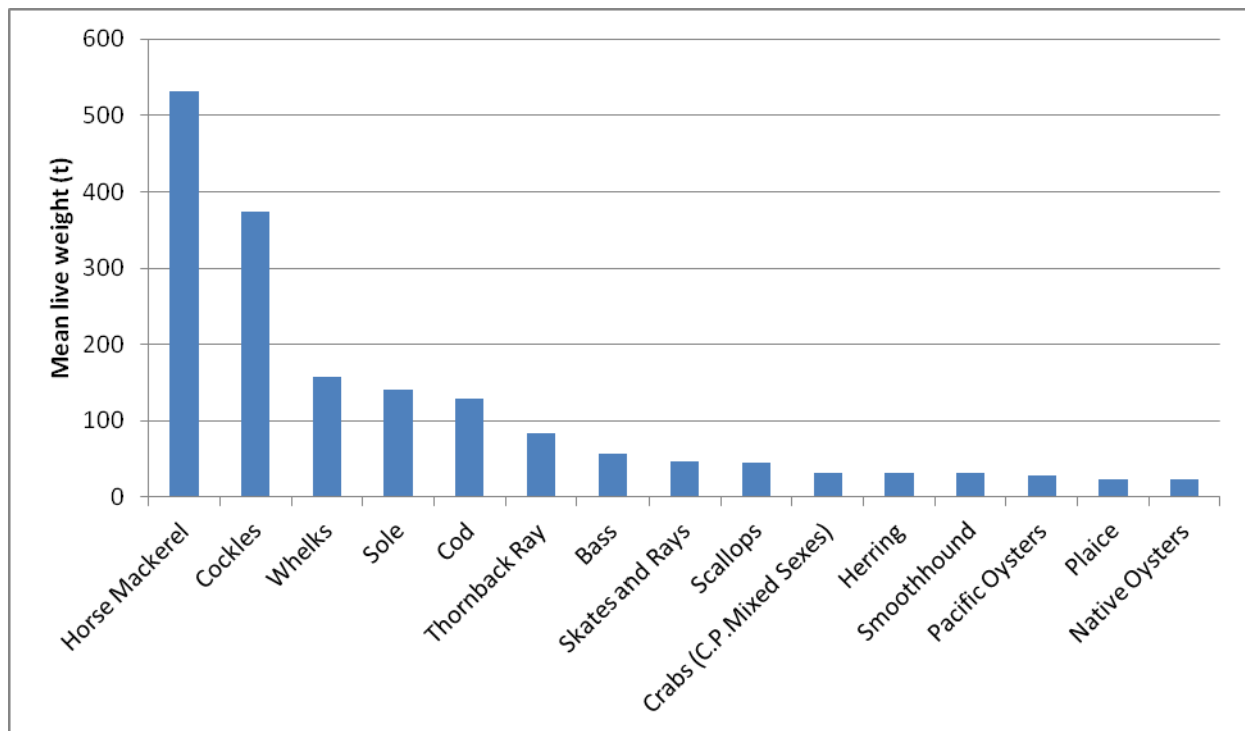


Figure 8-1-C: Mean annual live weight of the top 15 catches in ICES rectangle 31F1 (MMO, 2007-2009)

Landings and effort expended outside 12 nautical mile limit to median line

Figure 8-1-1 shows that a small portion of ICES rectangle 31F2 falls between the median line with France and the UK 12 NM limit, and that the cable route crosses this area. The data indicates that whelks, lobster and squid have the greatest catch value of shellfish species. However, finfish dominate landings in this rectangle, with plaice, sole, cod and bass being among the highest value species. These species are most commonly caught with beam and otter trawls although gillnets are also used.

Fishing vessels and gear operating within the 12 nautical mile limit

Consultation with the TFA suggests that the key fisheries associated with the inshore fishing fleet that operate static trammel nets and drift nets as well as lobster and whelk pots in the area between the coast and the South Falls Bank. VMS data is largely congruent with the TFA information identifying the key fishing methods in the vicinity of the cable route as gillnetting, trawling, drift netting and potting (Figure 8-1-2). Consultation with KESFC (now KESIFCA) revealed that the area around Pegwell Bay is popular with very small day fishing boats (<8m) based at Ramsgate as the area is in easy steaming distance from the port.

The majority of vessels operating in 31F1 are <10m in length, between 2007-2009 89% of fishing effort in 31F1 was undertaken by <10m vessels, this rose to 93% between 2010-2011. Between 2007-2009, 10 % of fishing effort was undertaken by vessels between >10-<20m in length declining to 6% 2010-2011. Vessels >20m accounted for a mere 1% of fishing effort between 2007-2009 and <1% between 2010-2011.

Within 31F1 gillnets account for the highest value landings of the gears deployed by <10m vessels, followed by pots, otter trawls and trammel nets (ICES, 2011). (Figures 8-1-3 & 8-1-4).

Both set and drift gillnets are deployed. Drift gillnets are set to drift with the tide and cannot exceed 500m. The nets can drift approximately 2 NM during a deployment and the vessel stays with the gear for the entire time. These vessels operate in water depths between 10 and 30 m. Set gillnets are generally set diagonally to the tide in strong tidal areas. Trammel nets are similar to gillnets and other

fixed nets in terms of the basic fishing procedure. KEIFCA restricts the soaking time of nets to 30 hours and no net, or continuous line of nets is allowed to exceed 1km in length (KESFC, 2010). Trammel nets are an efficient general purpose net which can be used to catch a wide variety of fish species from cod to sole. The net consists of three walls of netting and there is plenty of slack netting to allow fish to become entangled in it (Marine Services, 2005).

Otter trawling consists of cone shaped nets towed across the seabed with otter boards which hold the horizontal spread of the net and keep the gear on or near the seabed. The speed ranges from 1.5 to 3 knots for 0.5 to 3 hours at a time. Multi-rigs are commonly used in the area surrounding the Nemo Link cable route.

Mid-water pair trawling involves two vessels towing a set of trawl gear. This method targets pelagic species rather than demersal species. All trawling vessels operating within the 12 NM limit are restricted to engine powers of 300 hp or less and have an average speed whilst towing of approximately 2.6 knots (4.63 km/hr). It is generally accepted that vessels of this type tow for an approximate average of 1.5 hrs at a time (KESFC pers. comm.). A vessel therefore covers approximately 7 km in one tow.

Baited crab, lobster and whelk pots are strung together on a lead line of up to 20 pots. The pots are laid at water depths usually between 5 and 35 m and are allowed to soak for 12 to 48 hours before they are retrieved.

Although the available data indicates that mechanised dredges for shellfish are used in rectangle 31F1, discussions with TFA indicate that they are not being utilised within the vicinity of the cable route.

Ports in the local area of Thanet include Ramsgate, Broadstairs, Herne Bay and Margate. Whitstable is sometimes listed within this group, however it is outside of the Thanet area and so was not included. Ramsgate, Folkstone and Whitstable are key ports for landings from rectangle 31F1 and the rest of this region. To give an example of the landings to these ports during 2011 into Whitstable £64,786 worth of seabass, £4,544 of cod, £14,224 of skates and rays and £27,111 of sole was landed, whereas Shellfish landings were dominated by whelks with a value of £59,071 followed by £34,744 of oysters and £29,357 of lobster (although this landings data does not state the ICES rectangle in which catches were made) (MMO, 2011).

Fishing vessels and gear operating from the 12 nautical mile limit to median line

A small portion of ICES rectangle 31F2 falls between the median line with France and the UK 12 NM limit, and that the cable route crosses this area.. Of the fishing effort (days at sea) recorded in this rectangle with 56 % was undertaken by vessels less than 20m between 2007 and 2009 and a mere 15% from 2010-2011. Only 24 % of fishing effort recorded in this rectangle was by boats greater than 10-m but less than 20m between 2007-2009, declining to 3% from 2010-2011. Vessels <10m in length accounted for 20% of recorded effort there between 2007-2009, this increased to 82% 2010-2011 a trend which mirrors and increase in <10m fleet and improvements to engine capacities. The lack of exploitable shellfish beds and the large distance small fishing vessels would have to travel to reach offshore grounds in this rectangle result in less diverse fishing activities occurring than in more inshore areas. Within 31F2 beam trawling accounts for the highest value of catch per by gear type, vessels generally tow at speeds (ranging from 5.5-7.5 knots) for 1.5 -2 hours with beams up to 24m in aggregate width. The next highest values of catch were captured using trammel nets, then by otter trawls. Trammel nets are used to target cod in this area while the beam and otter trawls capture a wide range of species including bass, cod, plaice, brill, sole, turbot, skates and rays (ICES, 2011). _

Traditionally landings caught in ICES rectangle 31F2 have not been of great significance to local ports with catches tending to be landed into foreign or more distant British ports.

Seasonality

The fisheries in the vicinity of the proposed cable route are seasonal in nature and also restricted by quotas, both within the 12 NM limit and between the 12 NM limit and the median line. Figure 8-1-D below shows the months when 10% or more of the mean yearly catch is landed based on MMO ICES rectangle data.

Species name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horse Mackerel												
Cockles												
Sole												
Cod												
Skates and Rays												
Sprats												
Thornback Ray												
Plaice												
Whelks												
Bass												
Herring												
Scallops												
Crabs (C.P.Mixed Sexes)												
Pacific Oysters												
Lobsters												

Figure 8-1-D : Lists the top 15 most commonly caught species in the ICES rectangles surrounding the cable route (2007-2009). Months when 10% or more of average yearly catch is landed are shown in dark blue and months where less than 0.05% of the years catch are landed are shown in white, those in between are shown in light blue.

Figure 8-1-D is based on 2007-2009 fish catch data and indicates that the majority of species are caught year round including; sole, cod, skates and rays, thornback rays, plaice, whelks, bass, crabs, pacific oysters and lobsters. However, it is acknowledged that seasonality of fisheries is highly variable as it relies on as fishing effort (dependent upon a number of variables such as weather, sea temperature, quota etc.) and therefore it is not directly equitable with fish abundance. Seasonality is displayed by the majority of species and is reflected in the fishing activities employed by fishermen throughout the year. The winter fin-fishery targets cod, herring, mackerel and sprat, while key summer species are seabass, Dover sole and Thornback ray. With the exception of scallops that are a winter fishery most shellfish are targeted in spring (whelks) and summer crab, lobster and oysters.

Anecdotal evidence from the Thanet Fisherman’s Association (TFA) indicates that seasonal variation in the targeting of different species by fishermen is also dictated by when fish quotas have been reached, this is generally supported by the Thanet Offshore Wind Farm Environmental Statement (TOW ES). There were, however, some differences including that Thanet considered most plaice to be caught in spring and summer while the data above suggested it was not a seasonal catch. While, the data above suggested lobster were caught mostly in summer the Thanet ES suggested lobsters were not seasonal. However, it is important to note the potential for seasonal variability when considering this anecdotal evidence.

The MMO data (2007-2011) reflects the seasonal variation in the use of different fishing methods and the general trend for increased fishing activities throughout summer months. Many gears e.g. gillnets, trawls and pots are used year round as they target different species at different times of the year e.g. gillnets target cod in winter and seabass in summer, dredgers target scallops in winter and oysters in summer (ICES, 2011).

Restrictions to fishing activity in the area crossed by the cable route

Fishing activity in the vicinity of the Project cable system is affected by a number of restrictions defined by the EU Common Fisheries Policy (CFP) and local KEIFCA byelaws and agreements. The key geographical restrictions are outlined below

- The CFP allows EU member states to fish up to the 12 NM limit.
- Vessels operating between the shore and the 6 NM territorial limit are restricted in length to 17 m or less (KESFC, 2010).
- Vessels operating between the shore and the 12 NM limit are restricted to engine power of 300 hp or less and an aggregate beam length of 9 m.
- Vessels operating between the 12 NM limit and the median line are restricted to engine power of 2000 hp or less and an aggregate beam length of 24 m.
- No fixed engine (staked nets) shall be set within a radius of 1.5 nautical miles of the chimney of Richborough Power Station, Kent (51°18.56'N, 01°20.85'E) from April to September (KESFC, 2010).
- There is a seasonal closure zone to the north of the cable route in ICES rectangle 33F2 with a radius of 10 nautical miles, closed from January to April².
- KEIFCA By-Laws:
 - Application to fish for scientific or breeding purposes
 - Whelk Pot Limitation Emergency By-Law
 - Winkle closed season
 - Lobster permit
 - Dredging for, fishing for and taking of oysters & clams and removal of cultch
 - Fixed engines (nets)
 - Fishing for and taking of whelks
 - Vessel length
 - Fishing instruments (permitted fishing methods)
 - Trawling exclusion
 - Scallop closed season

Shellfish harvesting is also governed by a number of separate restrictions to encourage sustainable exploitation of the resource. These include restrictions relating to the size and engine power of vessels and the size of the dredge heads used as well as the enforcement of "closed" seasons. Cockle vessels are restricted to a power of 300 hp or less and dredge heads cannot exceed 76 cm in width. The fishery is also closely monitored throughout the year via enforcement of set quotas along with minimum shell landing size and maximum shell damage rates. The Thames Estuary Cockle Fishery Regulating Order (1994) divides the Thames Estuary into regulatory fishing areas which are illustrated below (Figure 8-1-E). The Nemo Link cable route only crosses the South Kent Coast to Dungeness area which falls outside of the estuary and is not covered by the Thames Estuary Fishing order (1994).

² In 2011 this seasonal closure zone was reopened on the 1 March.

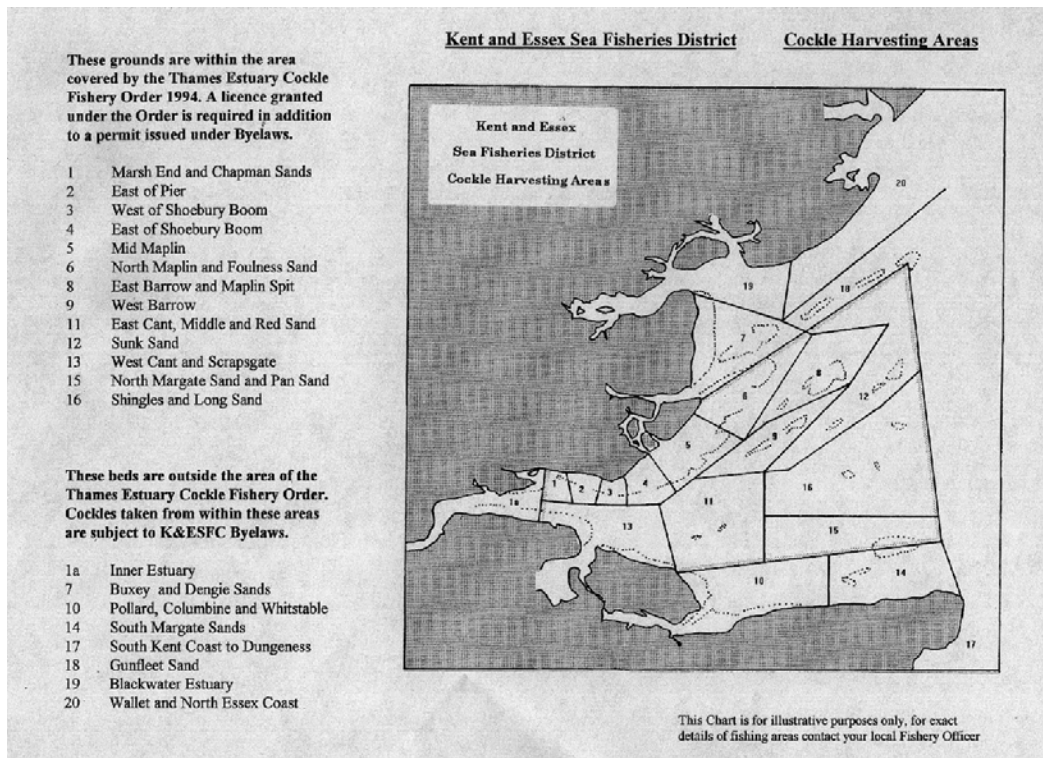


Figure 8-1-E : Kent and Essex Sea Fisheries District showing the cockle harvesting regulatory areas

8.1.4. Description of potential impacts

The table below provides details of how receptor value has been defined for the purposes of the impact assessment. A detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Fishing rendered permanently impractical or impossible over an area of national commercial importance. The viability of regional fishing fleet is threatened.
Medium	Fishing impractical or disrupted over an area of regional commercial importance. The viability of local fishing vessels is threatened. Temporary loss of income .
Low	Fishing impractical or disrupted over a local area. Loss of income to some local vessels. The viability of fishing is not threatened.

Table 8-1-1 : Definition of receptor value

The possible impacts on commercial fisheries both inshore and offshore of the 12 NM limit are discussed below. Impacts on fish ecology are discussed separately in Section 7.5 – Fish and Shellfish Ecology. Impacts upon commercial fisheries during the installation, operation and decommissioning of the Project cable have been quantified on the basis of quantity of fishing grounds affected during these phases.

The table in Appendix 6 provides the detailed impact assessment work. The information below provides a summary of the key findings of the impact assessment.

Consultation with the TFA suggests that key fisheries liaison issues will be with the inshore fishing fleet that operate static trammel nets, drift nets and lobster and whelk pots in the area between the coast and the South Falls Bank. Vessel Monitoring System (VMS) data is largely congruent with the TFA suggestion and identifies the key fishing methods in the vicinity of the cable route as gillnetting,

trawl, drift nets and potting (Figure 8-1-2). Based on the MMO data (2007-2011), the TFA and the VMS data it appears the most significant fishing types within the area are:

- gillnetting
- trammel netting
- trawl
- drift net
- pots

Commercial fisheries may be affected in four ways:

1. During installation there will be a mobile exclusion zone of approximately 2 km by 1 km around the cable laying spread, moving at the rate of installation, which will be typically 300 m/h. Fishing vessels using drift nets and trawl gear will be required to avoid this temporary exclusion zone.
2. Direct disturbance of any seabed fisheries (e.g. beam trawling, potting, dredging and fixed net grounds). The footprint of the burial machine used will be a maximum of 10 m in width. The maximum trench width will be 1–2 m if a jetting machine is used and less if a plough is used. The creation of a trench into which to lay the cables may disturb objects (e.g. clinker and shells) present in the first 1-2 m of sediment, and leave some of these on the seabed surface. Although these features would be unlikely to impede a trawler which happens to tow over the cable, it may render the ground too rough for fine gillnetting gear.
3. Indirect disturbance of the fishery due to the dispersal of sediment displaced during pre-sweeping and burial of the cable. There are three areas that are expected to require pre-sweeping within British waters these are at Kilometre Points (KP) 82.3 to 87, KP 99 to 100.8 and KP 123 to 123.5. The approximate extraction dredging from these regions is expected to total 118,778 m².
4. Cable protection and rock placement at cable crossings may exclude some types of gear being used for fishing the area directly over the cable and damage may be caused to fishing gear that is used over the cable.

Based upon the discussion above the following impacts have been assessed:

- Displacement of fishing activity within the area of temporary exclusion zones and the indirect impacts on fishermen outside of the cable installation area by the displaced vessels
- Disturbance of bottom trawling and dredging activity that will need to avoid the installed cable and associated cable protection
- Damage to certain types of fishing gear (for example, risk to nets and pots laid along the route etc.)

Installation Impacts

A 2 km² exclusion zone will be a temporary measure that will move with the installation array at 300 m/hr (typically) and therefore it is expected that any hindrance to fishing activity would be for a relatively short period of time. The entire installation phase in UK waters is expected to take less than 3 months, although it is likely that each ground will be affected for a few weeks given the nature of cable route installation.

Displacement of fishing activity

Marine cable installation is likely to take place between the months of April and October, which is when sole, thornback rays, cockles, whelks, Pacific oysters, crabs and lobsters are mainly being targeted. Most fishing methods are used throughout the year, in particular gillnetters operate with no seasonal peak in activity. The use of trammel netting peaks from June to October and the majority of

trawling occurs from April to October as weather conditions during the spring and summer months are usually more favourable. Some fishermen will experience a temporary loss of traditional fishing grounds in the immediate vicinity of the cable route, during the installation of the cable. Only a very small area of total available fishing grounds will be affected at any one time and only for a short period of time therefore it is predicted that only an impact of minor significance will result.

Fish stock displacement

Indirect impact to the commercial fishing industry may occur through impacts on fish and shellfish species due to sediment re-suspension and deposition. The dredging or pre-sweeping of sand waves will account for approximately 95 % of the sediment released during installation, the remaining 5 % of sediment will be related to the cable burial activities. Impacts of sediment re-suspension and deposition on fish and shellfish are discussed in Chapter 7.5 – Fish and Shellfish Ecology.

Operation Impacts

Damage to fishing gear

Damage to certain types of fishing gear, especially drift and trammel netting, may occur during the operation phase of the project as a result of rock placement for cable protection or interaction with material used for cable crossings. There is one cable crossing between the landfall and the UK median line. Although this crossing will require the placement of rock or concrete mattresses it will be over a very limited extent; approximately 30 m wide along a 100 m of the cable route. Given the limited spatial extent of the area affected in relation to the total fishing area available the impact on commercial fishing activity is expected to be negligible. It is, however, understood from the local fishing industry that Thanet Offshore Wind Farm and the BritNed cable, have had some challenges burying cables to a depth of 2m (pers comm. W. Wright, KESFC, May 2011). Thus it is acknowledged that it is possible that rock armouring may be required if sufficient burial cannot be achieved in particular areas. If this is the case, it is likely that the impact will increase to minor significance due to the increased area that would become difficult to fish with trammel and drift nets. This is likely to be perceived as a large level of change to the small number of day vessels that fish the inshore area around Pegwell Bay who will find it difficult to travel to alternative fishing areas. However it is not possible to determine the level of impact until the location or extent of any potential rock armouring is known. It is important to note that any rock armouring required for cable protection will require a separate Marine Licence application to be submitted which would be accompanied by a full assessment of the likely effects of that rock placement.

There is a potential risk of drift and trammel nets becoming snagged and damaged as a result of rough ground or anchor mounds created during the cable laying process. Burial in hard ground is most likely to increase the potential for snagging of fishing gear. Seabed surveys indicate that much of the seabed is fine sand and gravel in the area crossed. Hard ground, in the form of chalk, is expected to be encountered over a 15 km stretch of the cable route, running between KP 100 and 115, spanning the 12 nautical mile limit (see Chapter 4 – Project Description). This represents a very small area in relation to the total available fishing ground. Additionally the project will aim to bury the cable at a depth of 2-3m below the seabed. At this depth it is unlikely that trawlers will snag the cable and this should ensure that should a trawler accidentally trawl over the cable system it is unlikely that there will be damage to their equipment or vessel. Taking this and the temporary nature of the exclusion zone into account it is anticipated that installation impacts on commercial fisheries will be minor.

Reduction in fish stocks

A minor impact on fish resources in the vicinity of cable is expected during cable operation. Emissions of electromagnetic frequencies (EMF) and heat from the cable or accidental contamination by vessels or equipment may lead to disturbance of sensitive species, spawning and/or nursery grounds. These impacts on fish are discussed further in Chapter 7.5 – Fish and Shellfish Ecology.

Displacement of fishing activity

Trammel and other set nets and pots will be displaced from the one crossing where rock placement has been used. Static nets are mostly used within the 12 NM limit. Bottom trawlers and dredgers are expected to be displaced from the length of the cable route as this fishing method may lead to cable

snagging/ exposure. The area that the cable occupies is relatively small in comparison to the total trawling area, it is therefore expected that the cable will cause an impact of **minor** significance to commercial fishing.

There will also be brief periods of repair and survey work during the life of the cable, these will cause similar disruption to the construction period but will likely be on a smaller scale and shorter in duration. Overall it is expected that impacts during the operation phase of the project will be **minor**.

Decommissioning Impacts

It is likely that any impacts during decommissioning will be similar to those experienced during installation. It is often the practice to leave cables on the seabed after they are no longer in service as this action often causes the least environmental disruption.

8.1.5. Mitigation measures

During cable installation a Fisheries Liaison Officer (FLO) will be employed from the local fishing industry to ensure that interactions between the cable installation vessels, personnel and equipment and fishing activity are managed. It is proposed that detailed information (including locations and programmes) about installation, maintenance and survey work be passed on to the FLO in good time before the installation work commences. This will help to ensure that disturbance to fishing is kept at a minimum. Additionally to this Notices to Mariners (NtM), will be issued in good time to advise fishermen of where and when the installation spread will be operating, as well as the expected vessel speed. Local fishing associations will also be contacted directly.

Post-installation fishermen will be advised of the presence and location of the operational cable system via the Kingfisher Cable awareness charts. This will enable them to avoid interactions between their fishing gear and the cable system during its operational phase. If any geophysical surveys are to be completed prior to construction, these will be used to identify any debris or rough ground. Findings will then be compared to any post-construction geophysical survey results to assess whether the cable laying process has created rough ground that may snag fishing gear. Furthermore, if complete burial of the cable is not possible, the fishermen will be consulted on the burial solutions under consideration so that any potential impacts to fishing can be assessed as required.

In the event a trawler was to snag the cable it is unlikely the vessel would have sufficient power to bring the cable off the seabed. The vessel is more likely to back down the gear to try and dislodge it from the cable, or otherwise cut the gear. A strategy for dealing with/compensating fishermen for gear snagging will need to be developed. A handful of vessels may have winches with adequate pulling force to damage the cable. In reality these low-powered vessels are at greater risk keeping their vessel stable if entanglement occurs, rather than cause the cable damage.

8.1.6. Residual impact

Installation

The impact on displacement of fishing activity is likely to remain negligible if the above mitigation measures are implemented. The likelihood of any impact will be reduced to unlikely if Notices to Mariners are issued to fishermen (given the short term disturbance to fishing grounds and the range of fishing grounds in the area), as this will allow fishermen time to plan alternate fishing for this period.

Operation

The likelihood of damage to certain types of fishing gear will be reduced if Notice to Mariners are issued to fishermen and fishermen are advised of the cable location via the Kingfisher Cable

Awareness charts. The overall impact is predicted to be reduced to negligible significance if the above mitigation is implemented.

Decommissioning

The impact on displacement of fishing activity is likely to also remain negligible if the above mitigation measures are implemented similar to that experience in installation (given the short term disturbance to fishing grounds and the range of fishing grounds in the area). The likelihood of any impact will be reduced to unlikely if Notices to Mariners are issued to fishermen.

Details of the full impact assessment are included in Appendix 6.

8.1.7. References

- ABPmer Ltd (2009) Development of spatial information layers for commercial fishing and shellfishing in UK waters to support strategic siting of offshore windfarms. Commissioned by COWRIE Ltd (project reference FISHVALUE-07-08).
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- MMO (2010B) UK Fishing Industry in 2010 Landings
<http://www.marinemanagement.org.uk/fisheries/statistics/documents/ukseafish/2010/landings.pdf>
- MMO (2010C) UK Fishing Industry in 2010 Structure and Activity
http://www.marinemanagement.org.uk/fisheries/statistics/documents/ukseafish/2010/structure_activity.pdf
- http://www.vattenfall.co.uk/en/file/110321_Section_13_Commercial_Fisheries_V3.0.pdf_17881609.pdf

8.2. Shipping and Navigation

8.2.1. Baseline data sources

The following sources of information were used as per MCA guidance;

- Admiralty Charts (Chart Number 323)
- DECC Maritime Data including International Maritime Organisation (IMO) routing, Recreational Routing and Radar recordings from Dover Vessel Traffic Services (VTS) and AIS data.
- MGN 371 - Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues.
- DECC Methodology for Assessing Marine Navigational Risk
- RYA Data - RYA Sailing Areas, Racing Areas and Cruising Routes Data

To ensure impacts on shipping and navigation in UK waters are fully assessed, this chapter assesses the impact upon shipping and navigation out to longitude 2° 08'E (which is in French Waters) as requested by the MCA (Captain Clive Lane – 22nd November 2010). Specialist environmental consultants are undertaking similar studies for France and Belgium.

8.2.2. Baseline

The planned cable route transits through several areas of dense marine traffic and IMO designated shipping routes (as shown in Figure 8.2.1). Figure 8-2-A provides an overview of a month of AIS data from summer 2012.

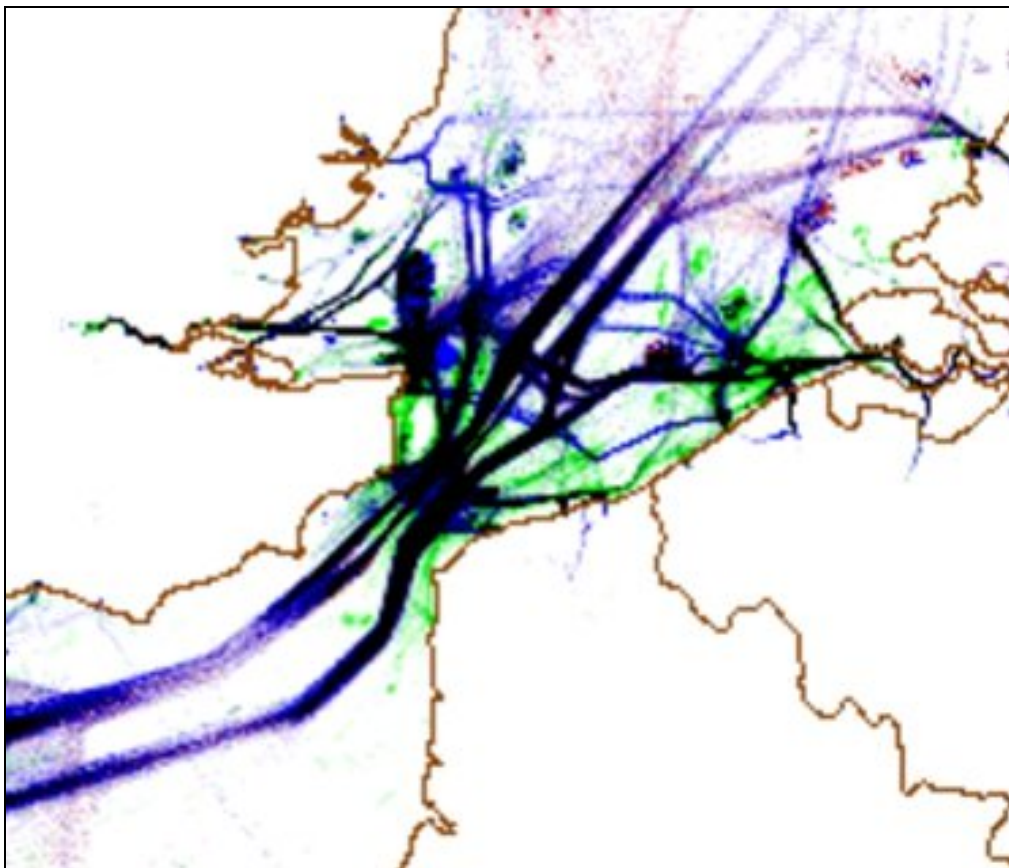


Figure 8-2-A : Overview of a month of AIS data from Summer 2012 (AIS Llive, 2012)

A baseline navigational review has been undertaken of the proposed cable route and impacts have been informed and assessed using information on the existing level of sea use in the area. The following significant marine risks have been considered:

- the potential for installation of the cable system to pose a hazard to marine navigation in terms of significant risk of vessel collision;
- or
- the potential for installation of the cable system to pose a significant obstacle to navigation in terms of causing significant diversion of vessels' passage from their normal route through the area.

It is expected that a 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 several hundred metres to 1km per hour.

The main navigational areas crossed by the cable system in UK waters are detailed below.

Ramsgate Harbour Approaches

Traffic within this area is within buoyed or depth constrained channels and is multi directional. Within the buoyed channels, traffic is diverse including recreational, commercial and passenger ferry traffic. Outside of the main buoyed channel, the traffic is smaller and combined with recreational craft. RYA data indicates that there are recreational racing and sailing areas within vicinity of Pegwell Bay and a number of heavy and medium cruising routes will be crossed by the cable route.

Ramsgate Harbour Approaches are covered by Channel Navigation Information Service (CNIS) radar coverage, required reporting area (CALDOVREP – Vessels 300GT) and CNIS Vessel Traffic Services (VTS) Coverage area. See Section 8.2.5.1 for description of the role of CNIS. Required reporting and VTS coverage means that all vessels transiting the CNIS and VTS are required to report in and are monitored through the area. This includes the provision of information and navigational warnings.

The cable also crosses the Port of Ramsgate port control reporting area, although it remains south of the West Cardinal Buoy which marks a sand bank and therefore also remains south of the main Ramsgate approaches and buoyed channel (as shown on Figure 8-2-B).

The tidal stream sets across the harbour entrance in a north easterly / south westerly direction, with the north going tide running from about 1½ hours before high water to 4 hours after high water. A risk exists from vessels Not Under Command (NUC) which could drift towards the installation spread. Guard vessels shall therefore include procedures for dealing with a vessel Not Under Command.

There are small craft holding areas, for when large vessels are transiting the break waters and awaiting marina openings. These are located directly to the north and south of the buoyed channel. As these are located along different sections of the cable route, either one could be used during installation works, depending on the position of the installation spread.

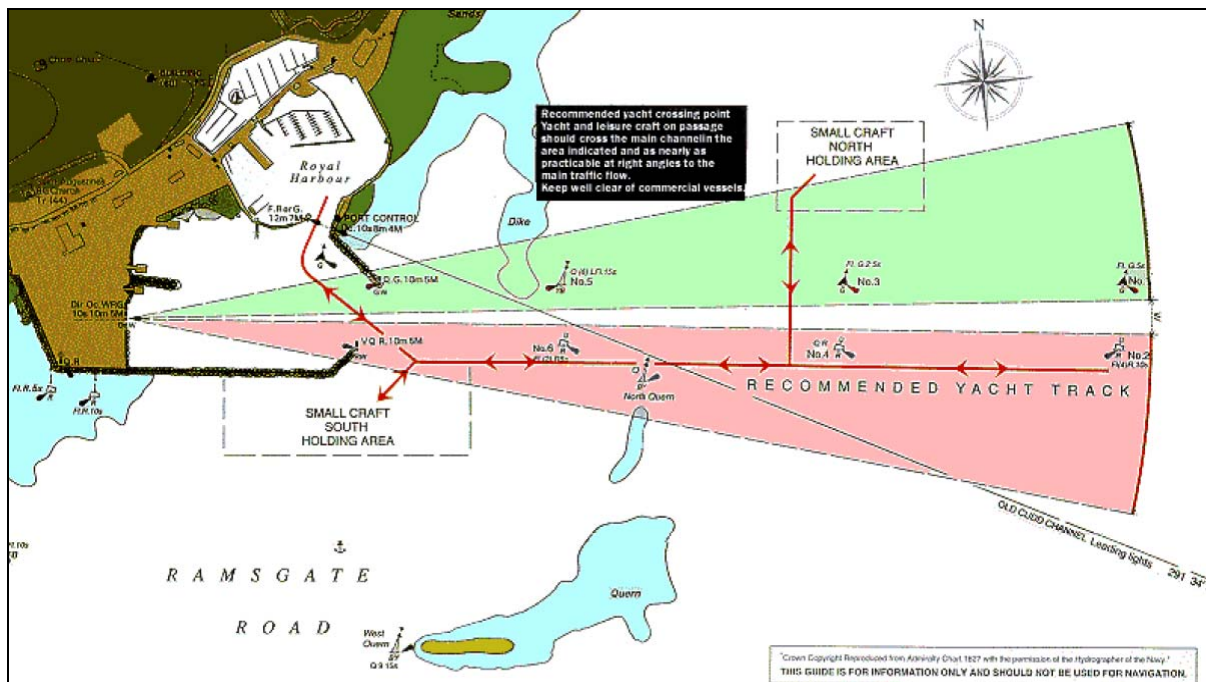


Figure 8-2-B : Small Craft Holding Areas - Ramsgate Harbour Approaches (Source: Port of Ramsgate, 2011)

Radar data indicates that a small number of small craft approach Ramsgate from the south via the Ramsgate Channel and Gull Channel (see Figure 8-2-A). Larger vessels using the Gull Channel continue to enter Ramsgate Harbour via the main buoyed channel turning between the South and East cardinal buoys just north of the proposed cable route. This would be a potential risk area during cable laying due to surrounding shallow banks, converging and crossing of traffic and pilotage movements.

Ramsgate Harbour operates a Pilotage system; the Pilot station is located over 2 nautical miles north of the proposed cable route and operations should not interfere with the boarding of pilots. Communications should however be maintained with the Pilot service and a watch maintained on the ports working channel (VHF Channel 14).

There are heavy and medium Royal Yachting Association (RYA) recreational routes that transit across the proposed cable route. The cable route passes through areas used for RYA racing and there are a number of seasonal buoys (April to September only, unlit yellow spherical buoys) within the vicinity of the cable route. There are seasonal variations in recreational activity which mean heavy levels of recreational activity during late spring, summer and early autumn seasons including the Royal Harbour Yacht Club who have a yacht racing week in July and August. Separate consultation with local and national water sport associations will be required to ensure that installation can be timed to avoid major recreational events.

Inshore Shipping Route

The inshore shipping route (see Figure 8-2-B) is generally used by medium sized vessels transiting between UK coastal ports and therefore is not required to comply with the Traffic Separation Scheme (TSS). The traffic is multi directional within these areas.

The western inshore traffic route where cable laying will occur is covered by CNIS radar coverage, which incorporates the required reporting area and CNIS VTS coverage area. The eastern inshore traffic route is within radar coverage but outside of the VTS and reporting areas. However vessels generally call the VTS in advance of reaching the designated CALDOVREP line and therefore within the vicinity of the cable installation vessels should already be in contact with CNIS.

Vessels enter Ramsgate Harbour via the main buoyed channel and turn south of the north east Goodwin buoy and directly north of the proposed cable route. This would be a potential high risk area during cable laying operations due to surrounding shallow banks and converging / crossing of traffic. This would need to be mitigated by use of guard vessels and promulgation of information to mariners.

There is also high level of fishing activity within the vicinity of Ramsgate and the inshore routes (see Chapter 8.1 – Commercial Fisheries for further details). Although the effect on the fishing activity will be assessed separately, there will also be the potential for displacement of fishing vessels into areas used by commercial and recreational craft during installation works. Consultation will be required with local fishing organisations (this will be undertaken via the Fisheries Liaison Officer) and extensive promulgation through Notice to Mariners and Kingfisher Bulletins.

Rule 10 of the International Regulations for Prevention of Collisions at Sea (COLREGS) and its effects on traffic within and in proximity to Traffic Separation Schemes (TSSs).

Rule 10 of the International Regulations for Preventing Collisions at Sea 1972 (as amended) and also known as the COLREGS, specifies the conduct of vessels in (TSS) adopted by the IMO.

The installation of the cable may at times prevent vessels, especially crossing vessels, being able to fully comply with the requirements of Rule 10 however this should not significantly increase the risk if effectively mitigated through promulgation of information and traffic management.

South West (SW) Traffic Separation Scheme (TSS) Lane

The cable installation across the SW TSS lane is within radar coverage but outside of the VTS and reporting areas.

The traffic is dense but controlled by the rules of the TSS. The cable lay area crosses the SW TSS lane within the vicinity of traffic crossing the Channel.

Within and around the lane there are also a number of recreational routes (including sailing and recreational diving excursion transit routes) and fishing areas. No wrecks, used for recreational diving, are crossed and therefore impacts would be from a traffic management perspective rather than interference with the diving.

A temporary and minor displacement of commercial vessels and recreational craft is expected to occur but can be mitigated with effective promulgation of information.

North East (NE) Traffic Separation Scheme (TSS) Lane, Deep Water Route and Restricted Vessels

The cable laying with the NE TSS lane will be within CNIS radar coverage and CALDOVREP reporting areas.

The traffic is dense but controlled by the rules governing the TSS. The area where the cable installation will cross is at a wider section of the lane allowing adequate room for vessels to manoeuvre around the installation vessels.

As with the SW lane a temporary and minor displacement of commercial vessels and recreational craft is expected to occur but can be mitigated with effective promulgation of information.

The NE TSS lane is also used as a deep water route and deep draught vessels will be restricted in their manoeuvrability and navigational choices. These vessels are extremely slow to manoeuvre and need to make early course alterations. The slow speed at which the cabling will be undertaken, early notification and communication with the vessels will help mitigate risk.

To the East of the Sandettie Bank is the second NE route (non deep water). The cable route crosses to the north east of the Sandettie Buoy. An area of increased risk will occur due to the shallow Sandettie Sand Bank to the west which means vessels can only alter course to the east. Again early

communication with vessels, promulgation of information and the guard vessels will help mitigate this temporary risk.

Crossing Channel Traffic

As noted above the cable route is in close proximity to the main cross Channel route. Rule 10 (of the COLREGS) states that vessels crossing a TSS must do so on a heading as near as practicable to right angles to the direction of traffic flow. The main area of increased risk is within the SW lane where the cable installation takes place in close proximity to the main cross channel route. Areas of concern would include areas where crossing traffic, including high speed ferries, comes into close proximity with the traffic in the south west TSS lane and the cable installation spread. The crossing traffic is restricted in its movement by the requirements of Rule 10 COLREGS which states that vessels crossing a TSS must do so on a heading as near as practicable at right angles to the direction of traffic flow. There is adequate water depth to allow crossing vessels to make small course adjustments and still be able to meet the requirements of Rule 10 of COLREGS.

8.2.3. Description of potential impacts – Installation & Decommissioning

For shipping and navigation, installation and decommissioning impacts are considered to be similar.

As any effects on shipping and navigation are more risks than impacts it is not appropriate or meaningful to assign a receptor value in this analysis, although a detailed assessment of the risks has been included in the impacts matrix in Appendix 6. This impact assessment therefore outlines the risks and associated mitigations that will reduce the risks to as low as reasonably practicable.

8.2.3.1. Temporary mobile Safety Zone around the cable recovery spread/s

Potential impacts from the temporary Safety Zone, as outlined in the baseline section, are as follows:

- Displacement of shipping vessels and recreational craft from the area surrounding the cable laying spread. This would be of particular concern for:
 - Cross Channel Ferries and their ability to comply with Rule 10 of COLREGS including interaction with other traffic within the TSS.
 - Commercial vessels and recreational craft crossing the TSS and their ability to comply with Rule 10 of COLREGS including interaction with other traffic within the TSS.
 - Recreational craft and commercial vessel interaction.
 - The Deep Water Route and the restricted manoeuvrability of vessels using it.
 - Creation of choke point in the vicinity of Sandtette Buoy where manoeuvrability of vessels altering to avoid the installation is restricted by the shallow water of the Sandtette Bank.
- Impeded access to the Port of Ramsgate
 - Minimal impact on Pilotage activities.
 - Inshore and recreational traffic when installing in proximity of channels such as limited use of Gull Stream during installation within the channel.
 - Interaction and congestion in vicinity of NE Goodwin Buoy.

Displacement caused by the works is considered to be a temporary and low impact and effects mitigated with methods listed in 8.2.5.

8.2.4. Description of potential impacts – Operation

8.2.4.1. Electromagnetic Interference (EMI)

Concern has been expressed on similar projects as to the potential for vessels navigating with magnetic compasses being affected by the Electro Magnetic Field (EMF) associated with operational

HVDC cables. An increase in risk would occur particularly in areas of a restricted nature such as in channels and in proximity to banks such as Sandettie. Hence, there is an increased risk of vessels running aground or collisions particularly during periods of restricted visibility. The MCA has confirmed that compass deviation of less than 5 degrees would be acceptable in terms of risk to vessels.

8.2.4.2. Emergency Anchoring within Vicinity of Cables.

Although there are no designated anchorages crossed by the cable route within UK waters there is still a requirement for adequate cable protection post installation. This will be required in order to mitigate against anchor damage to the cable system in the event that a vessel needed to deploy an anchor in an emergency in the vicinity of the cable. Although accidental anchor deployment is unlikely, and damage to a vessel minimal, should an instance occur significant damage could be sustained to an unprotected cable. It is therefore in the interests of the Project to ensure the cable system is well protected by suitable burial methods.

Receptor Value	Definition
High	Permanent disruption to an IMO shipping route, a route used by vessels of limited manoeuvrability resulting in an increase in journey distances, permanent disruption to a shipping route resulting in unacceptable impacts on the safety of navigation. Permanent disruption to commercial shipping routes.
Medium	Permanent disruption to a recognised shipping route, but alternative route does not result in additional journey times or impacts on the safety of navigation.
Low	A temporary and minor impact resulting in displacement for vessels and obstruction of navigational routes. A permanent but minor (e.g. within the 5 degree limit outlined by the MCA) effect on compass deviation.

Table 8-2-1 : Definition of Receptor Value

8.2.4.3. Cable Exposure

Should any part of the cable become exposed for extended periods, additional mitigation measures may be required to protect both the cable and prevent vessels potentially interacting with it and potentially becoming snagged. Mitigation measures could include buoyage as per Trinity House Lighthouse Service (THLS) requirements or additional guard vessel cover depending on the density of traffic within the vicinity.

8.2.5. Mitigation

A temporary, minor displacement of shipping activity is expected to occur during cable installation. Due to the speed and size of the installation spread it will only require temporary mitigations to aid the flow of traffic and prevent high risk choke and crossing points for vessels. Any impacts on vessels navigating in the region will be temporary and only affect a limited area at any given time. The mitigation measures outlined below will be implemented for the installation works to ensure that impacts upon shipping and navigation are minimised.

8.2.5.1. Cooperation with Channel Navigation Information Service (CNIS)

The objective of the CNIS is to contribute to the safety of navigation in the Dover Strait by encouraging vessels to comply with IMO procedures for vessels navigating within a TSS and to provide the latest information to shipping on activities, conditions and navigational irregularities which may affect safe navigation.

The mandatory reporting scheme, CALDOVREP, and the area radar coverage provide substantial risk mitigation for the cable installation. It is important for the project to communicate its planned operation with advance notification and daily reports to CNIS.

The CNIS area is monitored by Dover Coastguard Station in the UK and Cap Gris Nez Station in France.

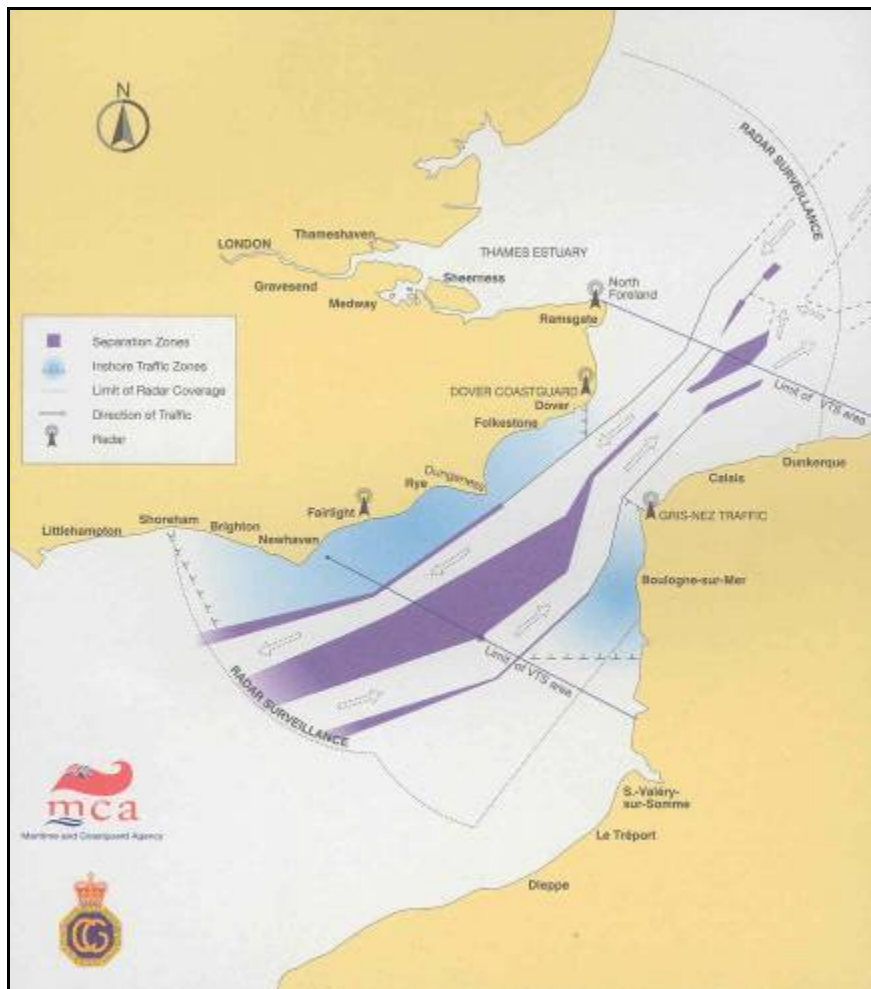


Figure 8-2-C : Extent of Dover Straights TSS (Source: MCA, 2011)

A regular plan for communication including daily position and activities will be established with CNIS to ensure that there is a continual two way flow of information. A communications plan will be in place prior to commencement of works and will be controlled by the installation contractor.

Although an unlikely occurrence, occasionally 'rogue' vessels still transit the TSS. These are vessels that are not in communication with CNIS as required by CALDOVREP regulations. Should a situation occur, guard vessel response plans shall include procedures for dealing with the 'rogue' vessel.

8.2.5.2. Provision of an Emergency Response Coordination Plan (ERCoP)

The HSE representatives for the offshore operations will provide an Emergency Response Coordination Plan to cover all phases on the Project. This ERCoP will be required to be approved by

the Maritime and Coastguard Agency. This plan will include details of cooperation with the CNIS, MCA emergency response resources, Ramsgate Harbour and Pilot.

8.2.5.3. Promulgation of Information to Mariners

Safety information will be promulgated by the installation contractor in accordance with MCA guidance and through the United Kingdom Hydrographic Office (UKHO) who promulgate maritime safety information and update nautical publications including NAVTEX, Local and National Notice to Mariners. Safety information and notices will include a description of the operation and area of operation and will be regularly updated to show accurate information on the current location of the installation spread and the names of the vessels onsite including clear identification of the guard vessels.

Kingfisher Information Service who provides accurate positional information for all offshore surface and sub-sea hazards will also be notified so details of the works and final cable route can be published in their bulletins.

Local recreational and fishing organisations will also be notified by the installation contractor via a Fisheries Liaison Officer (FLO).

8.2.5.4. Guard Vessels

Guard vessels will be assigned to both protect and support the cable laying activities and will be chosen according to speed, maritime equipment provision and endurance.

Two guard vessels shall be assigned to the installation spread. One guard shall provide close protection to the installation vessel spread whilst a secondary vessel will be available to enable interaction with any rogue vessels or vessels in distress approaching the spread.

A clear vessel management and response plan will be provided by the vessel operators which will include communication and cooperation with Ramsgate Harbour, Ramsgate Pilots, channel ferry operators, CNIS and other Emergency Response Resources in the area.

8.2.5.5. Lighting and Marking

The cable installation vessels will show such lights and shapes as required by the COLREGS.

8.2.5.6. Cable Protection

Rock placement/mattresses are currently only intended to be used at cable crossings (there are no pipeline crossings in the UK). Burial depths will be determined based on estimated anchor and fishing gear penetration depths and precedent. Captain Lane of the MCA recommended that cable burial should be an absolute minimum of 0.5m along the entire length of the route.

8.2.5.7. Emission of EMF from cables and magnetic compass interference.

A study was undertaken as part of the BritNed Development (2004) to determine the maximum deviation possible from a DC interconnector of similar specification to the Nemo Link cable system. The study found that the deviation was less than 5 degrees (SwedPower, October 2003). The MCA confirmed these levels of compass deviation are acceptable. Due to similar burial depth / voltage, it is assumed that similar levels of maximum deviation will be present upon installation of the Nemo Link cable and therefore would be within MCA acceptable limits.

8.2.6. Residual Impacts

It is expected that the implementation of the above mitigation measures will mean that the residual effects of the development on any shipping and navigation receptors will be **minor to moderate** (see Appendix 6 for details of impact assessment).

The risk of collision with other vessels during construction has been considered to be reduced to minor significance in view of the mitigation measures such as the communication of safety information, establishment of safety zones enforced by guard vessels, continuing consultation with appropriate shipping and navigation stakeholders and the requirement for vessels to comply with lighting and marking requirements. Likewise the risk of electromagnetic interference affecting navigational instruments, has been reduced to minor significance taking into account the previous work completed by the BritNed development which measured electromagnetic interference at less than 5 degrees deviation, which was confirmed by the MCA to be an acceptable level of deviation for compasses.

In relation to anchoring, the armouring of the cable and burial to a safe depth in addition to charting the position of the installed cable are considered to significantly reduce the risk of anchoring along the cable route. However, anchoring of vessels remains a moderate risk.

8.3. Archaeology and Cultural Heritage

8.3.1. Introduction

The Nemo Link passes through English Territorial Waters (to the 12 nautical mile limit) and extends beyond the limit to the UK EEZ (see Figure 8-3-1). This section provides a brief overview of legislation and guidance – more detail can be found in the marine archaeology desk-based assessment Volume II (Wessex Archaeology 2011) and a full report covering French, Belgian and British waters can be found in Appendix 12.

From the low water mark to the 12 nautical mile limit, the archaeology and historic environment is under the responsibility of English Heritage who are a statutory consultee to the Marine Management Organisation in relation to heritage matters relating to environmental impact assessment or appropriate assessment in relation to marine development. In addition, some UK legislation applies to English wrecks whether in English or international waters. In general, newly discovered maritime sites in the UK are not automatically protected under the current legislation until a request for protection is formulated following an identified threat upon the site or an evaluation of its particularity. Military aircraft are however automatically protected. The current legal framework relates to the Ancient Monuments and Archaeological Areas Act (AMAA, 1979), the Protection of Military Remains Act (PMRA, 1986) and the Protection of Wreck Act (PWA, 1973).

International heritage policies can apply beyond a country's territorial waters. Current international law such as UNCLOS Articles 149 and 303, places on signatory states, a direct duty of care in regards to wrecks and other submerged historic environment resources. Additionally, some indirect regulation arises from the environmental controls placed on the regulated exploitation of natural resources.

Legislation in England is currently under review. Although not yet ratified, the draft Heritage Protection Bill, published in 2008, has been designed to unify the terrestrial and marine heritage protection systems, and will replace the provisions of the Planning (Listed Buildings and Conservation Areas) Act (1990), the Ancient Monuments and Archaeological Areas Act (1979) and the Protection of Wrecks Act (1973). But as in the present situation, the laws and guidance mentioned above are in force.

8.3.2. Baseline data sources

The principal sources consulted in drafting this chapter of the Environmental Statement comprise:

- United Kingdom Hydrographic Office (UKHO) wreck record;
- English Heritage's National Monuments Record (NMR);
- Kent Historic Environment Record (Kent HER);
- Previous archaeological studies in the area;
- A wide range of secondary sources, including those providing an overview of the historical and archaeological resources of Kent, France, Belgium and the Southern North Sea, and with particular reference to:
 - sources related to historic shipping patterns and potential wreck sites and casualties, specifically *England's Shipping* (Wessex Archaeology 2003) and *Navigational Hazards and Areas of Marine Archaeological Potential* projects (Bournemouth University 2007, 2008, Seazone ongoing);
 - sources related to historic aviation patterns and the potential for aircraft crash sites, specifically *Aircraft Crash Sites at Sea* (Wessex Archaeology 2008b) which provided an understanding of the potential density and general distribution of wartime aircraft activity across the English Channel;
 - sources relating to the palaeoenvironment of the Southern North Sea, with specific reference to submerged palaeolandscapes and coastal change; and
 - sources related to the terrestrial and marine historic environment of Kent, including the South East Research Framework (Kent County Council), the Maritime and Marine Historic

Environment Research Framework (University of Southampton, ongoing); the Isle of Grain to South Foreland Shoreline Management Plan (South East Coastal Group 2010).

- Geophysical data provided by Marin Mätteknik (MMT) AB that had been gathered from the Study Area during the summer of 2010, including: sidescan sonar, sub-bottom profiler (sparker and boomer), multibeam bathymetry and marine magnetometer datasets; and
- Geotechnical data provided by Marin Mätteknik (MMT) AB including 100 vibrocore logs and 10 actual vibrocores acquired from the Study Area during the summer of 2010.

8.3.3. Baseline

8.3.3.1. Introduction

This section covers a brief summary of the known and potential archaeological features present or potentially present in the study area. Further details can be found in the full technical report compiled by Wessex Archaeology for PMSS (Wessex Archaeology 2011).

8.3.3.2. Known Archaeological Features within the Study Area

The following presents a summary of the known and potential archaeological features in the vicinity of the marine cable route and landfall (Figure 8-3-2), further details can be found in the Desk-Based Assessment (Wessex Archaeology 2011):

- In the broad vicinity of Pegwell Bay:
 - 2 Listed Buildings
 - 69 other archaeological sites and findspots, dating from the Neolithic to modern period
- In English Waters:
 - 5 sites of anthropogenic origin of archaeological interest identified or confirmed by the archaeological assessment of geophysical survey data including:
 - 1 previously unrecorded wreck (located in the English Exclusive Economic Zone);
 - 4 further geophysical anomalies of anthropogenic origin and archaeological interest, including a live obstruction recorded by the UKHO;
 - 123 additional geophysical anomalies of possible archaeological interest;
 - 19 wrecks and obstructions recorded by the UKHO but outside of the geophysical survey area;
 - A number of channels of probable prehistoric date and potential archaeological interest.

Table 8-3-1 provides additional information about the five sites of anthropogenic origin considered to be of archaeological interest and confirmed by the archaeological assessment of geophysical survey data.

WA ID	Classification	Easting	Northing	Description
7024	Wreck	389786	5685532	Previously unrecorded wreck identified at least partly ferrous in nature by all geophysical equipment. Structure is relatively small and appears to be mostly buried, though still retains some structure and height. The wreck is orientated NNE - SSW, and is situated within a scour approximately 30m x 11m x 0.4m. A large sand wave lies to the north and east, so the structure is probably periodically buried (Figure 8-3-3).
7027	Debris	391279	5685143	Located in an area of sand ripples and probably partially buried ferrous debris or the remains of a badly degraded structure, identified originally as a medium magnetic anomaly (Figure 8-3-4).
7047	Debris	394777	5685245	Probably an area of ferrous debris, or the remains of a highly degraded structure, associated with a medium magnetic anomaly (Figure 8-3-5).
7049	Debris	395957	5685445	Large, elongate feature (or collection of features) upstanding and associated with a small magnetometer contact. Identified on multibeam

WA ID	Classification	Easting	Northing	Description
	[Live Obstruction]			bathymetry data as a depression measuring 22m x 15m x 0.5m, probably representing a scour. Probably an area of debris or the remains of a badly degraded structure. Observed at the location of a known obstruction (foul ground).
7098	Debris	416527	5686440	Two poorly defined, short, parallel linear dark reflectors with shadows possibly associated with a small magnetic anomaly. Possible partially buried ferrous debris (Figure 8-3-6).

Table 8-3-1 : A1 Geophysical anomalies of archaeological interest

Further details about other sites mentioned in this Chapter can be found in Appendix 12.

8.3.3.3. Potential Archaeology within the Study Area

Introduction

The baseline study revealed potential for as yet undiscovered sites and material dating from the Palaeolithic to the modern period, including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material. In the Palaeolithic and early Mesolithic, hominin populations occupied, when habitable, vast plains that extended between England and the Continent, and since the inundation of the Southern North Sea and English Channel, people have travelled across the waters in a variety of ever increasingly technologically advanced watercraft. Since the Neolithic, settlements on both sides of the Channel have flourished. The historic environment of the Kent coast and English territorial waters in between have to be viewed as a continuum, since the activities that shaped the cultural heritage land and seascape are intertwined.

Chronologies

Archaeological material is generally studied within a framework of 'Periods' or 'Ages' which reflect the activities and cultural changes taking place over time. However, because of geographical and cultural differences, the chronologies are defined slightly differently by each country. The following table provides a rough overview of the chronologies (Table 8-3-2). Note that for archaeological studies of the Palaeolithic period, dates are expressed in terms of years Before Present (BP), whereas from the Mesolithic period onwards, absolute (or calendar) dates are used, either in Before Christ (BC) or *Anno Domini* (AD).

Period Names	Dates for England
Palaeolithic	~900,000 BP-9500 BC
Mesolithic	9500-4000BC
Neolithic	4000-2200 BC
Bronze Age	2200-700 BC
Iron Age	700 BC – AD 43
Romano-British/Gallo-Roman	AD 43- AD 410
Anglo-Saxon	AD 410-1066
Medieval	1066 – 1500
post-medieval	1500 – 1800
Modern	1800 – present

Table 8-3-2: Chronologies

Palaeolithic

There were several periods during the Lower and Middle Palaeolithic (1,000,000 BP to 18,000 BP) when the Study Area would have been dry land. Areas that are now submerged would have been part of a vast plain, and the temperatures would have been moderate enough to be habitable (see Panels A, B, C Figure 8-3-7).

The Lower Palaeolithic begins with the earliest hominin occupation of an area: in Britain, evidence from the site at Happisburgh suggests that it could have begun over 900,000 years ago (Parfitt *et al.* 2010, Roberts and Grün 2010). There is extensive evidence for Lower Palaeolithic activity in Kent, particularly from the Thames gravels and other rivers, where artefacts were deposited as glaciers melted (Scott 2004: 7). At the end of the glaciation, as temperatures had begun to rise, there is evidence for hominin occupation in Kent, as three pieces of skull were found in the Upper Middle Gravels at Swanscombe (dated to c. 423,000 BP) (Scott 2004: 7).

The emergence of *Homo neanderthalensis* (Neanderthals) in the Middle Palaeolithic (around 300,000 – 40,000 BP) led to European-wide changes in technology. Middle Palaeolithic deposits have been found in Kent during quarrying (Scott 2004: 7).

The Upper Palaeolithic (roughly 40,000 BP to 10,500 BP) provides evidence for the emergence of *Homo Sapiens* in northern Europe. During the Devensian glacial maximum (roughly from 20,000 - 15,000 BP), sea levels were at a maximum of approximately 120 m lower than today (Pieters *et al.* 2010: 81). However, although the ice sheets did not reach as far south as the Study Area, the cold climatic conditions would have rendered the area difficult to occupy; at this time, the landscape in Britain would have resembled Arctic tundra. As glaciers began to melt, the area would have been impacted by major changes to river systems as a result of meltwater. As soon as climatic conditions ameliorated however, humans reoccupied the landscape. In Britain reoccupation appears to have begun around 13,000 BP (Scott 2004: 8).

Mesolithic

At the beginning of the Mesolithic, sea levels were still considerably lower than present with the sea level in Kent thought to be 40-65 m lower (Young 2004: 3). As a result of these lower sea levels, the Southern North Sea was a vast plain which comprised a habitable landscape, intersected by strongly flowing rivers (Scott 2004: 9). As sea levels rose the landscape became increasingly difficult to traverse, and human groups in Britain became increasingly isolated. By around 6700 BC, sea levels reached around 25 m lower than present, and the North Sea and the Channel flooded, breaching the Dover Straights. Britain was finally isolated from Europe around 6300 BC. A considerable amount of this now-drowned landscape is preserved underwater, and has been explored through projects such as Doggerland (Gaffney *et al.* 2009). In Kent, find types include stone, antler and bone tools possibly for tree felling and woodworking, however, there is little direct evidence for hunting and gathering activities (such as bone assemblages or plant remains). By the end of the Mesolithic, the majority of the cable route would have been completely submerged. The southern part of Pegwell Bay would also have been submerged, as part of the Wantsum Channel, which was not reclaimed until the post-medieval period. The northern part of Pegwell Bay (on the historic Thanet Island) remained dry land.

Neolithic

During the Neolithic, there is considerable evidence for cross channel traffic, such as the transport of material (including the many species of plants and animals that were used for food production but were not native to Britain) as well as the ideas of farming and animal domestication. The Neolithic period began in England around 4000 BC, and evidence includes particular styles of earthworks, causewayed enclosures, long barrows, evidence for pottery and the emergence of henges. It is not surprising that Kent was one of the first regions in England to undergo the economic, technological and social changes associated with the Neolithic period, as its proximity to the Continent was no doubt a great influence. There is evidence of pottery and a causewayed enclosure near Ramsgate (Ashbee 2004: 11). During the Neolithic, maritime transport was characterised by log boats and skin boats which are likely to have continued in use. These early logboats are from a time when sizeable trees

and appropriate tools were just becoming available. The earliest logboat in Britain was discovered at Locharbriggs, Scotland, and dates to around 1860 BC (McGrail 1998: 86).

Bronze Age

From the beginning of the Bronze Age, the expansion of trade in metals involved cultural contact through a system of sea routes which connected a network of rivers and roads used as the dominant way of transporting goods and people (Philippe, 2009, Lebecq, 1994). By the late second and early first millennia BC, active trade networks focussed on the transport of bronze implements (Cunliffe 2009, Muckelroy, 1981; O'Connor, 1980). In addition to metalwork, the archaeological evidence from ceramics confirms maritime trade and the movement of goods across the Dover Straights area and the southern North Sea (Piningre, 2005). Settlements in Kent were focussed on coastal locations, major river valleys and estuary foreshores, particularly on either side of Wantsum Channel, which would have been a key navigation route for regional exchange (Yates 2004: 14). Trade across the Channel was accomplished using boats such as the Dover boat (Clark 2004). It was a 3000 year old sewn plank boat capable of crossing the channel while carrying a substantial cargo of supplies, livestock and passengers. The hazardous nature of these journeys is represented by the Langdon Bay wreck, which is thought to have been carrying a cargo of scrap metal from France to Britain.

Iron Age

Although some cross-Channel trade networks continued into the Early Iron Age (between the 8th and 6th centuries BC), the decreasing numbers of elite exchange items found in Britain suggests that the intensity of cross-Channel traffic had slowed down by the Middle Iron Age. By the Late Iron Age, contact between Britain and the Roman Empire had increased (Parfitt 2004: 16). As maritime trade increased, so did the importance of settlements along the Kent coastline, and there was a concentration of Late Iron Age settlements in the east of Kent and on the Isle of Thanet (Parfitt 2004: 17). Settlements at sheltered inlets would have provided convenient ports of entry and access, with major rivers providing further access inland (Parfitt, 2004: 17).

Romano-British Period

In Britain, Claudius' invasion force arrived at Richborough in AD 43, and Kent rapidly became the industrial heartland of *Britannia*, producing a considerable quantity of iron with pottery and building tiles also important (Andrews 2004: 20). In addition, towns emerged, coastal fortifications and new transportation infrastructure were built, and various religious centres developed (Andrews 2004: 20). The large concentration of fortifications around Kent's coast reflects its vulnerability to threats from the Continent and the need to secure the shortest Channel crossing routes. Richborough is a major example of coastal fortification (Andrews 2004: 21). In addition to international trade, there was considerable traffic along the coast as well, for example Ragstone, a building material quarry in the Maidstone area (Kent). It was not only widely used locally, but for transportation by barge to Londinium for the construction of its walls in the 3rd century (Andrews 2004: 20). Kent's marine resources were also exploited probably by small local fishing and oyster dredging boats, and salt production was undertaken in coastal areas by evaporating seawater in large shallow reservoirs of unfired clay (ibid). While the designs of some of the Romano-Celtic vessels likely restricted them to use in estuaries or other sheltered waters, others, such as 'Blackfriars I' from London and 'St Peter Port I' from Guernsey are thought to be have been seagoing (ibid).

Anglo-Saxon

The Anglo-Saxon period was characterised by an influx of Anglo-Saxon peoples and material culture from Germany and southern Scandinavia in the 5th and early 6th centuries, followed by Viking raids and later settlement in the 8th and 9th centuries. The traditional landing place of the Saxons in Kent is at Ebbsfleet, in Pegwell Bay, in AD 449. During the early part of the period, Anglo-Saxon activity in eastern Kent is identified through cemeteries and burials, with the majority of evidence confined to rivers and the coast (Riddler 2004: 25-28). The finds of ceramics in Kent highlight changes in maritime trade – in the 6th and 7th centuries, in addition to local ware, ceramics were also imported from north France, and around AD 750, Ipswich ware was being 'imported' (Riddler 2004: 28). The pottery could

have been transported in boats similar to the 7th century clinker-built wooden boat discovered in the ship burial at Sutton Hoo near Ipswich. It appears that England may also have had a distinctive shipbuilding tradition in the 9th to 14th centuries, as indicated by the Graveney boat, excavated from a former tidal creek of the River Thames, east of Faversham, Kent (McGrail 2004: 218).

Medieval

Around 1050, the Cinque Ports developed in Kent and East Sussex, and comprised Sandwich, Dover, Hythe, New Romney and Hastings. These were based on an informal coastal defence arrangement made in the reign of Edward the Confessor, where in return for substantial constitutional fiscal and trading privileges, the Ports were required to furnish, for limited periods, ships and crews for the King's service (Lawson 2004: 52). The Nordic or 'Keel' tradition of boat building, with double-ended clinker built wooden vessels, continued into the later medieval period. Ship's timbers from this type of vessel have been recovered from re-use-locations such as waterfront structures in London (McGrail 2004: 223). Examples of clinker built vessels have also been depicted on the 11th to 12th century Bayeux tapestry, and later on town seals. However, from the 13th and 14th centuries, vessels of the Nordic tradition become rarer. The 'Cog' appears to have developed in the 9th century and early documentary examples are associated with Frisian shipping and trade (McGrail 2004: 232). References to cogs increase considerably in the 13th and 14th centuries; the vessels were widely used by the Hanseatic League in northern Europe and traded between Britain and Ireland and the Continent.

Post-medieval

In the 16th century, maritime trade in Sandwich began to decline, however, some trade did continue with the Low Countries and the Baltic through the 17th century (Bower 2004: 66). Ramsgate and Margate had easily overtaken Sandwich in the tonnage of vessels based there. In 1701, shipping tonnage in Sandwich had increased to around 1000 tons, while at Ramsgate it had increased to 2500 tons (Lawson 2004: 91). When trade with the Baltic began to decline in the 18th century, trade expanded to the Mediterranean, West Indies and the Americas (Killingray & Compton 2004: 129).

The post-medieval period witnessed some major battles at sea – and many of them took place within the vicinity of the Study Area. In England, a carvel built vessel known as the 'Gresham Wreck', was discovered in 2003 in the Princes Channel in the Thames Estuary, and recovered in 2004 (Wessex Archaeology website). A small to medium sized ocean-going armed merchantman, the vessel was carrying a cargo of iron bars when it sank. Four cannons were recovered from the site. Another wreck site, with artefacts and bronze cannon that appear to date to the 16th century has been found in the Goodwin Sands.

Modern

In the late 18th and through the 19th centuries in Kent, ports and harbours were constructed and improved and piers were built to facilitate sea-borne freight and passenger landings (Killingray & Crompton 2004: 129). In 1800, merchant ships and fishing boats were being built at Ramsgate and Sandwich, and although Sandwich ceased to build ships in the 1830s, construction at other ports increased between 1800 and 1860 (*ibid.*: 130). The import of coal from Wales and the North East for domestic use, gas works and later the railways was a major focus of maritime trade in Kent. Dover developed as the main cross-Channel ferry point, with regular cross-Channel steamboat services from the 1820s, and became a major shipping centre in terms of tonnage. The towns could also provide ships with supplies or repairs, and with boat pilots who navigated the ships past the Goodwin Sands and the shallows of the Thames Estuary. By the 1850s, Ramsgate had a fishing fleet 147 boats strong, each 35 tons or more, many of them were engaged in deep-sea fishing. The typical trawlers were still sailing vessels, and in 1914, Ramsgate had 172 sailing smacks. The lifeboat station at Ramsgate attests to the potentially hazardous nature of the sea and the Kent coast. Kent's long sea coast facing France and many north shore inlets made it a popular place for smugglers, and smuggling was a regular occupation of Kent sailors and fishermen. In the 18th and 19th centuries, smuggling increased, and the government made concerted efforts to suppress it. During the 19th century, ship technology underwent a revolution. The advent of steamships meant that ships were no longer at the mercy of wind and tide, and further advances such as the early steel-hulled ships meant

that ships were stronger than ever. In the UK, the vast majority of known shipwrecks date to the modern period.

World War I

In World War I, trade was disrupted, but economic and social changes were accelerated, as wartime industries expanded rapidly (Smith & Killingray 2004: 140). A vast number of Belgian refugees arrived in Kent between 1914 and 1915. Although aircraft were only just coming into their own, World War I saw the development of numerous airfields across Kent, such as at Ramsgate, Manston and Westgate (*ibid*: 141).

World War II

A coastal defence battery was located in the north of Pegwell Bay, and there were anti-aircraft batteries at Pegwell Bay, near Broadstairs and at Manston (Smith & Killingray 2004: 141). The anti-aircraft gun batteries were situated to protect vital infrastructure targets inland, such as the industries in Thameside, and they defended the enemy air routes to London. During the war Ramsgate was one of the 'most-raided parts of England' by air attacks (Whyman 2004: 179). In addition to being intermittently shelled by German guns from 1940-1944, roughly 1000 High Explosive Bombs were dropped on the city between 1939 and 1946 (Smith & Killingray 2004: 144-145). Airfields that had developed in World War I were revived, and Manston, located just inland from Pegwell Bay, was one of the main airfields during the Battle of Britain. A German Dornier 17 of the 'Blitz' Geschwader, KG3 crashed on the Sandwich Flats on 31 August 1940 after attacking Manston. A photograph of the aircraft crash site in Pegwell Bay has been uploaded onto flickr (www.flickr.com, <http://forum.12oclockhigh.net>). However, positional data for the site remains vague and a detailed location has not been confirmed. Locals have mentioned that the bent propeller blades used to be visible in the intertidal zone at low tide, and parts of the aircraft may have found their way to the Spitfire Memorial Museum at Manston. Another German Dornier 17 has been discovered in the Goodwin Sands (Wessex Archaeology in press), and is located 200 m to 300 m from the shore in front of Deal, Kent, over 5 km south of the study area.

8.3.4. Receptors of Importance

8.3.4.1. Known or Potential Terrestrial Sites and Submerged Prehistory of Importance

This section provides information about the importance of terrestrial sites and submerged prehistory – shipwrecks and aircraft will be discussed in the following sections. In the UK, the criteria for scheduling ancient monuments (AMAA 1979) is based on a site's period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential. Also, current international law such as UNCLOS Articles 149 and 303, places on signatory states a direct duty of care in regards to wrecks and other submerged historic environment resources

This section does not present a detailed assessment of the importance of terrestrial receptors, as a detailed assessment will be undertaken by the onshore contractor in their archaeological assessment of the landfall area above mean high water and the onshore cable route. The information presented here was researched to assist in the interpretation of the maritime assessment, and further information can be consulted in the desk-based marine archaeological environmental impact assessment compiled by Wessex Archaeology (Appendix 12).

There are two Listed Buildings at the landfall, and these are protected by their designation. Although the majority of other known sites have not been designated or scheduled, this does not mean that they lack importance, and they may in fact fulfil many of the criteria. The fact that they are included in the National Monument Record, Historical Environment Record, indicates that they have at least some value as historic and archaeological resources.

Despite the fact that there are no known archaeological sites or material that date to the Palaeolithic, if any remains were to be discovered, they would be of considerable national and international

importance, as finds from this period are relatively rare in the British and European records (English Heritage 1998).

Finds from the Mesolithic would also be of importance because of their rarity. A number of palaeochannels of archaeological interest have been identified in the Study Area (Figure 8-3-8). The discovery of peat (**WA VC7**) highlights the potential of these palaeochannels to provide further palaeoenvironmental information, and in addition, they indicate the potential for additional archaeological material in the vicinity.

There are a wide range of known sites from the Neolithic to post-medieval period across the Landfall Study Area. These sites provide details that enrich the historic environment resource and are locally, regionally, and nationally important. Further discoveries of sites or material from these periods also have the potential to be of local, regional or national importance.

The coast of Kent played a key role in defending Britain against attack during both of the World Wars, and therefore military material is likely to be of heightened importance. There is a wide range of known and recorded military sites at the Kent Landfall from World War I and World War II. English Heritage has produced guidance for evaluating 20th century sites (English Heritage 1998, 2003). These guidances are based on the site's national importance or the presence of structures of special interest, as well as the site's survival or completeness, group value, rarity of building types and historic importance. Details about the sites not discussed above can be found in Appendix 12.

8.3.4.2. Known and Potential Shipwrecks of Importance

In the UK, criteria have been developed for the identification of the importance of shipwrecks, including the criteria for designating shipwrecks under the Protection of Wrecks Act (1973) (based on period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential), the criteria of the Protection of Military Remains Act (1986) (based on military status), and the criteria outlined in On the Importance of Shipwrecks (Wessex Archaeology 2006) (based on the concept of 'ship biography' and covering: build, use, loss, survival and investigation).

There are no protected wrecks in the study area. All wrecks located in the vicinity of the cable route are illustrated in Figure 8-3-9.

Two of the known wrecks in the Study Areas were lost due to acts of war (**WA7275**, **WA7276**), and two further known wrecks had been in military use at some point in their careers (**WA7270**, **WA7274**). The military associations of all of these vessels would indicate high importance.

The two relatively recent wrecks (**WA7017** (1995), **WA7287** (1986)) may be regarded as having low archaeological importance. Other 'wrecks' with low archaeological importance include **WA7271** (abandoned four wheel drive vehicle), **WA7273** (steel tank), and **WA7286** (abandoned Suzuki jeep).

It is not possible to assess the importance of two of the wrecks with the limited information available (**WA7272**, **WA7277**), or the wreck discovered through the archaeological assessment of geophysical data (**WA7024**) shown in Figure 8-3-3. Nor is it possible to assess the importance of the known obstructions or the geophysical anomalies of possible anthropogenic origin. As such, the importance of each site must potentially be regarded as potentially high until further information becomes available.

So little is known about shipwrecks before the medieval period that any wrecks discovered are likely to be of considerable special interest, in addition, post-medieval shipwrecks are also rare and would be expected to be of special interest. There are more examples of boats and ships from the 19th century, so greater discrimination would be required to determine which ones are of special interest, but ship technology was rapidly changing as were the way vessels were used and any wrecks that make a distinct contribution to understanding and appreciating these changes could be regarded as having special interest. As mentioned above, ships lost during the two World Wars could have increased importance. However, a special case would need to be made for any vessels lost after 1945.

8.3.4.3. Known and Potential Aircraft of Importance

The majority of aircraft losses in the 20th century have been related to military activity, and, as mentioned above, British aircraft lost while in military service are automatically protected by the Protection of Military Remains Act (1986).

There is a known report of a German World War II aircraft in the intertidal zone of Pegwell Bay, a Recorded Loss of a British World War II aircraft (WA1235) and considerable potential for the discovery of additional aircraft crash sites in the Study Areas. If the remains of any military aircraft were to be discovered, whether in English waters or in international waters, they would automatically be protected under the Protection of Military Remains Act (1986). These archaeological receptors would be of high importance. However, because these sites lack detailed positional data, they have not been illustrated in the figures.

Aircraft are also important because they provide a tangible reminder of the development of aviation in the UK and on the Continent throughout the 20th century. Because of their recent history, aircraft crash sites also have significance as survivors and living relatives may be found, and they are important for remembrance and commemoration. They also have importance through their cultural value as historic artefacts and for the information they contain about the aircraft itself and its circumstances of loss (English Heritage 2002, Wessex Archaeology 2008b).

8.3.5. Assessment of potential impacts

8.3.5.1. Overview

There is potential for impact to the known and potential archaeological receptors from route installation, operation and decommissioning activities. This section provides an overview of the impact assessment. A detailed methodology for the impact assessment, and further details about the results are outlined in the Desk-based Assessment (Wessex Archaeology 2011). The impact assessment was based on: the nature and magnitude of the effects and the value of the receptor, which has been determined from the receptor's sensitivity, recoverability and importance. Table 8-3-3 outlines the receptor values. Appendix 6 presents the impact assessment in table form.

Receptor Value	Definition
High	Designated receptor of national or international importance (e.g. intact, in situ feature of historical interest. Feature will be permanently damaged.
Medium	Receptor of non-designated archaeological importance, and/or interest, whether intact or of degraded quality (e.g. feature not intact or in situ). Feature will be permanently damaged.
Low	Receptor of limited archaeological importance/historical interest. Feature will not be permanently damaged.

Table 8-3-3 : Receptor Value

The possible impacts on known and potential archaeological receptors comprise damage or destruction to both archaeological material and the disturbance or destruction of relationships between material and the wider surroundings. Archaeological receptors include: known and potential terrestrial sites and findspots, submerged prehistoric archaeological material (including palaeoenvironmental evidence), shipwrecks, aircraft crash sites, associated material, and geophysical anomalies of possible anthropogenic origin.

The types of impacts can be described as direct, indirect, secondary and cumulative. Direct impacts are those that directly impact archaeological receptors on or under the seabed. Indirect effects are those beyond the primary footprint of the development, affecting archaeological sites or deposits that are located some distance away, for example as a result of changes to erosion/sedimentation regimes. Secondary impacts arise from activities that occur as part of the development process but

might not be considered to be part of the development as such, for example from anchorages for construction vessels. Cumulative impacts include: impacts occurring over a wider area as a result of various development activities; impacts within the development that affect different environmental topics; and visual impacts / changes to setting.

This section examines the potential impact based on the installation, operation and decommissioning activities, and explores the nature of the effect (the likelihood of potential impact, spatial extent, level of change and duration) in order to determine the magnitude of impact. The description of the receptor (its sensitivity to change, potential for recoverability and importance) are taken into account to determine the value of the receptor. The significance of impact is based on the value and sensitivity of the receptor.

Because of the nature of archaeological receptors, the vast majority of archaeological receptors have the same level of change, duration of impact, and sensitivity and recoverability. Therefore, these will be discussed first before identifying the individual impacts, in order to minimise repetition in the following paragraphs.

The level of change of known and potential archaeological receptors from direct and secondary impacts would be high, as any change would be more than what is predicted as part of the natural baseline. In addition, and as the archaeological receptors are sensitive to change and will not recover, the duration of the effects are long term, and therefore any change is permanent. The historic environment is a non-renewable resource, and once an archaeological receptor has been damaged or destroyed or its context altered it is not possible to repair or reinstate the lost value. Hence, the impact from a temporary anchorage is of the same magnitude as the impact from cable installation, because if an anchor is dropped on an archaeological receptor such as a wreck or dragged through the site the damage would be permanent.

The design of the cable route has been proposed in order to avoid all known wrecks. However, the following impacts are still possible.

As a result of pre-installation, installation, operation and decommissioning impacts, the following effects are possible and have been assessed:

- Potential damage or destruction of known marine archaeological receptors (submerged prehistoric archaeological material; shipwrecks; aircraft crash sites; associated material; and geophysical anomalies of possible anthropogenic origin) from direct or secondary impacts;
- Potential damage or destruction of the relationships between known or potential marine archaeological receptors and their wider surroundings;
- Potential damage or destruction of marine archaeological receptors as a result of indirect impacts, in particular changes to erosion and sedimentation regimes;
- Potential cumulative effects from a combination of seabed developments being undertaken in the area (i.e: other cable routes, offshore wind farm developments, port / harbour dredging, etc).

8.3.5.2. Installation impacts

There is potential for direct and secondary impact to archaeological receptors from route preparation and installation activities. The potential impacts that may occur (if no mitigation is applied) are detailed below and summarised in Appendix 6.

Damage or destruction of submerged prehistoric material below the seabed

The cable trench will have a width of 1–5m and a depth of 2-3m. It should be noted that the archaeologically interesting material from **WA VC7** (Wessex Archaeology 2011:16) was located 4.28 m below seabed and is unlikely to be impacted, however, it is possible that shallower sediments exist and may be impacted upon. The spatial extent of impact is within the immediate vicinity, as impact will

only affect the directly affected area. The level of change will be medium, as the archaeological receptor covers a wide area, and only a small section of it will be impacted. Duration of the effect will be long term. Overall, the magnitude of impact is moderate. The sensitivity of the receptor is medium, as some of the shallower sediments could have been reworked by natural processes, however, in areas where there are still sealed deposits, the level of change would be high, were it to occur. The recoverability is low as once damaged a receptor will not recover. Although submerged prehistoric material below the seabed is of high archaeological interest, because it has not been designated, it is classed as of moderate importance. The value of the receptor has been rated medium, and the overall impact would be **moderate** and negative should such material be disturbed

Damage or destruction of late 20th century wrecks (WA7017, WA7287, WA7292, and WA7303) and other 'wrecks' of low archaeological importance (WA7271, WA7273, and WA7286)

Impacts could occur as a result of:

- the pre-sweeping of sandwaves (to a maximum path width of 20 m)
- use of a grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (e.g. rock placement with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present
- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1 – 5 m wide and a depth of 1 – 2 m)
- cable burial
- use of anchors to maintain position of installation vessels.

These impacts are however unlikely, as the sites are located some distance from the cable route. The spatial extent of impact is low, as impact will only affect the direct area, and therefore these wrecks are unlikely to be impacted. However, any impact would cause a high level of change and be of long duration. Overall, the magnitude of impact has been determined to be moderate. The sensitivity of the receptors is high and recoverability is low. These sites are currently interpreted as of low archaeological importance because they represent modern material with low archaeological interest. Overall, their value is low, and the significance of impact is **minor**.

Damage or destruction of A1 (wrecks and geophysical anomalies of archaeological interest) archaeological receptors and A3 (historic records of possible archaeological interest with no corresponding geophysical anomaly) receptors

As these receptors are located some distance from the path of the cable route, they are unlikely to be directly impacted by the majority of cable laying activities, however there is still potential for secondary impacts from anchors. The spatial extent of any impact would be within the immediate vicinity. However, any impact would cause a high level of change – as the damage from an anchor could destroy an archaeological site, and the duration of that change would be permanent. The magnitude of the impact is considered to be moderate. The sensitivity of the receptors is high and the recoverability is low. These sites are not designated, however they are of archaeological interest, so their importance has been rated moderate. Overall, the value is high and the level of significance of impact is significant.

Damage or destruction of A2 (geophysical anomaly) archaeological receptors

Impacts could occur as a result of:

- the pre-sweeping of sandwaves (to a maximum path width of 20 m)
- use of a grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (e.g. rock placement with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present

- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1 – 5 m wide and a depth of 1 – 2 m)
- cable burial
- use of anchors to maintain position of installation vessels.

The likelihood of impact is almost certain, as a number of the A2 geophysical anomalies are located in the path of the cable route and therefore will be impacted. Additionally, there is also potential for anomalies located some distance away from the cable route to be impacted from anchors of installation vessels. The spatial extent of impact will be limited to the immediate vicinity of the receptors. The level of change from any impact would be high, and the duration of that change would be long term. Overall, the magnitude of the impact would be high. Although A2 geophysical anomalies have been identified of possible archaeological interest, as they could represent previously unidentified archaeological sites, there is also the possibility that they could turn out to be modern debris of no archaeological importance. For this assessment, a precautionary view has been taken – and the sites have been identified as having moderate archaeological importance, until proven otherwise. These sites and features are of high sensitivity and low recoverability. Overall, the value is high and the level of impact **significant**.

Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites)

Impacts may occur as a result of:

- pre-sweeping of sandwaves (to a maximum path of 20 m)
- use of grapnel hook to clear obstructions (over the length of the cable route)
- construction of bridging and separation structures (with a footprint of roughly 100 m by 30 m)
- trenching for cables in areas of the seabed where bed rock is present
- cable laying (seabed impacted by burial machine to a width of 10 m with a trench between 1-5m and a depth of 2-3m)
- cable burial
- use of anchors to maintain position of installation vessels.

It is not possible to determine the location of potential archaeological receptors, as they could be obscured by sandwaves or could comprise archaeological receptors that are difficult to identify through geophysical survey. The likelihood of impact is assessed as possible, and any archaeological receptors that have been obscured by areas of sandwaves could be impacted by the pre-sweeping of sandwaves. There will only be impact in the immediate vicinity of any receptor, however, the level of change would be high and the duration long term. Overall, the magnitude of impact would be moderate. Hitherto unknown sites could be of considerable archaeological interest, and therefore they are considered to be of medium importance. The overall value is high based on the high sensitivity of the receptor and the low level of recoverability, and the impact would be **significant** and negative.

Damage or destruction of relationships between known or potential archaeological receptors and the wider environment

Impacts may occur as a result of:

- pre-sweeping of sandwaves
- use of a grapnel hook to clear obstructions
- construction of bridging and separation structures
- landfall installation activities
- trenching for cables
- cable burial
- use of anchors to maintain position of installation vessels.

The likelihood of impact is possible – if any archaeological receptors are impacted, their relationships with other receptors and the wider environment will be affected. In this case, the spatial extent is local

to regional, as archaeological receptors can have relationships with receptors within the vicinity but also international relationships based on their character, period, and a number of other factors. For example, submerged prehistoric material can have international interest and linkages, as can WWII shipwrecks or aircraft crash sites, while fishing vessels may have more local connections. The level of change from any impact could be high and the duration long term. Therefore, the magnitude of impact has been determined to be moderate. The sensitivity of the receptors is moderate and recoverability is low. No sites in the area have been designated, however they are still of archaeological interest and therefore their importance is considered to be moderate. Overall, the value is considered to be high and the impact would be **significant** and negative.

8.3.5.3. Installation and Operation

Changes to the erosion and sedimentation regimes during installation and operation could have a degree of impact as detailed below.

Indirect negative impacts on known or potential archaeological receptors and their relationships with the wider environment

Such changes could be caused by changes to erosion regimes at bridging structures (i.e. rock placement) – depending on the height of the bridging structure from the seabed. There is however unlikely to be an impact, as any changes to erosion regimes are expected to be within natural variation. The spatial extent would also be low, as the bridging structures are expected to be effectively flush with the seabed, and therefore any erosion would be localised. Should there be change, it could represent a significant alteration in local conditions for archaeological receptors – as any material that is exposed through erosion would begin to degrade and would be permanently damaged. Overall, the magnitude of this impact is considered to be moderate. The sensitivity of the receptors is moderate (due to the fact that most areas will already have been reworked) and recoverability is low. The importance of any receptors impacted by erosion is medium, and the value is considered to be medium. Overall, the impact is considered to be **moderate** and negative.

In areas where sedimentation is increased, the archaeological receptors will be afforded increased protection. There is unlikely to be impact, as any changes to sedimentation regimes are expected to be within natural variation. If there are any changes, they will likely be within the immediate vicinity of structures such as cable crossings which stand proud of the seabed. The level of change to archaeological receptors is expected to be medium, and the duration of change could be medium- to long-term. Overall, the magnitude of the effect is considered moderate. The receptors have a high level of sensitivity and a low level of recoverability. The importance of the archaeological receptors is rated medium. Overall, the value is high and the impact would be positive.

8.3.5.4. Operation and decommissioning

There is potential for direct and secondary impact to archaeological receptors from route operation activities.

Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors

Impacts could arise from activities including repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) as well as the removal of infrastructure (cable-de-burial, cable removal). Impact to archaeological receptors within the immediate vicinity of the cable route is expected to be unlikely at this stage, as any impact will already have occurred during the installation phase. The spatial extent of any change will be within the immediate area. The level of change will be low and the duration negligible. The sensitivity of the receptor is considered to be low, as the receptor would already have been impacted, and there is low recoverability. Although the importance of the receptors is medium, the overall value is low. This impact would be **negligible**.

Secondary impacts may also occur as a result of anchors used to maintain position of repair for decommissioning vessels. The likelihood of impact is possible. The extent of impact will be in the immediate vicinity of the works. The level of change to any impacted archaeological receptors would be medium, and the duration of impact would be long term. The magnitude of impact would therefore be high. The sensitivity of the receptors is low with low chance of recovery. The archaeological receptors are of archaeological interest but not designated and therefore are of medium importance. Overall, any impact would be **significant**.

8.3.6. Mitigation

With regards to the archaeological resource, international best practice and government policy favours preservation *in situ*. As part of the Nemo Link cable route design, all known wrecks were avoided.

A number of geological features of potential archaeological and palaeoenvironmental interest have been identified along the proposed cable route (see Figure 8-3-10), namely the terrestrial/estuarine deposits and palaeochannels. With regards to cores **WA VC7** (peat), a Stage 3 archaeological geotechnical assessment of the samples taken during Stage 2 would provide additional information about the palaeoenvironment and about changes that took place within this landscape. The Stage 3 assessment would comprise an assessment of the pollen, diatoms, foraminifera and ostracods within the sedimentary sequence and scientific dating and recommendations as to whether any further analysis is warranted. No additional vibrocores are needed to complete the Stage 3 scientific dating and palaeoenvironmental work.

Palaeoenvironmental work and scientific dating are standard archaeological techniques used as mitigation for deeply buried or submerged sedimentary sequences. This is a cost effective method, the alternative being a diver based visual survey and manual sampling/excavation of the identified terrestrial sediments for artefactual and ecofactual remains. These palaeoenvironmental and dating techniques have the capacity to elucidate anthropogenic activity. For example, the successive arboreal flora known from Northern Europe has changed by both natural climatic and human activity from prehistoric times to today by activities such as deliberate woodland clearance. The evidence of such activity in the form of relative abundances of microscopic plant remains and charcoal can be found using these methods. Scientific dating is recommended in order to better understand the chronology of the sedimentary sequence and therefore the archaeological periods which they span which are impacted by the development. The scientific dating and palaeoenvironmental work should generate significant archaeological information which can be used to mitigate against the impact of the development.

However, due to the limited vertical and lateral impact expected to be caused by the emplacement of the cable, and the generally large size of these features as a whole, no further mitigation measures (such as exclusion zones) are deemed necessary. No further coring or sampling is expected to be undertaken, however, should future coring programs be undertaken in areas of high palaeo-archaeological potential, further archaeological advice will be sought, and the coring will be undertaken in line with the methodologies outlined in COWRIE 2010.

To support the avoidance of known wrecks, particularly with regard to secondary impact activities such as the anchorages of vessels, Temporary Archaeological Exclusion Zones have been placed around the five wrecks and geophysical anomalies of archaeological interest (A1s) identified during the archaeological assessment of geophysical survey data (Table 8-3-4) (Figure 8-3-11). Exclusion zones prohibit development related activities within their extents and have been widely applied in offshore development contexts to sites and anomalies with known or potential archaeological significance.

Class	WA_ID	Type	Name	Easting	Northing
A1	7024	Wreck	-	389786	5685532
	7027	Debris		391279	5685143
	7047	Debris		394777	5685245

Class	WA_ID	Type	Name	Easting	Northing
	7049	Debris		395957	5685445
	7098	Debris		416527	5686440

Table 8-3-4 : 'A1' wrecks assigned Temporary Archaeological Exclusion Zones

For the previously unrecorded wreck site (**WA7024**), a Temporary Archaeological Exclusion Zone is also recommended and further work to fully ascertain the nature and archaeological potential of the site would be advantageous if it is deemed likely to be impacted.

Sites **WA7027**, **WA7047**, **WA7049** and **WA7098** are areas of ferrous debris of unknown origin and could represent the remains of badly degraded wrecks or other structures (Figures 8-3-4 to 8-3-6). Temporary Archaeological Exclusions Zones and further investigation are again recommended for these sites, especially since all but **WA7098** are relatively close to the proposed route.

For the wreck sites of archaeological importance that are recorded in UKHO data, but that were not identified in the geophysical data, buffers have been suggested (Table 8-3-5) (Figures 8-3-9 and 8-3-11). As the extent of the wrecks is unknown, and as wreck material can be spread over a wide area in the vicinity of the wreck site, the buffers comprise a 100 m radius around the gazetteer points. Buffers do not limit development activities to the same extent as exclusion zones, but should assist in planning, for example, the location of anchorages.

WA_ID	Type	Name	Easting	Northing
7259	Recorded Wreck	-	506371	5686959
7270	Recorded Wreck	<i>Harvest Moon</i>	386196	5685927
7272	Recorded Wreck	-	386928	5685054
7274	Recorded Wreck	<i>LCP 586</i>	389454	5685030
7275	Recorded Wreck	-	396314	5685228
7276	Recorded Wreck	<i>Rydal Force</i>	396458	5686183
7277	Recorded Wreck	-	404300	5687128

Table 8-3-5 : 'A3' wrecks assigned temporary buffers

Buffers are not recommended for the remaining A3 records (representing recorded obstructions or those representing wrecks or wreckage of low archaeological importance), or for the further 123 geophysical anomalies, rated A2 (of possible anthropogenic origin and archaeological interest) that were identified (Figures 8-3-9 and 8-3-11). However, some of the A2 or A3 anomalies could represent features of archaeological importance. If further assessment is undertaken prior to installation, these records will be detailed in an archaeological reporting protocol for the cable installation works

In response to the Scoping Document, English Heritage recommended the implementation of an archaeological Written Scheme of Investigation (WSI). The Written Scheme of Investigation would address pre-installation and installation activities, such as the grapnel run, and would probably also include a protocol to substitute for a watching brief offshore. A WSI would also be required onshore at the Kent Landfall covering intertidal and terrestrial works.

A detailed level of assessment has been carried out already (Wessex Archaeology 2011, Vol I and II), any further changes would include only minor modifications. Should any further geophysical, geotechnical, dropdown camera, video or diver survey be undertaken, archaeological advice will be sought in designing the methodologies for these activities (English Heritage 2010), and archaeological assessment of any resulting data will be undertaken if required.

It is possible that previously unknown archaeological sites or material may be encountered during the course of the cable route trenching or installation, operation or decommissioning. For example, there is a high potential for the discovery of material from Goodwin Sands. Hence, measures should be taken to reduce the development impact in this instance. A formal Archaeological Reporting Protocol

will be established and agreed with the appropriate statutory consultees and national heritage bodies to ensure that any finds are promptly reported to the correct authority, archaeological advice is obtained and any recovered material is stabilised, recorded and conserved.

A positive cumulative effect of offshore developments is the accumulation of archaeologically interpreted geophysical and geotechnical data regarding prehistoric land surfaces, palaeo-environmental evidence, wrecks on the seabed, and associated material. Any positive effects will be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available.

English Heritage has recommended (English Heritage 2010) that the Project ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). The project are committed to ensuring this takes place and will also copy all relevant documentation to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER).

8.3.7. Residual impact

It is expected that the implementation of the above mitigation measures will mean that the residual effects of the development on any archaeological receptors will be **moderate** to **negligible** (see Appendix 6 for details of impact assessment). All of the known wrecks have been avoided and the mitigation measures minimise impact on geophysical anomalies and areas of archaeological potential. A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis. It should be noted that the archaeology reporting protocol to be implemented during installation will reduce impacts to as low as reasonably manageable.

The residual impacts only affect areas of archaeological potential - which will be dealt with through the Archaeological Reporting Protocol.

8.3.8. References

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8.4. Cables and Pipelines

8.4.1. Baseline data sources

The presence and location of submarine cables has been determined using two key sources of information:

- Kingfisher Cable Awareness Charts (KISCA), which provide detailed information and data on the location of major telecommunications cables and some interconnector cables;
- SeaZone HydroSpatial Data, which has been used to indicate the location of charted cable features not included in the Kingfisher Cable Awareness Charts.

A magnetometer survey (part of the geophysical survey) has been used to confirm the precise locations of the cables crossed. In addition, the detailed route position lists for live cables have been acquired directly from the asset owners.

8.4.2. Baseline

The table below presents each of the cables crossed by the Nemo Link cable within UK waters. Zero pipelines are crossed within UK waters.

Power Cable	Telecom Cable	Name	Cable owner	Notes
	✓	Atlantic Crossing 1	Global Crossing Global Network	Crossing agreement will be sought. Contact is ongoing with cable owner and crossing agreements will be finalised. Agreement in principle has currently been reached.
	✓	UK Belgium 5	BT	Out of service. Contact with cable owner ongoing.

Table 8-4-1 : Cables crossed by the proposed Nemo Link cable route

Figure 8-4-1 shows the routes of each of these cables. One of the cables detailed above is out of service and may be recovered from the seabed by the cable owner resulting in no crossing being required.

The Nemo Link cable route also passes in close proximity to the Tangerine cable, owned by Level 3 Communications. The approximate distance of the Tangerine cable from the Project cable route is 270 m.

In the intertidal area, the Nemo Link cable will be located in close proximity (perhaps within 100m) of the Thanet Offshore Wind Farm export cable. Such a separation is typically acceptable in intertidal areas. The proximity will be discussed with both The Crown Estate and the Thanet offshore transmission owner (OFTO) (Balfour Beatty plc as they are the preferred OFTO bidder for the Thanet project) and a suitable proximity agreement will be drafted.

There are no pipeline crossings for the UK section of the cable route.

8.4.3. Description of potential impacts

Crossing agreements that specify the design of cable crossings will be negotiated with the relevant cable owners to ensure the safety of both the Project cable system and the cables crossed by the Nemo Link. The proposed Nemo Link cable system will be installed whilst the existing cables are in service, using well established industry procedures. No adverse impacts are expected in relation to submarine cables and pipelines. Example crossing designs are detailed in Chapter 4 – Project Description.

The pre-lay grapnel run undertaken before cable installation will remove any out-of-service cables from the vicinity of the route prior to installation taking place.

The Crown Estate has requested that the cable route runs parallel to existing cables as far as possible to ensure efficient spatial use of the seabed. With this in mind, the cable route has been designed to minimise cable length and optimise proximity to existing cable systems such as the Tangerine and the Thanet Offshore Wind Farm cables.

8.4.4. Mitigation

No impacts are expected, therefore no mitigation measures are proposed.

8.4.5. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

8.5. Military and Other Sea Users

8.5.1. Baseline data sources

A desk top study has been conducted of all known areas of sea used by marine industry and the impact of the cable route has been assessed in respect to these. Specifically the following marine uses have been taken into account:

- Wind farm developments and their associated export cables
- Marine aggregate extraction and dredging (including licensed, active, application, option and prospecting areas)
- Oil and gas development
- Disposal sites

SeaZone Hydrosatial data has been used to provide details of the location of oil and gas development, disposal and dredging sites and military practice and exercise areas and the locations are shown in Figure 8-5-1.

Data describing the locations of existing wind farms and future offshore wind developments and aggregate extraction areas have been acquired from The Crown Estate website and the locations are also included in Figure 8-5-1.

Consultation with The Crown Estate has not indicated any further marine developments in the vicinity of the cable route.

8.5.2. Baseline

Wind farms

The Thanet Offshore wind farm, owned by Vattenfall Wind Power, is located approximately 8 km north of the cable route (Thanet Offshore Windfarm Ltd, 2005). The landfall location of the Thanet export cable is near to the previously considered Service Station North landfall option for the Project. The landfall site for the Project is Service Station South, and therefore work will occur near to the Thanet export cable but the cables will not cross.

The Crown Estate had awarded Vattenfall Wind Power the opportunity to extend the Thanet project by up to 50% additional capacity. Vattenfall has however since withdrawn from this process stating that tight timescales and limited grid access made the project unfeasible (Shankleman, 2010). They have noted, however, that they do not rule out future development but this is unlikely to occur before the Nemo Link is completed.

Marine aggregate extraction and dredging

There are no known aggregate extraction sites in close proximity to the cable route in the UK. A former dredging area (used during the construction of the Channel Tunnel) was located approximately 10 km south of the cable route (SeaZone, 2009), however this has been disused since construction was completed on that structure. The Crown Estate has indicated that the cable route may cross areas of potential for aggregate extraction but no data is yet available for specific prospecting areas. It is understood that aggregate extraction vessels cross the cable route transiting to and from extraction sites and ports.

Oil and gas development

There is no oil and gas development in close proximity to the cable route in the UK.

Disposal sites

Dredging occurs in the Ramsgate port area, in particular the port approach and internal port and harbour areas are dredged when required throughout the year (Thanet Coast, unknown). The dredged

material is disposed of at disposal site TH140 in Pegwell Bay which is located near the Sandwich flats landfall site (see Figure 8-5-1, Thanet Coast, 2000). The cable route has been designed to avoid this disposal site and will pass approximately 200 m to the south of the site.

Military practice and exercise areas

There is a military exercise area in open water 3.5 km north of the planned cable route. It is categorised as Navy Department Area X5123 and is a mine disposal area.

8.5.3. Description of potential impacts

The table below provides details of how receptor value has been defined in the impact assessment. A detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Fundamental long term damage, loss or disruption to essential zones of military activity or other sea users or their property and equipment.
Medium	Short term loss or disruption to military activity or other sea users or long term disruption to military activities causing them to relocate.
Low	No measurable direct or indirect impacts that would affect military activities or other sea users. Small-scale, temporary disturbance to military and other sea users identified as being of local importance.

Table 8-5-1 : Definition of receptor value

Wind Farms

There is no direct interaction between the Project and any existing or planned wind farm areas. The landfall of Thanet Offshore Wind Farm export cable is in near to planned landfall of the Nemo Link but the cables will not cross offshore. No adverse impacts are expected in relation to the Thanet Offshore Wind Farm.

Marine aggregate extraction and dredging

There is a considerable distance between the dredging site and the cable route, and therefore no impacts are expected.

Disposal sites

The cable route does not cross the Pegwell Bay disposal site so it is not anticipated that the Project will have any impact on the site.

Military practice and exercise areas

The cable route does not cross any military exercise areas so it is not anticipated that the Project will have any impact on military activities.

8.5.4. Mitigation

No mitigation measures are required as it is not foreseen that the cable route will have an impact on the military or other civilian sea users.

8.5.5. Residual Impacts

No discussion regarding residual impacts is included within this section as no mitigation has been proposed.

8.5.6. References

- Thanet Offshore Windfarm Ltd. (2005) *Thanet Offshore Wind Farm Environmental Statement: Non Technical Summary*. Warwick Energy: Wellesbourne, Warwickshire

- SeaZone (2009) *Shipping and Navigation Extraction_Dredge [GIS Data]*. SeaZone: Wallingford
- Shankleman, J. (2010) *Vattenfall scraps Thanet wind farm extension*. businessGreen: London
- Thanet Coast (unknown) *6. Ports and Harbours* [online]. Thanet District Council: Margate. Available from: [www.thanetcoast.org.uk/docs/6_Ports_and_Harbours_0407.doc] Accessed 7 Dec 2010.
- Thanet Coast (2000) *North East Kent European marine sites management scheme: 6.9 Ports and Harbours* [online]. Thanet District Council: Margate. Available at: [http://www.thanetcoast.org.uk/pdf/6_7TO6_9a.pdf] Accessed 7 Dec 2010.

8.6. Unexploded Ordnance

There is potential for Unexploded Ordnance (UXO) risks along the cable route due to its South East location (WWI / WWII activity). Items of UXO are regularly encountered within the North Sea and rarely become inert or lose effectiveness with age. Over time, mechanisms such as fuses and gains can become more sensitive and therefore more prone to detonation. This applies equally to items that have been submersed in water and/or lodged within the seabed. It is possible that significant kinetic energy created by the intense impacts generated by marine engineering, such as cable trenching, could cause an inadvertent detonation.

8.6.1. Baseline data sources

A desktop UXO Threat and Risk Assessment was undertaken to address the first stage of the UXO risk management process by providing a holistic overview of the UXO threats and risks for the entire marine operation. It was concluded that the main UXO risk for the project is WWI and WWII UXO, although other types of UXO cannot be discounted. The following facets were considered as part of the desktop study:

- The history of the route;
- Relevant military records;
- Wartime activities;
- The holistic UXO threat including the types that could be encountered, the probabilities of encountering them as well as exposing their potential mechanisms and risks of detonation;
- An outline assessment of the maximum likely UXO seabed burial depth;
- The risks regarding UXO;
- The consequences of an inadvertent High Explosive (HE) detonation.

The sources of information consulted for this report included:

- Royal Navy (Southern Diving Unit), Portsmouth;
- The National Archives, Kew;
- Naval Historical Centre, Portsmouth;
- UK Hydrographic Office, Taunton;
- 6 Alpha's "Agility Database ©" which contains historic maps, aerial photographs and records;
- Project related reports;
- Department of Research and Information Services (DoRIS), RAF Hendon.

8.6.2. Baseline

A specialist review was undertaken by 6 Alpha Associates and the details of this report are summarised below (6 Alpha Associates, 2010). For the purposes of UXO assessment the overall route was divided into five distinct segments. Each segment was defined by both the geographical location and the nature of the proposed engineering works. The five segments are as listed below. These areas are considered within the overall UXO report. However, due to geographical location, only Segments 1 and 2 are considered within this report as they are the only segments falling within:

- **Segment 1** - Area surrounding a 500 m radius from the landfall point at Richborough in the UK;
- **Segment 2** – 500m either side of the Cable Corridor as it passes through UK territorial waters;
- **Segment 3** - 500m either side of the Cable Corridor as it passes through French territorial waters;
- **Segment 4** - 500m either side of the Cable Corridor as it passes through Belgian territorial waters;
- **Segment 5** - Area surrounding a 500m radius from the landfall point at Zeebrugge West.

8.6.3. Aerial Bombing Campaigns and Military Fortification

8.6.3.1. Richborough Landing Points

During WWII in 1943 the site was commissioned by the (British) Royal Navy and designated as HMS Robertson, which acted as a holding base for Royal Marine landing craft personnel (gun crews) as well as a (minor) landing craft base. There are no records to suggest that this site was bombed by the German Luftwaffe, although, in the region, Royal Air Force (RAF) Manston and two bombing decoy sites were bombed.

8.6.3.2. Sea Convoy Routes

In 1939 the Thames Estuary and approaches from the east were probably the world's busiest waterway. The Port of London was then Europe's largest and handled one-third of all Britain's foreign trade. The East Coast ports were important commercially and, as WWII progressed, they achieved strategic importance for the transport of coal, as well as from fishing (which was considered key to helping feed the UK's wartime population). A military lesson from WWI was implemented, which saw merchant ships gathered into convoys for protection. Notwithstanding the Royal Navy's attempts to afford such convoys protection, they were regularly attacked from the air as well as by the German surface and U-Boat (i.e. submarine) fleets. The Luftwaffe also dropped thousands of HE bombs on these convoys.

8.6.3.3. Tip and Run

A significant number of air-to-air battles also occurred over this area, some of which resulted in numerous allied and enemy aircraft jettisoning all or part of their payloads i.e. *inter alia* medium and large capacity, HE iron bombs (a tactic known as "Tip and Run"), either in an attempt to escape their pursuers, or to quickly offload weapons from damaged aircraft, before returning to base. Although records of these events are poor, the threat of encountering jettisoned munitions in the sea must be considered an unquantifiable risk when assessing the background UXO threat for all areas in the North Sea.

8.6.4. Allied Sea Minefields

8.6.4.1. Overview

During WWII it is estimated that Allied Forces and Axis Forces laid in excess of 566,000 sea mines in the North Sea. There are over five hundred WWII Royal Navy mine laying reports in the British National Archive for the North Sea region alone; in addition the Royal Air Force (RAF), also emplaced sea mines from the air. The Germans also delivered sea mines (by air, ship and U-Boat); the precise quantities laid are not known.

8.6.4.2. Strategic Planning

As a result of enemy sea mining activity, proposals were made in November 1939 to mine the English Channel. These proposals considered the likely effect on fishing as well as the requirement to provide mine-clear sea-channels for British, Dutch and Belgian shipping. It was finally recommended that, as a first action, the southern part of the area should be "notified" and sown with both deep and shallow water mines.

8.6.5. Effectiveness

Generally the sea minefields were a better “psychological” deterrent, than an operational success, as there were more casualties caused to the Royal and Merchant Navies than the German Navy. There is only one record of a German U-Boat being successfully attacked by mines laid off the Essex coast and that occurred on the 7th November 1940 (when the U-Boat T6 struck a mine and sunk).

8.6.6. Mine Clearance

At the end of WWII there was a significant sea-mine clearance operation undertaken by both Allied and German Navies, who attempted to clear their respective minefields. This operation was undertaken by one of two methods:

- Using two minesweepers, a sweep-wire (with a serrated edge and an “otter” or “kite” to keep the sweep wire at the required depth), was laid into the water and both ends were attached to a winch at the stern of each ship. The sweep-wire was towed by both vessels over a mined area and, when connected to the “mooring stay” of a moored mine, the ships momentum would then force the stay to the serrated edge of the sweep wire, which cut it. The mine would then (usually), float to the surface for disposal.
- An alternative method was to use one ship only with the sweep wire attached to an oropesa float (to keep the sweep wire away from the ships), and the wire would then cut the mooring stay of the mine (as described above). The untethered mine would then (usually) float to the surface where it was then destroyed, often by rifle fire (however, on occasions the bullet only penetrated the outer casing of the mine, which allowed water to ingress and it would then sink and come to rest on the sea bed; an explosive hazard thus remained).

Historical Admiralty mapping confirmed that minefields that had been situated off the coast of Kent and Essex, were cleared post-War. Whether all those mines that were recorded as being laid, were *de facto* recovered during clearance, could not be confirmed (it should be noted that 100% clearance of minefields, even with today’s technology, is not always achievable).

8.6.7. Munition Sea Dumps

Post WWI and WWII, both chemical and conventional munitions were extensively dumped at sea, including in areas off the UK and Belgian coasts. The locations of some of these areas are well known as are the type and numbers of munitions deposited, but in other areas there are problems concerning accuracy of types and numbers dumped. This inaccuracy is incurred because of a combination of factors including: inadequate record keeping; the dumping of items outside designated official dumping areas; and, to an extent, the movement of munitions post dumping as the result of tidal flow. Notwithstanding the risk of UXO migrating on the seabed, there are no known munitions dumps within 5km of the cable route.

8.6.8. Military Training Areas

There is one military training area 3.5km to the north of the cable route within UK waters. It is categorised as Navy Department Area X5123 and is a mine disposal area.

8.6.9. Shipwrecks and Downed Aircraft Containing Munitions

Both merchant and naval vessels that were sunk in WWII may have contained munitions. Empirical evidence has shown that munitions did spill from the ships as they sank and subsequently broke-up. Similarly, aircraft that were shot down or otherwise had to ditch into the sea, may have also contained unexploded munitions. In general, the risk of munitions contamination is somewhat less in the vicinity

of wrecks as compared with munitions dumpsites and weapons trial areas because the munitions, in all probability, are most likely to remain enclosed and immobile within the body of the wrecks. However, it may be possible that some items may have been thrown clear of the vessel as it sank or they could become exposed as the wrecks gradually broke up.

8.6.10. Description of Potential Impacts

The principal risks associated with UXO relate to the safety of equipment and personnel through the installation phase, however there remains a low risk of encountering contamination from explosive materials contained within explosives.

The impacts upon unexploded ordnance, and their impacts on the environment are very unlikely to be a material issue should established protocols be followed within a risk assessment framework. As UXO is a risk rather than an impact it has not been included in the impact assessment matrix. Additionally it is not appropriate or meaningful to assign a receptor value to UXO. The impact assessment therefore outlines the risks and associated mitigations that will reduce the UXO risks to as low as reasonably practicable.

Survey data including comparison between magnetometer and side scan sonar data has been obtained for the entire survey corridor. The findings of the survey identify a number of objects of varying magnitudes of magnetic readings which will be avoided where possible during installation. In general it is unlikely that these metallic objects are UXO, however the possibility remains that this is the case. Furthermore there remains a possibility that potential submerged targets were not identified during the initial survey. Therefore the following mitigation measures are recommended to minimise the risks associated with encountering UXO during cable installation.

8.6.11. Mitigation

It is proposed that UXO issues form part of the construction planning for the project, through appropriate risk management. Following such risk assessment, the following mitigation measures will be implemented as necessary:

- A non-intrusive marine multi-sensor and magnetometer survey will be undertaken to provide any necessary additional information to the current survey;
- If required potential UXO targets should be avoided or investigated;
- The construction principal contractor should provide marine and land based Engineer Support;
- The risk mitigation plan should be flexible with an inherent capability to step up risk mitigation measures if a higher degree of risk presents itself.

Although Richborough has a lower risk profile (compared with Zeebrugge), the effort and cost to mitigate the risk level is comparatively small when compared with the significant benefit gained. The findings of surveys will be reviewed by a reputable UXO contractor and appropriate action agreed in each case. Where additional work (other than avoidance) is necessary, the works will be coordinated by a reputable UXO contractor who will liaise with the UK authorities concerning incident management and disposal actions.

The Principal Contractor will determine if a further detailed geophysical survey should be undertaken to determine the potential existence and location of potential UXO along the route. This will be undertaken in advance of Pre-lay Grapnel Run (PLGR) work and any route adjustments made based on potential UXO findings (if and where they occur). Once the UXO survey has been conducted and potential UXO “targets” avoided, then the intrusive ground investigation and PLGR will be undertaken. Whilst the risk of UXO encounter has significantly been reduced, during both operations there is the potential for smaller UXO to be brought aboard the vessel (e.g. been embedded within the clay attached to the grapnel). It would therefore be prudent to have a UXO specialist to inspect the PLGR equipment during the recovery process, in order to immediately identify and/or discount any potential UXO hazards, as the work proceeds.

8.6.12. Residual impact

The discovery of marine based UXO threats (i.e. washed up sea mines or torpedoes) are considered most unlikely at Richborough. The discovery of Land Service Ammunition are however considered reasonably likely because of the presence of the of the generic UK coastal defences.

The principle threat offshore is from munitions used during WWI and WWII, in the form of air delivered HE bombs in general and historic sea mines in particular. The presence of a body of water will have a considerable affect on the seabed penetration depth for air-delivered bombs. Bombs behave uniquely as they enter a body of water and the velocity is reduced significantly before the bomb penetrates the seabed. It has been assessed that the maximum penetration of a 500kg bomb along this route, is not likely to penetrate more than 1m below seabed level.

Due to the relatively slow tidal movement within the North Sea, tides are likely to have a minimal short-term effect on seabed munitions movement. In the coastal areas, however, there may be sufficient tidal flow to move threat items either into, or out of, the proposed path of the cable. In these areas, it would be prudent to assume that items are still in the process of migration, although the magnitude is likely to negligible. Targets identified (potentially as UXO) may have moved since the time of the geophysical survey, in addition to new items being introduced via migration along the route of the cable.

Depending upon the depth of water where detonation occurs underwater, the main consequence would be injury to personnel and damage to installation vessels, and associated support vessels and equipment. The potential damage may result from direct fragmentation as well as the pulsing gas bubble and its resultant shock wave. A reasonable and practical working assumption is that any UXO which has a charge weight of 40kg or greater, is capable of causing significant damage, given typical water depths seen in the North Sea.

As many of the sea mines and bombs that may be encountered have a Net Explosive Quantity (NEQ) of around 100kg or greater, the effect of these detonating even on the seabed is likely to be catastrophic in water depths of 10-15m, and extremely serious in the deeper waters of the rest of the North Sea.

The specific risk assessment within the UXO report shows that the greatest risk is posed to the PLGR seabed operations and to PLGR equipment recovery to vessel. Appropriate control measures will be included within the responsibility of the installation contractor.

8.6.13. References

- 6 Alpha Associates. (2010) Unexploded Ordnance (UXO) Threat & Risk Assessment. Ref P2068TRA prepared by 6 Alpha Associates on behalf of PMSS Ltd.

8.7. Tourism, Recreation and Amenity

8.7.1. Baseline data sources

The following data and information sources have been used to inform the summary of the baseline in this report.

- UK Offshore Energy Strategic Environmental Assessment (DECC, 2009).
- Kent Wildlife Trust.
- Royal Temple Yacht Club website.
- UK Coastal Atlas of Recreational Boating (RYA, 2008).
- Port of Ramsgate, Royal Harbour Marina (Thanet District Council, 2010)
- Sandwich Bird Tours (Van der Dol, 2007)
- VisitKent Business section.

8.7.2. Baseline

8.7.2.1. Tourism overview

There has been a general decrease in tourism over the past 10 years for the UK as a whole. In South East England, regional figures suggest an increase in overseas tourism and a decrease in domestic tourism (VisitEngland, 2011). County figures showing British tourism in Kent appear to go against the general UK trend and the overall regional shift in tourist demographic. These figures show a gradual increase in British holiday visitors to Kent from just under a million (2006 – 2008 inclusive) to over a million holiday trips (2008 – 2010 inclusive) (VisitEngland, 2011).

Conversely, when factoring in all UK visitors to the area (holidays, day trips etc.), numbers show a marked decrease (from an average of approximately 3.7 million in 2006-2008 to just below 3.3 million in 2008-2010).

There is a peak in overnight tourism in the South East in July and August, with a secondary peak in May and April. Kent is the 9th most visited county in England (when considering all UK visitors and not solely holiday trips) (VisitEngland, 2011). However, when focussing solely on holiday visitors, Kent does not appear within the top ten counties. VisitKent are actively trying to increase both domestic and European visitors to the county through several marketing campaigns.

8.7.2.2. Local Tourism Overview

The traditional seaside town of Ramsgate, located approximately 2.2 km north of the cable route, is a tourist destination in Kent. The Royal Harbour Marina in Ramsgate has been described as the defining characteristic of the town and both the town and Pegwell Bay are of historical interest (VisitKent, 2006). The district of Thanet is of moderate to high importance for tourism in Kent. It is estimated that approximately £162 million was spent on trips to Thanet in 2006 (VisitKent, 2006) and that Thanet is the third most popular district for over-night stay trips after Canterbury and Medway (Kahn, 2008). Recreational activity was by far the most common reason for over-night trips to the county. It is estimated that Thanet supports 8% of Kent's tourism related jobs, compared to other Kent districts this is jointly (with Maidstone) the fourth largest district for tourism related employment (Kahn, 2008). The majority of tourism spending within Thanet is concentrated in Margate, Ramsgate and Broadstairs (VisitKent, 2006; VisitKent, 2010). Ramsgate is a moderately important town in Kent for tourism ranked 7th out of 14 Kent towns in terms of visits to tourist information centres with just under 50,000 visits to the centre in 2009 (VisitKent, 2010). The beach at Ramsgate (Ramsgate Main Sands) has won Kent's Quality Coast Award, has Blue Flag status conferred on it once again in 2012 and is a

popular beach for visitors, with good facilities for children, coastal walks to the Pegwell Bay area, and close proximity to the Royal Harbour Marina, the port and town centre (VisitKent, 2006; VisitKent, 2011). The Pegwell Bay area is part of Kent's largest nature reserve, called the Sandwich and Pegwell Bay National Nature Reserve, and has geological, historical and ornithological features of interest. Facilities include parking, toilets, cafe/restaurant and picnic area (Kent Wildlife Trust, 2010).

8.7.2.3. Boating, Yachting and Passenger Boats

The Port of Ramsgate features the picturesque Royal Harbour Marina with 700 berths and many cafes and bars on the harbour front (Thanet District Council, 2010). This is one of the largest marinas on the south coast. The Royal Temple Yacht Club is located at the harbour and has over 700 members (Brand, 2009). Regular races and cruising events at weekends and in the evenings are organised by the club and it is understood that races take place in the Pegwell Bay area. The Ramsgate Festival sailing regatta takes place annually in August and attracts entrants from around the UK and Europe (Brand, 2009). The Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating (RYA, 2009) indicates that heavy and medium use recreational sailing routes cross the cable route in the area between the landfall and South Falls. It also indicates that the Pegwell Bay area is a racing and cruising area for recreational craft. Furthermore, several ferry services run from Ramsgate to continental ports such as Ostend and Boulogne which cross the cable route (Thanet District Council, 2010). Kite surfing is restricted to the north-eastern side of Pegwell Bay and is unlikely to be impacted by the cable route except if the Cliff End cable landing location is used (National Nature Reserve, 2006).

8.7.2.4. Recreational Angling

The Kent coast offers good fishing almost all year round with only a slight lull in spring. There are several sea angling charter vessels based at the Port of Ramsgate and they catch a large variety of species depending on the time of year. In spring they mainly catch bass, early smooth hounds, late cod and a lot of thornback rays. The fish tend to reside just offshore so this is where most charter vessels remain at this time of year. In summer there is a wide range of species and often in high numbers, inshore and offshore. Wreck fishing is also popular at this time of year. Congor, black bream and turbot are common off wrecks. While, in general the most prolific species are bass, smooth hound, mackerel and rays. In autumn and winter the main fish species pursued are bass, cod and whiting (KentCharterFishing, 2008). It is understood, from the local fishing community, that boats shelter in Pegwell Bay during northerly winds. It also believed that bait digging takes place in Pegwell Bay itself.

8.7.2.5. Bird Watching and Walking

The area offers coastline walks and, as noted in Section 7.2 - Ornithology, the Pegwell Bay area is subject to several conservation designations and parts of the Sandwich and Pegwell Bay nature reserve are accessible to the public (Kent Wildlife Trust, 2010). The area is particularly important for its bird life and is therefore popular for bird watching (Van der Dol, 2007). Kent is a prime county for bird watching due to its proximity to the continent and variety of habitat which ensure that a large variety of bird species can be seen. Pegwell Bay is a nationally important stop-over point for migrating shorebirds and waterfowl and year round guided bird watching tours operate in and around Pegwell Bay (Van der Dol, 2007).

8.7.3. Description of potential impacts

The table below provides details of how receptor value has been defined in impact assessment. Detailed description of the potential impacts is included in Appendix 6.

Receptor Value	Definition
High	Damage or loss of an area of national or international importance for tourism, recreational activity or amenity. The area will not recover.

Receptor Value	Definition
Medium	Damage or loss of an area of regional importance for tourism, recreational activity or amenity, the area may not recover. Temporary disturbance to sites of national or international importance.
Low	Small-scale, temporary disturbance to sites identified as being of regional, national or international importance to tourism. The area will recover.

Table 8-7-1 : Definition of receptor value

The project is located adjacent to the National Nature Reserve and areas of international importance to migratory birds. However, given the nature of the project, it appears that the seabed in this area is rarely used for recreational activities (SCUBA diving is uncommon in the area), thus impacts will likely be limited to surface restrictions during installation, repair, and decommissioning work.

The greatest level of disruption is likely to be to recreational sea users such as yachtsmen and deep sea anglers as their access will be restricted to areas of the bay and open sea for certain periods of time. A temporary exclusion zone will be employed around the installation works and they will be notified in accordance with statutory procedures such as notices to mariners.

8.7.3.1. Cable Installation

The impacts of cable installation across the marine area will be transient; the entire laying process in British waters is predicted to take less than 2 months. Thus users of the area will be inconvenienced for a short period of time. Furthermore, the majority of the installation work will take place in offshore areas where there is little recreational activity.

During the installation, large vessels will be used for pre-sweeping sand waves and to lay and bury the cable. There is likely to be a temporary disruption to recreational sea users as there will be an exclusion zone employed around the cable installation works. The installation vessels will also be visible from the shore for a period of time reducing the visual amenity of the area. This may be disruptive to walkers, bird watchers and visitors to the National Nature Reserve during installation phase. This will mostly occur in the form of reduced visual amenity but there is also the possibility of temporary disruption to birds present in the area. Based on this information it is predicted that the cable installation will have an impact of **minor** significance on recreation and leisure activities and a **negligible** impact, as well as on the natural character and visual amenity of the coastal region.

8.7.3.2. Cable Operation

Transient periods of disruption may occasionally occur during the operation phase due to surveys and repair work. However, this will likely be less disruptive than the installation phase as activity and vessel sizes are lessened for this work. It is predicted that the operation phase will be on **negligible** significance to recreation and leisure activities, as well as to the natural character and visual amenity of the coastal region.

8.7.3.3. Decommissioning

There may be further disruption in the decommissioning phase, similar to that experienced during installation. However, it is often the practice to leave cables on the seabed after they are no longer in service as this action causes the least disruption. Based on this information it is predicted that the cable decommissioning will have a **negligible** impact on recreation and leisure activities, as well as on the natural character and visual amenity of the coastal region.

8.7.4. Mitigation

To minimise the impacts on those using the area for recreational purposes, as much advanced notice as possible will be given of the commencement of installation activities and any changes will be updated. In addition to the required public notices, all local sailing clubs and businesses involved in vessel chartering will be informed of the proposed activities. Notices will also be posted at local harbourmaster offices and at various points close to landfall.

As it is impossible for all third parties of the development to be informed, all activity will be controlled in an appropriate manner, which includes an exclusion zone around the installation vessel and the use of lighting and horns where necessary. Efforts will be made to minimise the duration of the installation phase as much as possible in order to reduce the period of disruption.

8.7.5. Residual impact

The mitigation measures above may assist in reducing the likelihood of potential impacts and therefore it is anticipated that the level of impact will remain of **minor significance** following mitigation. Details of the full impact assessment are included in Appendix 6.

8.7.6. References

- VisitEngland (2011) Regional and County Tourism Statistics/Reports. EnjoyEngland: London.
- VisitKent (2006) Thanet – Margate, Broadstairs & Ramsgate. VisitKentBusiness: Canterbury
- VisitKent (2011) Kent's Resort Coast [online]. VisitKent: Canterbury.
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- Thanet District Council (2010) Port of Ramsgate – Royal Harbour Marina [online]. Thanet District Council: Margate. Available from: [http://www.portoframsgate.co.uk/welcome_to_the_marina.aspx] Accessed 3 Dec 2010.
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- KentCharterFishing (2008) The Fishing [online]. KentCharterFishing: Herne Bay. Available from: [<http://www.kentcharterfishing.com/fishing.html>] Accessed 3 Dec 2010.
- Van der Dol, J. (2007) Sandwich Bird Tours [online]. Sandwich Bird Tours: Sandwich. Available from: [http://www.sandwichbirdtours.co.uk/tours/birding_breaks.asp] Accessed 3 Dec 2010.

9. Cumulative Effects

9.1. Introduction

Cumulative impacts are those resulting from the combined effects of the proposed development with other subsea cable projects through space and time, in the context of natural variability. It also includes the combined effects with other sea users generating similar effects.

9.2. Cumulative Effects

The assessment of cumulative impacts considers the following:

- Existing interconnector cables - BritNed Interconnector and Interconnexion France-Angleterre
- Proposed future interconnector projects located within the vicinity
- Other sea users/uses generating similar effects. These include:
 - Recreational users (bait diggers, dog walkers, kite surfers etc.)
 - Offshore Wind (export cabling)
 - Commercial Fishing

The activities detailed above have been considered in the assessment of cumulative effects for the following reasons:

- The fishing industry has raised concerns regarding the impact upon commercial fishing of increased rock placement, rendering some areas unfishable with gears such as drift and trammel nets.
- Recreation activities in the Pegwell Bay area (including kite surfing, bait digging and dog walking) are understood to contribute to disturbance of birds using the area (see Chapters 7.2 and 8.7)
- Thanet Offshore Wind Farm export cable maintenance activity, if required, could contribute to disturbance of species or habitats
- Both wind farm export cables and interconnector cables emit electric and magnetic fields and there may be cumulative effects associated with these emissions

There are no known existing or planned MoD or aggregate extraction activities taking place in close proximity to the cable route. The level of shipping activity and noise associated with the marine cable installation and operation is insignificant when considered in relation to the shipping activity in the area (see Chapter 8.2 for further details).

The key environmental impacts resulting from the cable installation and operation in relation to cumulative impacts are:

- Seabed disturbance from pre-sweeping and burial activities impacting on ecological and archaeological features
- Turbidity created as a result of pre-sweeping and burial activities
- Noise associated with pre-sweeping and burial activities
- Disturbance as a result of works within the intertidal area
- EMF emissions
- Potential damage to fishing gear associated with rock placement at cable crossing

It is assumed that rock placement will only be required at a single cable crossing location. However, it is possible that additional rock placement may be required in other locations to protect the cable where burial to a sufficient depth cannot be achieved. The requirement for any further rock placement and the location and extent of any such protection will be determined following installation.

It is currently proposed that installation contractors ensure the burial equipment they intend to use is suitable for the ground conditions experienced and will enable sufficient burial depths to be achieved. However, if this is not possible in certain locations, the use of rock armour could give rise to localised effects including making it difficult to fish in those locations with trammel and drift nets. Concern regarding this potential cumulative impact has been expressed by the commercial fishing industry during the EIA consultation process and is noted. It is considered that any other potential environmental effects would be localised given the small scale loss of seabed, and there may be a longer term increase to biodiversity ultimately. However, this would be addressed under a separate application if rock armour is considered to be necessary and the concerns expressed during consultation would be considered during this process.

It should be noted that, if further rock placement is deemed necessary for the purposes of cable protection, a separate Marine Licence will be applied for and an environmental impact assessment, including consideration of cumulative impacts, will be undertaken.

Table 9-1 outlines the cumulative impacts identified. These have been derived through review of the assessments presented in Chapters 6 – 8.

A full assessment of potential cumulative effects on Natura 2000 sites is provided within the The Nemo Link: Pegwell Bay – Assessment of Likely Significant Effects Report, which is available as Appendix 8.9 of the UK onshore Environmental Statement at the following website: www.nemo-link.com.

Potential cumulative effect arising from the Nemo Link	Activities/Projects with similar effect where overlap may occur	Receptors that are potentially impacted by cumulative effects
Seabed disturbance from pre-sweeping and burial activities	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF export cable maintenance • Commercial Fishing – interaction of gear on the seabed • Recreation Activities – bait digging 	<ul style="list-style-type: none"> • Benthic ecology – There is potential for the Project to cause a localised, temporary cumulative impact on benthic ecology with demersal fishing activity, bait digging in the intertidal area and Thanet cable maintenance. Due to the localised and temporary nature of seabed disturbance as a result of the Project it is anticipated that there will be no cumulative impact on benthic species and habitats. Although impacts on <i>Sabellaria</i> reef will be less temporary, cable routeing has been undertaken to avoid areas of reef. Overall no cumulative impact is anticipated. • Fish and Shellfish– There is potential for cumulative impacts on shellfish beds and spawning and nursery areas arising from any maintenance of the Thanet Offshore Wind Farm cable. Given the localised and temporary nature of the activities it is unlikely to give rise to a cumulative impact. No cumulative impact is anticipated. • Archaeology – Cumulative impacts on archaeological features could arise between the Nemo Link and Thanet cable maintenance. Given the localised nature of the effect and the anticipated low level of maintenance expected on the Thanet export cable no cumulative impact is anticipated.
Turbidity created as a result of pre-sweeping and burial activities	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF export cable maintenance • Commercial Fishing – interaction of gear on the seabed 	<ul style="list-style-type: none"> • Benthic ecology – There is potential for the Project to cause a localised, temporary cumulative impact on benthic ecology with demersal fishing activity and Thanet cable maintenance. Given the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable and the limited extent of demersal trawling in the offshore region it is not anticipated that the additive effect of the Nemo Link will give rise to a significant cumulative impact. No cumulative impact is anticipated. • Fish and Shellfish– There is potential for cumulative impacts on shellfish beds and spawning and nursery areas arising from potential Thanet OWF cable maintenance. As with benthic ecology above, the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable and the extent of demersal trawling in the offshore region is not anticipated to give rise to a significant cumulative impact. No cumulative impact is anticipated. • Water quality – Given the localised and temporary nature of the impact assessed in Chapter 6 in relation to similar effects from demersal trawling and the low level of maintenance expected on the Thanet OWF export cable, cumulative impacts to water quality are not anticipated. No cumulative impact is anticipated.
Noise associated with pre-sweeping and burial activities	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF export cable maintenance • Shipping 	<ul style="list-style-type: none"> • Marine Mammals, Fish and Shellfish and Tourism, Recreation and Amenity – Given the low levels of noise generated by the project and the temporary nature of the effect no cumulative impact is anticipated.
Disturbance as a result of works within the intertidal area	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF export cable maintenance • Recreation Activities 	<ul style="list-style-type: none"> • Ornithology – Given the low level of maintenance expected on the Thanet export cable, it is unlikely that any cable maintenance will occur at the same time as the Nemo Link installation. Also the Nemo Link works in the intertidal zone will be temporary in nature and sensitive periods of the year will be avoided where practical. As such, no cumulative impact is expected. • Conservation Designations – There is no cumulative impact anticipated on the Thanet Coast and Sandwich SPA (see above and Table 9-2). Residual impacts on SACs, Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs) and

		<p>Local Nature Reserves (LNRs) have been assessed to be minor due to the limited extent and duration of the works and the fact that the cable route avoids the most sensitive habitats and features of the site (see Chapter 7.1). In terms of recreation activities (e.g. dog walkers and/or bait diggers), there is unlikely to be a cumulative impact as Kent Wildlife Trust restricts access to the more sensitive areas (saltmarsh and bird breeding areas) within Pegwell Bay (Kent Wildlife Trust, 2011). In addition, given the low level of maintenance expected on the Thanet export cable, it is unlikely that any cable maintenance will occur at the same time as the Nemo Link installation. No cumulative impact is anticipated.</p> <ul style="list-style-type: none"> • Tourism, Recreation and Amenity – Given the localised and temporary nature of the impact coupled with the low level of maintenance expected on the Thanet export cable, it is not anticipated that the additive effect of the Nemo Link will give rise to a significant cumulative impact. Therefore, No cumulative impact is anticipated.
EMF emissions	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF export cable operation • Interconnector cables: BritNed Interconnector; Interconnexion France-Angleterre 	<ul style="list-style-type: none"> • Fish and Shellfish – There is potential for cumulative effects, from the project impacts on electro-sensitive fish species. The assessment in Chapter 7.5 identified the impact on these species to be of minor significance. EMF emissions from AC cables, such as the Thanet OWF export cables, are greater than the emissions from DC cables. As a result, it is anticipated that cumulative impacts could be of minor significance but there is currently no evidence of such cumulative effects.
Disturbance associated with rock placement at cable crossing	<ul style="list-style-type: none"> • Offshore Wind – Thanet OWF turbines and rock placement • Subsea cables: BritNed Interconnector; Interconnexion France-Angleterre 	<ul style="list-style-type: none"> • Commercial Fisheries - impact on commercial fishing could arise from the use of rock placement for this project along with other projects that prevent the use of fishing gear at the seabed. Given that rock placement will only be required at one crossing location in the UK for the Nemo Link this impact will be localised. However, taking into account the crossings in French and Belgium waters as well as rock placement used in other project there will be a cumulative impact on commercial fishing as areas where rock is placed become unfishable by some trawl gears and drift and trammel nets. As the contribution of the Nemo Link to this is going to be relatively small (there is only a single cable crossing in UK waters and this is outside of the key sensitive fishing areas used by the inshore fishing fleet) it is anticipated that the cumulative impact on commercial fishing will be of minor significance.

Table 9-1 : Cumulative Impacts

10. Summary of Effects of Other Project Elements

This section provides an overview of the likely environmental effects of the other elements of the Nemo Link. These other elements comprise:

- Offshore Cable Installation in French Waters
- Offshore cable installation in Belgian Waters
- Onshore UK elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.
- Onshore Belgian elements including the construction of an electricity converter station and substation and the installation of underground electricity cables from the landfall to the converter station.

10.1. Offshore Cable Installation in French Waters

Cable installation continues in French waters outside of the boundary of the UK waters. Installation proceeds in the same way with the same type of cables as those discussed in Chapter 4 (Description of Proposed Development) as there is one unified process across the Project. This length of cable installed in French waters is approximately 23 km.

A summary of the findings of the French environmental assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

The major impacts considered were those during the installation phase. These mainly concern cable laying vessels operating at a restricted speed and limited manoeuvrability. The fact that the cable will be buried beneath the surface of the seabed will limit the operational impacts of the interconnector in French Waters.

Further information regarding the offshore elements of the project in France can be found in the Non-Technical Summary document within Appendix 13 in French. This document will be available in translation at the following website: www.nemo-link.com.

10.1.1. Physical Environment

10.1.1.1. Geology and seabed processes

In France the cable route crosses the borders of two of the sandbanks forming part of the area known as 'Bancs des Flandres' (although the cable route does not pass through the designated area itself). The sandbanks are composed of fine and gravelly sand, similar to that found in the Belgian and UK sections of the cable route. Although the cable route only crosses the borders of the sandbanks, the changes in the seabed processes could influence the movement of sediments around the borders or on the summits of the sandbanks. However, the terrain will quickly return to its natural state once cable laying activities are completed. Consequently there will be no long term change to the topography of the seabed.

10.1.2. Biological Environment

10.1.2.1. Fish ecology

In France it is recognised that the diversity of fish species is greater towards the south of the North Sea than in the central areas. The species found along the cable route are a heterogeneous coastal mix and it is difficult to identify with precision the exact species that could be impacted by the cable.

10.1.2.2. Benthic ecology

The effect on benthic organisms, one of the main food sources for the fish population, will be temporary, with the area quickly being recolonised post-cable lay by the surrounding communities. The cable route also avoids the most sensitive of the fish feeding and breeding areas as well as the zones frequented by protected marine mammals.

10.1.2.3. Ornithology

The cable route passes to the north of the protected Natura 2000 zone of the 'Bancs des Flandres'. This is designated an area of importance by la Directive Oiseaux as a bird feeding zone, a passage of migration and an area of hibernation. However the vessels linked to both installation and operation should not have any more impact on the migration or feeding habits of birds than the vessels routinely using this area.

10.1.2.4. Marine mammals

No protected marine mammal species frequent the sandbanks of this area.

10.1.2.5. Conservation designations

With regard to the Habitats Directive for this element of the Project, the impacts on the flora and fauna will be temporary and localised.

10.1.3. Human Environment

10.1.3.1. Shipping and Navigation

In France the cable route crosses an important navigational channel used to separate the vessels entering and leaving the Belgian ports. The impacts on shipping traffic are linked to the presence of cable laying vessels which have restricted capacity for manoeuvre and travel at low speeds crossing the path of vessels using the navigational channel. The presence of vessels could therefore create a temporary disruption to the control of shipping traffic in this area, both during the cable laying process with slow moving vessels crossing the path of navigation and during operation when maintenance vessels will be stationary with a safety zone of 2km.

This impact will be reduced by ensuring that cable joints, which will require the presence of stationary vessels for connection and maintenance, are not placed in the navigational channel. In addition, shipping routes are submitted in advance to CROSS Gris-Nez and the Préfecture Maritime de Cherbourg; during cable laying operations this information can be used to redirect marine traffic.

As with the navigational channel, the presence of installation or maintenance vessels may cause a temporary disruption to vessels accessing commercial fishing zones. However, the distribution of fishing zones is vast and local fishing has a tendency to be situated in coastal areas. In addition, the season with the greatest fishing activity tends to be during the fourth quarter, whereas the most favourable period for cable laying is from April to October. The impact on fishing will therefore depend upon whether the cable laying activities can be limited to a timescale outside the main fishing season.

10.1.3.2. Cables and pipelines

The Tangerine communications cable route, situated in French territorial waters, lies 250m to the east of the Nemo Link cable route. However the recommended secure distance between underwater installations has been respected, therefore the impact is negligible. There are no other cable crossings within French territorial waters.

10.2. Offshore Cable Installation in Belgian Waters

Cable installation continues in Belgian waters in the same way with the same type of cables as those discussed in Chapter 4 (Description of Proposed Development) as there is one unified process across the Project. This length of cable installed in Belgian waters is approximately 60 km.

A summary of the findings of the Belgian environmental assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

A semi-quantitative approach has been taken in performing the assessment. The effects are described in relation to their size, their range (dimension) and their temporary or permanent character. In the impact assessment, distinction has been made between effects during construction, operation and potential decommissioning. Knowledge gaps and possible mitigating measures have also been indicated. Attention has been given to both the negative and possible positive environmental effects.

Further information regarding the offshore elements of the project in Belgium can be found in the Non-Technical Summary document within Appendix 14.

10.2.1. Physical Environment

10.2.1.1. Geology and seabed processes

In Belgium sand waves are located at several locations along the route, rising up to 6 m above the surrounding seafloor. The sand waves are usually covered with smaller ripples. Pre-sweeping will result in an increased turbidity and sedimentation in the vicinity of the works. However, because of the limited volume of sand to be moved and because of the high mobility and dynamics that sand waves already naturally exhibit, the impacts on sediment from pre-sweeping is considered small.

At crossings with other cables and pipelines, protective measures and bridges are proposed. In Belgian waters five existing cables and one pipeline need to be crossed. The protective measures disturb the original geological structure. However, given the very limited size of the protective measures, this effect is very limited.

No effect is expected on sediment quality due to accidental discharges from ships and machinery during construction or due to loss of pollutants from the cables or from crossing infrastructures.

10.2.1.2. Water quality

During pre-sweeping operations for cable burial and cable burial itself, there is potential for an impact on water quality arising from the release of existing heavy metals and organic pollutants within the sediment. As the pre-sweeping involves removal of coarse sediments with a low percentage of fine and organic material and consequently low concentrations of heavy metals, this effect is considered negligible. A temporary increase in localised turbidity will also arise from these activities. No long term effects are expected and this will be minimised by carrying out installation in quiet (low flow) weather when the natural turbidity is low and which will allow for quicker sedimentation of the disturbed seabed material.

As part of the overall safety system, there will be a clear procedure available which defines the roles and responsibilities and actions to be taken if an emergency should arise during installation, operation or decommissioning that could adversely affect water quality (e.g. oil spill).

10.2.2. Biological Environment

10.2.2.1. Benthic ecology

In Belgium both during the preparatory work and during cable laying the impacts upon the benthic habitat is considered negligible due to the size of the area affected and the temporary nature of the activities. Permanent habitat loss is unlikely to occur as the cables are entirely laid below the seabed at a minimum depth of 1 m and the benthic communities mainly occur in the first 20 cm of the sediment. It is anticipated that following construction, a natural recovery of the benthic community will occur in areas where there has been small scale disturbance. The effects on fish in relation to ground disturbance are less pronounced due to the mobility of the species.

There are considered to be no significant impacts upon benthic species due to warming of the cable and the surrounding seabed during operation due to the burial depth and, as the majority of benthic species reside within 20 cm of the surface of the seabed, the cooling effects of the seawater.

The potential effects of localised and temporary increases in turbidity upon benthic communities and habitat are considered negligible due to the existing ecosystem being well adapted to a sandy surface that is naturally in motion, the high mobility of fish species present and the limited size of the impact zone.

During the operational phase, an electromagnetic field (EMF) will be generated around the HVDC interconnector. The impacts of EMF on the benthos are largely unknown. EMF can be detected by and affect certain sensitive species, but the extent of the impacts are not yet fully understood and there are thought to be variations at the individual level within species. Given the very local nature of the generated EMF during operation, the rapid decrease of field strength in relation to distance from the cables and the reduction of exposure of sensitive species as a result of cable burial (which creates a physical barrier of some thickness), the potential effects are considered to be minor.

10.2.2.2. Ornithology

Local seabird populations are accustomed to foraging in turbid water, and most species feed close to the surface. Therefore, the effects of increased turbidity and sedimentation on birds are considered to be small.

The increased presence of vessels and machinery can cause a temporary disturbance of birds, especially at the landfall. However, due to the proximity of the port of Zeebrugge to the landfall area, the area already contains a relatively high activity/disturbance level primarily from busy shipping traffic. Therefore the effects upon birds are thought to be negligible.

10.2.2.3. Marine mammals

No long term effects due to disturbance or noise are anticipated upon marine mammals or their migratory patterns in Belgian waters. It is expected that marine mammals will temporarily avoid the area during construction. Short term effects from this avoidance of the area are considered minor to negligible.

10.2.2.4. Conservation designations

No significant impacts are predicted on the special protection areas SPA3 and SPA2 or the future SAC 'Vlaamse Banken'. Similarly no significant impacts on the quality of the habitat of porpoises are predicted during the construction, operation or decommissioning phases.

10.2.3. Human Environment

10.2.3.1. Landscape and visual

In Belgium during the preparation work and the actual installation of the HVDC interconnector there will be a short term visual change of the seascape due to passage of several vessels and a temporary landscape change at the landfall. The perception of these activities can be assessed as negative (disturbance) or positive (point of interest). Both impacts are temporary and the impact is therefore considered to be negligible. Methods of communication with the public are to be explored to provide informative information regarding construction activities.

10.2.3.2. Archaeology

The positions of known wrecks were avoided during cable routing following consideration of the available data. Existing data was verified against the Side Scan Sonar data originating from the geophysical surveys which also served to identify previously unknown wrecks to maximize avoidance of these historic features and minimise any potential impacts. If a previously unidentified wreck is discovered during construction, the competent authorities will be informed as soon as possible.

10.2.3.3. Commercial fisheries

Disturbance to fishing grounds during construction is considered to be limited and temporary during the construction phase. Fishing grounds will be inaccessible during construction within a given distance from installation activity and associated works.

Potential damage to the cable caused by use of fishing gear is considered to pose a minimal risk at the burial depths anticipated. The Project is located in an area with existing subsea cables present.

No safety risks arising from damage to the cables are expected given the small risk of occurrence and the security mechanisms within the converter station.

10.2.3.4. Tourism and recreation

Only minor negative effects are anticipated on tourism and recreation offshore during construction. The use of safety zones during construction means that a short term disturbance to recreational sea users may be experienced. The effects of this disturbance will be temporary and are considered to constitute a minor impact. The safety zones will be actively monitored during construction and communication with the coastguard will be maintained.

10.2.3.5. Military areas

Communication will be maintained with the maritime agencies during the installation of the HVDC interconnector in the vicinity of the designated military areas.

10.2.3.6. Cables and pipelines

If necessary, out of service telecommunication cables may be cut to allow for cable installation during construction. If this occurs, the appropriate health and safety and environmental precautions will be taken.

10.3. Onshore Installation in the UK

The onshore UK elements of the project include the construction of an electricity converter station and substation located in Richborough, Kent, and the installation of underground electricity cables from the

landfall to the converter station. The site is located approximately 4 km to the southwest of Ramsgate, 3.5 km north of Sandwich and 1.6 km inland from the east Kent coastline.

The purpose of the converter station is to convert between DC (of the interconnector) and AC (of the UK's transmission system). The substation is necessary to connect the converter station to the grid. The converter station will require a footprint of approximately 5 ha and the substation a smaller footprint of 2.65 ha. The onshore cable route which connects the landfall to the converter station is approximately 2.3 km in length and will be installed using a mix of open trenching and HDD,

Further information regarding the UK onshore elements of the project can be found in the Non-Technical Summary document within Appendix 15.

A summary of the findings of the UK onshore environmental impact assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

The assessment covers the impacts of UK onshore elements of the Nemo Link which are the subject of a planning application, plus the grid connection that will be required to enable the Project to operate. The grid connection is being developed separately by National Grid Electricity Transmission plc and the route and technology to be used has not yet been determined. Accordingly, the onshore ES assesses the likely effects of a connection to a range of possible grid supply points, using either an overhead line or underground cable.

10.3.1. Physical Environment

10.3.1.1. Land use

In respect of land use, the construction of the converter station and substation will result in the permanent loss of approximately 8 hectares of derelict brownfield land. The converter station will occupy the footprint of the existing turbine hall and adjacent land. There will be no permanent land take from the installation of the cable, solely temporary disturbance. All effects upon land use during construction will be highly localised and temporary so will be of low significance. Where open space and land which is available for recreation and walking is disturbed, there will be alternative routes available and the absence of any facility will be short term and reversed after the reinstatement of the land. There is no defined ongoing land use and so there would be no adverse effects from the loss of the derelict land to the development.

10.3.1.2. Ground conditions and contamination

A number of potentially contaminated sites within the area of development have been identified, such as areas where there has been previous oil contamination. Due to the ground disturbance from construction activities, targeted investigation works will be undertaken in agreement with an Environmental Health Officer to assess the nature and extent of all known existing areas of contamination and develop appropriate mitigation measures prior to construction commencement. The risk of ground and water contamination from spillages of fuel, oil and chemicals and from the importation of contaminated materials from off-site will be managed by adherence to best practice guidelines enforced through the implementation of a Construction Environmental Management Plan which will be prepared to set out the minimum requirements which contractors will be required to undertake in order to prevent adverse impacts. Where there may be a potential for significant cumulative effects with the grid connection works in relation to ground conditions, the implementation of best-practice industry-standard mitigation and preventative measures will ensure that these effects can be avoided.

10.3.1.3. Hydrology

The hydrological assessment identified that there was a moderate potential impact upon the environment from the construction of the converter station as the area where the onshore components are sited is within an area of high flood risk. The potential risk of accidental spillage into controlled waters (tidal ponds and the BayPoint sports complex pond) situated close to the construction site was also identified to be of moderate significance. Also during construction, the increase of introduction of impermeable surfaces leading to

surface water run off and the material stockpiles and operations changing overland flood flow pathways were identified as being of minor to moderate adverse impact, the former being an impact that persisted during the operational phase of the converter station. A number of mitigation measures were proposed to address these potential impacts, such as pollution prevention measures which will be contained within a Construction Environmental Management Plan in line with the Environment Agency's Pollution Prevention Guidelines, and the development of a Spillage Emergency Response Plan to minimise the likelihood for spillages which would contain measures such as requirements for bunding of storage areas. In relation to drainage and potential effects upon surface water, drainage solutions have been suggested and built into the design of the substation and converter station. Following mitigation, all impacts formerly identified to be of moderate significance were deemed to be of minor significance,

Where there may be a potential for significant cumulative effects with the grid connection works in relation to hydrological and hydrogeological receptors, the implementation of best-practice industry-standard mitigation and preventative measures will ensure that these effects can be avoided.

10.3.1.4. Air quality

Wind-blown dust may be a short-term nuisance during construction resulting in the deposition of dust on the local area. Construction traffic may also be responsible for carrying dust and mud from the working area.

The construction process has the potential to include dust generating activities and a range of mitigation measures will be used during construction including site management, maintenance of equipment and vehicles used on site and the careful location of storage to avoid wind-blown dust. Following the implementation of these mitigation measures, effects on air quality resulting from construction traffic and other dust generating activities will be negligible.

10.3.2. Biological Environment

10.3.2.1. Ecology

No nature conservation sites of national or international importance will be directly impacted by the construction and operation of the converter station and substation. A number of designated sites are located along the proposed cable route and it crosses the designated areas at three locations along the route. Mitigation measures will be developed in consultation with Kent Wildlife Trust to minimise impacts on, and reinstate, the habitats within these sites.

The construction of the converter station and substation will not have a significant impact on nature conservation due to a lack of ecologically sensitive features within the site.

The cable has been routed to minimise effects on important species and habitats and site specific mitigation measures will be applied where valuable areas cannot be avoided. Those identified along the cable route include reptiles, amphibians and breeding birds and habitats such as (amongst others) saltmarsh and woodland. Water voles have also been identified but works will not affect habitats where these are present. Impacts affecting protected species will be short-term and mainly associated with site clearance during construction and temporary disturbance or loss of habitat. Habitats affected by the works will be reinstated to prevent long term habitat losses and botanical surveys will be repeated prior to the works to confirm the absence of protected plant species. Where necessary, licences to carry out the works will be obtained from Natural England. Potential disturbance to breeding birds will be mitigated by seasonal timing of construction works (to be agreed with the statutory authorities). Overall a minor adverse to negligible impact during construction is predicted. No impacts are envisaged during operation.

There is potential for cumulative ecological effects with the grid connection works on a number of SSSIs through habitat loss, habitat fragmentation and impacts on important species. However, such effects can be mitigated through detailed design and mitigation when the connection option is finalised. Environmental assessment work will also be undertaken for the connection option to determine the significance of likely effects and appropriate mitigation.

10.3.3. Human Environment

10.3.3.1. Heritage

There are no Scheduled Monuments, UNESCO World Heritage Sites, Registered Parks and Gardens or Registered Battlefields within 1.5km of the development area. A total of 165 designated and non-designated heritage assets were recorded, of which only 7 are designated receptors of high importance and 28 are non-designated receptors of medium importance. The remainder are of low importance. There is the potential for deposits from varying ages, to a greater or lesser degree. No significant impacts on above ground or shallow archaeological deposits are predicted, however, a watching brief is proposed during cable installation to identify the presence of unknown archaeological deposits. Where there may be a potential for significant cumulative effects with the grid connection works in relation to archaeological receptors, the implementation of best-practice industry-standard mitigation and preventative measures will ensure that these effects can be avoided.

10.3.3.2. Landscape and views

A moderate adverse visual effect is anticipated on the setting of Richborough Castle. The gently undulating landscape, existing vegetation, and local industrial context will help to reduce the intervisibility between the Proposed Development and the monument. A landscape scheme, to be implemented as part of the Richborough Energy Park proposals around the southern peripheries of the converter station and substation site, will further reduce intervisibility. Following the implementation of a programme of mitigation, the archaeological and cultural heritage resource within, and close to, the development site will remain unaffected and the overall impact of the scheme is not considered to be significant.

It is considered that the onshore components of the development will be consistent with the existing landscape character of the site and immediate surroundings and would match the scale of existing industrial built form. The existing landscape character of the underground cable route is generally urban as the route runs close to the A256 and the landscape will be reinstated following construction. The Zone of Visual Influence (ZVI), which encompasses the Stour Valley and Pegwell Bay, extends up to 10km inland due to the open nature of low lying ground in the valley floor views. However, views from the north and south have restricted views from natural and man made features. The majority of public and private visual receptors within the ZVI have existing views of the derelict frame of the former turbine hall building within the converter station and substation site.

Mitigation measures have been incorporated into the development proposals to mitigate effects on landscape and views during construction and operation, such as using colour graded cladding where the colours used would be sensitive to the surrounding environs as well as a native tree and shrub planting programme, amongst others. Taking into account the mitigation measures, the underground cable route is not considered to have any effect on landscape character or views 15 years after the reinstatement of land. The above ground cable route through the northern part of Pegwell Country Park will be quickly re-established as grassland resulting in a very limited negative effect on landscape and views after reinstatement. Following 15 years' establishment of the planting proposals surrounding the converter station and substation site it is anticipated that there would be a small negative effect on landscape character as the development would increase the extent of industrial development evident in the locality. However, the converter station and substation development would be consistent with the existing character of the A256 coastal corridor between Ramsgate and Sandwich and vegetation within the coastal corridor along with new planting to the site perimeter would help in accommodating the development in the landscape. Following 15 years' establishment of new planting to the site perimeter the greatest effect on public views would be from the section of the Saxon Shore Way adjacent to the converter station and substation site and by river users on the Stour also adjacent, although there will be partial screening from these viewpoints from planting, resulting in a reduced negative effect on these views.

The cumulative effects of the development have been assessed in combination with neighbouring proposals currently being developed for the remainder of the Richborough Energy Park site, including an internal road and a Peaking Plant Facility. The development of the wider Richborough Energy Park would be consistent with the character of A256 coastal corridor and following the establishment of new planting, there would be a small negative effect on landscape character. The greatest negative visual effects would be experienced by

a few sensitive visual receptors in closer proximity to the Richborough Energy Park site, particularly users of the Saxon Shore Way and river users to the immediate south of Richborough Energy Park, although the views from these locations would be similar to existing.

The significance of cumulative effects on landscape character and on views of the proposed converter station and substation in combination with all development proposals (excluding the solar farm) is considered as being no greater than residual effects (with landscape mitigation and after establishment) recorded in relation to the proposed converter station and substation. Upon completion (with landscape mitigation and after establishment), cumulative effects of the solar farm on landscape will result in a slightly greater adverse effect than reported for the proposed converter station and substation in isolation, but no greater than minor adverse overall. The cumulative operation effects with other unrelated projects on landscape and views are anticipated to be no greater than moderate adverse due to the presence of existing infrastructure in the surrounding area including three 132kV overhead lines, a wind turbine and two masts.

10.3.3.3. Traffic and transport

It is predicted that overall the long-term environmental impact of the Proposed Development on traffic and transport will be negligible, partly due to the introduction of a range of mitigation measures including traffic management during construction, appropriate signage in the local area and the preparation of a Transport Management Plan. There are likely to be a number of minor environmental impacts that cannot be fully mitigated during the construction phase, primarily including those relating to pedestrian and cyclist delay which will be addressed by signage and delivery agreements with routes to be agreed for construction and delivery traffic. This is likely to be temporary during the construction period and is not expected to continue during the operation of the converter station and substation.

The results of the study indicate that noise complaints would not be considered likely and the maximum noise effect, based on the results, would be considered to be small on the most sensitive receptors including local residents. The mitigation of any construction and operational noise has been taken into account in the assessment and would include best practice methods such as proper maintenance of plant and machinery on site, enforced through a Construction Environmental Management Plan and regular communication with local residents. In addition, the design of the Converter Station and Substation would include appropriate measures for sound reduction. Therefore, it is predicted that any significant noise, associated with the development, would be appropriately mitigated by these measures.

10.3.3.4. Coastal tourism, recreation and socio-economics

Indirect impacts on tourism and recreational activities would result from temporary disruption caused by construction activities. This would affect coastal recreational activities during the landfall and cable installation works at Pegwell Bay. However the duration of works in this area would be very short and the wider area of the Bay will provide undisturbed opportunities. Clearly signed temporary diversions will be in place so that coastal trails can remain open throughout the duration of the installation works and access to local amenities and parks will be maintained as far as possible. The reinstatement of the land following construction will mean that there is no permanent disturbance to access of features of tourism and recreational amenity.

There will be a very small number of permanent employment opportunities resulting from the development. The converter station is likely to operate with approximately 6 personnel per day divided between 3 shifts over a 24 hour period. The substation will operate unmanned with only occasional inspection and maintenance required. Converter station and substation personnel are required to be skilled workers and are therefore more likely to be recruited from existing workers in the electricity industry which will assist job retention. However, there would be a large number of construction jobs which would be temporary and short-term. These will be valuable to the local economy and the service industry supporting these temporary workers are also considered to benefit in the local area. Overall, construction is considered have a small benefit through the creation of temporary and permanent jobs locally and nationally.

10.3.3.5. EMF

The Nemo Link, when operational, will produce both alternating and direct currents, therefore both static and alternating electric and magnetic fields will be produced. The new converter station and substation will be designed to ensure that they are compliant with the relevant Code of Practice and UK Government guidelines. The cable installation techniques used will also be compliant with exposure limits. The assessment carried out regarding the likely impacts of the cable route, converter station and substation has demonstrated that no mitigation will be required because the EMFs are within UK Government guidance levels and there will not be any significant effects arising from the NEMO link.

10.4. Onshore Installation in Belgium

The Belgian onshore elements of the project are located in the administrative area of the city of Brugge, west of the harbour of Zeebrugge. They consist of the construction of an electricity converter station and connection to the existing Stevin substation in addition to the installation of underground electricity cables from the landfall to the converter station. The cables will be installed using a mix of open trenching and HDD,

The purpose of the converter station is to convert between DC (of the interconnector) and AC (of Belgium's transmission system). The substation is necessary to connect the converter station to the grid. The converter station will require a footprint of approximately 4.6 ha.

A summary of the findings of the Belgian onshore environmental impact assessment is presented in this section categorised in respect of those topics falling under physical, biological and human environment.

Further information regarding the UK onshore elements of the project can be found in the Non-Technical Summary document within Appendix 16.

10.4.1. Physical Environment

10.4.1.1. Soils

There is potential for the soils to be heated in the locality of the installed cable due to heat dissipation. This is partially mitigated by an insulating layer of dolomite. It is anticipated that this effect will be restricted to cold weather and, even in peak use periods, the temperature increase will remain less than 15°C.

There will be no significant soil profile degradation in the soil surrounding the trenches, which is mainly homogeneous in nature and has already undergone disturbance. Reinstatement of the original top layer of soils will occur and during construction steel planking will be used to minimise compaction of the clay components. No significant effects are expected at the converter station site as it is already paved and the results of ground investigations show that the only soils present are of anthropogenic origin. The re-use of any soils from the trenches will be recorded to minimise the risk of spreading any contaminated soil. Any soils identified as contaminated prior to construction will be decontaminated before works commence.

10.4.1.2. Water

The existing paved portion of ground will be halved by the construction of the development, which will consequently lead to an increase in infiltration (addition to the groundwater) and/or a decrease of surface area run-off. The proposed development will meet the urban regulation on rain water wells, infiltration facilities, buffer facilities and separate discharge of sewage and rain water.

Groundwater levels and flow are likely to be affected during open trench cabling work, however this is anticipated to be relatively small because of the low permeability of the soils. The cable route lies in an area with shallow salinised groundwater, however the duration and depth of the anticipated drainage during

construction is not of the degree that it will lead to an increase in salinity. There are potential for significant groundwater and surface water changes in the de Fonteintjes nature reserve in relation to composition (salinity) and overall level (potential for reduction). Mitigation measures will be applied in order to minimise the potential for this informed heavily by the results of the Appropriate Assessment. Furthermore, the use of dolomite (which is highly permeable) unlike the recipient soils, could cause a draining effect in some connecting grounds and ditches and could extend to the nature reserve. A number of mitigation measures have been proposed to minimise/prevent the above effect, such as re-pumping of groundwater to the site or application of clay plugs to limit the hydraulic contact between the two soil interfaces, amongst others. After mitigation has been applied, significant effects upon groundwater level and flow will be avoided.

10.4.2. Biological Environment

The proposed development is situated within a number of sites designated for nature conservation: an SPA, a Special Habitat Protection Area and a nature reserve. Impacts have been examined in relation to habitat loss, disturbance to birds, drying out and soil heating. These are discussed in summary below.

Temporary habitat loss could potentially occur prior to mitigation as a result of the storage of the ducts bundle, creation of the construction area, trench excavation and installation of jointing pits in the SPA. However, HDD installation will be used under the protected areas, thus eliminating the need for trenching. Furthermore, the ducts bundle will be stored partially at sea or installed on the beach, where possible, and onshore will be stored on the less biologically valuable arable plots. These measures significantly decrease the level of temporary habitat loss. Additionally, the vegetation will be reinstated upon installation of the cables. Permanent habitat loss will only be experienced as a result of the construction of the jointing pits and converter station. Because of the minimal area of permanent land take, and at the converter station site only affects biologically less valuable habitats, the impacts of this on biotopes are considered negligible.

Construction noise impacts upon birds are not considered to be significant given the temporary nature of the noise, the current ambient audible noise (and the subsequently more tolerant species already present), and the relatively limited number of sensitive birds. Operational noise levels will not reach as far as the SPA and therefore no significant impact is predicted.

For the reasons discussed in section 10.4.1 (Physical Environment) in relation to drying out of the nature reserve, the potential effects upon the habitat and species have been examined. Appropriate mitigation measures will be applied in order to minimise the potential for this informed heavily by the results of the Appropriate Assessment.

Soil heating, also discussed in section 10.4.1 (Physical Environment) if left unmitigated has the potential to speed up the growth of vegetation and may also contribute to the drying out effect. However, due to the installation of a protective dolomite layer which significantly minimises the heating effect, this is not considered to give rise to a significant adverse effect on the natural features present.

10.4.3. Human Environment

10.4.3.1. EMF

The HVDC cables installed will generate EMFs, however the electrical field is considered to be almost completely screened off by the metal screens on the outside of the insulation around each conductor. Magnetic fields conversely are not and further mitigation measures have been required, involving significant neutralisation from the laying of 2 cables close to one another. In relation to the converter station, the equipment is shielded by the converter building which significantly reduces the EMFs. No cumulative impact is anticipated with the future Stevin substation located in the vicinity of the Belgian onshore components of the Nemo Link.

10.4.3.2. Landscape

In the area covered by the Proposed Development, there are no protected landscapes, village views, demarcated anchorages or heritage landscapes. The project has no visual relationship with the protected area in the beach district northwest of the proposed converter station. Visual disruption during the construction phase is caused by the presence of temporary site buildings and soil storage. Upon completion of the work, the surface will be restored to its original condition, linking it up with the existing micro-relief. Because of the temporary nature of the impact, this is not considered significant. The jointing pits are constructed completely underground, although the associated inspection pit will be visible above ground. As the size of the pit and the height of the structure above ground level are limited, there will be no significant visual disruption. For landscaping reasons, erecting a high fence around the inspection pits is not deemed desirable. The former military area has an industrial character, which is further enhanced by the presence of the harbour infrastructure and activities in the surrounding area. It is expected that the erection of a converter station in this area will have little impact on the character of the surrounding landscape. However the architectural and landscaping design of the converter station has been developed to fit the building into the landscape as naturally as possible. In relation to cumulative effects, it is expected that the Stevin substation will cause a potentially greater visual disruption on sensitive receptors than the Nemo Link Belgian onshore components, however it is considered that cumulatively the effects will be relatively limited.

The Central Archaeological Inventory shows that no archaeological finds have so far been reported in the area covered by the Proposed Development. The beach is subject to the effects of tidal movements, and therefore the chance of any archaeological finds in this area will be virtually non-existent. During HDD cable installation, the potential risk upon archaeological heritage are deemed fairly limited, however, an archaeological investigation will be carried out for the part of the HVCD cable that will be installed in an open trench in consultation with the relevant Belgian archaeological agency. Effects upon potential archaeological deposits are considered more unlikely in areas where the soil has already undergone significant human disturbance in the past. In these locations, there will be no archaeological watching brief.

10.4.3.3. Noise

Current audible noise quality at the converter station site already exceeds Belgian standards during the day, although levels are met overnight. It has been concluded, following analysis, that the converter station (after implementing a series of mitigation measures) will have a negligible effect upon ambient noise levels. During the night, it is anticipated that an increase to ambient noise perceptible to the human ear may occur at one measuring point. A cumulative impact assessment was undertaken in relation to the future Stevin substation located in the vicinity of the Belgian onshore components of the Nemo Link. Following mitigation measures, during the day and evening it was concluded that the total cumulative noise impact on top of the existing ambient noise is negligible, however a new study in relation to this will be completed once further details of the Stevin project have been determined. In relation to residents, exposure to human receptors is considered to be a minor negative from construction noise as the audible noise will comply with the relevant Belgian legislation, the effects are temporary, the existing ambient noise is of a high level and, noise reduction measures can be taken. Operational noise will not reach residential receptors.

10.4.3.4. Socio-economics and Tourism

There are considered to be limited impacts upon the residential human population as the project is largely non-residential, and is primarily set in industrial, ex-military and agricultural land. In relation to human agricultural activity, the potential for land take has been assessed. Once trenching has been backfilled, farming activities can be resumed for both grazing and crop cultivation. Compensation will be arranged in accordance with the protocol agreed between Elia and the agricultural organisations to the farmers who are adversely affected, although adverse effects are considered limited. There are considered to be no further land take issues which affect the human population.

Tourism and leisure users of the beach and cycle paths, and residents living along Evendijk West and Veerbootstraat may be considered to be affected by temporary visual impacts cabling and converter station construction. Because of the works' temporary nature, these impacts are considered limited. Following construction, only the inspection pits will be visible along the HVDC link, although this is not considered significant because of the limited size of the pits.

11. Conclusions

The purpose of this chapter is to summarise the potential impacts the cable route may have on the environment. The significance of individual impacts is considered before and after the application of the proposed mitigation measures.

11.1. Impacts and mitigation

As discussed in Chapter 5 – Environmental Assessment Methodology, the potential impacts of the UK marine elements of the Nemo Link on the environment have been assessed against the baseline conditions. The significance of the impacts has been discussed in detail in each chapter and are summarised in Appendix 6. Table 10-1 below provides a summary of the moderate and significant environmental impacts, the proposed mitigation and the associated residual impacts.

Table 11-1: Summary of potential impacts before and after adoption of proposed mitigation

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
6 Physical Environment				
6.1 Geology	No significant impacts	-	-	-
6.2 Bathymetry and Seabed Processes				
6.3 Water Quality				
7 Biological Environment				
7.1 Designated Sites	Disturbance of internationally designated areas (SACs and SPAs) due to installation of cables	Moderate	Avoidance of most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats.	Minor
7.2 Ornithology	No significant impacts	-	-	-
7.3 Marine Mammals	No significant impacts	-	-	-
7.4 Benthic and intertidal ecology	Disturbance of <i>Sabellaria</i> reefs during pre-lay grapnel run	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	Disturbance of <i>Sabellaria</i> reefs by anchors of the cable laying barge	Moderate	Vessels to be positioned and anchors deployed accordingly.	Minor
	Disturbance of <i>Sabellaria</i> reefs during cable trench excavation and cable burial	Moderate	Route designed to avoid reef by an appropriate distance in line with guidance from Natural England.	Minor
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fauna and displacement of benthic habitat	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
7.5 Fish and Shellfish Ecology	Disturbance and/or smothering of spawning and nursery grounds of the most sensitive species (most notably herring) that deposit demersal eggs/larvae during pre-sweeping of sand waves and the pre-lay grapnel run and during the cable laying	Moderate	Installation in relevant substrates (e.g. gravel) will occur in months least sensitive for spawning and nursery (e.g. February to October) where practicable.	Minor
	External cable protection may cause substrate change in that the sandy sediment will be buried by hard substrate, resulting in localised disturbance of fish communities	Moderate	Minimise use of rock protection. Note that although the impact upon substrate change would be moderate, the use of rock protection is likely to act as a fish aggregation device and increase species abundance and diversity. The effect is localised to the cable crossing.	Moderate
8 Human Environment				
8.1 Commercial Fisheries	No significant impacts	-	-	-
8.2 Shipping and Navigation	Risk of another vessel colliding with an installation or decommissioning vessel	Moderate	<ul style="list-style-type: none"> - Safety information will be promulgated by the installation contractor and will include descriptions of the operation and operation area and will regularly be updated - Establishment of 500m by 1000m Safety Zone around spread. - Two guard vessels shall be assigned to the installation spread - Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). - Vessels to comply with Collision Regulations lighting and marking requirements 	Minor
	Risk of electromagnetic interference from the cable affecting a navigating vessel's magnetic compass and causing compass deviation leading to navigational error and grounding	Moderate	Measurement of electromagnetic interference to ensure within accepted limits of less than 5 degrees deviation	Minor
	Risk of damage to cable, vessel or injury to persons on board during emergency anchoring event where the anchor then snags the cable	Significant	Charting of cable. And ensuring cable is buried to suitable depth.	Moderate
8.3 Archaeology and Cultural Heritage	Damage or destruction of submerged prehistoric material below the seabed during cable installation	Moderate	Based on analysis of the relevant survey data, little material of interest was discovered. Where material was found in a single core sample information about the submerged prehistoric resource is being gained from testing and analysis of the core.	Moderate

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
	Damage or destruction of A1 archaeological receptors (wrecks and geophysical anomalies of archaeological interest) and A3 receptors (historic records of possible archaeological interest with no corresponding geophysical anomaly)	Significant	All known wrecks have been avoided in the cable route design. Temporary exclusion zones will be placed around A1 geophysical anomalies during construction where practicable and buffers with a radius of 100m around the gazetteer points will be placed around A3 wrecks of archaeological potential. The locations can also be included in installation planning stages for example during locating anchorages.	Moderate
	Damage or destruction of A2 archaeological receptors (geophysical anomalies) during installation	Significant	A Written Scheme of Investigation (WSI) will address pre-installation and installation activities, such as the grapnel run, and may also include a protocol to substitute for a watching brief offshore. A2 archaeological receptors (geophysical anomalies) in the direct path of the cable route will be considered through the WSI and Archaeological Reporting Protocol.	Moderate
	Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites) during installation and decommissioning	Significant	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	Moderate
	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment during installation and decommissioning	Significant	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	Moderate
	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment through changes to erosion regimes due to bridging structures at the cable crossing	Moderate	Changes are expected to be minimal. Should bridging structures be used in areas in close proximity to known archaeological features monitoring of sediment mobility may assist in providing further information on the feature and act as a form of compensatory mitigation.	Minor
	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts through use of anchors during maintenance and decommissioning activities	Significant	Exclusion zones will be maintained around five known wrecks and will prohibit development related activities within their extents. 100m radius buffers will be placed around wreck sites of archaeological importance that are recorded in UKHO data, but that were not identified in the geophysical data. Any material discovered will be dealt with through the Archaeological Reporting Protocol	Minor
	8.4 Cables and Pipelines	No impact is expected	-	-
8.5 Military and other sea users	No impact is expected	-	-	-

Chapter	Potential Impacts	Significance	Proposed mitigation	Residual Impact
8.6 Unexploded Ordnance	The risk of encountering unexploded ordnance is low	-	-	-
8.7 Tourism, Recreation and Amenity	No significant impacts	-	-	-

The table above indicates that few of the impacts assessed have been determined to have the potential to cause moderate or significant impacts and almost all impacts can be reduced to have a minor impact when mitigation is applied.

Impacts upon designated sites and ornithology have been limited by routing the cable system to avoid the areas of greatest sensitivity. Impacts could be further mitigated by avoiding installation works in the intertidal areas in the key months of sensitivity and this will be done wherever practicable.

In order to avoid impacts upon sensitive and important features of benthic ecology the cable system has been routed to avoid areas of *Sabellaria spinulosa* aggregations by distance of 90m for the larger reef and 150m for the smaller area, which has been agreed in consultation with Natural England. Contractors will also be advised of the location of these features to ensure that deployment of anchors can be planned accordingly. The project intends to limit the use of rock placement to cable crossings which will limit the area of substrate change.

The impact assessment for fish species has concluded that herring spawning areas could suffer moderate impacts from the installation works as herring only spawn upon gravel seabed sediments for three months of the year. Therefore, it is proposed to avoid the key spawning period (November to January).

Assessment of impacts upon shipping and navigation has concluded that there is potential for moderate impacts/risks to navigation from vessel anchors snagging the cable system. This can be reduced by cable burial and ensuring the location of the cable system is marked on navigational charts. Although these mitigations are expected to avoid such an impact, the potential consequences of such an incident mean that it is not possible to reduce this to a level of minor or negligible significance.

The potential for encountering features of archaeological interest has been considered in detail and where the location of features is known these have been avoided such that no impacts can occur. Although detailed analysis of the geophysical survey data has been undertaken it is still possible that undiscovered and unknown features of archaeological importance could be impacted by installation works and this is why many of the impacts detailed cannot be reduced below a moderate level.

An environmental management plan will be produced prior to construction commencing to ensure that contractors are aware of the proposed mitigations and measures are in place to ensure the mitigation detailed is applied.

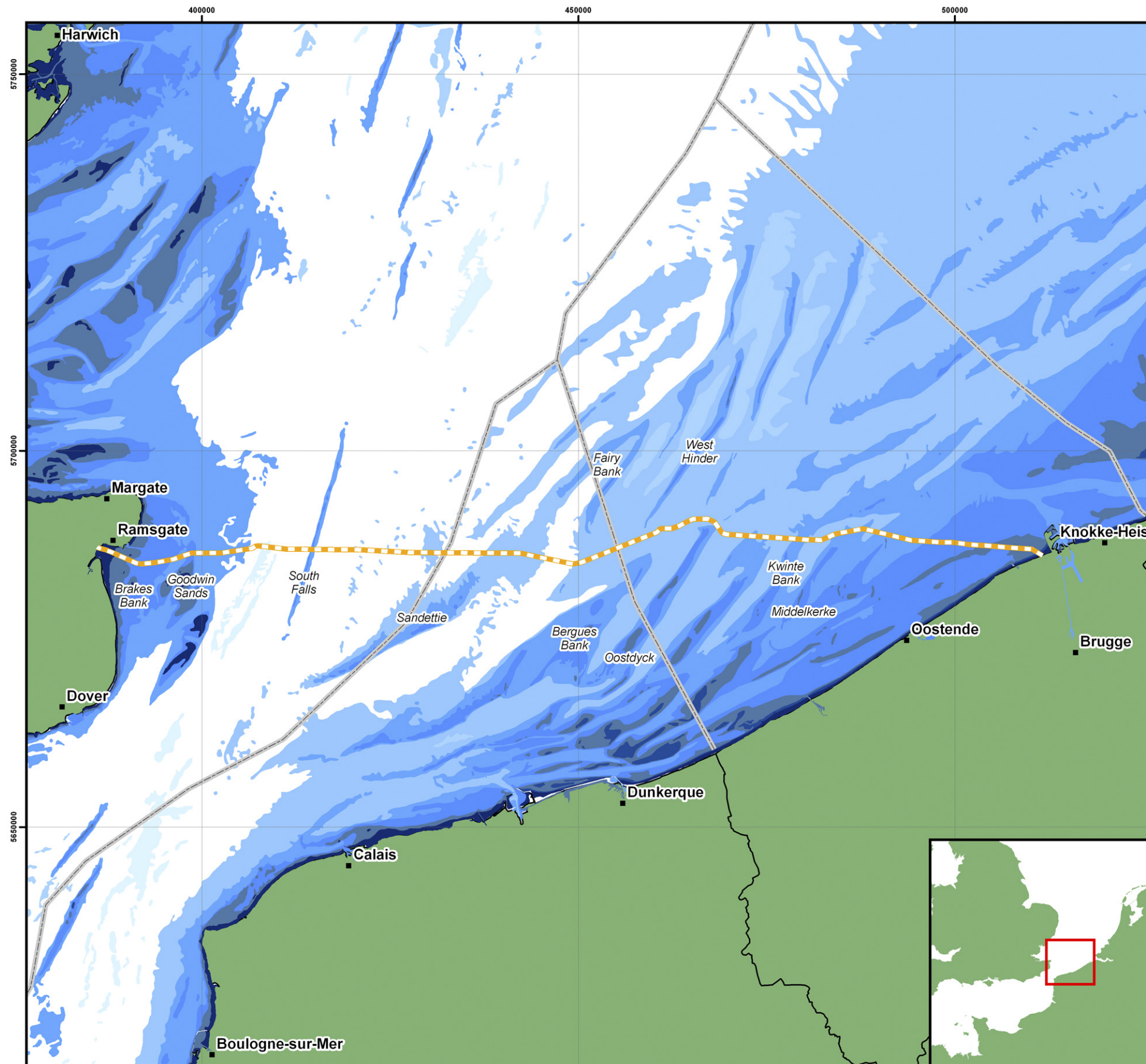
11.2. Monitoring

Following installation, the burial of the cable will be monitored via planned burial surveys that will include geophysical survey to assess the bathymetry and ground conditions and use of an ROV to determine the cable burial depth.

The first post installation survey will be used to ensure the ground along the cable system installation is clear of debris to satisfy the requirements of the fishing industry.

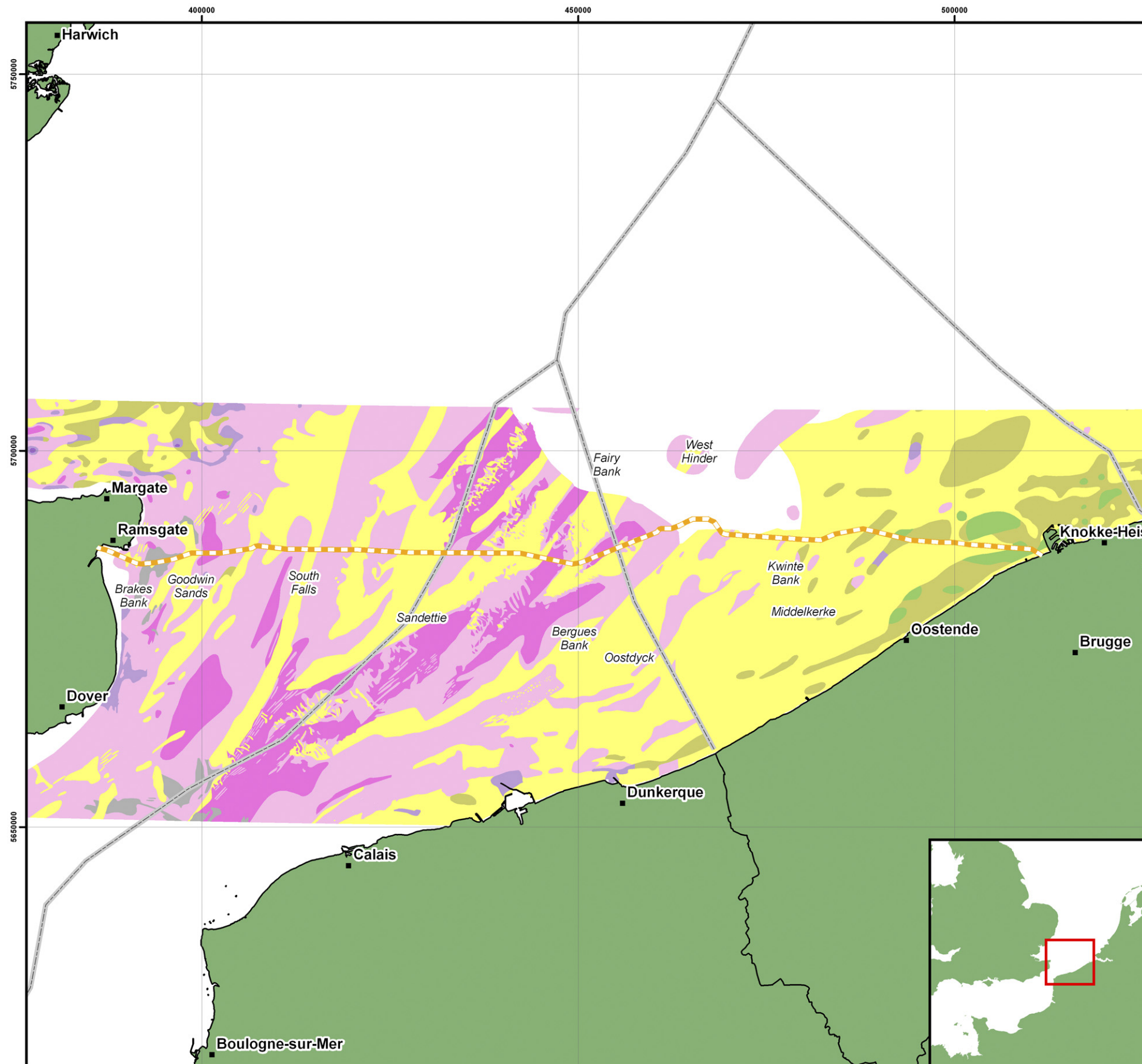
As the potential impacts on ecology detailed above are limited to the installation phase, which is of short duration, and features are expected to recover well it is not considered that monitoring for impacts on biological features will be meaningful.

Appendix 1: Figures



©MUMM

NEMO		
Bathymetry		
<p>— Maritime Boundaries</p> <p>--- Cable Route</p> <p>Bathymetry (mCD)</p> <ul style="list-style-type: none"> 0 2 5 10 20 30 40 50 60 		
Figure No. 6-1-1	Date 26/05/2011	Revision 003
Author dde	Check rjsw	Scale @A3 1:500,139
Data Source MUMM	Projection System UTM Zone 31N	
Spheroid WGS84	Datum WGS84	
<p>0 6 12 18 24 km</p> <p>0 3 6 9 12 nm</p> <p><i>Do not scale this drawing author to be notified of any discrepancies on this drawing. This drawing is copyright.</i></p>		



NEMO

Surface Geology

Maritime Boundaries
 Cable Route

Sediment Type

- Mud
- Gravel
- Mud, Gravel
- Sand
- Sand, Mud
- Sand, Gravel
- Sand, Mud, Gravel
- Rock

Figure No. 6-1-2	Date 26/05/2011	Revision 004
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Spheroid WGS84	Datum WGS84	

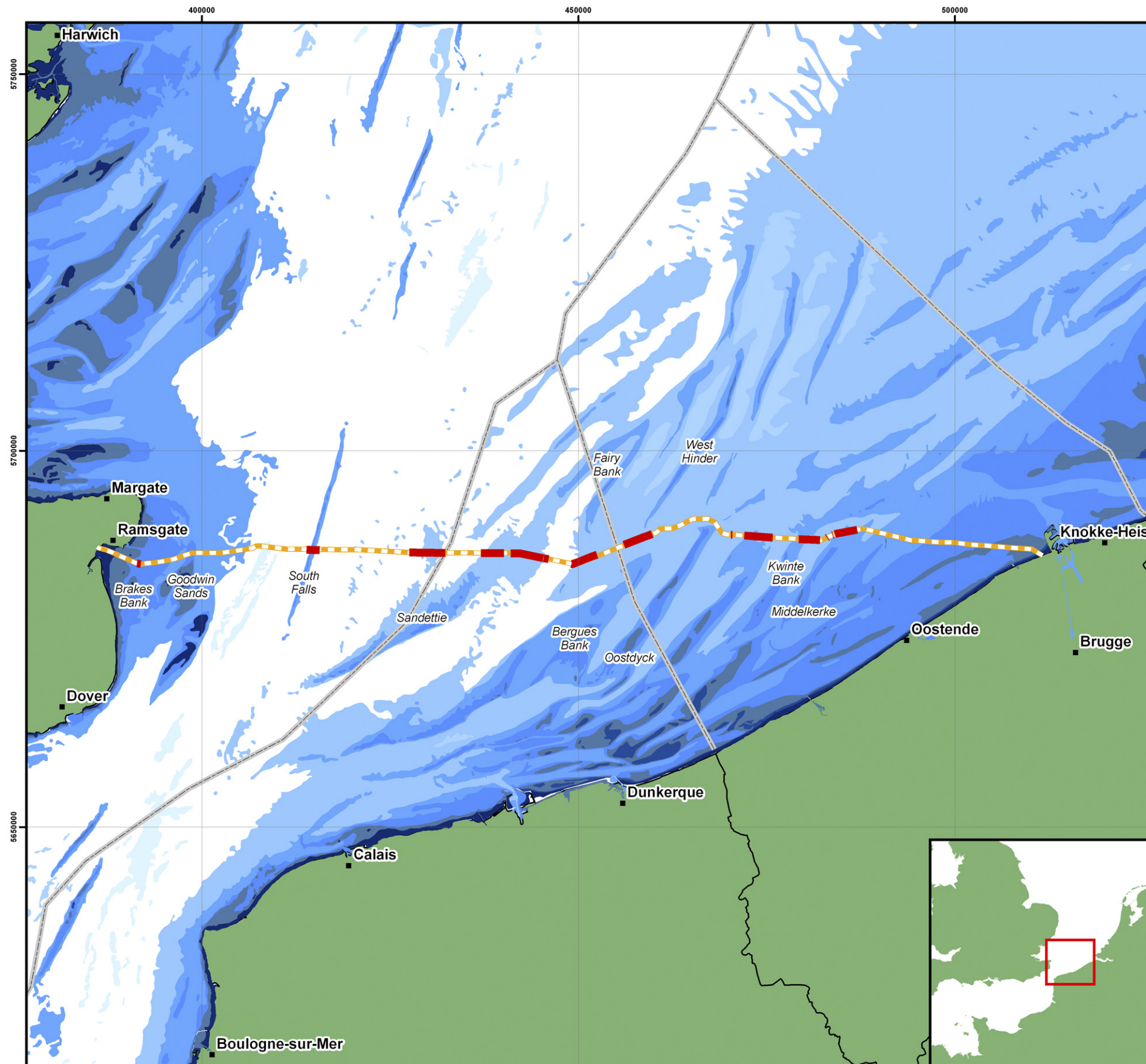
0 6 12 18 24 km

0 3 6 9 12 nm

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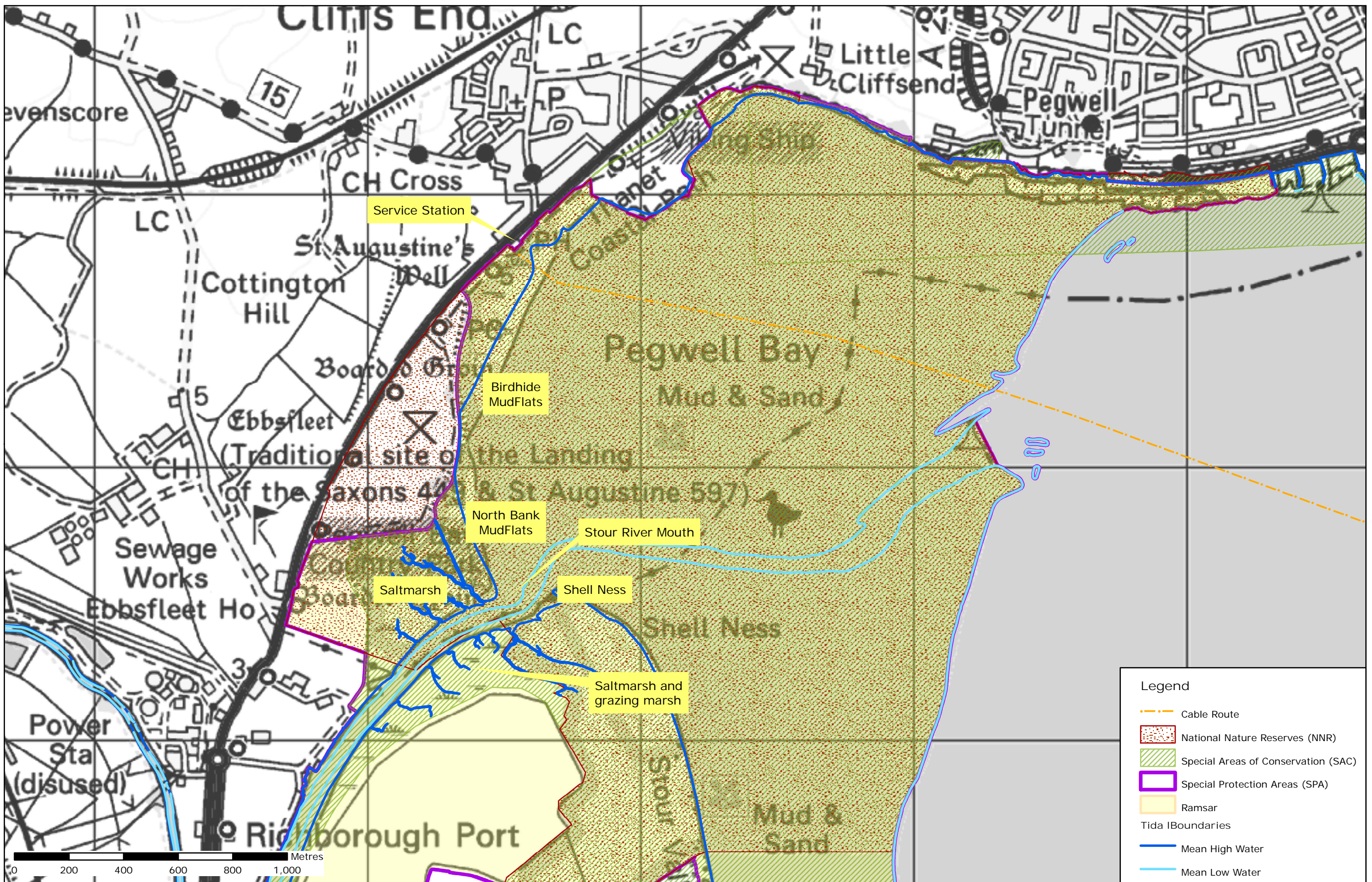
Powering a world in progress

Working with water

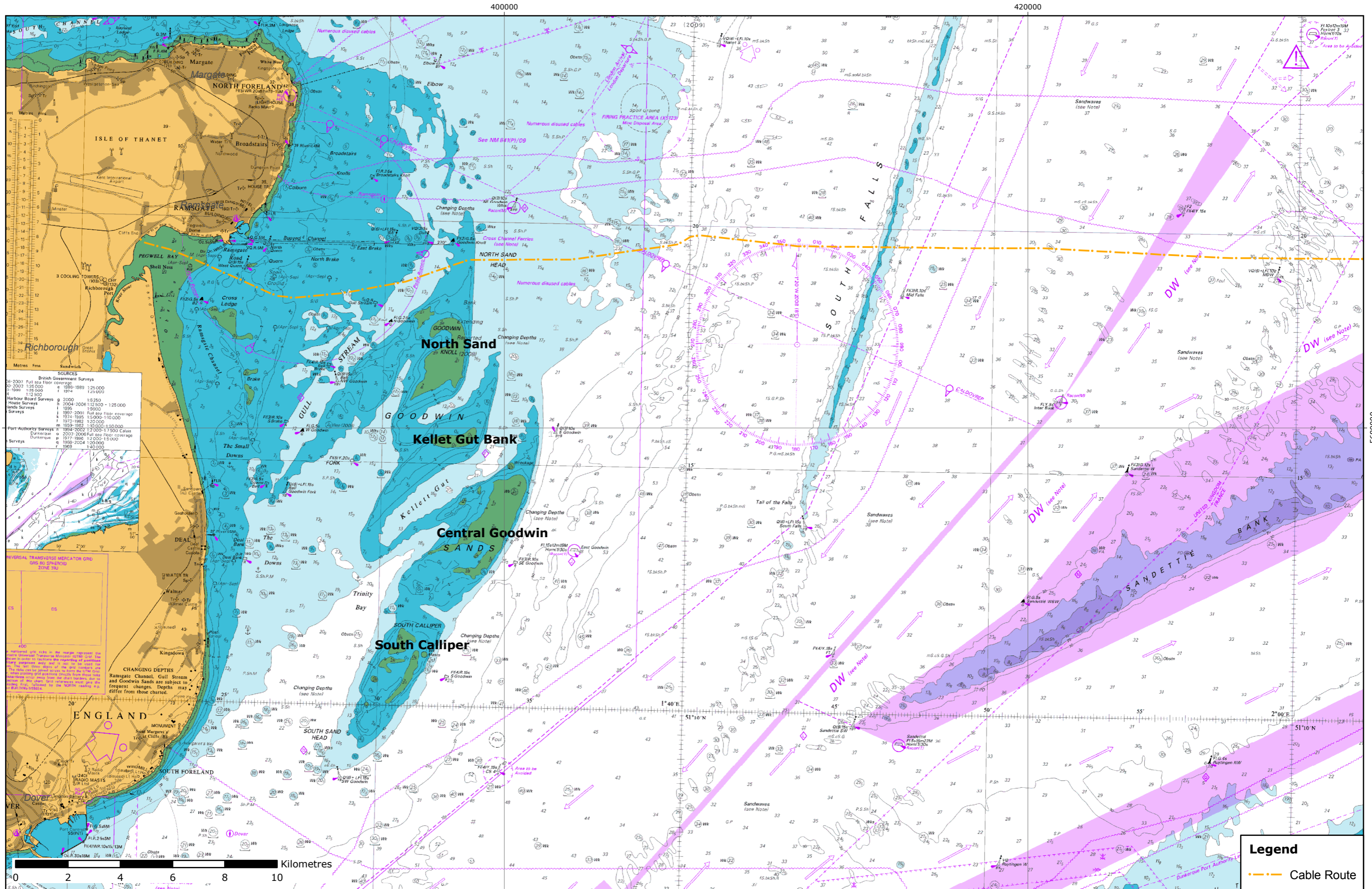


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NEMO		
Proposed Dredge Locations		
	Dredging Locations	
	Maritime Boundaries	
	Cable Route	
Bathymetry (mCD)		
	0	
	2	
	5	
	10	
	20	
	30	
	40	
	50	
	60	
Figure No. 6-2-1	Date 26/05/2011	Revision 002
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Spheroid WGS84	Datum WGS84	
<small>Do not scale this drawing author to be notified of any discrepancies on this drawing. This drawing is copyright.</small>		
		 Powering a world in progress
		 Working with water



NEMO		Figure No. 29689/2030	Date 25/05/2011	Data Source Seazone The Crown Estate Natural England JNCC	Projection System British National Grid		Client: elia Powering a world in progress	nationalgrid	PMSS
Figure 7-2-1: Illustration of areas of within Pegwell Bay		Author NDU	Check SAV	Scale @A3 1:12,500	Datum OSGB36		Spheroid Airy 1830		



NEMO

Figure 7-3-1 : Harbour seal and grey seal haul-out sites

Figure No.
29689/1988

Author
NDU

Check
SAV

Date
05/05/2011

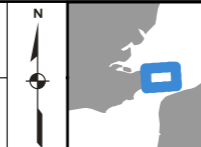
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Data Source
Seazone
The Crown Estate

Projection System
UTM Zone 31N

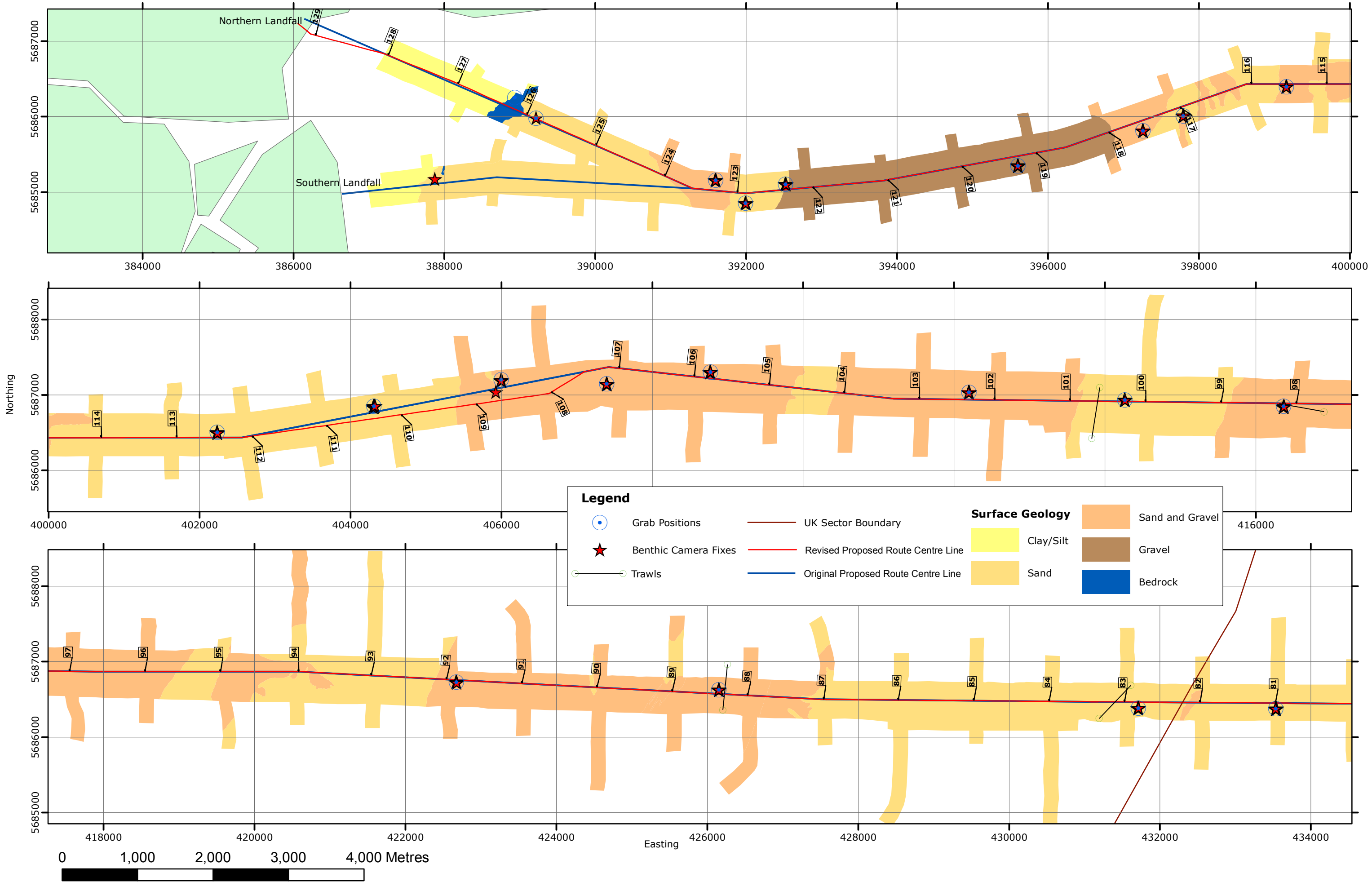
Datum
WGS84

Spheroid
WGS84



Client:  **nationalgrid**





Project Nemo - Benthic Environmental Survey

Environmental Sampling Positions

Figure No.
7-4-1

Date
21/02/2011

Data Source
MMT, 2010a; 2010b

Projection System
UTM Zone 31N

Author
GM

Check
FC

Scale @A3
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Datum
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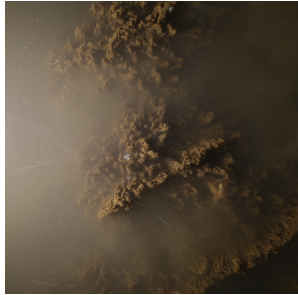
Spheroid
WGS84



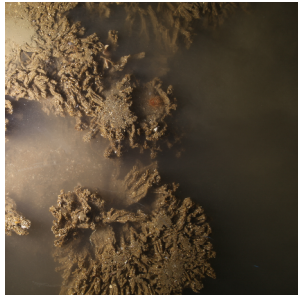
Client: 
Powering a world in progress



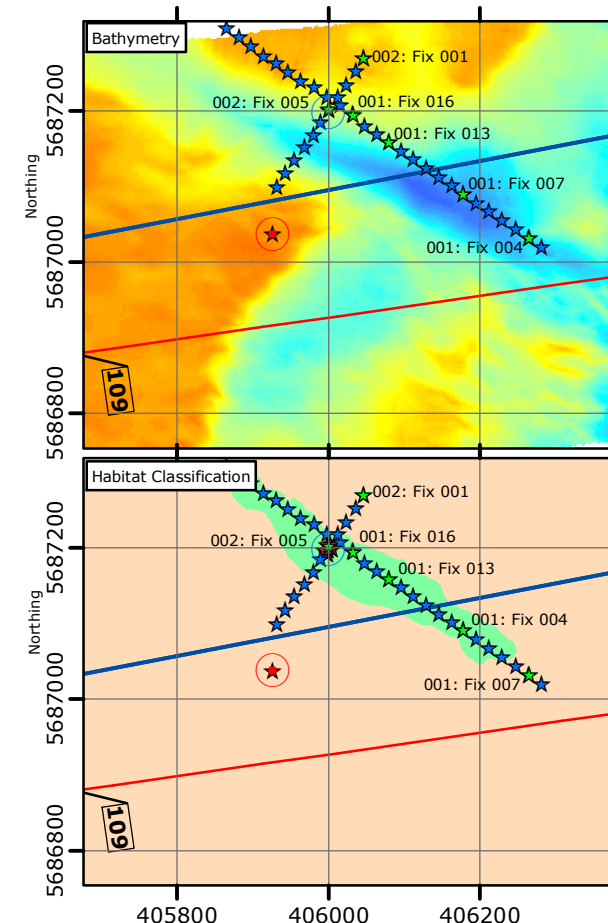
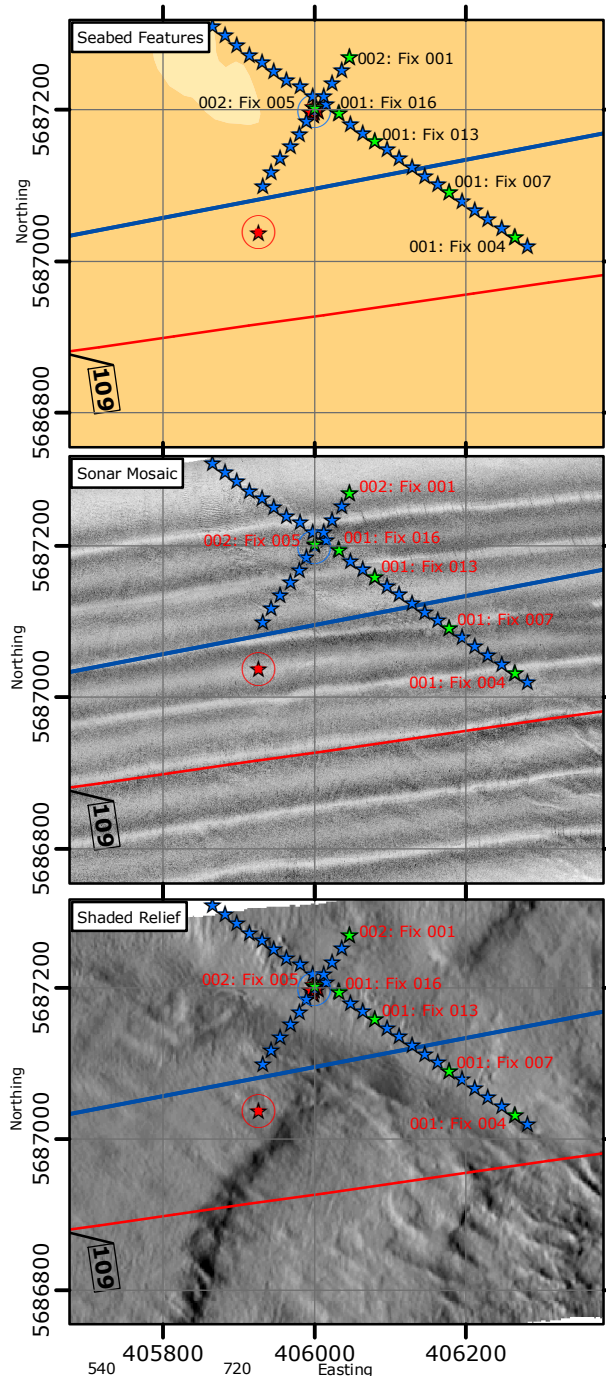
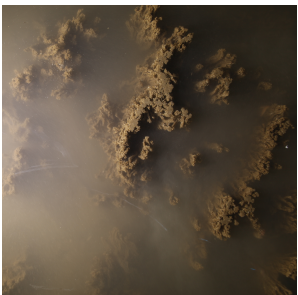

Transect B03-039_001 Fix 007
Sabellaria sp. present as large elevated colonies



Transect B03-039_001 Fix 013
Sabellaria sp. present as large elevated colonies



Transect B03-039_001 Fix 016
Sabellaria sp. present as elevated colony patches



Legend

- Proposed Grab Position (Red star in circle)
- Actual Grab Sample (Blue star in circle)
- Photos_presented (Green star)
- Transect Camera Fixes (Blue star)
- Benthic Camera Fixes (Red star)
- Revised Proposed Route Centre Line (Red line)
- Original Proposed Route Centre Line (Blue line)

Surface Geology

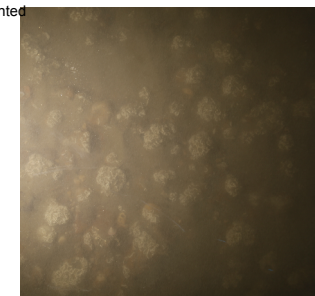
- Sand (Yellow)
- Sand and Gravel (Orange)

EUNIS Habitat Classification

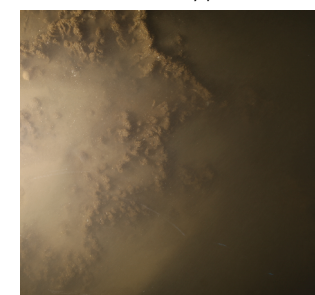
- A5.25 Circalittoral fine sediment (Light orange)
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Green)

Light Position
Azimuth: 270
Vertical: 45

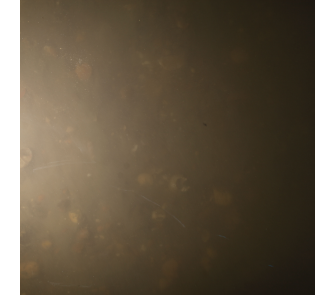
Transect B03-039_002 Fix 001
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



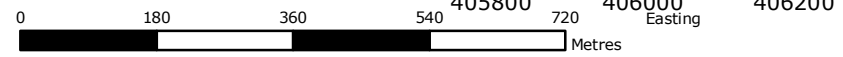
Transect B03-039_002 Fix 005
Sabellaria sp. present as slightly elevated colony patches



Transect B03-039_001 Fix 004
Photo fix from outside delineated area.
No *Sabellaria* sp. present.

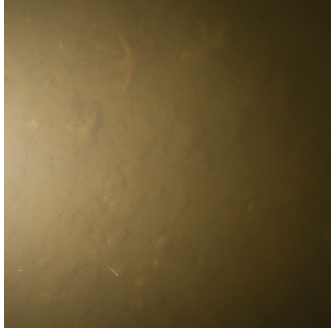


Sediment remaining after sieving (1mm)
Relatively large volume of fine sand



Project Nemo - Benthic Environmental Survey		Figure No. 7-4-2	Date 18/02/2011	Data Source MMT 2010a; 2010b	Projection System UTM Zone 31N		Client: Powering a world in progress		
Sabellaria Investigation - Station B03-039		Author GM	Check FC	Scale @A3 1:10,000	Datum WGS84	Spheroid WGS84			

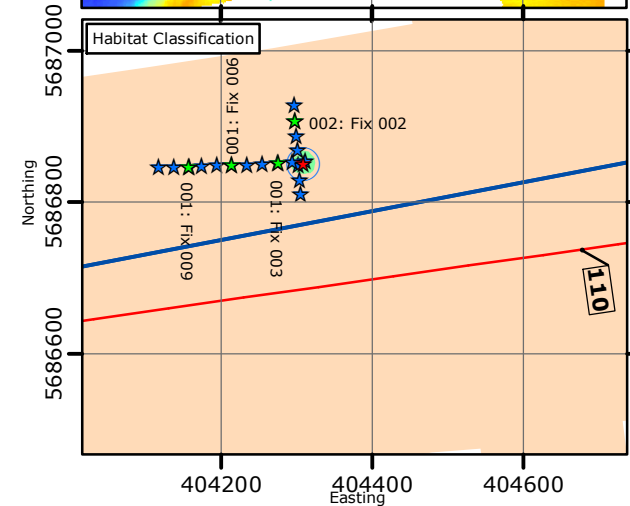
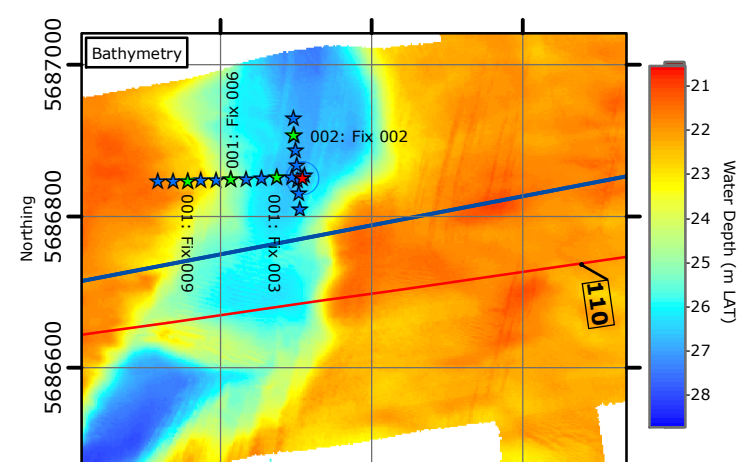
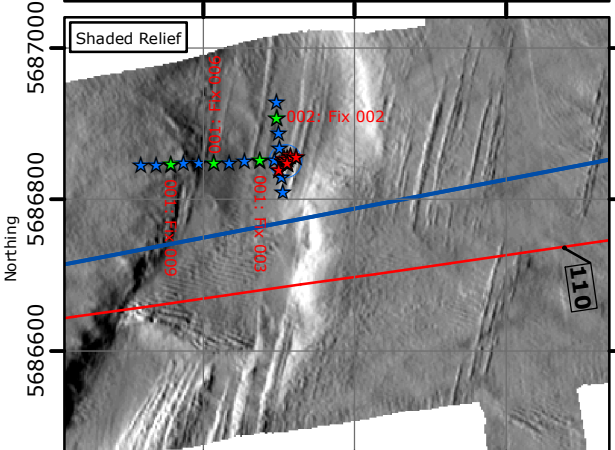
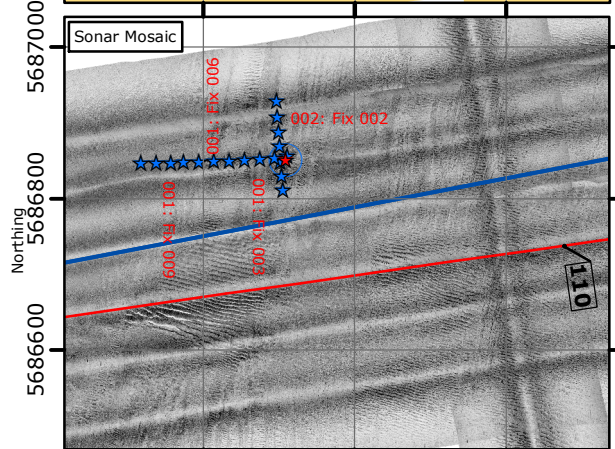
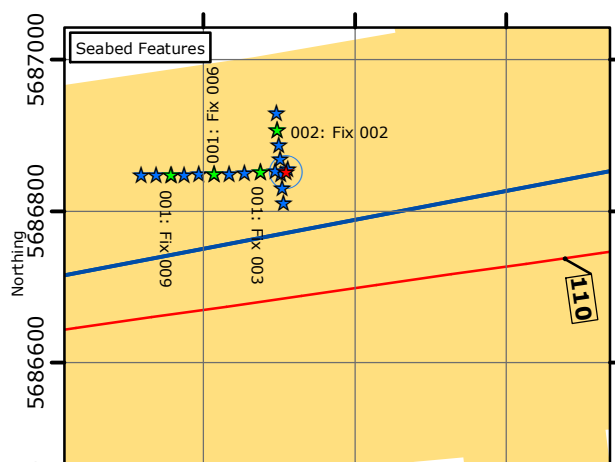
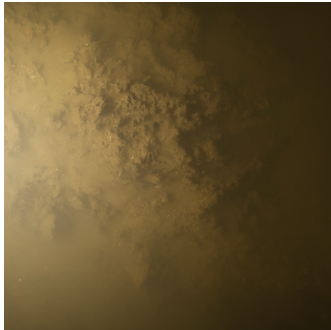
Transect B03-040_001 Fix 003
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



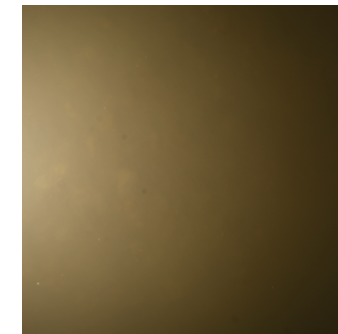
Transect B03-040_001 Fix 006
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



Transect B03-040_001 Fix 009
Photo fix from outside delineated area.
Sabellaria aggregation present



Transect B03-040_002 Fix 002
Photo fix from outside delineated area.
No *Sabellaria* sp. present.



Sediment remaining after sieving (1mm)
Very little sediment retained



Legend

- ★ Photos_presented_Stn40
- ★ Benthic Camera Fixes
- ★ Transect Camera Fixes
- Proposed And Actual Grab Sample
- Revised Proposed Route Centre Line
- Original Proposed Route Centre Line

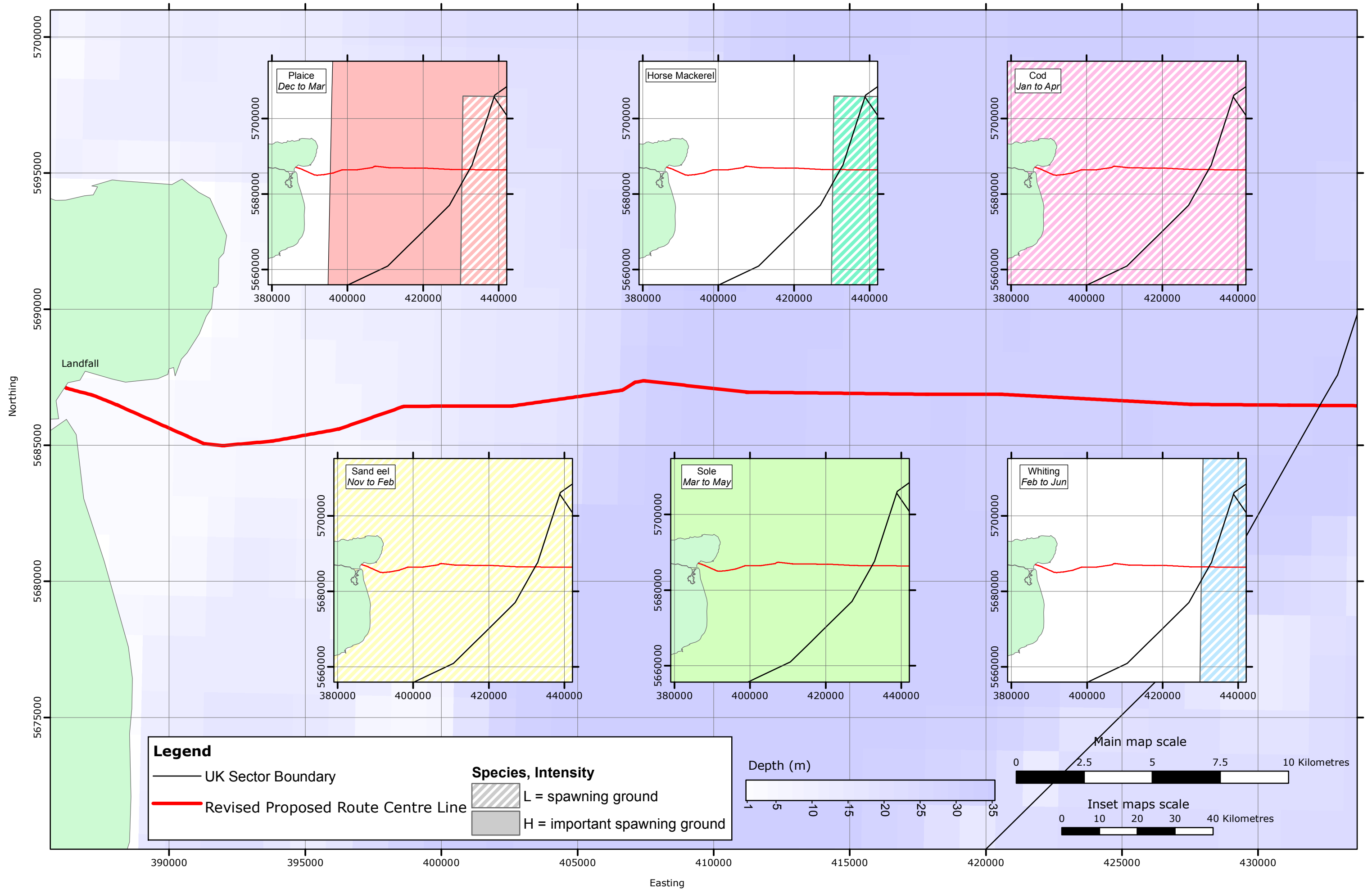
Surface Geology

- Sand

EUNIS Habitat Classification

- A5.141 *Pomatoceros triquetus* crusts on unstable circalittoral cobbles and pebbles
- A5.25 Circalittoral fine sediment
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment

Light Position
Bearing: 270
Vertical: 45



Project Nemo - Benthic Environmental Survey

7-5-1 Fish Spawning Grounds

Figure No.
2

Author
HM

Check
FC

Date
11/05/2011

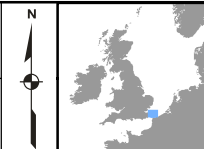
Scale @A3
1:125,000

Data Source
Coull *et al.*, 1998
Ellis *et al.*, 2010
GEBCO, 2008

Projection System
UTM Zone 31N

Datum
WGS84

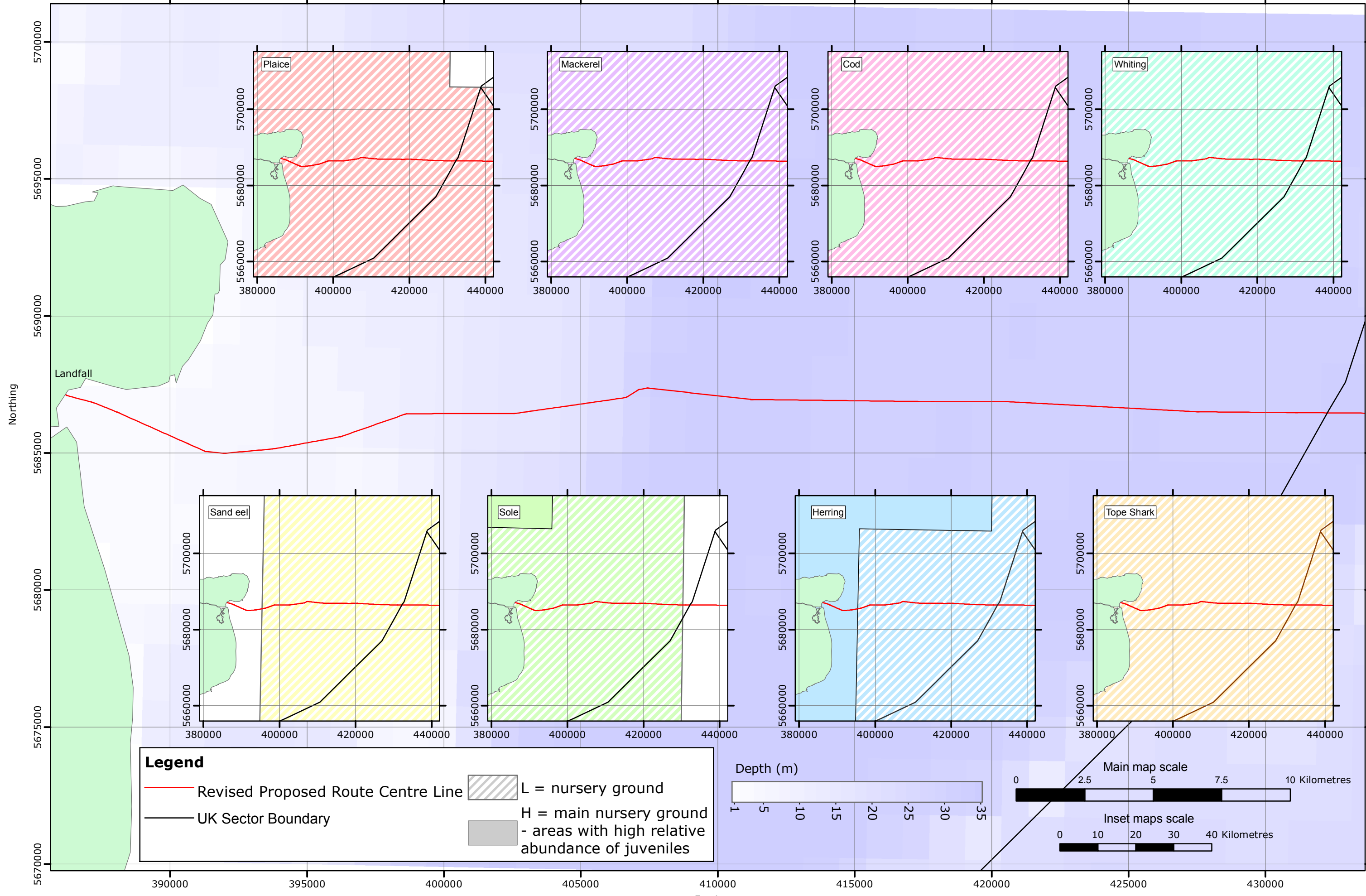
Spheroid
WGS84



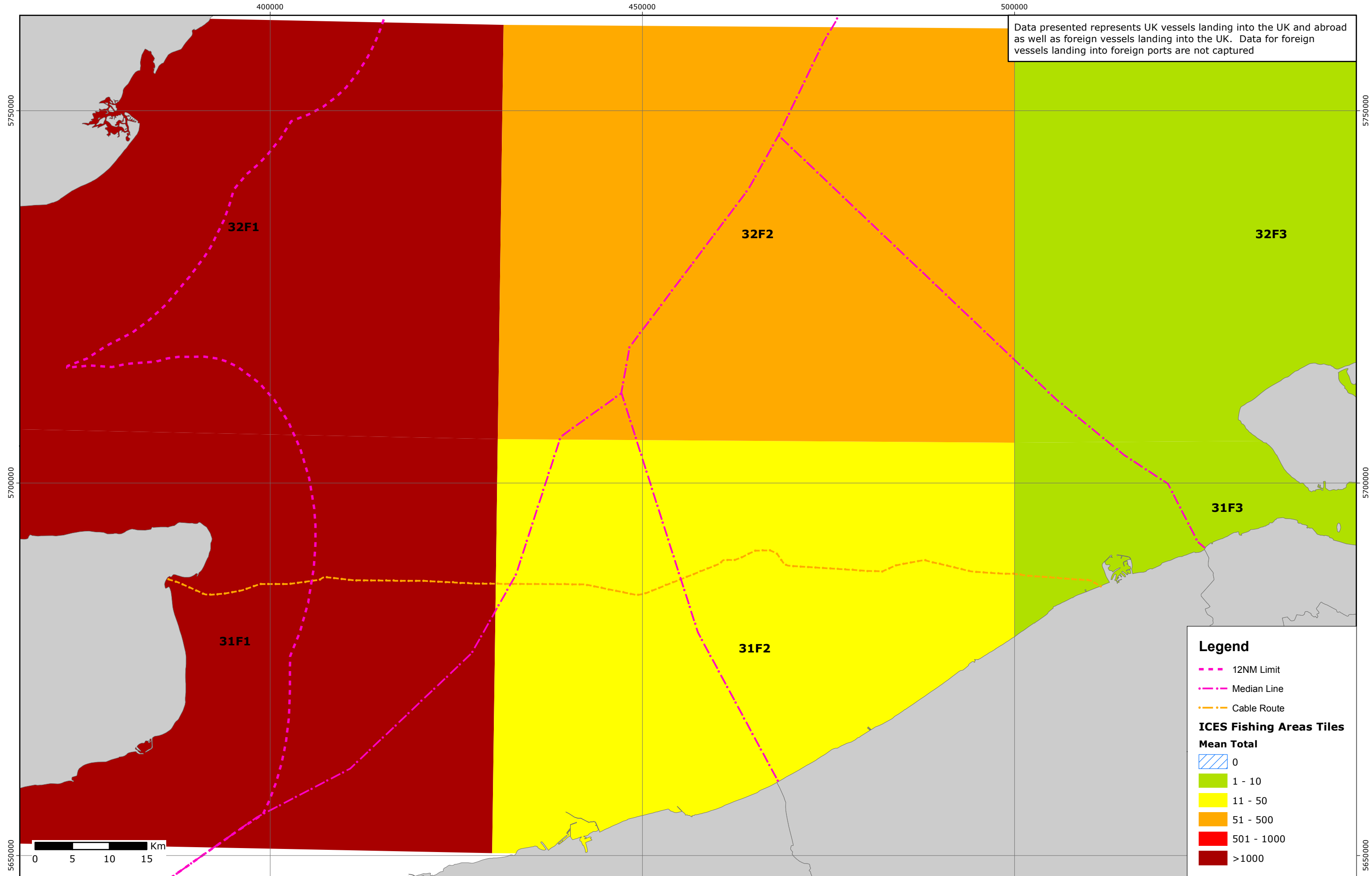
Client: **elia**
Powering a world in progress

nationalgrid

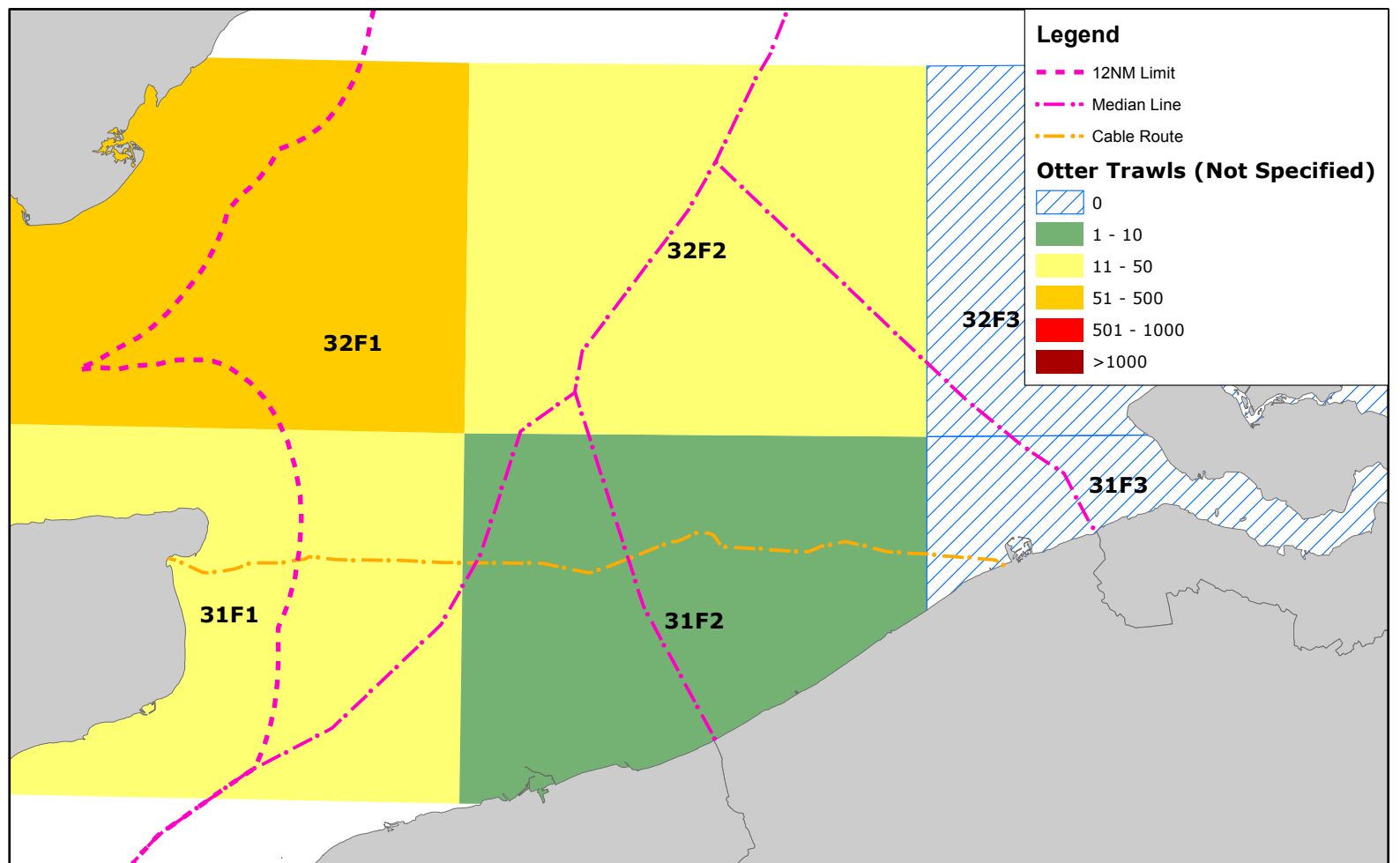
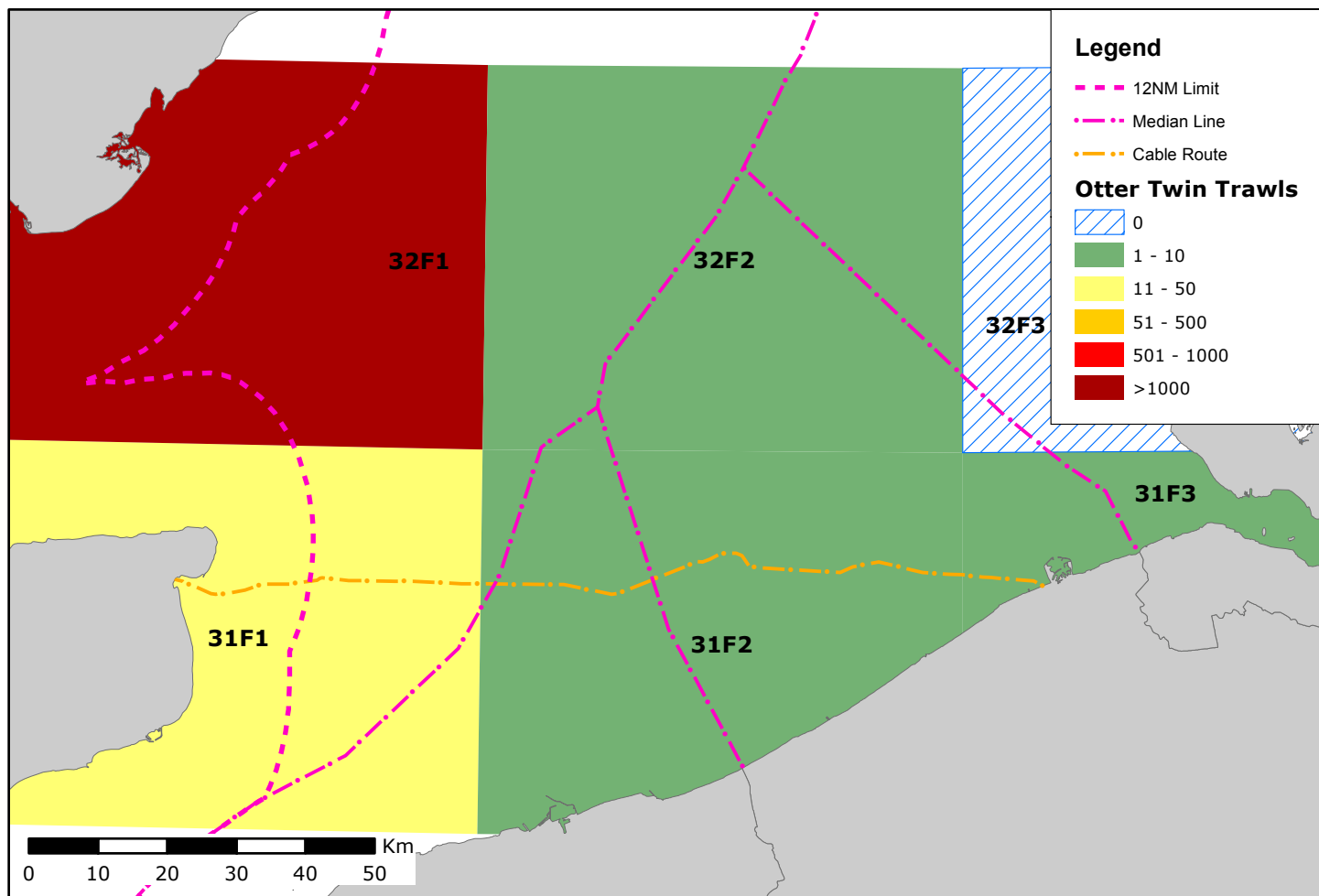
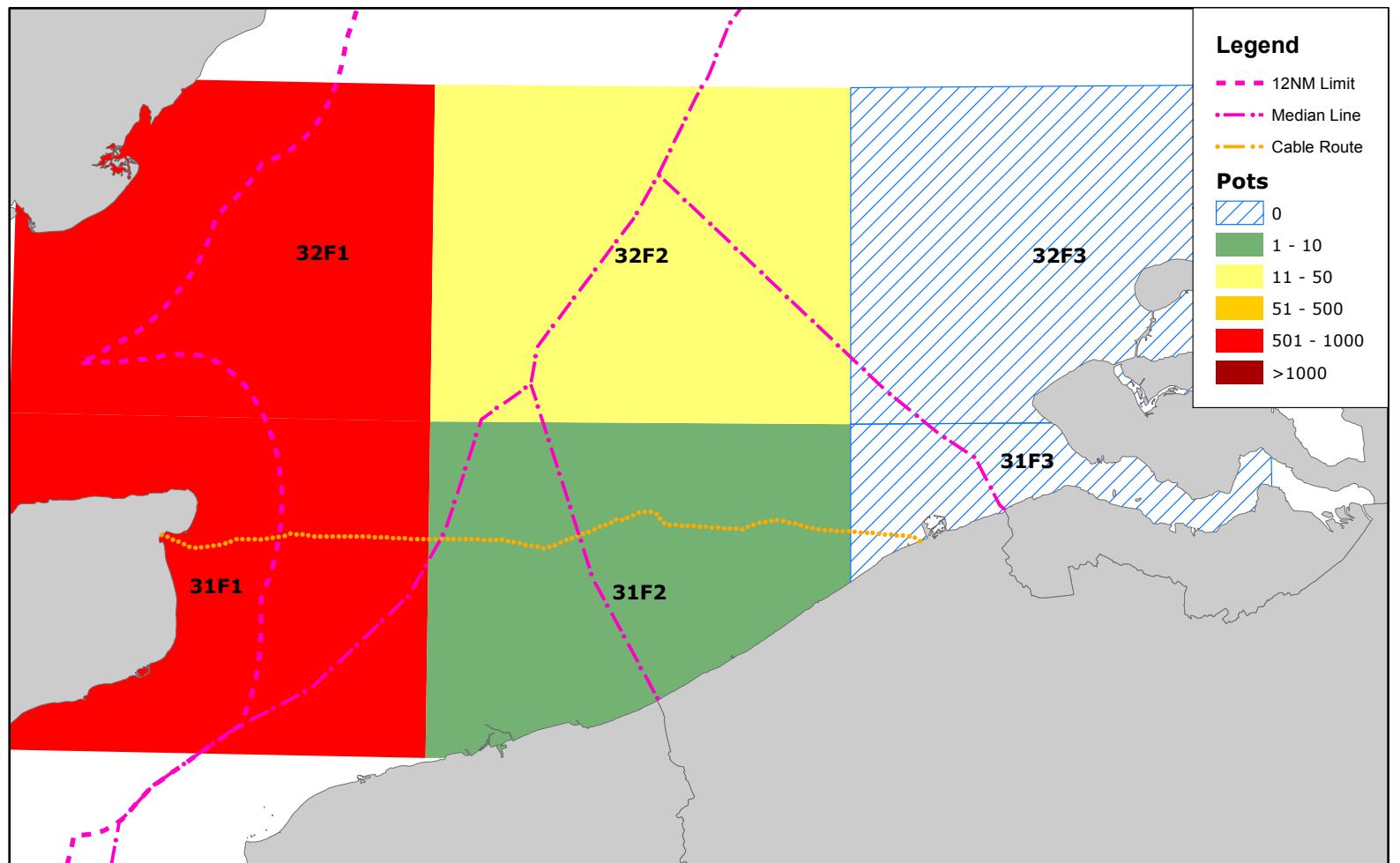
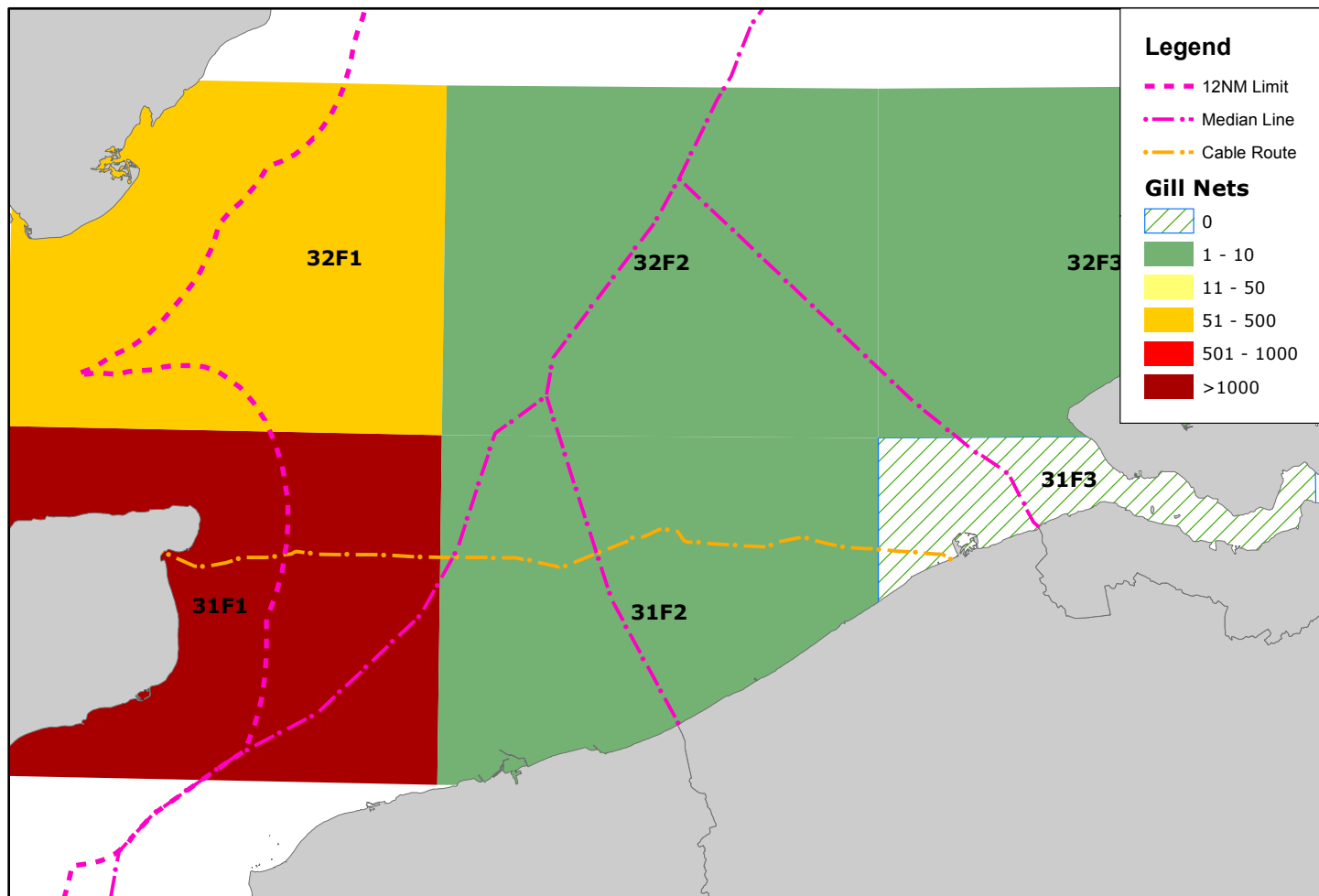







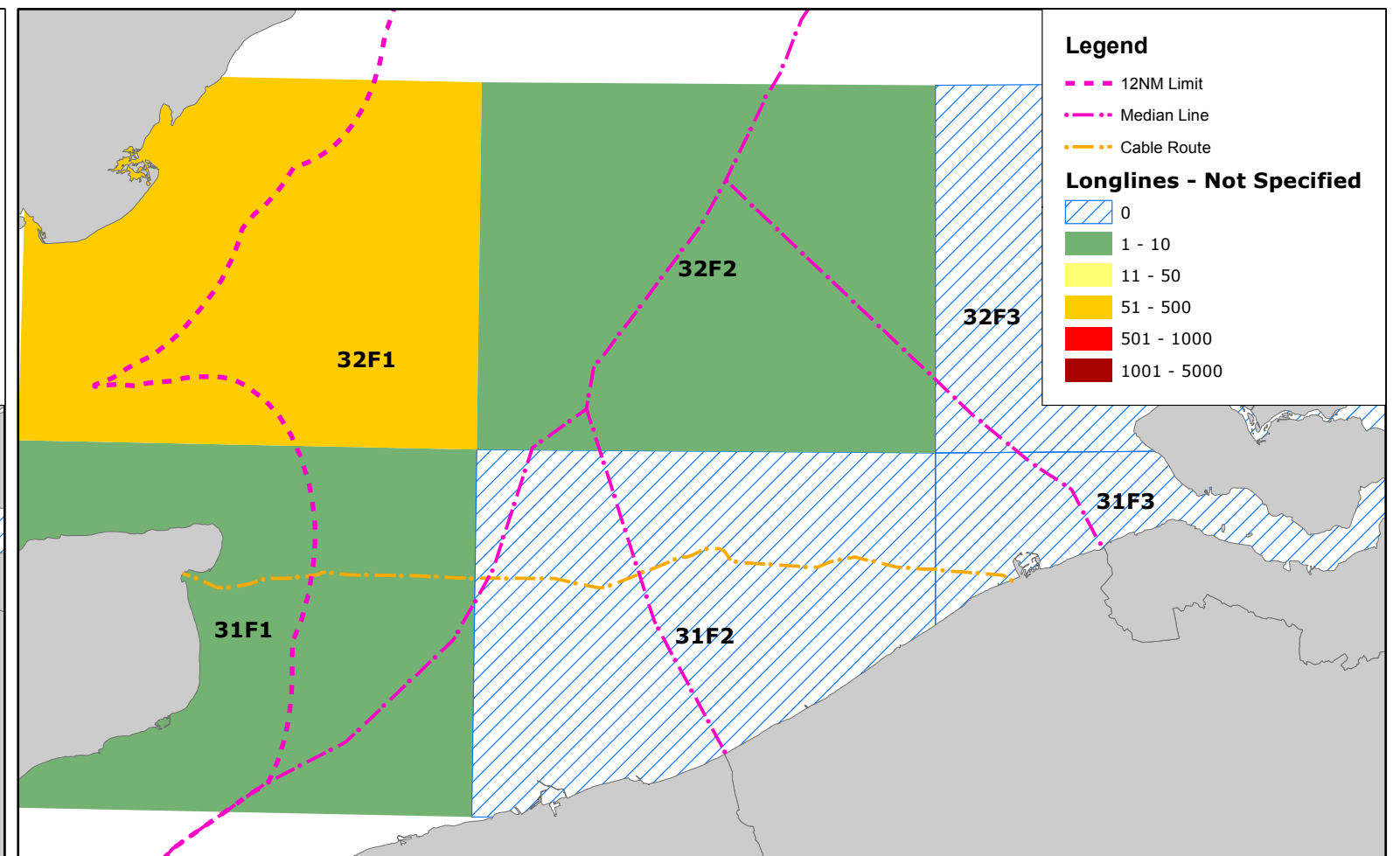
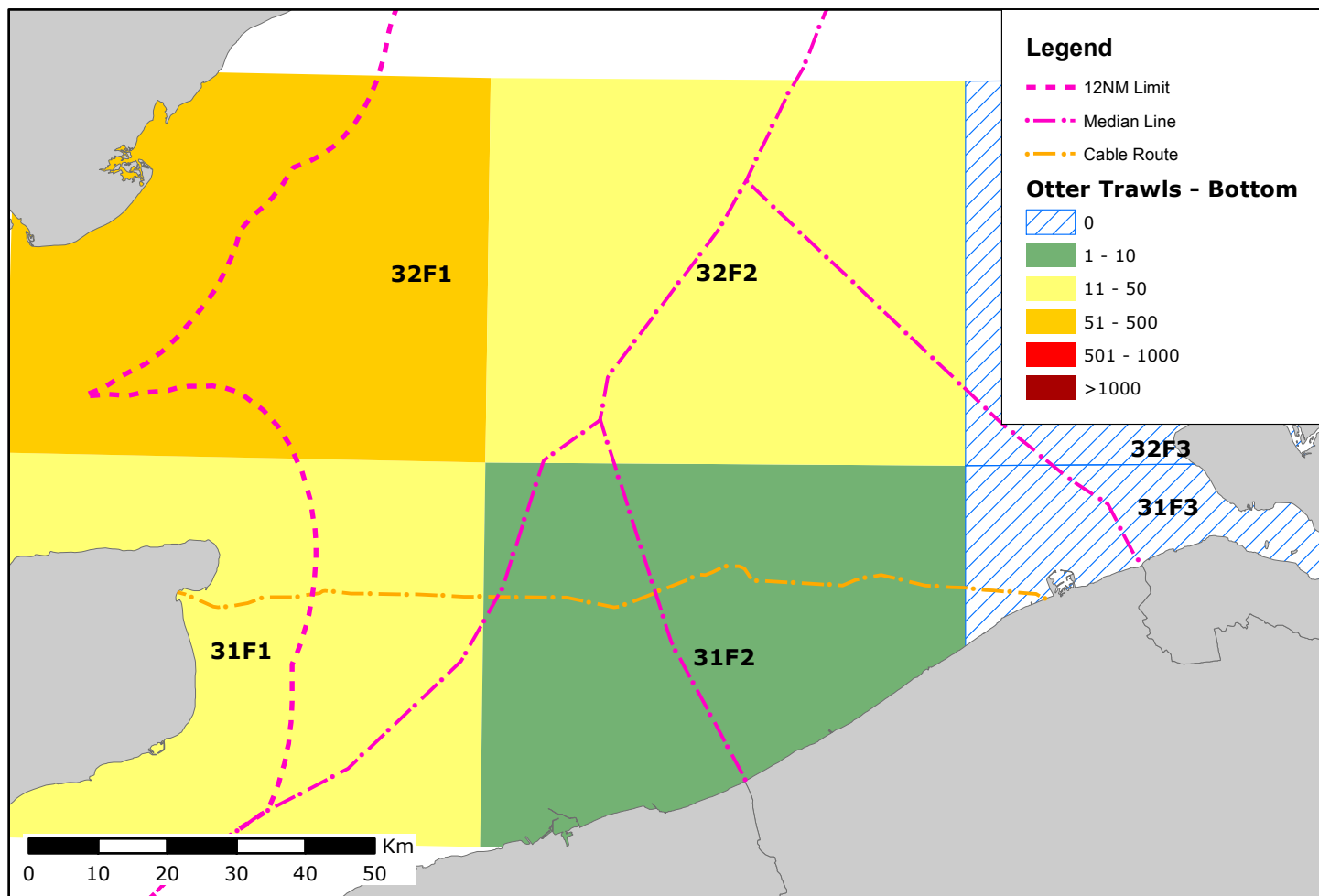
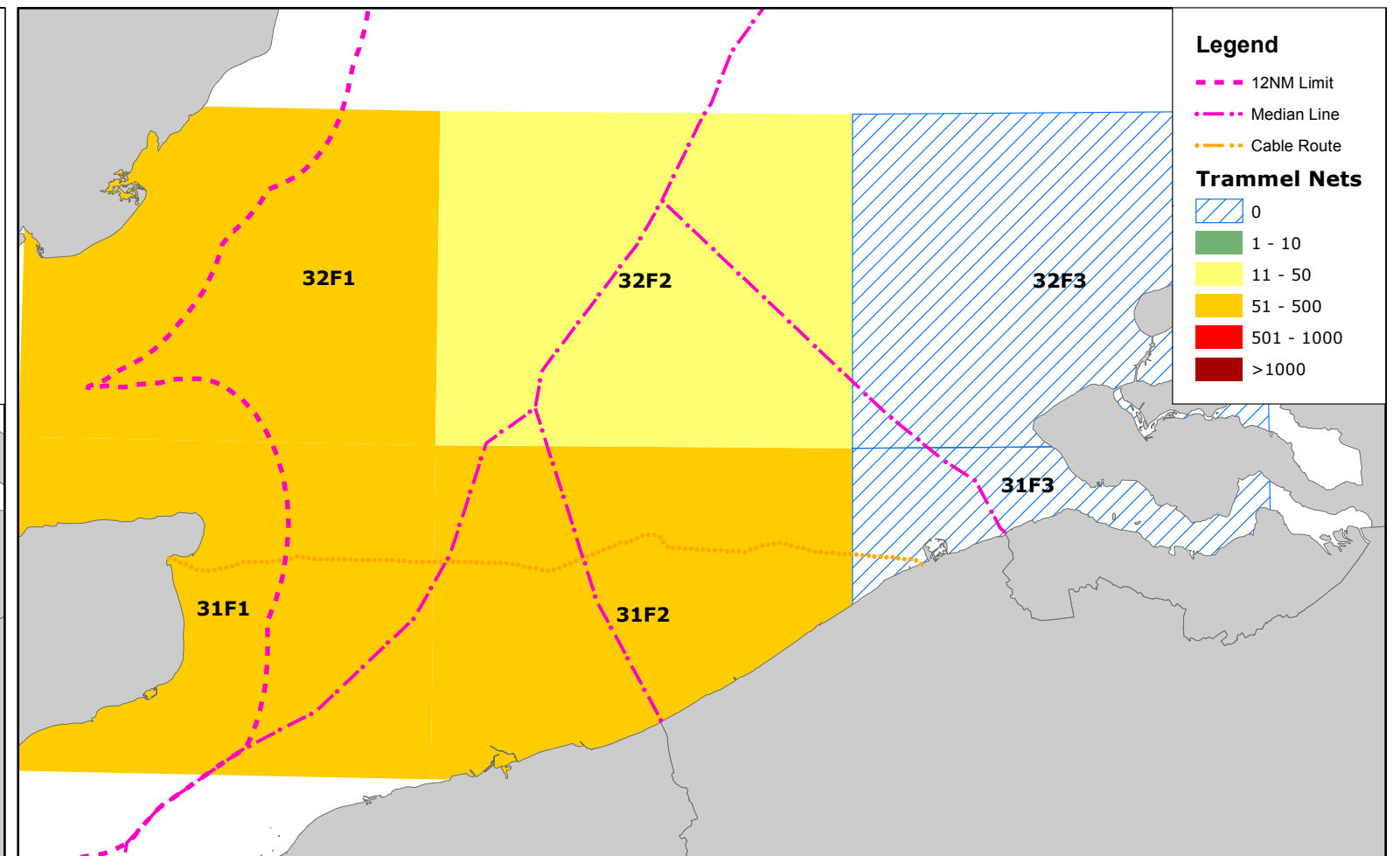
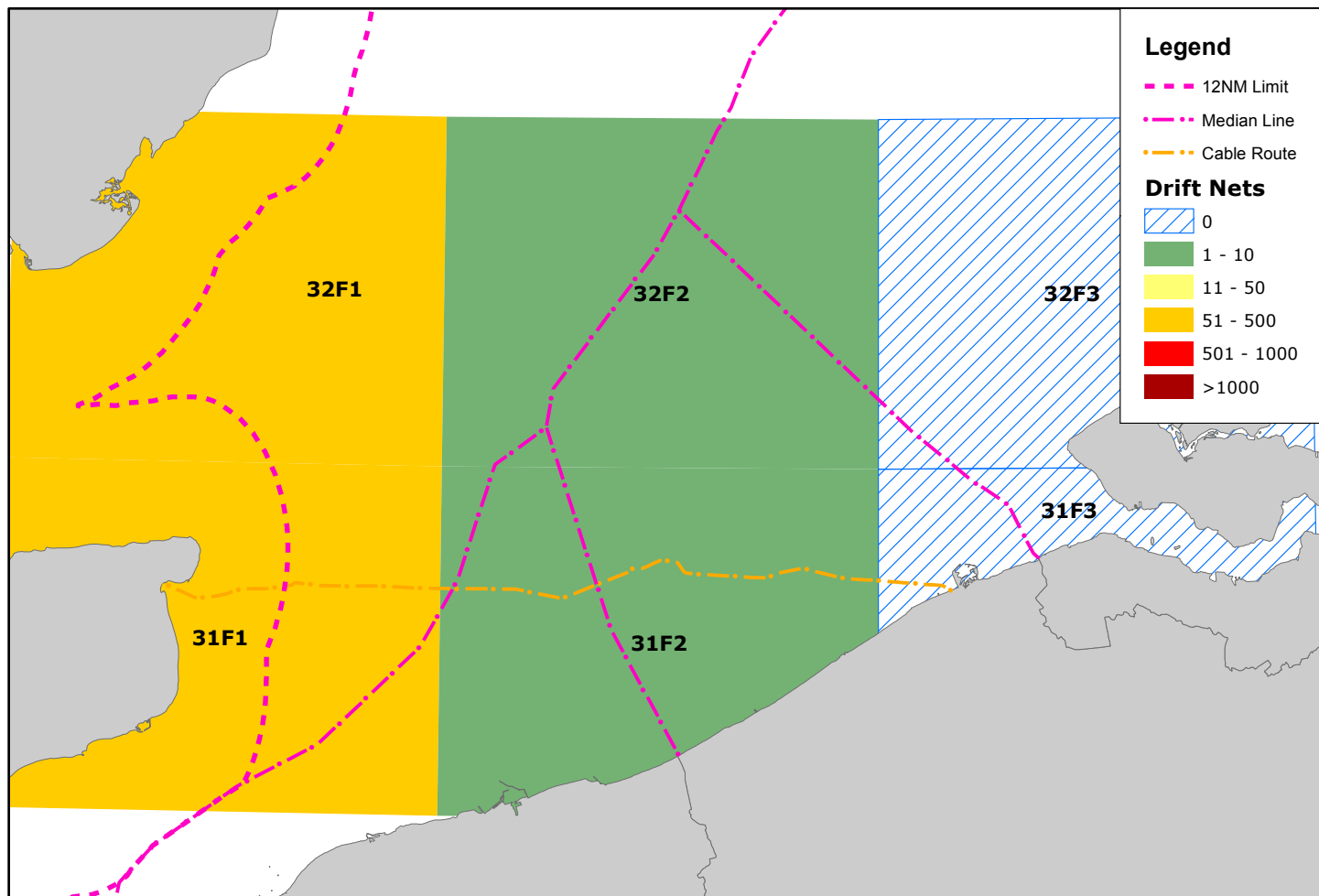
Project Nemo - Benthic Environmental Survey	Figure No. 3		Date 11/05/2011	Data Source Coull <i>et al.</i> , 1998 Ellis <i>et al.</i> , 2010 GEBCO, 2008	Projection System UTM Zone 31N			Client: Powering a world in progress		
	7-5-2 Fish Nursery Grounds	Author HM	Check FC		Scale @A3 1:125,000	Datum WGS84				



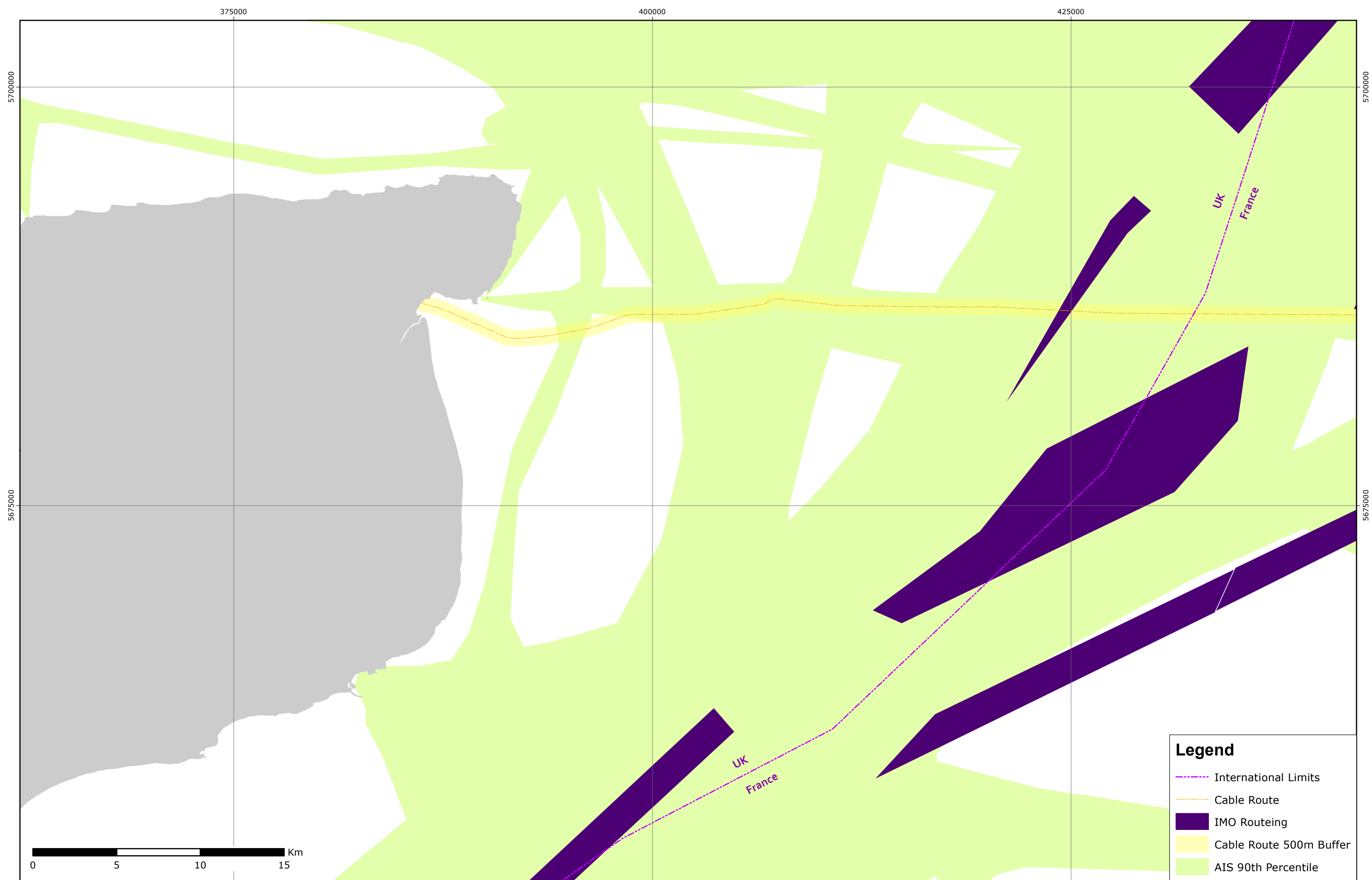
NEMO Figure 8-1-1 : Mean Annual Fishing Effort Expended by ICES rectangle (2007-2011)	Figure No. 29869/1861		Date 21/06/2012		Data Source DECC MMO		Projection System UTM Zone 31N			Client: elia Powering a world in progress nationalgrid	PMSS
	Author NDU	Check CGR	Scale @A3 1:450,000		Datum WGS84	Spheroid WGS84					



NEMO	Figure No. 29869/1862.1		Date 21/06/2012		Data Source DECC MMO		Projection System UTM Zone 31N		Client:  Powering a world in progress 	
	Figure 8-1-3 : Mean annual fishing effort expended by gear type (2007-2011): part 1		Author NDU	Check CGR	Scale @A3 1:1,000,000		Datum WGS84	Spheroid WGS84		



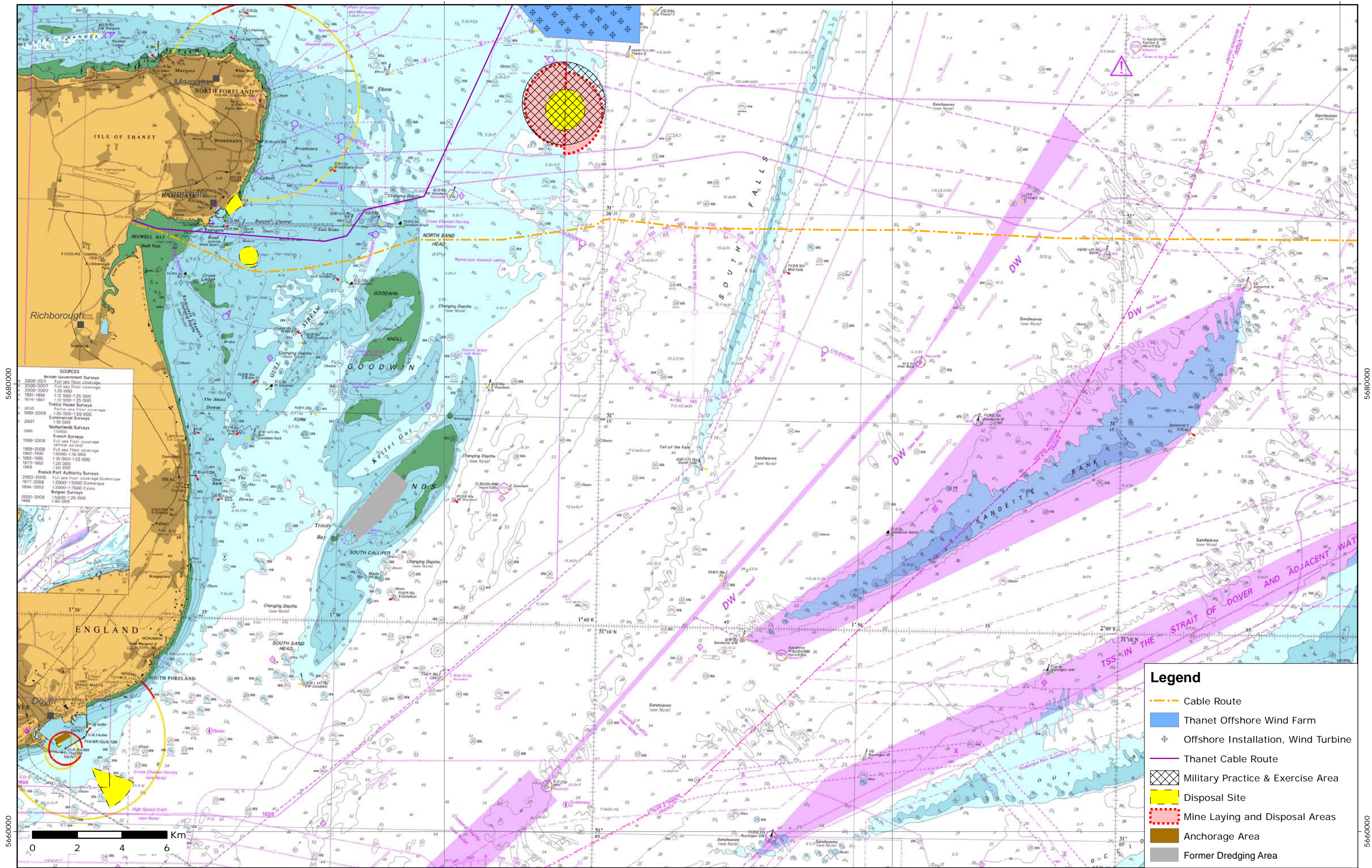
NEMO	Figure No. 29869/1863.1		Date 21/06/2012		Data Source DECC MMO		Projection System UTM Zone 31N		Client: elia Powering a world in progress nationalgrid	
	Author NDU		Check CGR		Scale @A3 1:1,000,000		Datum WGS84			



Legend

- International Limits
- Cable Route
- IMO Routeing
- Cable Route 500m Buffer
- AIS 90th Percentile

NEMO	Figure No. 29689/1796.4		Date 21/06/2012		Data Source Maritimedata UKHO Seazone		Projection System UTM Zone 31N			Client: Powering a world in progress 	
	Figure 8-2-1: Navigational Overview	Author NDU	Check CGR	Scale @A3 1:200,000		Datum WGS84		Spheroid WGS84			



SOURCES

2009-2011	British Government Surveys	Full sea floor coverage
2006-2007	Full sea floor coverage	
2000-2003	1:25 000	
1991-1998	1:12 500-1:25 000	
1974-1987	1:17 500-1:25 000	TRANSIT HOUSE SURVEYS
2010	Partial sea floor coverage	
1999-2009	1:25 000-1:50 000	Commercial Surveys
2007	1:10 000	
1995	1:5000	Netherlands Surveys
1998-2009	French Surveys	Full sea floor coverage (annual survey)
1993-2008	1:5000-1:10 000	
1962-1998	1:10 000-1:20 000	
1962-1995	1:20 000-1:50 000	
1973-1982	1:50 000	
1959	1:50 000	French Port Authority Surveys
2003-2006	Full sea floor coverage Dunkerque	
1977-2006	1:2000-1:5000 Dunkerque	
1984-2003	1:2000-1:5000 Calais	
1994-2003	Belgian Surveys	
2000-2008	1:5000-1:20 000	
1999	1:40 000	

- Legend**
- Cable Route
 - Thanet Offshore Wind Farm
 - Offshore Installation, Wind Turbine
 - Thanet Cable Route
 - Military Practice & Exercise Area
 - Disposal Site
 - Mine Laying and Disposal Areas
 - Anchorage Area
 - Former Dredging Area

<p>NEMO</p> <p>Figure 8-5-1: Military and other sea users</p>	<p>Figure No. 29689/1800.2</p>		<p>Date 21/06/2012</p>	<p>Data Source Season The Crown Estate</p>	<p>Projection System UTM Zone 31N</p>		<p>Client: nationalgrid </p>
	<p>Author NDU</p>	<p>Check CGR</p>	<p>Scale @A3 1:150,000</p>	<p>Datum WGS84</p>	<p>Spheroid WGS84</p>		

