Nemo Link®

Environmental Statement Volume II

Technical Appendix

February 2013

Volume II: UK Environmental Statement Technical Appendices

The Nemo Link

February 2013

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Table of Contents

Appendix 1: Route Position List 2
Appendix 2: Scoping Response Matrix 3
Appendix 3: MMO Scoping Response Letter 8
Appendix 4: Legislative Framework 14
Appendix 5: Habitats Regulations Assessment Signposting 17
Appendix 6: Assessment of Significance 19
Appendix 7: HR Wallingford Technical Report 30
Appendix 8: Winter Bird Survey 166
Appendix 9: Inter-tidal Sediment and Invertebrate Surveys 204
Appendix 10: Breeding Bird and Redshank Nesting Survey 235
Appendix 11: Benthic Survey Report 257
Appendix 12: Archaeological EIA 559
Appendix 13: French Offshore Non-Technical Summary 736
Appendix 14: Belgian Offshore Non-Technical Summary 775
Appendix 15: UK Onshore Non-Technical Summary 817
Appendix 16: Belgian Onshore Non-Technical Summary 834

Appendix 1: Route Position List

Reason	Longitude WGS 84	Latitude WGS 84	Easting UTM31N	Northing UTM31N	Cable Bearing
START POINT	3.1677	51.3270	511687	5686206	298°
ALTERCOURSE	3.1664	51.3277	511592	5686285	280°
ALTERCOURSE	3.1565	51.3295	510902	5686476	293°
ALTERCOURSE	3.1469	51.3335	510232	5686924	273°
ALTERCOURSE	3.1060	51.3353	507385	5687119	273°
ALTERCOURSE	3.0581	51.3379	504047	5687405	272°
ALTERCOURSE	3.0273	51.3392	501902	5687548	275°
ALTERCOURSE	2.9976	51.3416	499833	5687813	271°
ALTERCOURSE	2.9701	51.3419	497919	5687847	273°
ALTERCOURSE	2.9165	51.3444	494188	5688127	278°
ALTERCOURSE	2.8253	51.3580	487839	5689651	263°
ALTERCOURSE	2.7717	51.3516	484105	5688952	255°
ALTERCOURSE	2.7449	51.3442	482234	5688135	271°
ALTERCOURSE	2.7107	51.3449	479849	5688216	274°
ALTERCOURSE	2.7064	51.3451	479549	5688248	272°
ALTERCOURSE	2.5634	51.3505	469593	5688899	284°
ALTERCOURSE	2.5557	51.3524	469060	5689111	312°
ALTERCOURSE	2.5411	51.3653	468054	5690553	286°
ALTERCOURSE	2.5292	51.3687	467225	5690934	270°
ALTERCOURSE	2.5004	51.3686	465221	5690930	254°
ALTERCOURSE	2.4750	51.3606	463449	5690062	256°
ALTERCOURSE	2.4600	51.3570	462402	5689659	270°
ALTERCOURSE	2.4405	51.3571	461041	5689684	256°
ALTERCOURSE	2.4368	51.3562	460780	5689583	232°
ALTERCOURSE	2.4322	51.3526	460459	5689193	256°
ALTERCOURSE	2.2863	51.3152	450262	5685120	264°
ALTERCOURSE	2.2714	51.3137	449222	5684962	277°
ALTERCOURSE	2.2226	51.3196	445828	5685657	277°
ALTERCOURSE	2.1721	51.3259	442316	5686390	270°
ALTERCOURSE	2.0111	51.3253	431094	5686470	270°
ALTERCOURSE	1.9596	51.3252	427506	5686501	271°
ALTERCOURSE	1.8600	51.3276	420570	5686870	269°
ALTERCOURSE	1.8216	51.3272	417893	5686869	270°
ALTERCOURSE	1.7255	51.3269	411202	5686950	273°
ALTERCOURSE	1.6712	51.3301	407423	5687369	262°
ALTERCOURSE	1.6665	51.3295	407098	5687306	248°
ALTERCOURSE	1.6600	51.3268	406634	5687018	264°
ALTERCOURSE	1.6016	51.3209	402558	5686435	269°
ALTERCOURSE	1.5453	51.3201	398629	5686430	257°
ALTERCOURSE	1.5111	51.3122	396231	5685592	263°
ALTERCOURSE	1.4766	51.3078	393814	5685152	266°
ALTERCOURSE	1.4509	51.3059	392021	5684987	275°
ALTERCOURSE	1.4404	51.3064	391290	5685050	285°
ALTERCOURSE	1.3937	51.3187	388066	5686486	283°
ALTERCOURSE	1.3814	51.3216	387212	5686831	279°
ALTERCOURSE	1.3673	51.3237	386239	5687093	297°
END POINT	1.3654	51.3245	386108	5687180	0°

Table 1-A: Location of all points where Nemo cable will start, end and alter course.

Appendix 2: Scoping Response Matrix

Consultee	Summary of comments	Section of report where comments are addressed
Natural England	• Habitat characterisation of area crossed by cable route is required • Habitat characterisation to consider in faunal and epifaunal communities • Habitat characterisation should cover habitats and species of conservation importance including habitats listed under the Wildlife and Countryside Act, Annex I of the Habitats Directive, OSPAR requirements, UK BAP, species and habitats mentioned Features of Conservation Interest listed in the marine conservation zones ecological network guidance. • Impacts of pre lay grapnel run should be considered in EIA • Detailed consideration to be given to impacts of presweeping. • Need to consider maintenance requirements in impact assessment.	Section 7.4 – Benthic ecology Section 7.1 – Conservation Designations Section 7.2 – Ornithology Section 7.5 – Fish and shellfish
	• Details should be given in the ER of any statistical tests used	Appendix 10 – Benthic ecology
	• The EIA should consider the The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007. The noise impact assessment should determine what marine mammal species are likely to be present in the development area and will need to show whether the operations will potentially cause either a disturbance or an injury offence under the regulations and what mitigation measures will be put in place to prevent such offences occurring. Southall et all (2007) should be used to help determine significance of effects.	Section 4.7.3.3 – Noise Section 7.3 – Marine Mammals
	• Request that the number of cable crossings be minimised and that those required are fully justified. Frond matressing is prefereable to concrete matressing or rock armouring. Request ecological monitoring of cable crossing post installation.	Section 8.4 – Cables and Pipelines Section 10 - Monitoring
	• Prefer bundling of cables rather than separate installation (to minimise impacts). • Require dredging amounts to be quantified.	Section 4 - Project Description
	• Require cumulative impact assessment to be undertaken.	Section 9 – Cumulative Impact Assessment
	• EIA should propose a monitoring programme.	Section 10 - Monitoring
	• Consideration must be given to the MCZ process and the ecological network guidance.	Section 7.1 – Conservation Designations Section 7.4 – Benthic Ecology
	• Formally requested a copy of the survey results.	Acknowledged
	• Habitat Regulation Assessment should be included within the EIA in sufficient detail to inform an Appropriate Assessment Screening Exercise.	Appendix 4 – Appropriate Assessment
	• Advice on scope of benthic survey scope.	Acknowledged

English Heritage	• Seabed geophysical survey data to be corroborated with a desk-based examination of archaeological records • Any drop down camera survey should be optimised to assist ground-truthing of anomalies to support determination of archaeological potential. • The statement ""all known wrecks are avoided"" to be expanded to include other historic environment features that may exist within the foreshore area subject to this development. • Recommend that an Archaeological Written Scheme of Investigation is agreed with English Heritage at the earliest available opportunity to inform the setting of survey objectives and thereby to support the delivery of any necessary mitigation measures. • Scope of assessment of marine archaeological potential should be expanded to include action to be taken if any wreck material is encountered in the delivery of this project in accordance with the requirements of the Merchant Shipping Act 1995. • The developer will ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). To enable deposit of reports with the NMR the developer must ensure that an English Heritage OASIS (Online AccesS to the Index of archaeological investigationS') form is completed for the whole consented project, and all copies of completed and agreed archaeological reports are attached as PDF files. All further advice on completing this condition is to be directed to English Heritage's National Monuments Record (oasis@english- heritage.org.uk). Notification of the completion of the OASIS form is also be sent to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER). • There is a possibility of encountering previously unknown wrecks and especially the remains of military aircraft that are subject to automatic protection under the Protection of Military Remains Act 1986. Especially north of the Goodwin Sands. • The project programme should directly inform the production of an Archaeological Reporting Protocol which needs to be agreed with EH. • Advise that detailed consideration is given to the depth of cores to be taken and the potential to encounter sediments of archaeological potential.	Section 8.3 – Marine Archaeology
The Crown Estate	• No comments on survey scope or EIA method. • Require decommissioning to be covered in detail in the project planning. • Require evidence that decommissioning is incorporated into the project business plan.	This report refers to all predicted potential impacts from decommissioning under the relevant sections. Provision for decommissioning in project business plan is not within the scope of environmental assessment but will be discussed separately with The Crown Estate.
CEFAS	• EIA scope is adequate. • Impacts of rock/mattress placement, installation into chalk and incombination effects need to be considered. • A formal ES under EIA Regulations will not be required. • Defer to Natural England with regards to Appropriate Assessment. It should be noted that the CEFAS response referred to various receptors and environmental effects, all of which were detailed in the Scoping report.	Sections 6 - 8.
Environment Agency	• EIA proposed is comprehensive. • Acknowledge EIA is not a statutory requirement for this project but much of the information required to assess its impact still needs to be provided to the consultees (modelling, sediment contaminant data etc). EIA is the most practical way to do this.	Noted.

	• Water Framework Directive (WFD) protected areas to be considered - Kent North waterbody contains the following designations: Shellfish Water Directive and Bathing Waters Directive. • Impacts on Sandwich Bay and Ramsgate Western Undercliffe to also be assessed in the EIA. • Take into account EA WFD guidance http://www.environment-agency.gov.uk/business/sectors/116352.aspx. • Dredging within WFD area will require assessment under Stage 2 WFD Scoping Guidance, which should be covered in EIA if required. • Under the terms of our Land Drainage and Sea Defence Byelaws 1981, written consent from ourselves is required for any works between the mean low water mark and fifteen metres of the landward toe of the flood defence.	Section 6.3 – Water Quality
	• Acknowledge EIA is not a statutory requirement for this project but much of the information required to assess its impact still needs to be provided to the consultees (modelling, sediment contaminant data etc). EIA is the most practical way to do this.	Acknowledged
	• Under the terms of our Land Drainage and Sea Defence Byelaws 1981, written consent from ourselves is required for any works between the mean low water mark and fifteen metres of the landward toe of the flood defence.	Acknowledged
MCA	• Full traffic survey of intended area of operation • Details of how the cable will be laid e.g. trenched or rock armoured for protection against over-trawling and anchors etc. • The crossing of traffic lanes needs to be addressed. • The use of guard vessels during installation works should be considered. • Communications policy/strategy for the whole operation will need to be produced prior to construction commencing.	Section 8.2 – Shipping and navigation
JNCC	• As a result of its size and nature, that this project has the potential to have significant effects on the marine environment. • Highlight the importance of consultation with the relevant authorities in France and Belgium. • More detailed comments, than those that follow in this email, will be submitted to the MMO. Please note that these comments relate only to the marine environment outside of 12nm. • We would recommend that Cefas are consulted with regard to the scoping out of EMF in relation to non-elasmobranch fish species. • Please refer to our comments previously submitted with regards to survey methodologies.	Acknowledged.
	• Need to assess impacts on Annex I habitats in terms of hydrological processes and integrity of relevant habitat. • Full discussion, with reference to the data currently under collection along the cable route, of the potential impacts of this development on Annex I habitat is required. This should include an assessment of any impact in terms of affect on the hydrological processes in the area and also the integrity of the relevant habitat. • Further discussion of use of grapnel hook to clear out of use cables and how this will take place to minimise impacts on potential Annex I habitat and benthic habitat is required. In addition, the application of alternative methods should also be explored. • The use of rock dump or the placement of mattressing to bridge any active cables will result in a loss of benthic habitat at these locations. • Chalk cutting, again has the potential to impact on Annex I reef type habitat. We suggest that alternative options to this are fully explored and that any proposed works are analysed in terms of impacts on the integrity of the habitat feature. • Installation - It should be highlighted that pre-sweeping, rock dump and concrete mattress placement could result in a permanent loss in benthic habitat.	Section 7.4 – Benthic ecology

	• With relation to the decision to be made to employ a single or separate trenches, JNCC would prefer the application of the single trench option.	Section 4 – Project Description
	• Careful consideration to be given to most appropriate route across designated sites and alternatives should be considered.	Section 2.2 - Alternatives
	• Analysis into the potential effects on sediment transport and other hydrological processes will be required. We also suggest that the potential risk of de-stabilising sandbanks such as the South Fall is also explored.	Section 6.2 – Sediment transport and coastal processes Section 6.1 - Geology
	• We are satisfied that within the assessment of projects that the 'Rochdale Envelope' principle will be applied, to ensure that the consent is sufficient to encompass the worst-case scenario of potential impacts, where multiple options exist for an aspect of the project plan. However, in terms of reducing survey costs and increasing efficiency, it is advisable that the projects are finalised as much as possible as early in the life of the project as possible to limit the complexity of the environmental report in terms of identifying 'worst-case' for environmental receptors. In light of this we welcome the proposal to review the design of the 'Rochdale Envelope' with the progression of data collection and stakeholder consultation.	
	• The ecological links between receptors and impacts should be fully considered under each receptor section eg. birds and prey species.	Sections 6 - 8
	• We would recommend that the discussion of the cumulative effect of this development include the full consideration of the ecological links between environmental receptors.	Section 9 – Cumulative effects
Port of Ramsgate	• Content with scope of environmental assessment • If damage occurred to the Thanet Offshore wind cables the environmental impact would be larger than forecast.	Section 8.4 – Pipelines and cables
Trinity House	• No objections to the proposals in principal. • Once the final landfall site has been confirmed, further consideration can be given to any marking requirements depending on location, any existing marking, complete burial of the cable etc. • Any vessels used in the works to exhibit signals as per collregs.	Chapter 8.2 – Shipping and navigation
Thanet District Council	• Report focuses on marine aspects so may fall outside of Council's jurisdiction at this stage. • Council reserves the right to comment at a later date on any aspect that they consider would have significance to this District • Council would like to consult with other consultees before commenting on the report under the Town and Country Planning Act. • Council requires further detail/information on the land based aspect of the scheme which does fall in their jurisdiction, with this info they would also wish to consider whether the development would require planning permission; and to screen the scheme to establish whether or not it is EIA development.	Acknowledged. Onshore consultants will be leading on the onshore aspects of the project and will liaise with TDC accordingly.
Royal Yachting Association	• Wish to ensure safety of marine recreational interests. • Welcomes the detailed description of recreational activity provided. • Encouraged that the UK Coastal Atlas of Recreational Boating and the GIS data is being utilised and considered at this early stage, this information should also be considered in the environmental report. • Recreational boating should be considered as part of the effects on shipping and navigation.	Chapter 8.2 – Shipping and navigation Chapter 8.7 – Recreation and tourism
Kent Wildlife Trust	• Preferred landfall option is service station north, landfall at the country park should also be considered. • Would prefer cables to be laid in a single trench rather than two separate ones.	Section 4 – Project description
	• KWT owns part of the NNR and manages it on behalf of others.	Acknowledged

	• Using the Rochdale principle for the project description is satisfactory but may require an update to the habitat regulations assessment once the installation methods etc are finalised.	Section5 - EIA Method
	• EIA must be coordinated with the terrestrial aspects of the project.	Acknowledged. Onshore consultants will be leading on the onshore aspects of the project and will liaise with KWT accordingly.
	• Concerned about the impacts of installing into chalk, would like installation into exposed chalk to be avoided due to habitat value and would like any sabellaria reefs to be avoided. • Concerned about damage to habitats from the prelay grapnel run.	Section 7.4 – Benthic Ecology
	• Enquired whether backscatter data will be assesses from the multibeam survey.	Appendix 10 – Benthic survey report
	• Request that decommissioning is considered in EIA.	Sections 6 - 8
	• Impacts on spawning and nursery grounds should be minimised. • EMF impacts on eels should also be considered.	Section 7.5 - Fish and Shellfish
	• Sea mammal numbers in the area are often under estimated. Suggest contact SMRU and [redacted] at the Kent Mammal Group. 50 common seal in Stour Estuary and 20 on Goodwin Knoll (haul out)	Section 7.3 – Marine mammals
	• The area is very important for flowering lizard orchids	Information passed on to onshore consultants.
	• There are naturally important populations of sanderling, grey plover and important populations of greenshank at Pegwell Bay.	Section 7.2 - Ornithology
Marine Management Organisation	• The ER needs to include mitigation for any potential harm to mussel beds or Sabellaria biogenic reefs to safeguard against possible disturbance during preparatory works. Additionally interference to any sensitive Elasmobranch species in the area must also be mitigated for if effects from the cable are detected.	Section 7.4 – Benthic ecology
	• The MMO also suggests that alternatives to concrete be explored as bridging materials where the cable crosses other cables and/ or structures to provide extra habitat options e.g. rock.	Section 4 – Project description
	• The MMO would also like to point out that there is a commercial cockle fishery in Pegwell Bay, and also a population of grey Seals in the River great Stour.	Section 7.5 – Fish and shellfish Section 8.1 – Commercial Fisheries
	• The MMO would like to suggest that the local Inshore Fisheries and Conservation Authority (IFCA) be contacted and consulted (Kent & Essex Sea Fisheries Committee currently have this responsibility.	Acknowledged
	• The MMO advises that the proposed Project Nemo lies within the South East Marine Conservation Zone and therefore it is recommended that the project reviews whether baseline environmental data provides enough information to assess the impacts of the works on the broad-case habitats and Features of Conservation Importance of the area e.g. areas of chalk off the Kent coast.	Section 7.1 – Conservation designations Section 7.4 – Benthic ecology
	• The MMO suggests that a monitoring programme should be proposed as part of the EIA to verify predictions made within the ER and also the effectiveness of mitigation.	Section 10 - Monitoring
	• The MMO asks that the EIA includes references to all historic environment features, and all known wrecks. Attention must be given to the possibility of encountering previously unknown wrecks and military aircraft. An Archaeological Written Scheme of Investigation should be prepared and agreed with English Heritage, alongside an Archaeological Reporting Protocol, which ensures that a copy of any archaeological reports are deposited with English Heritage's National Monuments Record and Kent County Council, by completing an OASIS form (Oasis Access to the Index of Archaeological InvestigationS).	Section 8.3 – Marine archaeology

Appendix 3: MMO Scoping Response Letter

marine management organisation

PO Box 1275
Newcastle Upon Tyne
NE99 5BN

[redacted]
[redacted]@marinemanagement.org.uk

FAO: [redacted]

17 December 2010

Proposed National Grid Electrical Interconnector from Richborough, Kent to Zeebrugge, Belgium (Project Nemo)

Dear [redacted]

I am writing in reply to your correspondence dated 19th October 2010 requesting a screening and scoping opinion.

Background
The Marine Management Organisation has consulted its own scientific advisers (Centre for Environment, Fisheries & Aquaculture Science), Natural England, the Environment Agency, and the MMO coastal office local to the area. In reaching a conclusion, full regard has been paid to the responses and to the information submitted.

I attach a statement below that sets out our response.

The items highlighted in the statement below should be considered in the voluntary Environmental Impact Assessment (EIA) and Environmental Report (ER), which will form part of the application to the MMO for a Licence to undertake works below Mean High Water Springs. However, this letter is not a definitive list of all requirements and other subsequent work may prove necessary, such as consent from the Environment Agency under the Land Drainage and Sea Defence Byelaws 1981 for any works in, over or under sea defences between Mean Low Water and 15m from the landward toe of the defence.

Should you have any further queries in relation to this advice, please do not hesitate to contact [redacted] in the future.

Yours sincerely

[redacted]
Marine Case Officer
Marine Management Organisation

REQUEST FOR COMMENTS ON THE SCOPING REPORT: FORMAL RESPONSE

Proposed National Grid Electrical Interconnector from Richborough, Kent to Zeebrugge, Belgium (Project Nemo)

Description: The proposed works involve the preparation, laying and burial of an electrical interconnector cable with approximately 1000 MW capacity that will transfer power between Belgium and the UK. The proposed cable route would run from Richborough, Kent, UK to Zeebrugge, Belgium. The project comprises of two main stages, preparation of the route for laying the cable, and then the laying and burial of the cable. Within each stage a number of activities are planned to lay the cable but the works are not expected to start until 2014, with construction taking two years.

Conclusion: Following submission of a scoping document to the MMO in October 2010, discussing the areas to be covered by a voluntary Environmental Impact Assessment (EIA), this response provides comments on the content of an 'Environmental Report' (ER), which will be produced to support future applications:

- The scoping document adequately describes the proposed works and considers and assesses all potential effects and issues of the project.

- The proposal does not fall under Annex II 10(c) of the Marine Works (EIA) Regulations 2007, and therefore, a formal Environmental Statement is not required.

- A Licence will be required under the Marine & Coastal Access Act 2009, for the following aspects of the project: laying and burial of the cable from MHWS to 12 nautical miles; dredging and disposal required to pre-sweep sand waves; rock/ concrete mattress placement; and horizontal directional drilling.

- The MMO would like to see an assessment of 'in-combination effects' to identify, describe and evaluate the potential of effects from other projects and activities within the area.

- An Appropriate Assessment under the Conservation (Natural Habitat & c.) Regulations 1994 needs to be undertaken to investigate whether the project is likely to have a significant effect on the designated sites (either alone or in combination with other plans or projects), because the project is not directly connected to the management of the sites. The sites include: Sandwich Bay Special Area of Conservation (SAC), Thanet Coast and Sandwich Bay Special Protection Area (SPA) and Ramsar, and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI). The MMO requests that the project provides the regulator with sufficient information in a section of the EIA to adequately inform the appropriate assessment process: detail regarding the features for which the sites are designated; how the development will affect the structure and function of the features, directly and indirectly; identification of mitigation measures that may be needed to avoid, minimise or reduce any adverse significant effects.

- The MMO would like to see the Sandwich Bay and Ramsgate Western Undercliffe Bathing Water areas and other potential impacts of the project further addressed in the ER (See Annex 1 attached at end).

- The MMO would like to see concerns regarding the two techniques for cable laying addressed, namely: use of a coffer dam that could significantly alter patterns of sediment transfer; and the recovery of the cable laying vessel's anchors, which may disturb saltmarsh and further substrates.

- The ER needs to include mitigation for any potential harm to mussel beds or *Sabellaria* biogenic reefs to safeguard against possible disturbance during preparatory works. Additionally interference to any sensitive Elasmobranch species in the area must also be mitigated for if effects from the cable are detected.

- The MMO also suggests that alternatives to concrete be explored as bridging materials where the cable crosses other cables and/ or structures to provide extra habitat options e.g. rock.

- The MMO would also like to bring to point out that there is a commercial cockle fishery in Pegwell Bay, and also a population of grey Seals in the River great Stour.

- The MMO would like to suggest that the local Inshore Fisheries and Conservation Authority (IFCA) be contacted and consulted (Kent & Essex Sea Fisheries Committee currently have this responsibility, see address at end).

- The MMO advises that the proposed Project Nemo lies within the South East Marine Conservation Zone and therefore it is recommended that the project reviews whether baseline environmental data provides enough information to assess the impacts of the works on the broad-case habitats and Features of Conservation Importance of the area e.g. areas of chalk off the Kent coast.

- The MMO suggests that a monitoring programme should be proposed as part of the EIA to verify predictions made within the ER and also the effectiveness of mitigation.

- The MMO asks that the EIA includes references to all historic environment features, and all known wrecks. Attention must be given to the possibility of encountering previously unknown wrecks and military aircraft. An Archaeological Written Scheme of Investigation should be prepared and agreed with English Heritage, alongside an Archaeological Reporting Protocol, which ensures that a copy of any archaeological reports are deposited with English Heritage's National Monuments Record and Kent County Council, by completing an OASIS form (Oasis Access to the Index of Archaeological InvestigationS).

Copies of letter (with formal response) to:
(by email only)

[redacted], Regulatory Assessment Team, Cefas

[redacted], Natural England

[redacted], Offshore Industries Advisor, JNCC

[redacted], Marine Planning Unit, English Heritage

[redacted], Environment Agency

[redacted], Kent & Essex Sea Fisheries Committee

Annex 1: Areas of potential impacts of the project as advised by Cefas

- The landfall area is designated as a SSSI (Sandwich and Hacklinge Marshes SSSI) which is of interest for its geological features including Thanet formation geology which contains significant fossils of fish fauna and Devensian loess. It is one of the most important sites for loess studies in Britain. The proposed cable route runs approximately east-west from Pegwell Bay to Zeebrugge. Immediately east of Pegwell Bay, the surface sediments consist of sands and mud, followed by a chalk outcrop between banks known as 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.

- No impacts on Metocean conditions or sediment transport are expected as a result of installation, operation or decommissioning of the cable system.

- Installation, operation and decommissioning of the cables could cause environmental impacts upon the biological environment in the area crossed by the cable. The following aspects have been identified as having potential to result in adverse environmental impacts: noise from installation and decommissioning activities; disturbance, suspension and re-settling of sediment during cable burial, pre-sweeping of sand waves and decommissioning; heat, electric and magnetic field emissions from the operational cables and accidental spillages from vessels and equipment.

- Under the UK Marine and Coastal Access Act 2009 work is underway to identify and designate Marine Conservation Zones (MCZs) around the UK. The process of site identification in the area of the cable route is at an early stage and no information is currently available on the potential locations of such sites. However, Balanced Seas, the organisation responsible for identifying MCZs in this area, is expected to report its recommendations for sites by June 2011. National Grid has attended a local meeting of the Balanced Seas project and will continue to monitor progress on the identification of MCZs.

- The offshore sector of the cable route in the UK crosses coastal areas in the South Falls Bank, where reef habitat or sandy sediment in less than 20 m water depth may be encountered. These habitats are listed under Annex I of the Habitats Directive as being of conservation interest. Natural England and JNCC have recently undertaken an extensive search programme to identify areas of these habitats suitable for designation as SACs and none of the areas crossed by the cable route have been identified to date. However, geophysical and benthic survey work is being undertaken with a key aim of identifying Annex I habitats located in proximity to the cable route. The Annex I Habitats “submerged or partially submerged sea caves”, “coastal lagoons”, and “mudflats and sandflats not covered by seawater at low tide” are all thought to occur in the area of Pegwell Bay where the UK cable landfall will be located.

- The proposed cable landfall area is designated as a SPA and Ramsar site. Specifically the site is designated for supporting over-wintering populations of European importance of turnstone (*Arenaria interpres*) and golden plover (*Pluvialis apricaria*), and a breeding population of little terns (*Sterna albifrons*). There are also nationally important numbers of ringed plover and greenshank during their migration and red-throated diver during the winter period. The area is also of importance for several other species including wintering populations of dunlin, curlew, oystercatcher, redshank, sanderling and grey plover and breeding populations of shell duck, redshank and oystercatcher. Potential impact of the proposed works could result on direct, temporary local, disturbance to the SPA site and associated bird populations.

- Fish species diversity in the southern North Sea is rich in comparison to the central North Sea, and some key commercial species targeted in the southern North Sea and English Channel area use the offshore area as nursery and spawning grounds. Herring, lemon sole, sole, plaice, whiting, sand eel, sprat, ray and skate use the area as spawning grounds. Lemon sole, sole, sand eel, cod, plaice, sprat, skate, ray and mackerel use this area as nursery.

- Each of the species noted above has the potential to be affected during installation works as they either spawn on the seabed or in the water column (or may be affected by turbidity as a result of

cable installation). Herring are particularly sensitive as they only spawn on areas of gravel seabed. Sand eel, plaice and sole also spawn on the seabed.

- Areas of the Kent coast are also important for various shellfish, including cockles, mussels, oysters, whelks, periwinkle, crab, lobster and razor clams. Pegwell Bay is designated as a Shellfish Water under the Shellfish Waters Directive. It is understood that there are also fisheries for whelks and lobster in the vicinity of Pegwell Bay. Trenching and dredging operations associated to the proposed works can potentially affect these populations, directly by smothering, and indirectly, by affecting water quality.

- Cetacean species diversity and abundance is low in the area of the cable route compared to other areas in the North Sea. The only frequently occurring species in this southern area of the North Sea is the Harbour Porpoise. Harbour Porpoise are known to be present all year round and are the most frequently observed cetacean in European waters in both inshore and offshore waters. The Cetacean Atlas indicates that common bottlenose dolphin and white-beaked dolphin are also occasionally present in the area along the cable route. 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.

- The abundance of pinniped species is also very low in comparison to other areas in the North Sea. However, 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. There is also a minor Grey Seal breeding colony located off Ramsgate, approximately 1.5 km from the cable route. Potentially, localised, temporary disturbance to cetaceans and pinnipeds could result as a consequence of the operations related to the installation of the cables.

- The cable route crosses an area of high density commercial shipping, transiting in a predominantly north south direction. The area crossed is a key junction for shipping with extensive traffic routeing measures in place. Vessels are transiting to and from ports of the UK, mainland Europe and the North Sea. Thus, the cable installation operations can potentially affect shipping on a temporary basis.

- The potential impacts of the placement of hard substrate, such as chalk arisings, cable protection mattresses and any other structures on a predominantly sandy seabed should also addressed in the ER. This assessment should also consider in combination effects with nearby offshore wind farms.

Appendix 4: Legislative Framework

Although not an exhaustive list, the following table outlines the key policies, laws and guidelines relevant to this project which are considered in this report and the scope of environmental assessment proposed.

Convention/Directive/Legislation	Description	Relevance to Project Nemo
	International Conventions	
Convention on Biological Diversity (CBD) 1992	The objectives of the convention are: • Conservation of biological diversity • The sustainable use of its components • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources	The UK Biodiversity Action Plan is the UK Government's response to the Convention. The UKBAP provides plans for the conservation of the biological resources of the UK. It provides priority lists of species and habitats and action plans for the most threatened. The aim of the UKBAP is to significantly reduce loss of biodiversity, as called for by the CBD (UKBAP, 2010). Impacts on BAP species and habitats present along the cable route will be considered in the environmental assessment.
Convention on Environmental Impact Assessment in a Transboundary Context (Espoo) 1991	• Sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning • Lays down a general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries (UNECE, 2010)	As the project crosses the waters of the UK, France and Belgium environmental assessment will also be carried out in these countries as required. The results of each environmental assessment will be provided to the relevant authorities in each country.
Convention for the Protection of the Marine Environment of the North East Atlantic (Oslo Paris Convention (OSPAR) Convention) 1992	OSPAR is the mechanism by which fifteen Governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic (OSPAR, 2010). A key part of OSPAR's biodiversity strategy is to establish a network of marine protected areas which is both ecologically coherent and well-managed by 2010. The UK has currently identified 63 Marine Protected Areas (JNCC, 2010).	Some OSPAR sites in the UK are also Special Protection Areas and/or Special Areas of Conservation. The cable route may cross the Thanet Coast SAC which is also an OSPAR site. Any impacts on this area will be considered in the environmental assessment.
The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)	Covers all aspects of wetland conservation . Three main 'pillars' of activity: • Designation of wetlands of international importance as Ramsar sites • Promotion of the wise-use of all wetlands in the territory of each country • International co-operation with other countries to further the wise-use of wetlands and their resources	Sites designated under the Ramsar Convention are also designated as Special Protection Areas in the UK. The cable landfall options cross the Thanet Coast and Sandwich Bay Ramsar site. Any impacts on this area will be considered in the environmental assessment.
	EC Law	
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 (Water Framework Directive)	Purpose of the Directive is to establish a framework for the protection of: • inland surface waters (rivers and lakes) • transitional waters (estuaries) • coastal waters and groundwater It will ensure that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands meet 'good status' by 2015	The landfall options under consideration for the project are within the Kent North and Stour water bodies of the Water Framework Directive. The Directive requires that waters within defined River Basin Management Plans must reach at least good status.

Directive 2008/56/EC on establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)	The over-arching goal of the Marine Strategy Framework Directive (MSFD) is to achieve Good Environmental Status, across Europe's marine environment by 2020.	Any potential impacts on the Good Environmental Status of the area crossed by the cable route will need to be considered in the environmental assessment.
Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive)	• Aim of the Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species (specified in Annexes I and II of the Directive) at a favourable conservation status, introducing robust protection for those habitats and species of European importance (JNCC, 2010). • Provides for the designation of sites as Special Areas of Conservation (SACs) to create an ecologically coherent network of sites to protect the habitats detailed in Annex 1 and the species specified in Annex II.	The cable landfall options under consideration cross a SAC. Impacts on this area and particularly the features for which it is designated will be considered in the environmental assessment.
Directive 2009/147/EC on the conservation of wild birds (Birds Directive)	• Provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. • Requires Member States to take measures to maintain favourable conservation status of wild birds. • Provides for the designation of Special Protection Areas (SPAs) to protect rare and vulnerable bird species.	The cable landfall options under consideration cross a SPA. Impacts on this area and particularly the features for which it is designated will be considered in the environmental assessment
National Policy		
Marine Policy Statement	A Consultation on the Draft Marine Policy Statement (MPS) is currently in process. The MPS is the first step in a new system of marine planning being introduced around the UK as a result of the Marine and Coastal Access Act 2009. It will provide the high level policy context within which Marine Plans will be developed, and set the direction for marine licensing and other authorisation systems. The Marine Policy Statement is due to be finalised in Spring 2011 after which point a series of spatial plans will be drawn up for the waters around England (DEFRA, 2010).	The licence decision for the for the project under the Marine and Coastal Access Act will need to follow the Marine Policy
UK Legislation		
Marine and Coastal Access Act 2009	The Act provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment. It covers eight key areas - creation of a MMO; creation of a strategic marine planning system; provision of streamlined marine licensing system; provision of powers to enable marine nature conservation; fisheries management and marine enforcement; migratory and freshwater fisheries; coastal access; and coastal and estuarine management (JNCC, 2010). From April 2011 the Marine and Coastal Access Act (MCAA) will combine the requirements of the Coast Protection Act 1949 and the Food and Environmental Protection Act 1985 to create a single Marine Licensing process. The act makes the MMO the competent marine planning and licensing authority on behalf of UK Government, delivering marine functions in English territorial waters and UK offshore waters (for matters that are not devolved) such as marine licensing and enforcement of marine legislation.	From review of the MCAA and associated draft secondary legislation, and consultation with DEFRA's marine policy unit it is understood that the licence requirements for the project are as follows: Under Section 81 of the MCAA submarine interconnector cables are interpreted to be "exempt cables". Therefore, a Marine Licence is required for: • Laying and burial of the cable system between mean high water springs and the 12 nautical mile limit. Under Section 81 of the MCAA the MMO are obligated to grant a licence for this work, but can place conditions on that licence. No licence is required for a section of cable laid outside of 12 nautical miles. • A Marine Licence/s will be required for dredging of sand waves, disposal of dredged material, rock or concrete

	The act also provides for enforcement of the legislation.	mattress placement, and horizontal directional drilling and the associated installation of conduits.
Town and Country Planning Act 1990	The aspects of the project situated above the mean low water spring tide line constitute development regulated under the previsions of the Town and Country Planning regime.	A separate environmental scoping and assessment process and planning application will made for the terrestrial aspects of the project which will include the onshore section cable and a converter station
Environment Act 1995	Consent from the Environment Agency required for works affecting sea defences and flood defences.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of sea and flood defences in proximity to the cable route
Land Drainage Act 1991	Consent from the Environment Agency required for works affecting drainage ditches.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of drainage ditches in proximity to the cable route
Water Resources Act 1991	Consent from the Environment Agency required for works affecting sea defences and flood defences.	Clarification to be sought via this scoping report from the Environment Agency in relation to the location of sea and flood defences in proximity to the cable route
The Conservation of Habitats and Species Regulations 2010	Development within or adjacent to existing, proposed or potential Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) is subject to the Conservation of Habitats and Species Regulations 2010 which relate to onshore sites and those located within territorial waters. The Regulations provide for the designation and protection of 'European sites', the protection of 'European protected species', and the adaptation of planning and other controls for the protection of European Sites.	If the development has the potential to have a significant adverse impact on the conservation features for which the SAC or SPA is designated, then the proposal may be subject to Appropriate Assessment. This process aims to determine whether or not the development would have a significant adverse impact on the conservation interest feature and on the overall ecological integrity of the site. Appropriate Assessment is carried out the by competent authority, which in this case is the MMO, advised by Natural England.
Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007	Development within or adjacent to existing, proposed or potential SACs and SPAs is subject to the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 which relate to sites located outside of territorial waters (i.e. outside of the 12 nautical mile limit).	
Wildlife and Countryside Act 1981	Provides for the protection of rare and vulnerable species and the notification of Sites of Special Scientific Interest (SSSI).	Licences may be required if vulnerable species or SSSI sites are to be impacted by the project
National Heritage Act 2002	This extends English Heritage's statutory responsibilities to the marine environment out to the 12 nautical mile limit.	Impacts on marine archaeology will considered in the environmental assessment
Protection of Wrecks Act 1973	Provides protection for designated wreck sites. Wreck sites can be designated for historical, archaeological or artistic value or if they are deemed dangerous.	Protected wreck sites will be avoided by the cable route by the required distance.
Ancient Monuments and Archaeological Areas Act 1979	Provides for archaeological sites to be designated as Scheduled Ancient Monuments (SAMs) and requires scheduled monument consent for activities that might impact upon such sites.	SAMs will be avoided by the cable route.
Protection of Military Remains Act 1986	Provides for the protection of underwater military remains, including ships and aircraft.	Wrecks including military remains will be avoided by the cable route

Appendix 5: Habitats Regulations Assessment Signposting

A Habitats Regulations Screening Assessment report is included within the Project Nemo application and covers both offshore and onshore elements within the UK (Nemo Link: UK to Belgium Interconnector: Pegwell Bay – Assessment of Likely Significant Effects Report)

Thanet Coast and North-east Kent Natura 2000 Sites

Project Nemo Appropriate Assessment Signposting Document for Thanet Coast and North East Kent Natura 2000 Sites			
Conservation Objectives	**Chapter Issue Discussed**	**Page**	**Sections (if relevant)**
Thanet Coast SAC			
Reefs	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Submerged or partially submerged sea caves	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Thanet Coast and Sandwich Bay SPA			
Sand and shingle shores	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Shallow coastal waters	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Intertidal mud and sandflats	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Chalk shores	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Little tern (breeding population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Golden plover (wintering population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Turnstone (wintering and migratory population)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Sandwich Bay SAC			
Shifting dunes along the shoreline with *Ammophila arenaria* (“white dunes”)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Fixed dunes with herbaceous vegetation (“grey dunes”)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Dunes with *Salix repens ssp. argentea* (*Salicion arenariae*)	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Embryonic shifting dunes	Chapter 7.1 Conservation Designations	85	Table 7-1-1
Humid dune slacks	Chapter 7.1 Conservation Designations	85	Table 7-1-1

Thanet Coast and Sandwich Bay Ramsar Site			
Rocky shore, estuary, dune, saltmarsh and martime grassland habitat	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2.1.Intertidal communities
Turnstone	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Sanderling	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Ringed plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Golden plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Grey plover	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
Invertebrates	Chapter 7.1 Conservation Designations	85	Table 7-1-1
	Chapter 7.2 Ornithology	91	7.2.2.1.Intertidal Bird Species
	Chapter 7.4 Benthic and Intertidal Ecology	107	7.4.2Baseline Environment

Appendix 6: Assessment of Significance

Description of Impact				Nature of Effect					Description of Receptor				Impact Significance	Consideration of Mitigation							Residual Impact Significance	Section in Report
Section	Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value		Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation		
A - Bathymetry and Seabed Processes																						
A - 1	Installation	Pre-sweeping of sand waves	Localised changes to seabed	100	10	10	1	Moderate	Low	High	Low	Low	Minor	An appropriate dredging technique (likely to be a Trailing Suction Hopper Dredger) is to be used. The sweep corridor will only dredge through areas judged to be at risk of either mobility or preventing cable burial equipment from operating effectively.	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
A - 2	Installation	Disposal of dredged material from pre-sweeping	Localised changes to seabed	100	10	10	10	Moderate	Low	Moderate	Low	Low	Minor	Dredged material is to be disposed within 1 km of the proposed cable route, rather than being taken to licensed disposal sites	10	10	10	1	Moderate	The residual impact will extend over a greater geographic area, but there is likely to be much smaller impact at any one point	Minor	
A - 3	Installation	Cable burial	Localised changes to seabed	100	1	10	1	Moderate	Low	High	Low	Low	Minor	Appropriate ploughing or jetting techniques are to be used to minimise sediment disturbance	100	1	10	1	Moderate	The residual impact is unchanged	Minor	
A - 4	Operation	External cable protection	Localised changes to seabed	10	1	10	10	Moderate	Low	Low	Low	Low	Minor	Appropriate cable burial depths are to be achieved to minimise the need for external cable protection	10	1	10	10	Moderate	Impact will be prevented as far as possible. Should external protection be required, appropriate techniques will be used to minimise the possibilities of scour and facilitate easier recovery	Minor	
A - 5	Decommissioning	Cable removal	Localised changes to seabed	100	1	1	1	Moderate	Low	High	Low	Low	Minor	Appropriate recovery techniques will be used to minimise sediment disturbance	100	1	1	1	Moderate	The residual impact is unchanged	Minor	
B - Geology																						
B - 1	Installation	Cable burial	Direct damage to geological features of interest associated with the Sandwich and Hacklinge Marshes SSSI.	1	1	1	100	Moderate	Low	High	Low	Low	Minor	The cable will be routed through an area with less geological interest features in accordance with scoping responses and boring techniques will be used to minimise the geological disturbance	10	1	10	100	Moderate	High geological value area will be avoided, so issues of recoverability and sensitivity will be reduced	Minor	
B - 2	Decommissioning	Cable removal	Direct damage to geological features of interest associated with the Sandwich and Hacklinge Marshes SSSI.	1	1	1	1	Low	Low	High	Low	Low	Negligible	The cable will be removed through only the previously disturbed area to prevent the possibility of damage to any other geological feature					no impact	Since the route was already moved to go through an area lower value geology, therefore issues of recoverability and sensitivity will be reduced	no impact	
C - Water Quality																						
C - 1	Installation	Pre-sweeping of sand waves	Increased turbidity	100	10	1	1	Moderate	Low	High	Low	Low	Minor	Only the areas in need of sweeping will be dredged and appropriate dredging techniques will be used to minimise sediment resuspension	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
C - 2	Installation	Pre-sweeping of sand waves	Potential re-suspension and settling of contaminated sediments	10	1	1	1	Low	Low	High	Low	Low	Negligible	Only the areas in need of sweeping will be dredged and appropriate dredging techniques will be used to minimise sediment resuspension	10	10	10	1	Moderate	Sweeping of sand waves is kept offshore, where sediment contamination is unlikely and will not affect other seabed areas	Minor	
C - 3	Installation	Disposal of dredged material from pre-sweeping	Increased turbidity	100	10	1	1	Moderate	Low	High	Low	Low	Minor	The dredger overflow will be minimised and the sediment will be disposed within the vicinity of the cable route, rather than relocated to distant licensed disposal sites	100	10	1	1	Moderate	The residual impact is unchanged	Minor	
C - 4	Installation	Disposal of dredged material from pre-sweeping	Release of contaminants from sediments	10	1	10	1	Moderate	Low	High	Low	Low	Minor	Contaminated sediments are not considered likely to occur in offshore dredging areas	1	1	1	1	Low	Sediment contamination is unlikely and will not affect other seabed areas	Minor	
C - 5	Installation	Cable burial	Increased turbidity	10	1	1	1	Low	Low	High	Low	Low	Negligible	Appropriate techniques of ploughing or jetting will be used for cable burial, to minimise sediment resuspension	10	1	1	1	Low	Residual impact unchanged	Minor	
C - 6	Installation	Cable burial	Disturbance of contaminated sediment	10	10	10	1	Moderate	Low	High	Low	Low	Minor	Sampling of nearshore sediments shows acceptable levels of sediment contamination, ensuring that contamination dispersion to other areas will be minimised	1	1	1	1	Low	Disturbance of nearshore sediments will not release unacceptable levels of contaminants	Minor	
C - 7	Operation	Heat emissions from cable system	Increased ambient seabed temperatures	10	1	1	100	Moderate	Low	High	Low	Low	Minor	The cable design should incorporate adequate thermal insulation and be buried sufficiently deeply for surface sediments to not be heated	1	1	1	1	Low	Heat escape is unlikely to be detectable at the seabed and water interface	Minor	
C - 8	Operation	Accidental contamination from associated vessels and equipment	Deterioration in water quality	1	1	1	1	Low	Low	High	Low	Low	Negligible	Maintenance will only be carried out when necessary, which will be minimised by good installation practice. MARPOL regulations to prevent accidental pollution will be observed	1	1	1	1	Low	Adequate precautions and the use of best practice will minimise the likelihood of accidents	Minor	
C - 9	Decommissioning	Cable recovery	Increased turbidity	10	10	1	1	Moderate	Low	High	Low	Low	Minor	No mitigation identified	10	10	1	1	Moderate	The residual impact is unchanged	Minor	

C - 10	Decommissioning	Cable recovery	Disturbance of contaminated sediment	10	1	10	1	Moderate	Low	High	Low	Low	Minor	Contaminated sediments are not considered likely to occur in offshore sediments, whilst sampling of nearshore sediments shows acceptable contamination levels	1	1	10	1	Low	There is no anticipation of contaminant loading being increased during the operational period, therefore removal will not mobilise any more contaminants than installation	Minor	
D - Conservation Designations																							
D - 1	Construction	Installation of Cables	Disturbance or destruction of internationally designated areas (SACs and SPAs)	100	1	10	1	Moderate	Moderate	High	High	Moderate	Moderate	Avoidance of the most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats. Avoid nesting areas and nesting and wintering season where practical.	10	1	1	1	Low	Impacts will only affect habitats where they can accept some level of disturbance and recover in short periods of time (such as sands and mudfalts). It should be noted that by taking into account this mitigation impacts on the most senstive features of the SAC site (e.g. the wave cut platform habitats will be avoided)	Minor	
D - 2	Construction	Installation of Cables	Disturbance or destruction of nationally and locally designated areas (SSSI, NNR and LNR)	100	1	10	1	Moderate	Moderate	High	Moderate	Moderate	Moderate	Avoidance of the most sensitive habitats, install cables in habitats that have high recoverability rates such as sands and mudflats. Avoid key geological features of the SSSI.	10	1	1	1	Low	Impacts will only affect habitats where they can accept some level of disturbance and recover in short periods of time (such as sands and mudfalts).	Minor	
D - 3	Decommissioning	Cable removal	Disturbance or destruction of internationally designated areas (SACs and SPAs)	100	1	10	1	Moderate	Moderate	High	High	Moderate	Moderate	Cable can be left in situ to lessen the magnitude of impact on qualifying features of designations.					No Impact	Qualifying features of affected designations will be unaffected by decommissioning if cable left insitu. An environmental assessment will be undertaken prior to any decommissioning being undertaken.	no impact	
D - 4	Decommissioning	Cable removal	Disturbance or destruction of nationally and locally designated areas (SSSI, NNR and LNR)	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Cable can be left in situ to lessen the magnitude of impact on qualifying features of designations.					No Impact	Qualifying features of affected designations will be unaffected by decommissioning if cable left insitu. An environmental assessment will be undertaken prior to any decommissioning being undertaken.	no impact	
E - Benthos																							
E - 1	Pre-installation	Pre-lay grapnel run	Disturbance of inter-tidal communities	10	1	1	1	Low	Moderate	High	Low	Low	Negligible	None required due to high recoverability and limited duration and spatial extent									
E - 2	Pre-installation	Pre-lay grapnel run	Disturbance of subtidal benthic communities	10	1	1	1	Low	Moderate	High	Low	Low	Negligible	None required due to high recoverability and limited duration and spatial extent									
E - 3	Pre-installation	Pre-lay grapnel run	Disturbance of Sabellaria reefs	10	1	10	10	Moderate	Moderate	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	None	Minor		
E - 4	Pre-installation	Pre-sweeping of sand waves	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required due to high recoverability and limited duration and spatial extent									
E - 5	Pre-installation	Pre-sweeping of sand waves	Disturbance of Sabellaria reefs	1	1	1	1	Low	High	High	High	Medium	Minor	None required due to high recoverability and limited duration and spatial extent									
E - 6	Pre-installation	Pre-sweeping of sand waves	Smothering of subtidal benthic communities from deposition of suspended sediment	100	10	10	1	Moderate	Moderate	Moderate	Low	Low	Minor	None required									
E - 7	Pre-installation	Pre-sweeping of sand waves	Smothering of Sabellaria reefs from deposition of suspended sediment	1	1	1	1	Low	High	Moderate	High	Medium	Minor	Assumption: dredged material to be deposited up to 1500m away from area of pre-sweeping - this should not be deposited close to area of S. spinulosa reef.									
E - 8	Installation	Use of cable lay barge anchors	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required									
E - 9	Installation	Use of cable lay barge anchors	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None required									
E - 10	Installation	Use of cable lay barge anchors	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	High	High	High	Medium	Moderate	Re-rerouting to avoid reef. Anchors are expected at up to 100m from vessel - slight possibility that they may hit the area of reef 90m from the cable route. Vessel should be positioned and anchors deployed accordingly.	1	1	1	1	Low	None	Minor		

E - 11	Installation	Excavation of cable trench	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Bundling cables together and in one trench to reduce footprint. Ploughing should be used to minimise sediment re-suspension.	100	1	1	1	Moderate	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 12	Installation	Excavation of cable trench	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Bundling cables together and in one trench to reduce footprint. Ploughing should be used to minimise sediment re-suspension.	100	1	1	1	Moderate	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 13	Installation	Excavation of cable trench	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	High	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	None	Minor	
E - 14	Installation	Excavation of cable trench	Effect of suspended sediment on intertidal communities	10	1	1	1	Low	Moderate	Moderate	Low	Low	Negligible	Use of non-displacement plough instead of jetting to minimise sediment re-suspension								
E - 15	Installation	Excavation of cable trench	Effect of suspended sediment on benthic communities	10	1	1	1	Low	Moderate	Moderate	Low	Low	Negligible	Use of non-displacement plough instead of jetting to minimise sediment re-suspension								
E - 16	Installation	Excavation of cable trench	Effect of suspended sediment on Sabellaria reefs	10	1	1	1	Low	High	High	High	Medium	Minor	Re-rerouting to avoid reef. Use of non-displacement plough instead of jetting to minimise sediment re-suspension	1	1	1	1	Low	Minor. Sediment deposition is <0.1mm.	Minor	
E - 17	Installation	Cable burial	Disturbance of intertidal communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Simultaneous cable laying and burial should be conducted to minimise duration of impact.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Negligible	
E - 18	Installation	Cable burial	Disturbance of subtidal benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Simultaneous cable laying and burial should be conducted to minimise duration of impact.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Negligible	
E - 19	Installation	Cable burial	Disturbance of Sabellaria reefs	100	1	10	10	Moderate	Low	High	High	Medium	Moderate	Re-rerouting to avoid reef.	1	1	1	1	Low	Minor anticipated residual impact within footprint of or cable trenching and burial equipment.	Minor	
E - 20	Installation	Sub-tidal chalk cutting	Effects of suspension and deposition of chalk on subtidal benthic communities	10	1	10	1	Moderate	Moderate	High	Low	Low	Minor	None.	1	1	1	1	Low	Minor. Chalk deposition is negligible.	Minor	
E - 21	Installation	Sub-tidal chalk cutting	Effects of suspension and deposition of chalk on Sabellaria reef	10	1	1	1	Low	High	High	High	Medium	Minor	Re-rerouting to avoid reef.	10	1	1	1	Low	Minor. Chalk deposition is negligible.	Minor	
E - 22	Installation	External cable protection	Disturbance of benthic communities	100	1	10	1	Moderate	Low	High	Low	Low	Minor	None required								
E - 23	Installation	External cable protection	Substrate change	100	1	10	100	Severe	Low	High	Low	Low	Moderate	Minimise use of rock protection.						Important to note that this may be a positive impact as creating new habitat.	Moderate	
E - 24	Installation	Cable installation works	Impacts from noise and vibration	1	1	1	1	Low	Low	Low	Low	Low	Negligible	None required								
E - 25	Installation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
E - 26	Operation	External cable protection	Changes in current regime	1	1	1	10	Low	Low	High	Low	Low	Negligible									
E - 27	Operation	External cable protection	Disturbance of subtidal benthic communities (scour and substrate change)	10	1	10	100	Moderate	Low	High	Low	Low	Moderate							Potential creation of new habitats - not necessarily a negative impact	Moderate	
E - 28	Operation	Operational noise, vibration, heat and EMF emissions of the buried cables	Disturbance of subtidal benthic communities	1	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
E - 29	Operation	Maintenance of cable works	Disturbance of subtidal benthic communities	1	1	10	1	Low	Low	High	Low	Low	Negligible	None required								
E - 30	Operation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and subtidal benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
E - 31	Decommissioning	Intertidal works	Disturbance of benthic communities	100	1	10	1	Moderate	Moderate	High	Low	Low	Minor	Leave cable in-situ	1	1	1	1	Low	No residual impact.	Negligible	

E - 32	Decommissioning	Cable recovery	Disturbance of subtidal benthic communities	100	1	10	10	Moderate	Moderate	High	Low	Low	Minor	Leave cable in-situ	1	1	1	1	Low	No residual impact.	Negligible	
E - 33	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of intertidal and subtidal benthic communities	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low	Minor residual risk	Negligible	
F - Fish and Shellfish																					
F -1	Pre-installation	Pre-lay grapnel run	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F - 2	Pre-installation	Pre-lay grapnel run	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -3	Pre-installation	Pre-lay grapnel run	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -4	Pre-installation	Pre-lay grapnel run	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -5	Pre-installation	Pre-sweeping of sand waves	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -6	Pre-installation	Pre-sweeping of sand waves	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -7	Pre-installation	Pre-sweeping of sand waves	Disturbance of shellfish beds	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -8	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	10	1	1	Low	Low	High	High	Medium	Minor	None required								
F -9	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	1	Moderate	High	Moderate	High	Medium	Moderate	Assumption: dredged material to be deposited 1500m away from area of pre-sweeping. Restrict timing to avoid most sensitive spawning and nursery ground activity.	1	10	1	1	Low	None expected	Minor	
F -10	Pre-installation	Pre-sweeping of sand waves	Smothering, from deposition of suspended sediment, of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -11	Installation	Use of anchors on cable lay barge	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -12	Installation	Use of anchors on cable lay barge	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required								
F -13	Installation	Use of anchors on cable lay barge	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	
F -14	Installation	Use of anchors on cable lay barge	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -15	Installation	Excavation of cable trench	Disturbance of fish communities	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required								
F -16	Installation	Excavation of cable trench	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required								
F -17	Installation	Excavation of cable trench	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor	

F -18	Installation	Excavation of cable trench	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required							
F -19	Installation	Excavation of cable trench	Effect of suspended sediments on spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	10	1	1	Low	Low	High	High	Medium	Minor	None required							
F -20	Installation	Excavation of cable trench	Effect of suspended sediments on spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	10	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	10	1	1	Low	None expected	Minor	
F -21	Installation	Excavation of cable trench	Effect of suspended sediments on shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required							
F -22	Installation	Cable burial	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required							
F -23	Installation	Cable burial	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring). Simultaneous lay and burial.	1	1	1	1	Low	None expected	Minor	
F -24	Installation	Cable burial	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required. Simultaneous lay and burial.							
F -25	Installation	Sub-tidal chalk cutting	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required							
F -26	Installation	Sub-tidal chalk cutting	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	10	10	10	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring).	1	10	1	1	Low	None expected	Minor	
F -27	Installation	Sub-tidal chalk cutting	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required							
F -28	Installation	External cable protection	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	1	1	1	1	Low	Low	High	High	Medium	Minor	None required							
F -29	Installation	External cable protection	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	10	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring).	1	1	1	1	Low	None expected	Minor	
F -30	Installation	External cable protection	Disturbance of shellfish beds	10	1	1	1	Low	Low	High	Low	Low	Negligible	None required							
F -31	Installation	External cable protection	Substrate change	100	1	100	100	Severe	Low	High	Low	Low	Moderate	Minimise use of rock protection.						Important to note that this may be a positive impact as creating new habitat.	Moderate
F -32	Installation	Cable installation works	Impacts from noise and vibration	10	1	10	1	Moderate	Moderate	Moderate	Low	Low	Minor	None required							
F -33	Installation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor	
F -34	Operation	External cable protection	Disturbance of fish communities (scour and substrate change)	10	1	10	100	Moderate	Low	High	Low	Low	Minor	None required							
F -35	Operation	Maintenance of cable works	Disturbance of fish communities	1	1	10	1	Low	Low	High	Low	Low	Negligible	None required							
F -36	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Low	Minor	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor	

F -37	Operation	Emission of noise and vibration from cables	Disturbance to fish communities or changes in behavioural patterns	1	1	1	100	Moderate	Moderate	Moderate	Low	Low	Minor	None required									
F -38	Operation	Emission of EMF from cables	Changes in behavioral patterns of electrosensitive fish species including disturbance to feeding, spawning and migration	1	1	1	100	Moderate	Moderate	High	High	Medium	Minor	Bundling cables together and in one trench and burying to maximum depth would reduce footprint of any potential impact.	1	1	1	100	Moderate	The impact will continue for as long as the cable is operational	Minor		
F -39	Operation	Emission of heat from cables	Disturbance to spawning grounds and shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	Assumption: Cable to be buried at a minimum depth of 1m. Bundling cables together in one trench and burying to maximum depth would reduce footprint of any potential impact.									
F -40	Decommissioning	Intertidal works	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Minor	None required									
F -41	Decommissioning	Intertidal works	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Leave cable in-situ? Restrict timing to avoid most sensitive spawning and nursery ground activity	1	1	1	1	Low	None expected	Minor		
F -42	Decommissioning	Intertidal works	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	None required									
F -43	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	1	10	10	10	Moderate	Moderate	High	Low	Medium	Moderate	Follow strict environmental health and safety procedures to minimise spills and enforce effective clean up procedures	1	1	1	1	Low		Minor		
F -44	Decommissioning	Cable recovery	Disturbance of spawning and nursery grounds - less sensitive species (pelagic eggs/larvae etc)	10	1	1	1	Low	Low	High	High	Medium	Moderate	None required									
F -45	Decommissioning	Cable recovery	Disturbance of spawning and nursery grounds - most sensitive species (i.e. demersal eggs/larvae such as herring)	100	1	10	1	Moderate	High	Moderate	High	Medium	Moderate	Leave cable in-situ? If not, restrict timing to avoid most sensitive spawning and nursery ground activity (i.e. herring)	1	1	1	1	Low	None expected	Minor		
F -46	Decommissioning	Cable recovery	Disturbance of shellfish beds	10	1	1	1	Low	Moderate	High	High	Medium	Minor	Leave cable in-situ?									
G - Ornithology																							
G - 1	Installation	Intertidal works	Disturbance of birds	10	1	1	1	Low	high	High	high	Moderate	Minor	Construction activities in the intertidal area will aim to avoid Oct-Feb and May	1	1	1	1	Low		Minor		
G - 2	Installation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	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 suitable response plan will be initiated.	10	1	1	1	Low		Minor		
G - 3	Installation	Intertidal works	disturbance of nesting birds	10	1	1	1	Low	High	Low	Moderate	Moderate	Minor	fenced off to avoid installation work accidentally entering them. 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 Nemo will attempt to avoid the most sensitive periods within the breeding season.	1	1	1	1	Low		Minor		
G - 4	Installation/Operation	Intertidal works	Loss of prey species	10	1	1	1	Low	Low	High	Moderate	Low	Negligible										
G - 5	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Standard construction and environmental best practice will be used to minimise the likelihood of contaminants being released.	10	1	1	1	Low		Minor		
G - 6	Decommissioning	Intertidal works	Disturbance of birds	10	1	1	1	Low	high	High	high	Moderate	Minor	Construction activities in the intertidal area will aim to avoid Oct-Feb and May	1	1	1	1	Low		Minor		
G - 7	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	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 suitable response plan will be initiated.	10	1	1	1	Low		Minor		
H - Marine Mammals																							
H - 1	Installation	Noise associated with excavation of the cable trench	Disturbance to cetacean and pinniped species	10	10	10	1	Moderate	Low	High	Low	Low	Minor										
H - 2	Installation	Noise associated with presence of installation vessels	Disturbance to cetacean and pinniped species	10	10	1	1	Moderate	Low	High	Low	Low	Minor										

H - 3	Installation	Intertidal works	Disturbance of seals in intertidal area	10	1	1	1	Low	Moderate	High	Low	Low	Negligible								
H - 5	Operation	Noise associated with presence of any maintenence and repair vessels	Disturbance to cetacean and pinniped species	10	1	1	1	Low	Low	High	Low	Low	Negligible								
H - 6	Operation	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	10	1	1	Moderate	Moderate	High	Low	Low	Minor								
H - 7	Decommissioning	Noise associated with presence of decommissioning vessesls and equipment	Disturbance to cetacean and pinniped species	10	10	10	1	Moderate	Low	High	Low	Low	Minor								
H - 8	Decommissioning	Accidental contamination from associated vessels and equipment	Contamination of habitats and individuals	10	10	1	1	Moderate	Moderate	High	Low	Low	Minor								
I - Commercial Fisheries																					
I - 1	Installation	Temporary mobile exclusion zone around the cable laying and burial spread/s	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place. A Fisheries Liaison Officer Will be appointed to coordinate communication between the construction works and the fishing industry.	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. Although there will be some disturbance to fishermen due to the exclusion zone around the installation works it will be limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Minor	
I - 3	Operation	Cable laying and burial including use of anchors to maintain position of installation vessels	Damage to certain types of fishing gear. Drift and trammel netting can become snagged on rough ground that could be created as a result of cable burial and cable crossings.	10	1	1	1	Low	Low	High	Moderate	Low	Negligible	Notice to Mariners will be issued to advise fishermen where and when the installation will take place. A Fisheries Liaison Officer Will be appointed to coordinate communication between the construction works and the fishing industry.	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. The seabed surveys indicate that much of the seabed is fine sand and gravel in the area crossed. Therefore installation works are unlikely to increase the roughness of the seabed. There is only one cable crossing in UK waters. Although this will require the placement of rock or mattresses it will be over a very limited extent. Any debris encountered during the prelay grapnel run wil be cleared, therefore potentially reducing seabed debris.	Negligible	
I - 7	Operation	Burial surveys and repair work	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place	1	1	1	1	Low	The residual impact after mitigation is low and the resulting impact significance is negligable. Although there will be some disturbance to fishermen due any routine survey or repair work it will be extremely limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Negligible	
I - 8	Operation	Presence of cables	Disturbance to trawling activities that will need to avoid the installed cable and associated cable protection.	100	1	1	100	Moderate	Low	High	Moderate	Low	Minor	Fishermen will be advised of the presence and location of the cable system via the Kingfisher Cable awareness charts. This will enable them to avoid interactions between their fishing gear and the cable system. Additionally the cable will be buried below the depth where it could be expected that trawlers could snag the cable (i.e. 2m burial depth will be sought). This should ensure that should a trawler accidently trawl over the cable system there will be no damage to their equipment or vessel. Additona	100	1	1	1	Moderate	The residual impact will be unchanged as a result of mitigation as trawlers will still be recommended to avoid trawling over the cable system.	Minor	

I - 12	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Displacement of fishing activity within the area surrounding the vessel spread. There may also be indirect impacts on fishermen outside of the cable installation area as those fishing vessels displaced look to fish in other areas.	10	1	1	1	Low	Moderate	High	Moderate	Moderate	Minor	Notice to Mariners will be issued to advise fishermen where and when the installation will take place	1	1	1	1	Low	The residual impact after mitigation and the resulting impact significance is minor. Although there will be some disturbance to fishermen due to the exclusion zone around the installation works it will be limited in duration and extent and disruption will be minmised by effective fisheries liaison.	Negligible	
I - 13	Decommissioning	Cable recovery including use of anchors to maintain position of installation vessels	Damage to certain types of fishing gear. Drift and trammel netting can become snagged on rough ground that could be created as a result of cable recovery	10	1	1	1	Low	Low	High	Moderate	Low	Negligible	Mitigation will be determined when the decomissioning options are fully assessed towards the end of the cable system's lifetime. It is possible that a post decomissioning survey could be carried out to determine whether removed of the cable system results in increased roughness/debris on the seabed. Following this survey any substantial debris could be removed if neccesary.	1	1	1	1	low	This issue will only arise if the decision is taken to remove the cable. Leaving the cable in situ is often an attractive alternative to removing the cables. Even if the cable is removed it is expected that the impact will be low due to the limited extent of any area of orugh ground that will be created.	Negligible	
J - Shipping and Navigation																						
J - 1	Installation	Temporary mobile safety zone around the cable laying and burial spread/s	Impeded access to the Port of Ramsgate	10	1	1	1	Low	Low	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Prior liaison with Port of Ramsgate. Maintain watch on Port working channels during activities.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 2	Installation	Installation spread	Other vessel collides with installation vessels	10	10	10	1	Moderate	High	High	Low	Moderate	Moderate	Promulgation of MSI Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 3	Installation	Temporary mobile safety zone around the cable laying and burial spread/s	Displacement of shipping and recreational boating traffic from area surrounding the vessel spread.	10	10	1	1	Moderate	Moderate	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP). However unlike local effects there is a higher risk due to the nature of the traffic - many of which may be new to navigating to the area.	Minor	
J - 4	Operation	EMI from HVDC cables	Compass deviation leading to navigational error and grounding	100	1	1	100	Moderate	Moderate	High	High	Moderate	Moderate	Measurement of EMI to ensure within accepted limits	1	1	1	100	Moderate	Ensure within MCA Accepted Limits	Minor	
J - 5	Operation	Vessels anchoring	Damage to cable Damage to vessel/ injury to persons on board	10	1	100	100	High	High	Low	High	Moderate	Significant	Charting of cable Cable buried to minimum depth (0.5m) as specified by MCA. Cable is armoured.	10	1	10	100	Moderate	Anchoring in emergency remains a Moderate risk.	Moderate	
J - 6	Decommissioning	Temporary mobile safety zone around the cable recovery spread/s	Impeded access to the Port of Ramsgate	10	1	1	1	Low	Low	High	High	Moderate	Minor	Promulgation of Maritime Safety Information (MSI) Prior liaison with Port of Ramsgate. Maintain watch on Port working channels during activities.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 7	Decommissioning	Decommissioning spread	Other vessel collides with decommissioning vessels	10	10	10	1	Moderate	High	High	Low	Moderate	Moderate	Promulgation of MSI Establishment of Safety Zone around spread. Use of Guard Vessel. Consultation with local, regional and national organisations/authorities (inc CNIS/Dover Straits VTS). Vessels comply with ColRegs (lighting and marking)	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP)	Minor	
J - 8	Decommissioning	Temporary mobile safety zone around the cable recovery spread/s	Displacement of shipping and recreational boating traffic from area surrounding the vessel spread.	10	10	1	1	Moderate	Moderate	High	High	Moderate	Minor	Promulgation of Information and use of Guard Vessel. Consultation and cooperation with regional authorities including CNIS/Dover Straits VTS.	1	1	1	1	Low	Application of controls reduces the risk to a level as low as reasonably practicable (ALARP). However unlike local effects there is a higher risk due to the nature of the traffic - many of which may be new to navigating to the area.	Minor	
K - Archaeology and Cultural Heritage																						

K - 1	Installation	Cable installation	Damage or destruction of submerged prehistoric material shallowly buried below the seabed. Any material within 2 m of the surface could be impacted.	10	1	10	100	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Geotechnical samples from the cable route area have been archaeologically assessed – and Stage 3 assessment will provide further information	10	1	10	100	Moderate	Shallow sections of the resource will still be impacted by development, however, information about the submerged prehistoric resource will be gained from geotechnical assessment (as explained in section 11.1.3) – and the area of impact on the feature is comparatively small.	Moderate	
K - 2	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of late 20th century wrecks (WA7017, WA7287, WA7292, and WA7303) and other 'wrecks' of low archaeological importance (WA7271, WA7273, and WA7286).	1	1	100	100	Moderate	High	Low	Moderate	Low	Minor	None required, however, to prevent damage to cable laying equipment, wrecks should be avoided.	1	1	100	100	Moderate	None	Minor	
K - 3	Installation	Use of anchors to maintain position of installation vessels	Damage or destruction of A1 archaeological receptors and A3 known wrecks.	1	1	100	100	Moderate	High	Low	Moderate	High	Significant	All known wrecks have been avoided in the cable route design. Temporary exclusion zones have been placed around A1 geophysical anomalies and buffers have been placed around A3 wrecks of archaeological potential.	1	1	1	1	Minor	None	Moderate	
K - 4	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of A2 geophysical anomalies.	100	1	100	100	High	High	Low	Moderate	Moderate	Significant	Some A2 geophysical anomalies are in the direct path of the cable route and will be impacted. However, these will be considered through the WSI and Archaeological Reporting Protocol.	10	1	10	100	Moderate	A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis through the WSI	Moderate	
K - 5	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of potential archaeological receptors (such as potential shipwrecks or aircraft crash sites).	10	1	100	100	High	High	Low	Moderate	High	Significant	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	1	1	1	1	minor	Potential archaeological sites and material may still be affected by installation activities, however, reporting of discoveries through the Archaeological Reporting Protocol will considerably lessen impact	Moderate	
K - 6	Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment	10	10	10	100	Moderate	Moderate	Low	Moderate	High	Significant	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	1	1	1	1	minor	Mitigation measures will considerably lessen impact	Moderate	
K - 7	Installation and Operation	Changes to erosion regimes at bridging structures	Indirect negative impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	1	100	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Changes to erosion regimes are expected to be minimal – areas of high sediment movement will be monitored. Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	1	1	1	10	minor	Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	Minor	
K - 8	Installation and Operation	Changes to sedimentation regimes at bridging structures	Indirect positive impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	1	10	Minor	Moderate	Low	Moderate	Moderate	Minor	Changes to sedimentation regimes are expected to be minimal	1	1	1	10	Minor	Changes to sediment regimes are expected to be minimal	Minor	Positive

K - 9	Operation and Decommissioning	Repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) Removal of infrastructure (cable de-burial, cable removal)	Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors	1	1	1	1	Minor	Low	Low	Moderate	Low	Negligible	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	1	1	1	1	Low	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	Negligible	
K - 10	Operation and Decommissioning	Anchors used to maintain position of repair or decommissioning vessels	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts	10	1	100	100	High	Low	Low	Moderate	Moderate	Significant	Known sites will be avoided through the maintenance of temporary exclusion zones and buffers, and any material discovered will be dealt with through the Archaeological Reporting Protocol	1	1	1	1	minor	Although sites could still be impacted, the implementation of mitigation measures would greatly lessen impact	Minor	
L- Toursim, Recreation, Amenity and Leisure																							
L -1	Installation	Cable laying and burial including use of anchors to maintain position of installation vessels	Disturbance to recreation and leisure activities	10	1	1	1	Low	Moderate	High	High	Moderate	Minor	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use of lighting and horns where necessary.	1	1	1	1	Low	With local water users aware of cable installation activities it is highly probable that they will avoid the area and will therefore not be directly disturbed by the works. The region is reasonably unconstrained and so there is likely to be sufficient room for the installation spread and water users to co-exist.	Minor	
L -2	Installation	Cable laying and burial including use of anchors to maintain position of installation vessels	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										
L -3	Operation	Burial surveys and repair works	Disturbance to recreation and leisure activities	10	1	1	1	Low	Low	High	High	Low	Negligible	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use of lighting and horns where necessary.	1	1	1	1	Low		Minor	
L -4	Operation	Burial surveys and repair works	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										
L -5	Operation	Accidental contamination from associated vessels and equipment	Contamination of intertidal and coastal area	10	1	1	1	Low	Low	High	High	Low	Negligible										
L -6	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Disturbance to recreation and leisure activities	10	1	1	1	Low	Low	High	High	Low	Negligible	In addition to the required public notices, local residents will be informed of the planned works. There will be public notices placed at various points close to the landfall works. All activity carried out offshore will be controlled in the appropriate manner, which includes, the use of an exclusion zone around the construction fleet, and the use	1	1	1	1	Low		Minor	
L -7	Decommissioning	Temporary mobile exclusion zone around the cable recovery spread/s	Degradation of natural character and visual amenity in coastal region	10	1	1	1	Low	Low	High	Low	Low	Negligible										

Appendix 7: HR Wallingford Technical Report

Project Nemo - UK to Belgium Interconnector

Tidal Flow Modelling

Technical Note DDR4633-01

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Technical Note No.	DDR4633-01
Project Manager	[redacted]
Project Director	

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Date	Release	Prepared	Approved	Authorised	Notes
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Prepared [redacted]

Approved

Authorised

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Contents

1. Introduction 1

2. Model coverage 1

3. Model run and calibration 1

4. Baseline results 2

5. Use of model 2

6. References 2

Figures

Figure 1 Flow model bathymetry in metres with respect to Mean Sea Level 5
Figure 2 Model bathymetry local to the cable route 6
Figure 3 Model mesh local to the cable route 7
Figure 4a Spring tide observed and simulated currents 8
Figure 4b Spring tide observed and simulated currents 9
Figure 5a Neap tide observed and simulated currents 10
Figure 5b Neap tide observed and simulated currents 11
Figure 6 Peak ebb current – spring tide 12
Figure 7 Peak flood current – spring tide 13
Figure 8 Time series of current speed at three locations for the spring-neap cycle 14

1. Introduction

Tidal flows in the area of the NEMO project have been simulated using the TELEMAC modelling system and the model set up as part of the Southern North Sea Sediment Transport Study (HR Wallingford *et al*., 2002). The SNSSTS model was set up to define regional flows in the Southern North Sea and English Channel, and was not specifically calibrated or validated along the cable route corridor. The existing model was used as the basis for developing a new flow model tailored to simulating tidal flows in the NEMO study area of interest.

2. Model coverage

The model covers a large area of the Southern North Sea from Flamborough Head in the north and beyond the Strait of Dover to Plymouth in the south-west. The bathymetry for the model is presented in Figure 1, which was obtained by digitising UK Admiralty Charts that cover the area for the original study. The regional model has been locally revised and re-gridded to include detailed local bathymetry from digital Admiralty Charts provided under licence by Seazone (License details: © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 012010.011) and survey data supplied by the Client:

Survey data filenames - 702-NEMO_P_Landfall_Ramsgate_Gnodes_2x2m.txt
702-NEMO_P_Landfall_Zeebrugge_Gnodes_2x2m.txt
702-NEMO_IB_B1_Gnodes_2x2m.txt
702-NEMO_IB_B2_Gnodes_2x2m.txt
702-NEMO_IB_B3_Gnodes_2x2m.txt

The model grid mesh size is about 20 km at the northern open boundary, 5 km in the English Channel and 100 m along the cable route which is appropriate for determining local flow fields. Figures 2 and 3 show the bathymetry to Mean Sea Level and model grid for the area local to the cable route.

3. Model run and calibration

The model was run using water levels along both the northern boundary, which was located near Flamborough Head, across the North Sea to Europe and the southern boundary located near Plymouth across the English Channel to Roscoff. Siting the boundaries far away from the study area enabled good resolution of the tidal propagation through the Strait of Dover, and also simplified the boundary specification by using harmonic data from Primary ports and other published literature (the national British Oceanographic Data Centre (BODC) database).

No project specific flow data was available to refine the calibration of this model local to the cable route. Therefore, calibration targets against field measurements have not been set and evaluated. As a suitable alternative, a comparison of the model flows with relevant Admiralty current tidal diamond data has been carried out. This data is usually of sufficient quality for general model validation but does not for allow detailed validation as the data is typically derived from measurements which can be decades old. A model simulation which captures the broad behaviour of the flow field represented by

tidal diamonds provides local detail along the cable corridor route by virtue of the local bathymetry that has been implemented.

The model was run to simulate a spring-neap tidal cycle and model data for a mean spring tide and a mean neap tide were extracted for the current report. The comparison of the model flows with the Admiralty tidal diamonds is shown in Figures 4 and 5 (spring and neap tides, respectively). It can be seen that overall there is an appropriate level of agreement between the model current speeds and directions in terms of magnitude and phase with those observations.

4. Baseline results

Figures 6 to 8 illustrate the model flow vectors at peak flood and ebb for a spring tide for baseline conditions, i.e. pre-dredging. The vectors have been extracted on a regular grid for clarity of presentation. Moving from west to east along the cable route the direction of ebb flow varies from south to south-west and speeds at peak ebb tide reduce from over 1.5 m/s to below 0.5 m/s. For the flood tide flow directions change progressively from north to east as the flow expands once it has passed through the Strait of Dover, and speeds vary from over 1 m/s to around 0.5 m/s.

Figure 9 shows current speed at three locations along the cable route over a 15 day period. The current speeds time series are highest at Location 1 which is in deep water and slowest in shallow water at Location 3.

5. Use of model

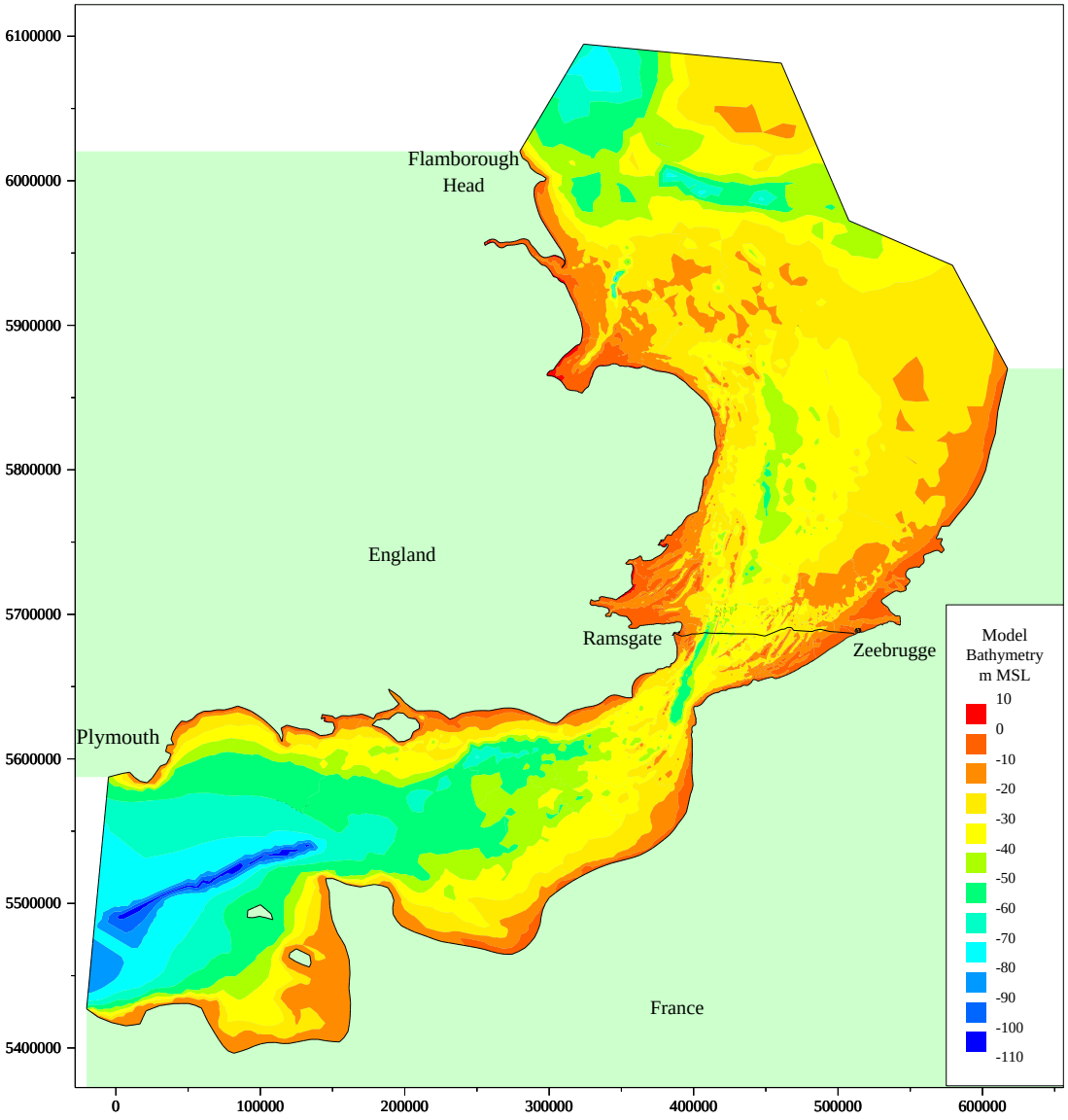
The results from the model run will feed directly into the baseline hydrodynamic assessment, the sediment transport and bedform modelling assessment, as well as the assessment of plume dispersion from dredging. Model results will be extracted at selected dredging locations to drive the plume dispersion model.

Selected final results from the model can be provided in GIS format.

6. References

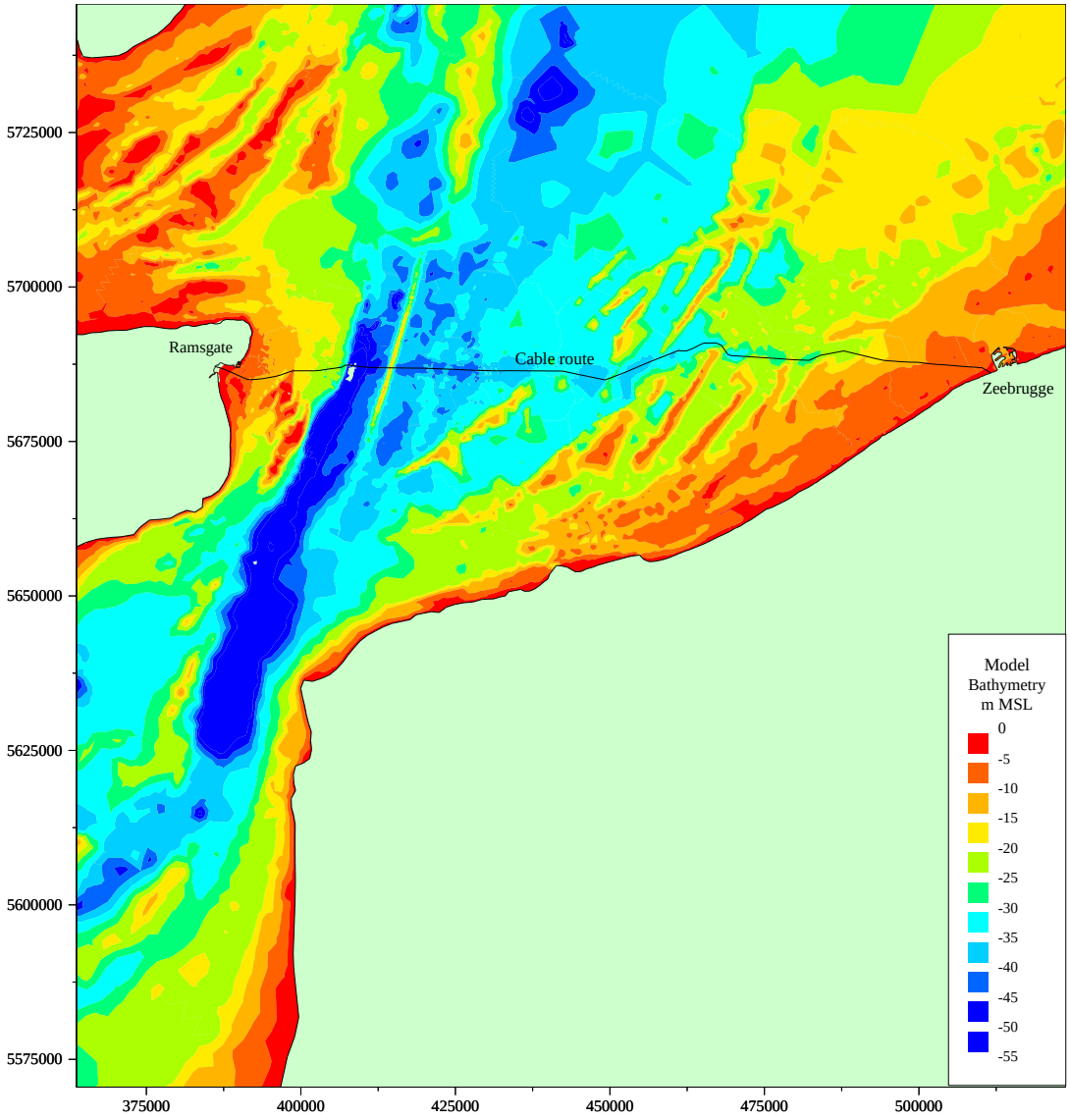
HR Wallingford, Cefas/UEA, Posford Haskoning & Dr Brian D'Olier, 2002. Southern North Sea Sediment Transport Study Phase 2, Sediment Transport Report, HR Wallingford Report EX4526 produced for Great Yarmouth Borough Council, August 2002 (see *http://www.sns2.org/theproject.html* and *http://www.sns2.org/project-outputs.html*).

Figures



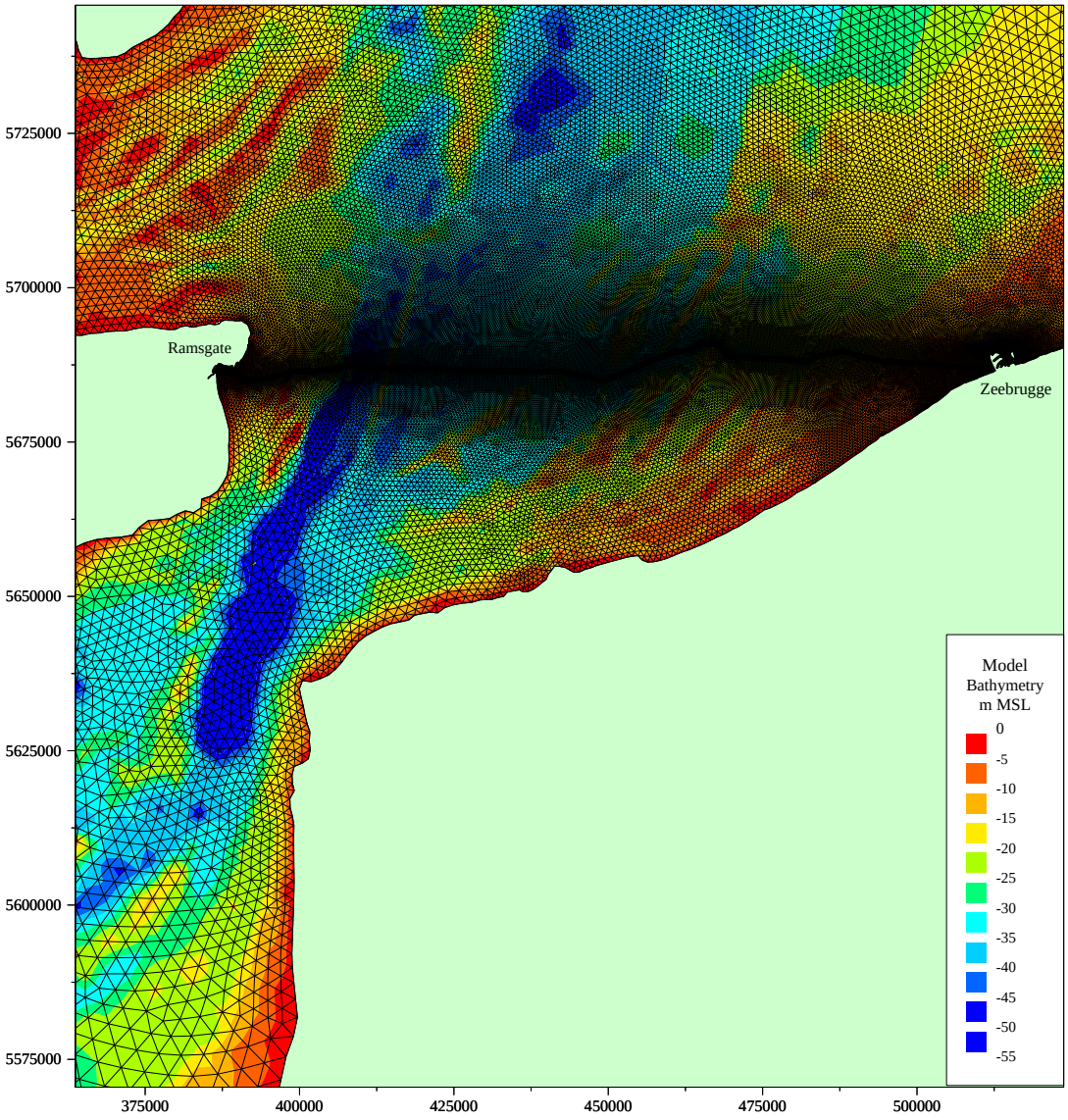
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Figure 1 Flow model bathymetry in metres with respect to Mean Sea Level



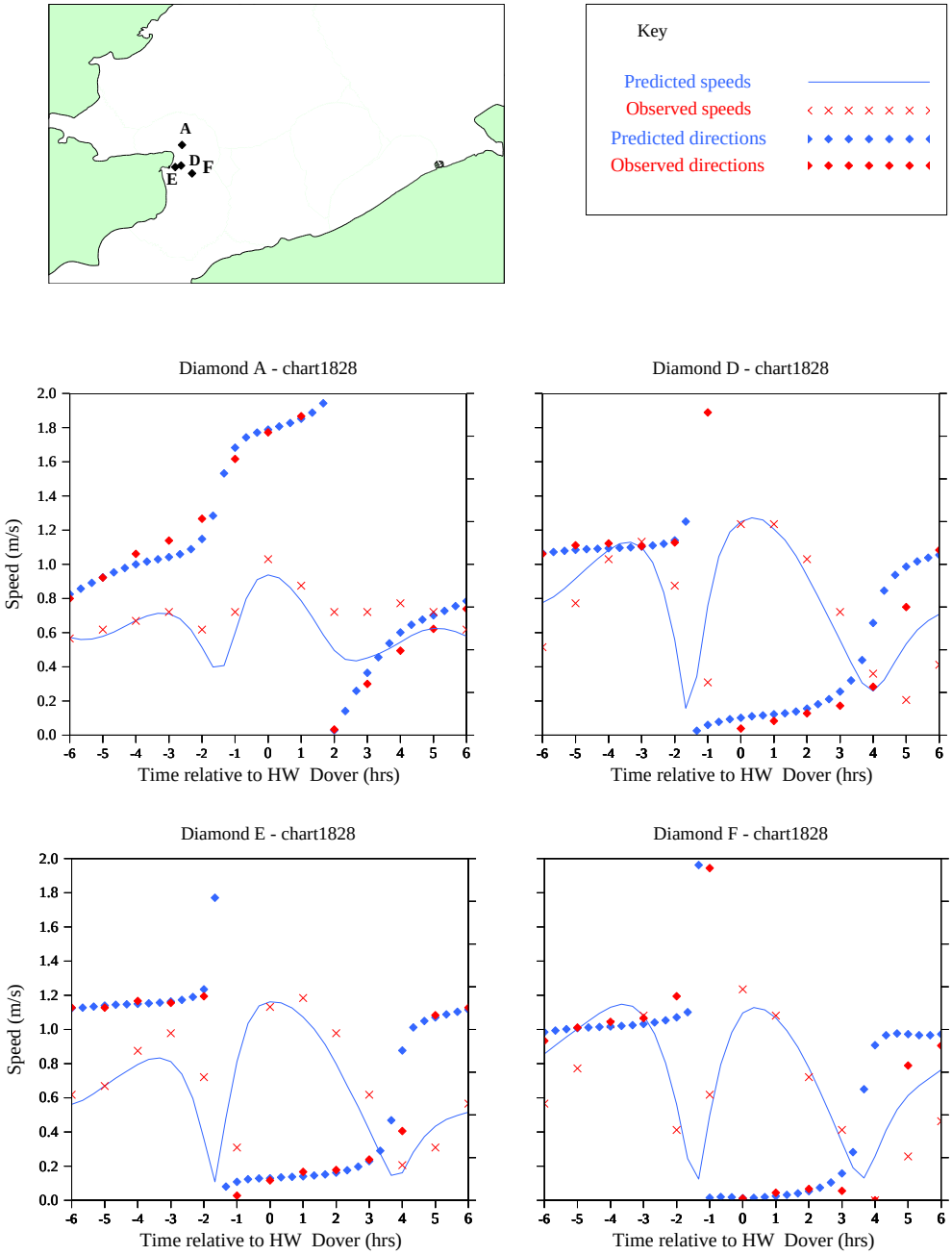
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Figure 2 Model bathymetry local to the cable route



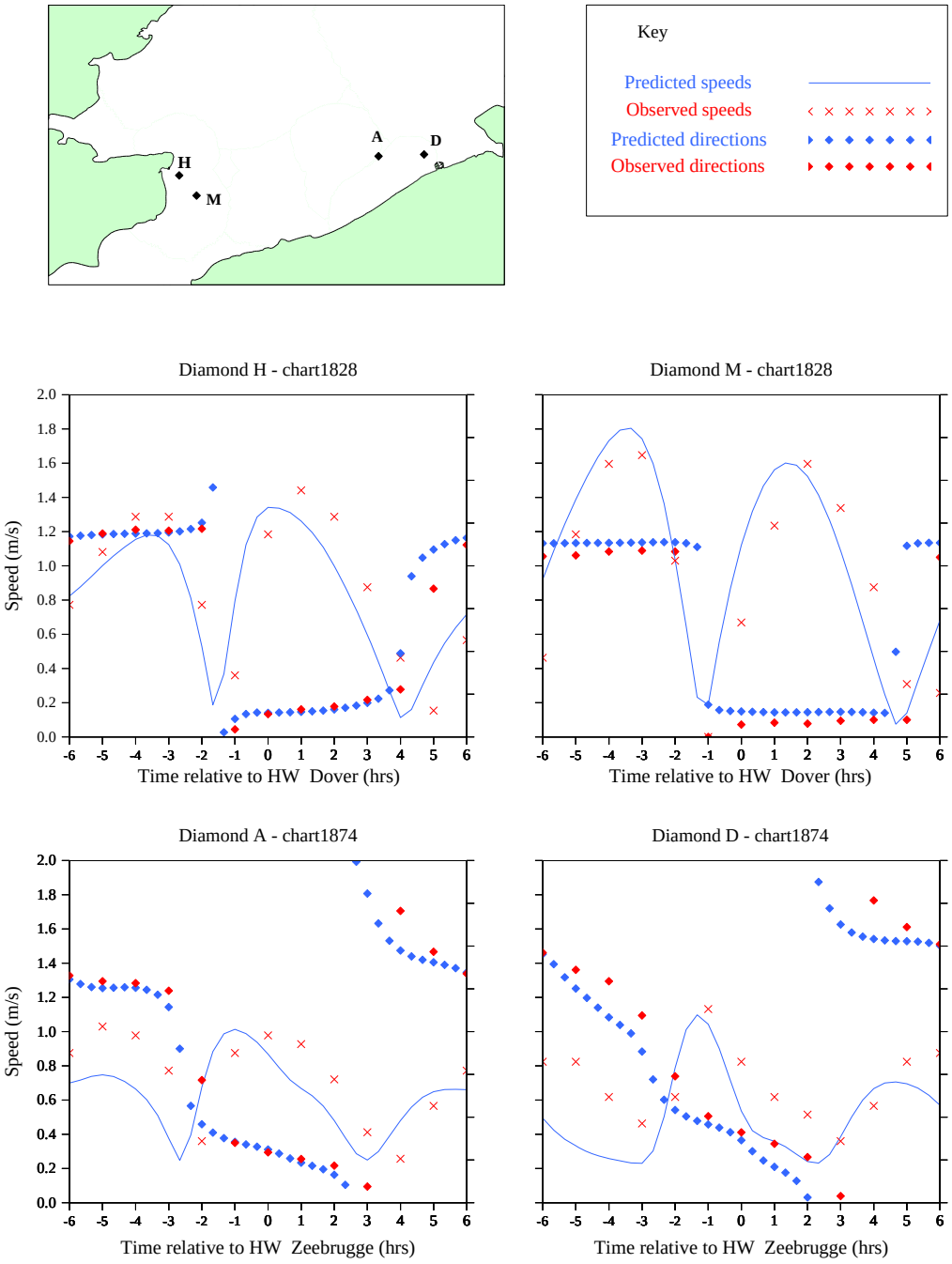
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Figure 3 Model mesh local to the cable route



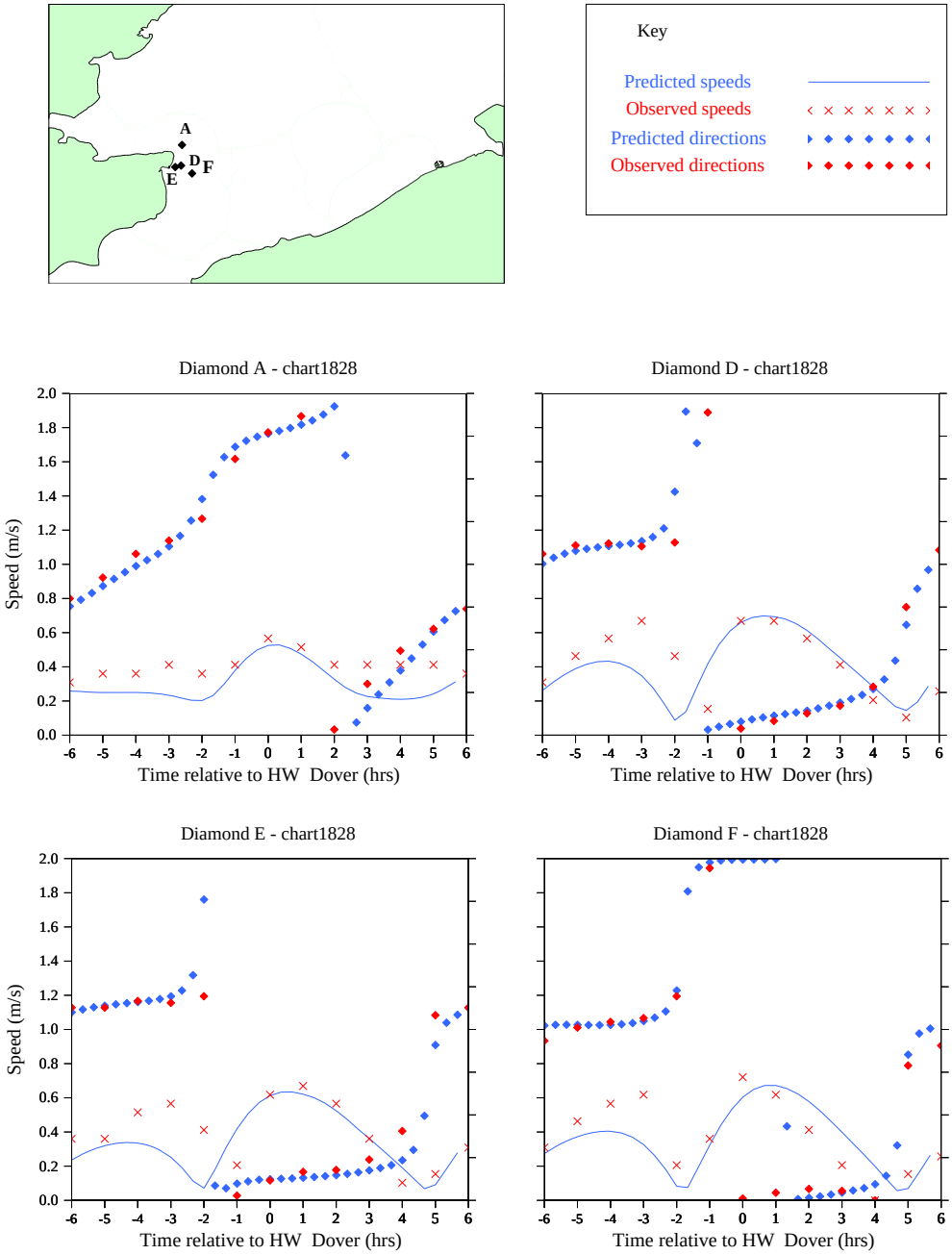
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Figure 4a Spring tide observed and simulated currents



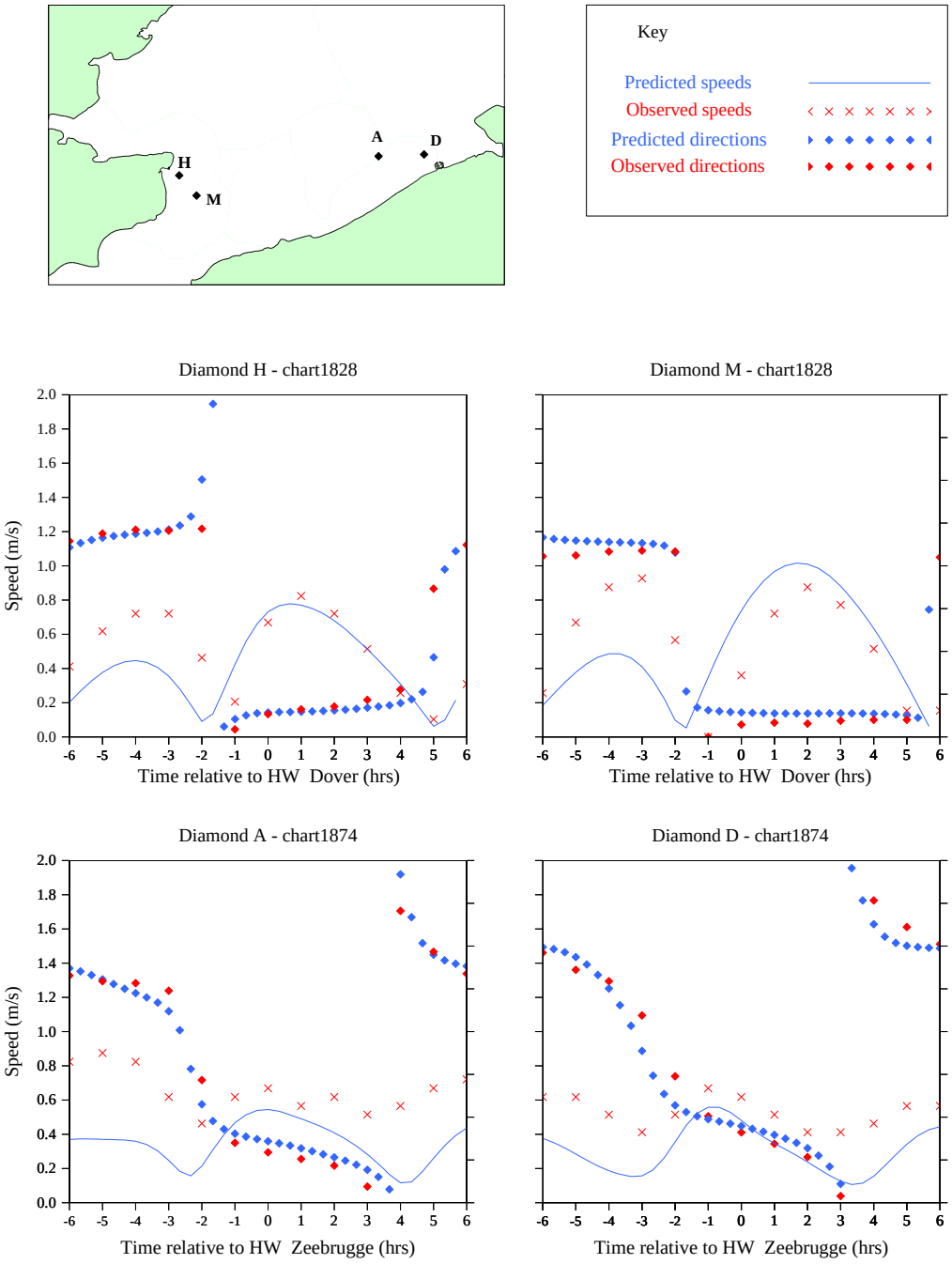
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Figure 4b Spring tide observed and simulated currents



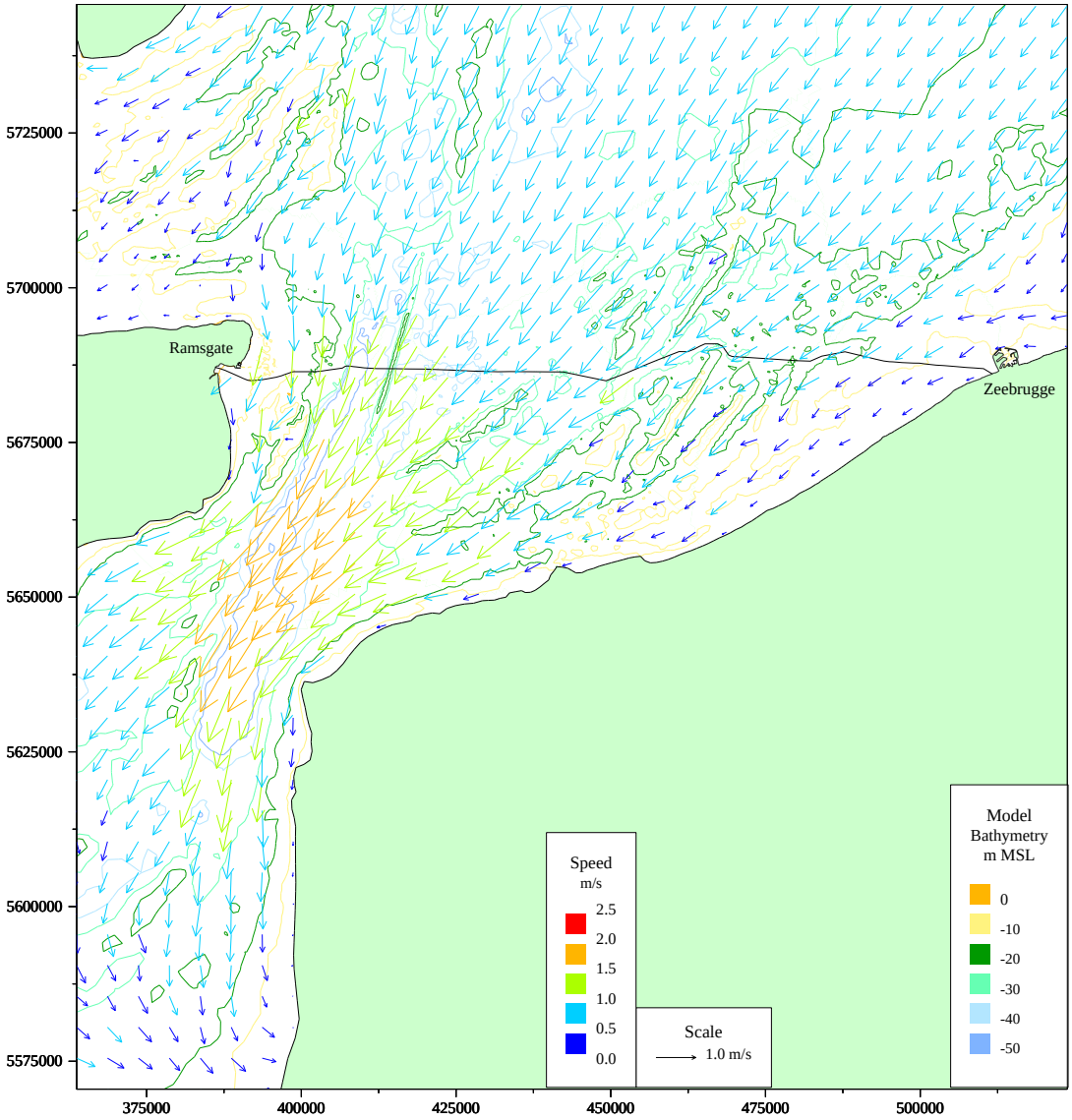
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Figure 5a Neap tide observed and simulated currents



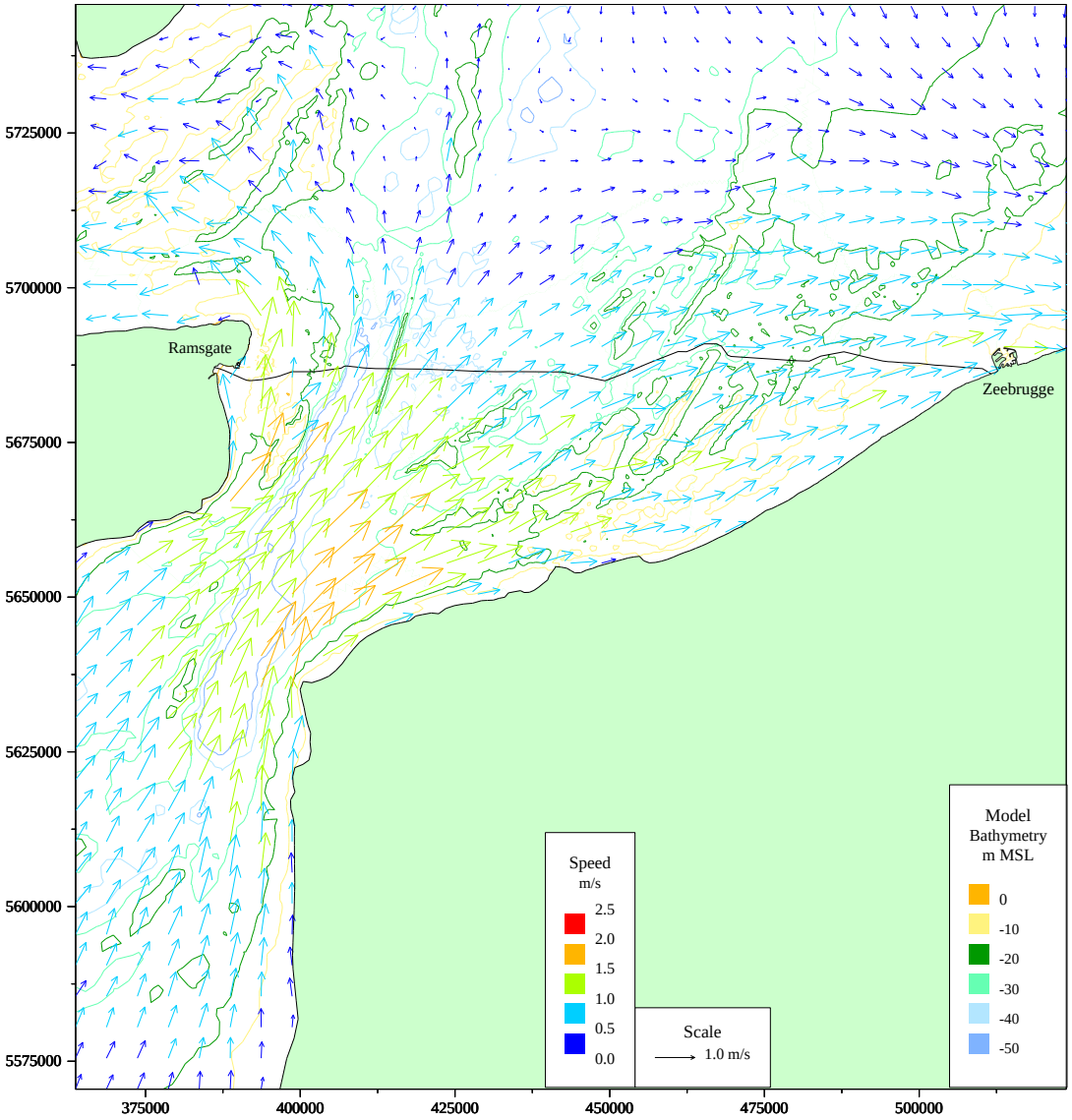
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Figure 5b Neap tide observed and simulated currents



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Figure 6 Peak ebb current – spring tide



/HRprojects/ddr4633/model/Rubensprojects/Nemo_np_spr_r2.RUB/peak_flood.i

Figure 7 Peak flood current – spring tide

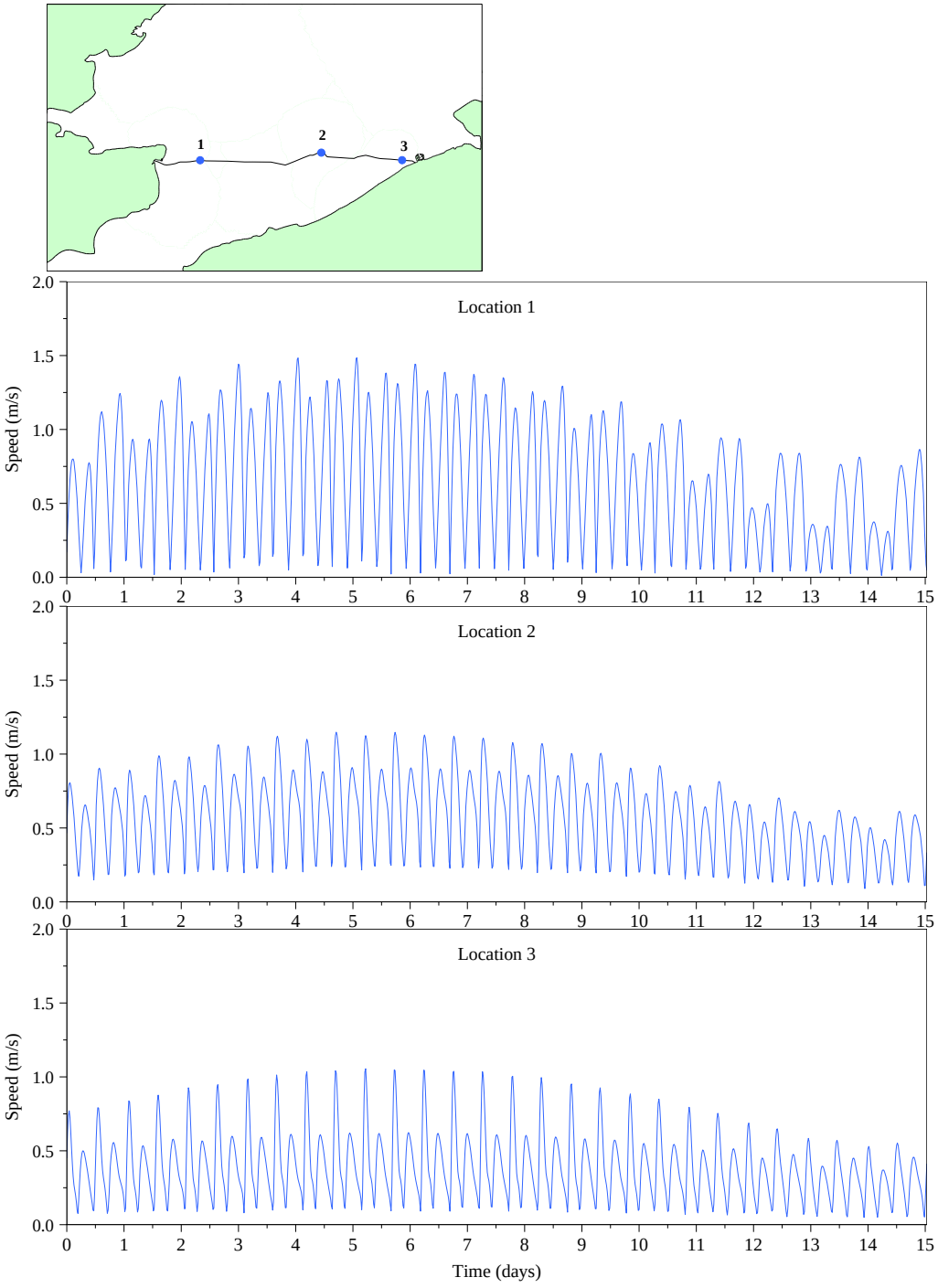


Figure 8 Time series of current speed at three locations for the spring-neap cycle

Project Nemo – UK to Belgium Interconnector

Sand Transport Modelling and Bedform Analysis

Technical Note DDR4633-02

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Prepared

Approved

Authorised

[redacted]

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Contents

1. Introduction 1

2. Model coverage 1

3. Sand transport modelling 1
3.1 Introduction 1
3.2 SANDFLOW sediment transport model description 2
3.3 Seabed sediment characteristics 2
3.4 Driving forces 2
3.5 TOMAWAC wave model description 3
3.6 Model results 3
3.6.1 Tide-only – 400 µm sand 3
3.6.2 Tide-only – 250 µm sand 3
3.6.3 Tide and wave-induced stirring – 400 µm sand 4
3.6.4 Tide and wave-induced stirring – 250 µm sand 4

4. Bedform analysis 5
4.1 Approach 5
4.1.1 Crest orientation 5
4.1.2 Determining the crest and trough positions 6
4.1.3 Wavelength 7
4.1.4 Height 7
4.1.5 Lee-stoss asymmetry 7
4.1.6 Migration rate 7
4.2 Results of bedform analysis 8
4.2.1 Height 8
4.2.2 Wavelength 8
4.2.3 Orientation 8
4.2.4 Migration rate 8

5. Sandwave recovery from trenching 9

6. Discussion 9
6.1 Sand transport modelling 9
6.2 Bedform analysis 10
6.3 Sandwave recovery from trenching 10

7. References 10

Figures

Figure 1 Model bathymetry (Project Nemo cable route indicated by black line)
Figure 2 Model bathymetry and mesh
Figure 3 Model bathymetry – near cable route (black line)
Figure 4 Model bathymetry and mesh – near cable route
Figure 5 Peak ebb flow velocities (m/s scaled on vector length) – Spring tide
Figure 6 Peak flood flow velocities (m/s scaled on vector length) – Spring tide
Figure 7 Peak ebb flow velocities(m/s scaled on vector length) – Neap tide
Figure 8 Peak flood flow velocities (m/s scaled on vector length) – Neap tide
Figure 9 Peak ebb sand transport rates – Spring tide, 400 µm sand

Figure 10 Peak flood sand transport rates – Spring tide, 400 µm sand
Figure 11 Peak ebb sand transport rates – Neap tide, 400 µm sand
Figure 12 Peak flood sand transport rates – Neap tide, 400 µm sand
Figure 13 Residual sand transport rates over Spring tide – 400 µm sand
Figure 14 Residual sand transport rates over Neap tide – 400 µm sand
Figure 15 Peak ebb sand transport rates – Spring tide, 250 µm sand
Figure 16 Peak flood sand transport rates – Spring tide, 250 µm sand
Figure 17 Peak ebb sand transport rates – Neap tide, 250 µm sand
Figure 18 Peak flood sand transport rates – Neap tide, 250 µm sand
Figure 19 Residual sand transport rates over Spring tide – 250 µm sand
Figure 20 Residual sand transport rates over Neap tide – 250 µm sand
Figure 21 Wave height and direction for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N
Figure 22 Wave orbital velocities for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N
Figure 23 Peak ebb sand transport rates – Spring tide and waves, 400 µm sand
Figure 24 Peak flood sand transport rates – Spring tide and waves, 400 µm sand
Figure 25 Peak ebb sand transport rates – Neap tide and waves, 400 µm sand
Figure 26 Peak flood sand transport rates – Neap tide and waves, 400 µm sand
Figure 27 Residual sand transport rates over Spring tide, with waves – 400 µm sand
Figure 28 Residual sand transport rates over Neap tide, with waves – 400 µm sand
Figure 29 Peak ebb sand transport rates – Spring tide and waves, 250 µm sand
Figure 30 Peak flood sand transport rates – Spring tide and waves, 250 µm sand
Figure 31 Peak ebb sand transport rates – Neap tide and waves, 250 µm sand
Figure 32 Peak flood sand transport rates – Neap tide and waves, 250 µm sand
Figure 33 Residual sand transport rates over Spring tide, with waves – 250 µm sand
Figure 34 Residual sand transport rates over Neap tide, with waves – 250 µm sand
Figure 35 Frequency of occurrence of the median wavelengths (m) of bedforms along the cable
Figure 36 Frequency of occurrence of the median bedform height (m) along the cable
Figure 37 Mean height of bedforms along the cable corridor
Figure 38 Maximum height of bedforms along the cable corridor
Figure 39 Bedform wavelength along the cable corridor
Figure 40 Bedform crest orientation in degrees with respect to north along the cable corridor
Figure 41 Bedform migration rate along the cable corridor

1. Introduction

An assessment of the potential non-cohesive sediment transport patterns in the vicinity of the proposed Project Nemo interconnector cable, between UK and Belgium, was made on the basis of sediment transport simulations over a spring-neap tidal cycle with HR Wallingford's non-cohesive sediment transport model SANDFLOW. This model was driven with simulated tidal flows as reported in Technical Note DDR4633-01 (HR Wallingford, 2011). The sensitivity of the model predictions was assessed for wave stirring effects and modelled grain size. The model results were interpreted to inform assessment of the potential transport patterns that are likely to exist in the area of the cable route.

Additionally, the potential bedform dynamics in the vicinity of the Project Nemo cable route are assessed on the basis of a detailed processing of the bathymetric data along the cable route. The analysis locates bedforms in the bathymetry, determines their shape characteristics wavelength, height, asymmetry and crest orientation. From these characteristics the migration rates that can be expected for these patterns are calculated, indicating the likelihood of future cable exposure.

The results obtained, of which this report forms a record, have been used to inform the preparation of the chapter in the Environmental Statement on Bathymetry and Seabed Processes.

The bathymetry used in the sand transport modelling was the same as reported in the flow modelling (HR Wallingford, 2011). The bathymetry analysis carried out to assess the behaviour of bedforms used the route survey data from 2010 (MMT, 2010).

2. Model coverage

The model domain of the sediment transport model was derived from that of the tidal flow model (shown in Figure 1 and Figure 2) and uses the same mesh and bathymetry over an area extending approximately 75 km north and south of the proposed cable route. Local views of the model domain and of the model mesh, together with the cable route, are shown in Figure 3 and Figure 4, respectively.

The size of the mesh elements varies from the order of 4 km near the northern and south-western boundaries of the domain to about 100 m along the cable route.

The bedform analysis was performed on the bathymetric data of the cable corridor, as provided by the client.

3. Sand transport modelling

3.1 INTRODUCTION

Several sediment transport simulations were carried out to assess the *potential* sediment transport patterns in the vicinity of the cable route. 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.

3.2 SANDFLOW SEDIMENT TRANSPORT MODEL DESCRIPTION

SANDFLOW is the non-cohesive sediment transport model developed by HR Wallingford for use with the TELEMAC system. SANDFLOW uses the flows calculated by a TELEMAC-2D flow model and wave orbital velocities from a TOMAWAC wave model to study the transport, deposition and erosion of non-cohesive (sandy) sediment and thereby identify areas of potential siltation and erosion. Although sand transport in estuaries and marine environments is really an unsteady, 3D problem, it has been shown by HR Wallingford that it can be dealt with using a 2D, depth-averaged model provided provision is made to account for the vertical profile effects of the sediment concentration. Deposition or erosion takes place depending on whether the instantaneous sediment load exceeds or is less than the saturated value.

3.3 SEABED SEDIMENT CHARACTERISTICS

Information on the characteristics and distribution of the seabed sediments over the model domain was available from the desktop study (HR Wallingford, 2010) in the form of a median grain size map of the Belgian Continental Shelf and a sediment type map of the study area (based on data from the British Geological Survey). This information indicates in general terms that gravel and sandy gravel is dominant along the western section of the cable route, with several sandy areas present, and sand is strongly dominant along the eastern section of the route. Along the eastern, sandy section the median sediment grain size decreases from medium to coarse (order 300 to 400 µm) to fine to medium (100 to 200 µm) in eastward direction. The gravels along the western section are likely to have larger median grain sizes (larger than 2 mm).

For the sediment transport simulations described in this Technical Note it was considered that the simplifying assumption of a uniform median grain size (d50) 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.

3.4 DRIVING FORCES

The model 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. Hence, the simulated sediment transport patterns are tide-only for this case.

In addition, a sensitivity test was conducted for an exemplary 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 that is subsequently advected by the ambient tidal current.

3.5 TOMAWAC WAVE MODEL DESCRIPTION

TOMAWAC is a phase-averaged spectral wave model. It was developed by the National Hydraulics Laboratory (LNH) of the Research and Development Division of the French Electricity Board (EDF-DER) and is part of the TELEMAC finite element hydraulic modelling system. TOMAWAC simulates the transformation of random directional waves considering the processes of wave refraction, shoaling, depth-induced breaking, bottom friction and white-capping.

3.6 MODEL RESULTS

The peak ebb and peak flood flow fields resulting from the tidal flow model are shown in Figure 5 and Figure 6 for a typical spring tide and in Figure 7 and Figure 8 for a typical neap tide.

3.6.1 Tide-only – 400 µm sand

The resulting instantaneous sediment transport patterns assuming abundant, uniform 400 µm sand at the same points in time are shown in Figure 9 and Figure 10 for the spring tide. These figures suggest that the largest potential transport rates occur off the English coast to the south of the cable route and gradually reduce in northward direction. During peak ebb the predicted potential transport rates are further reduced toward the European mainland coastline, whereas during peak flood there is less transport capacity north of the cable route near the English coast and somewhat increased rates along the French and Belgian coastline.

Figure 11 and Figure 12 show the transport patterns for the neap tide on the same scale. With the reduced tidal velocities the model does not predict large transport rates over the ebb phase, whereas during the flood phase some sediment transport potential remains near the Dover Strait.

In addition to the instantaneous transport patterns, the predicted sediment fluxes were integrated over a full tidal cycle to produce residual transport patterns. These are shown in Figure 13 for the spring tide and in Figure 14 for the neap tide. These figures 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.

3.6.2 Tide-only – 250 µm sand

The potential transport patterns predicted for a median grain size of 250 µm are shown in Figure 15 and Figure 16 for the spring tide, and in Figure 17 and Figure 18 for the neap tide, for respectively peak ebb and peak flood flow.

The predicted sediment patterns are rather similar to those predicted for the case with 400 µm sand, whereas 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.

Similar to the results for the case with 400 µm sand, the simulated sediment fluxes have been integrated over a full spring and neap tidal cycle. The resulting patterns of residual fluxes are shown in Figure 19 and Figure 20, respectively. Comparison of these figures

to those showing the residual fluxes for the coarser material confirm the previously mentioned increase in potential transport magnitude along similar patterns.

3.6.3 Tide and wave-induced stirring – 400 µm sand

The potential impact of wave-induced stirring of seabed sediments has been assessed by carrying out sensitivity tests in which, in addition to the tidal flow fields, a constant wave orbital velocity field has been imposed in the sand transport simulation. Wave orbital velocities cause an additional shear stress at the seabed that may result in additional suspension of mobile sediment present on the seabed.

For the purpose of these sensitivity tests a TOMAWAC wave model was set-up in which an offshore swell wave condition with a significant wave height of 2.0 m, a peak period of 8.0 s and an offshore direction of 135 °N was imposed on the northeastern boundary, considered to represent a fairly frequently occurring wave condition. The resulting field of significant wave height for a steady-state 1.0 m above MSL water level is shown in Figure 21, together with vectors indicating the mean wave direction. Figure 22 shows the corresponding field of wave orbital velocities as predicted by the wave model.

The potential transport patterns predicted for the case with wave orbital velocities and a median grain size of 400 µm are shown in Figure 23 and Figure 24 for the spring tide, and in Figure 25 and Figure 26 for the neap tide, for respectively peak ebb and peak flood flow.

Similar to the results for the case with 400 µm sand and tide-only conditions, the simulated sediment fluxes have been integrated over a full spring and neap tidal cycle. The resulting patterns of residual fluxes are shown in Figure 27 and Figure 28, respectively. Comparison of these figures to those showing the residual fluxes for the tide-only case (Figure 13 and Figure 14) suggests that, for the wave conditions considered, the effect of the wave orbital velocities on the sediment transport magnitudes and patterns is limited. Some differences can be identified near the English coastline and on the Flemish Banks where, as expected, the limited water depth leads to some influence of the wave orbital velocities on the potential sediment transport.

3.6.4 Tide and wave-induced stirring – 250 µm sand

A second simulation, using the same wave orbital velocity field as described in Section 3.6.3, was carried out for a median grain size of 250 µm. The potential transport patterns predicted for this case are shown in Figure 29 and Figure 30 for the spring tide, and in Figure 31 and Figure 32 for the neap tide, for peak ebb and peak flood flow respectively. The corresponding patterns of residual fluxes are shown in Figure 33 and Figure 34, respectively.

When compared to the results of the simulation with wave stirring and a median grain size of 400 µm, it is seen that qualitatively the predicted sand transport patterns for peak ebb and flood flow for both the spring and neap tide conditions are the same, however, transport rates are somewhat larger. Within the area nearer the European mainland coastline where a smaller grain size of 250 µm is likely to be more representative, this increase along the proposed cable route is particularly apparent over the spring tide, during peak ebb conditions and, as a result, also in the residual sand transport pattern for spring tide conditions (shown in Figure 27 for 400 µm and Figure 33 for 250 µm).

Comparison of the model results of the simulations for a median grain size of 250 µm with tide and waves (Figure 29 through Figure 34) to those for tide-only conditions (Figure 15 through Figure 20) reveals only small differences in the predicted sand transport patterns and rates. These differences are generally found in shallow areas where tidal flow velocities are relatively small. This indicates that for this median grain size sand transport is dominated by the tidal flow, and that enhancement of transport rates due to wave stirring is limited to shallow areas (sandbanks and near the shoreline) where waves dissipate and/or break whilst tidal flow is limited.

4. Bedform analysis

Large scale bedforms on the seabed increase the probability of exposure of cables and pipelines buried in the seabed. Most of these bedforms are non-stationary. Even though the displacement happens slowly at a migration rate of a few meters per year, crest locations at the time of installation may change to become a trough location over the lifetime of the buried cable. This may cause a lowering of the bed of several meters.

An assessment of the potential bedform dynamics in the vicinity of the Project Nemo cable route was made on the basis of a detailed analysis of the bathymetric data along the route. The analysis locates bedforms in the bathymetry, determines their shape characteristic wavelength, height, asymmetry and crest orientation. From these characteristics the migration rates that can be expected for these patterns are calculated.

Based on the migration rates, suggestions are made about mitigation options to prevent cable exposure.

4.1 APPROACH

Knaapen (2005) and Knaapen et al. (2006) were the first publications describing the analysis of large sets of multi-beam bathymetric data to determine the characteristics of offshore bed forms: sandwaves and mega-ripples, respectively. To enable large datasets to be analysed an automated approach was used and this leads to the required level of information on the bedforms where they exist in the bathymetry dataset. Here, the published approach is extended to include a measure for the sand volume within the profile, which is also a measure for the crest-trough asymmetry, and crest orientation. Additionally, the method of height estimation presented by Knaapen (2005) is improved to give a more accurate estimate.

4.1.1 Crest orientation

The first step in the analysis of the bedforms is to determine their orientation, here defined as the direction perpendicular to the crest line. The orientation is determined based on the gradients in the bathymetry, following the approach of Bazen and Gerez (2002). They determined orientation of ridges on grey-scale fingerprints, but the same principles are valid for bedforms in bathymetric data. This approach is based on the principle that in regular rhythmic patterns the steepest gradient is perpendicular to the direction of the crests. The orientation angle φ between the gradient vector and the x-axis is defined as:

$$\varphi = \tfrac{1}{2}\,\mathrm{atan}\left(\frac{2\,G_{xy}}{G_{xx} - G_{yy}}\right) + \varphi_c \qquad (1)$$

in which (x, y) are the coordinates of every measurement point and G_{ij} is the product of the gradient in direction i and the gradient in direction j:

$$\begin{aligned} G_{xx} &= \left(\frac{\partial z}{\partial x}\right)^2 \\ G_{yy} &= \left(\frac{\partial z}{\partial y}\right)^2 \\ G_{xy} &= \frac{\partial z}{\partial x}\frac{\partial z}{\partial y} \end{aligned} \qquad (2)$$

where z is the measured bed level and φ_c is a correction to adjust for the fact that areas on opposite sites of the crests have opposing gradient vectors:

$$\begin{aligned} \varphi_c &= \pi \;\forall G_{xx} - G_{yy} < 0 \;\&\; G_{xx} - G_{yy} \geq 0 \\ \varphi_c &= -\pi \;\forall G_{xx} - G_{yy} < 0 \;\&\; G_{xx} - G_{yy} < 0 \\ \varphi_c &= 0 \;\forall G_{xx} - G_{yy} \geq 0 \end{aligned} \qquad (3)$$

If one applies this algorithm to the matrix containing the seabed bathymetry, it produces an array of local estimates of the orientation of the smallest bedform. Therefore, one has to smooth the bathymetric data removing all bedforms smaller than the bedform of interest. A window size that is about half the wavelength of the targeted bedform gives reliable and robust results.

The calculation of the orientation using equation (1) seems rather cumbersome compared to the straightforward estimate with the tangent of the gradients in x and y direction. However, with the tangent of the gradients, averaging gives the problems that opposing vectors average out to zero which is avoided when using equation (1).

Once the orientation of the bed forms is known, determination of the other shape characteristics along crest-normal profiles can be undertaken.

4.1.2 Determining the crest and trough positions

Based on the orientation, the bathymetric data is interpolated to a regular orthogonal grid with the main axis perpendicular to the mean crest direction (parallel to the mean orientation of the bedforms. Taking the profiles in the direction of the bedform orientation, which is normal to the crests, the crest and trough positions in bedforms are identified following an improved approach to the one proposed by Knaapen (2005).

In that approach, the bathymetry is smoothed using weighted averaging in which the weight reduces linearly with distance (Bartlett window). The size of this window is dependent on the typical wavelength of the targeted bedform. It should be considerably less than this wavelength but larger than the typical size of smaller bedforms. A window size that is about half the wavelength of the targeted bedform gives reliable and robust results.

The crests and troughs are then defined as the highest and lowest points in the profiles of the smoothed profiles. The weighted averaged smoothing leads to an underestimation of the crest position, especially in case of sharp crested sandwaves. In the new approach, a fourth order polynomial is fitted through the original measurements that are in the

neighbourhood of the extreme points in the smoothed profile. Once the crest and trough positions are known, they are analyzed to retrieve information on the wavelength, height and asymmetry. Although the definition of these characteristics is straightforward, to calculate them from the observed crests and troughs requires making a few assumptions.

4.1.3 Wavelength

The distance between the trough positions on both sides of the crest (x_1, x_2) determines the length of the bedform L:

$$L = | x_2 - x_1 | \cos(\alpha) \tag{4}$$

With α being the angle between the mean crest orientation and the direction of the profiles.

4.1.4 Height

The height H is defined as the difference between the crest levels z_c at location x_c and the line through the neighbouring trough levels (x_1, z_1) and (x_2, z_2).

$$H = z_c - \frac{z_1(x_c - x_2) + z_2(x_c - x_1)}{L} \cos(\alpha) \tag{5}$$

The height of the pattern is here defined as the height of the envelope resulting from a linear interpolation of the crest and trough levels. This results in heights that are equal to the difference between a crest level and the mean level of the neighbouring troughs weighted by the distance between those troughs and the crest. Using this weighted value, the method is valid for bed forms on arbitrary sloping surfaces, whereas more straightforward averaging of the two trough levels will cause errors for asymmetric waves on a sloping mean surface. For superimposed bed forms it is important to avoid such errors.

4.1.5 Lee-stoss asymmetry

The lee-stoss asymmetry A is defined as the difference of the distance between the trough south of the crest and the distance between the crest and the trough north of the crest divided by the wavelength:

$$A = \frac{L_2 - L_1}{L} \tag{6}$$

Following this definition, a perfect symmetric wave has an asymmetry value A=0. A positive asymmetry value denotes a wave with the steepest side facing North.

4.1.6 Migration rate

The migration rate c can then be estimated using the predictive formula of Knaapen (2005), which has been verified for a number of locations in the North Sea:

$$c = 9.78 \cdot 10^{-4} \frac{L^2}{H} A|A| \tag{7}$$

4.2 RESULTS OF BEDFORM ANALYSIS

The approach of section 4.1 has been applied to the data available for the project (MMT, 2010).

The results of the bedform analysis are averaged over half a kilometre stretches along the profile. In the bathymetry two types of bedforms can be distinguished. Both the mega-ripples and the sandwaves show up in the histograms of the median wavelength per stretch (Figure 35), represented by a peak at about 75 m and between 150-175 m, respectively. The majority of the bedforms have heights less then 2 m (Figure 36), but distinct peaks are visible around 4 m, 5 m and 6 m.

4.2.1 Height

The analysis shows the presence of bedforms for most of the cable route. However, for the majority of the route, the mean height is below 1 m. Higher bedforms are found (Figure 37) between Easting 428 km and 432 km, around 436 km between 438 km and 445 km (Sandettie), between 450 km and 453 km (Fairy Bank), around 459 km (West-Hinder) and around 472 km (Kwintebank). Bedforms with a mean wave height above 2 m are found between Eastings 441 km and 456 km, near 459 km and near 480 km (Middelkerke Bank).

However, as Figure 38 shows, the maximum observed bedform heights along the cable route can be significantly higher than the mean height. Especially between 428 km and 430 km, individual bedforms reach up to 8 m high, in an area where the mean height is below 2 m. Other individual high bedforms are found around 422 km, 451 km (Fairy Bank), and 469 km (Kwintebank).

4.2.2 Wavelength

The wavelength of the bedforms ranges from 50-100 m in the west up to Easting 435 km, apart from a short stretch east of 402 km (Figure 39). From 435 km eastward, the pattern is more patch, with bedforms longer than 200 m between 435 km and 445 km, around 450 km, between 460 km and 465 km and around 478 km. Wavelengths between 200-250 m can be seen from 470 km to 475 km (Kwintebank) and around 455 km. All other locations show shorter bedforms.

4.2.3 Orientation

The orientation of the bedforms varies between an east-west alignment of the crests in the west (90^o in Figure 40) to west-northwest to east-southeast aligned crests (up to 120^o in Figure 40) in the centre and the east. For the majority of the cable route this implies that the route is oblique to the bedform crests.

4.2.4 Migration rate

The migration estimates for most of the observed bedforms is well below 1 m per year (Figure 41). The bedforms are quite symmetric, which means that their location is stable and does not change much. However, on several locations there are short stretches where moving bedforms are predicted: 400 km to 405 km, 416 km (South Falls), 420 km to 425 km, 436 km (Sandettie), 450 km (Fairy Bank), 453 km, 461 km to 463 km (West-Hinder), 470 km (Kwintebank) and the area east of 480 km.

5. Sandwave recovery from trenching

Few data are available describing the recovery of the bed after trenching through a sand wave crest. However, a good indication of the trench infill for such a case is published by Knaapen et al. (2006). They use data from a navigation channel monitoring program to evaluate the dynamics of a trench through a sandwave in the approach to Rotterdam Harbour. The sandwave was 5 m high in a mean water depth of 32 m. The trench reached all the way down to the trough levels of the sandwave. The trench had disappeared almost completely within the first year, leaving little or no evidence of the presence of a trench.

Being only a few tens of kilometres more to the south, there is little reason to suspect that the trenching for Project Nemo through the sandwave crests will recover any slower than in this location.

6. Discussion

The approach to understanding the sediment dynamics along the Project Nemo cable route has combined predictive computational modelling of sand transport and the analysis of bedforms identified in the 2010 route survey. The results have been used to inform preparation of the chapter in the Environmental Statement on Bathymetry and Seabed Processes.

6.1 SAND TRANSPORT MODELLING

The model results presented are indicative of the potential sediment transport patterns along the cable route. Limited availability of the sediment simulated would reduce the expected transport rates. For example, given that the largest sediment fluxes are predicted in areas where the available sedimentological information indicates gravel and sandy gravel to be present, 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 sheltered by coarser fractions, rates could be larger.

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 an indication of the likely sediment transport patterns under the imposed flow conditions in a qualitative manner.

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 English coast. Based on the apparent presence of coarser gravels in this area would suggest transport rates will be smaller than those presented.

Comparison of the sediment transport patterns predicted by the model for the cases with and without the imposed wave conditions suggests that the sediment transport pattern is largely tide-dominated for both simulated median grain sizes, albeit that localised effects are seen near the English coast and the Flemish Banks along the European mainland coast.

6.2 BEDFORM ANALYSIS

In general, the migration rates for the bedforms are estimated to be low as the overall pattern of sandbanks and associated bedform patterns are broadly stable and non-migratory. However, individual bedform crests might still move significantly related to changes in crest bifurcations and/or crest end positions.

The location of the most dynamic bedforms coincides with the locations of the (tails of the) tidal sandbanks in the area. These locations are notoriously dynamic, with large fluctuating residual transport patterns. This explains the high likelihood of moving bedforms and the size of the bedforms.

The locations where the cable route passes the sandbank tails are covered with dynamic bedforms. In these areas, maximum care should be taken to determine the cable installation profile as the probability of cable exposure during its lifetime is high.

Away from the sandbanks, the patterns appear stable with little bedform migration. The probability of exposure due to bedform movement is much lower in these areas. However, there is still a possibility of individual moving crests, so any part of the cable that is above the local trough levels may be exposed. The benefit to be gained from burying the cable much deeper than local trough level will need to be evaluated on cable protection grounds.

6.3 SANDWAVE RECOVERY FROM TRENCHING

There is little published information about the recovery of sandwaves after sweeping with a dredger. The only surveys from scientific publications show that the trench disappeared within a year (Knaapen, *et al.*, 2006). However, it is not possible to determine from this data whether the trench filled over days, weeks or months.

7. References

Bazen A.M. & Gerez S.H., 2002. Systematic methods for the computation of the directional fields and singular points of fingerprints. IEEE transactions on pattern analysis and machine intelligence, 24 (7): 905-919, July 2002.

HR Wallingford, 2010. NEMO – Electrical Interconnector between Great Britain and Belgium, Detailed Desktop Study, Report EX6310, Release 2.0, June 2010.

HR Wallingford, 2011. Project Nemo – UK to Belgium Interconnector. Tidal Flow Modelling, Technical Note DDR4633-01, Release 1.0, June 2011.

Knaapen, M.A.F., 2005. Sand wave migration predictor based on shape information. Journal of Geophysical Research, 110: F04S11. DOI:10.1029/2004JF000195.

Knaapen, M.A.F., Hulscher, S.J.M.H., Tiessen, M.C.H. & van den Berg, J., 2006. Using a sand wave model for optimal monitoring of a navigation depth. In: Parker, G. and Garcia, M. (eds). River, Coastal and Estuarine Morphodynamic, 2005. Taylor and Francis Group, London, pp999-1007.

MMT, 2010. Marine survey report Project NEMO. Geophysical Survey 2010. Report prepared for Elia and National Grid. Draft final report, October 2010 (rev 02).

Figures

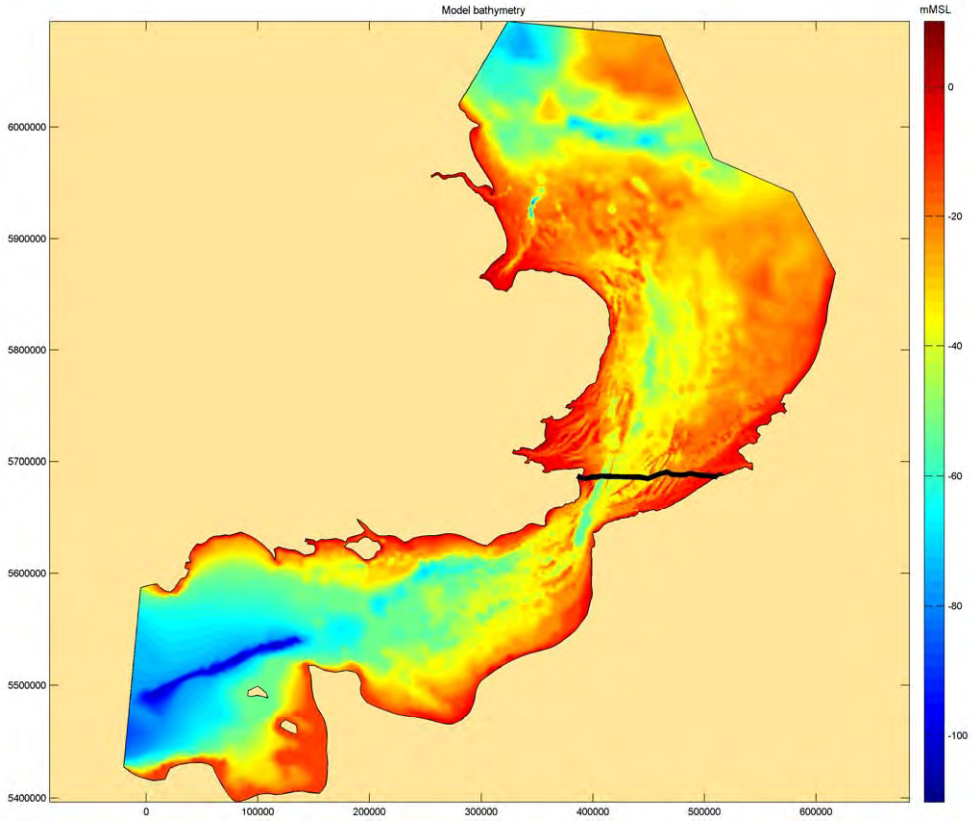


Figure 1 Model bathymetry (Project Nemo cable route indicated by black line)

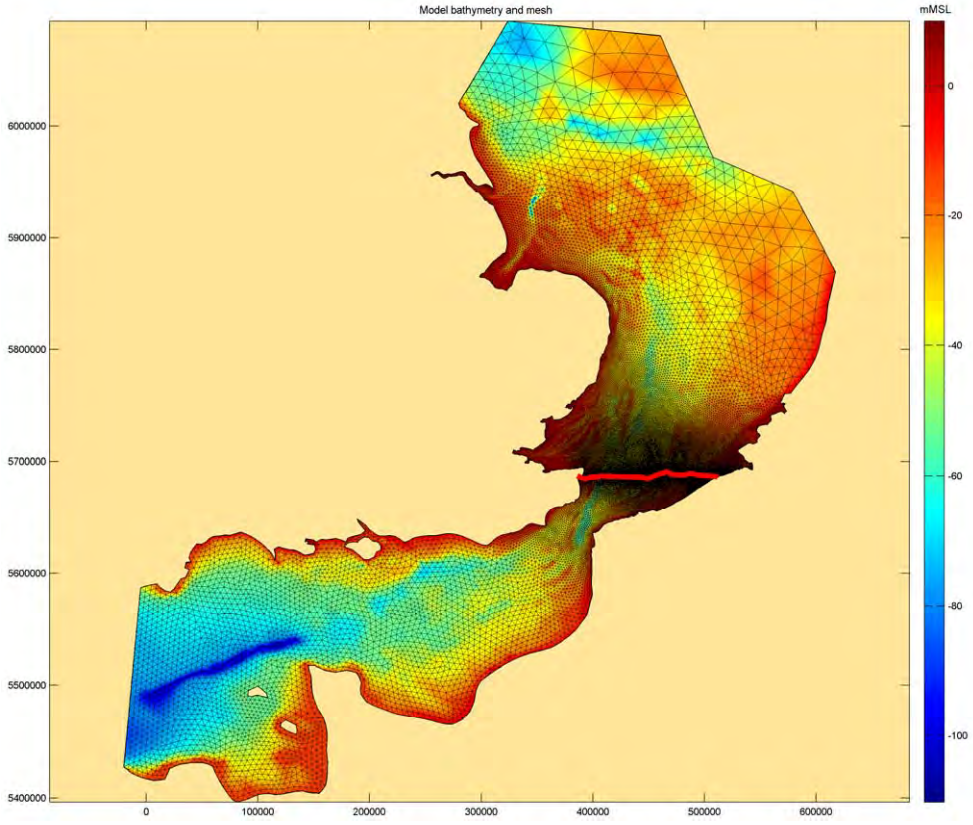


Figure 2 Model bathymetry and mesh

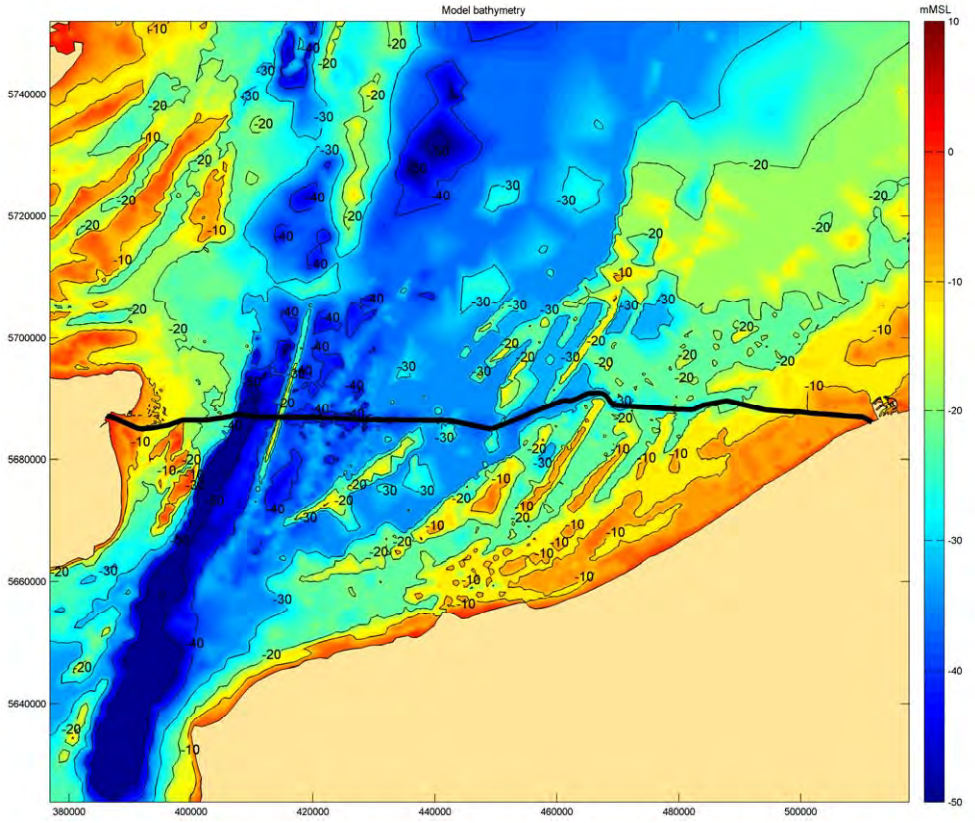


Figure 3 Model bathymetry – near cable route (black line)

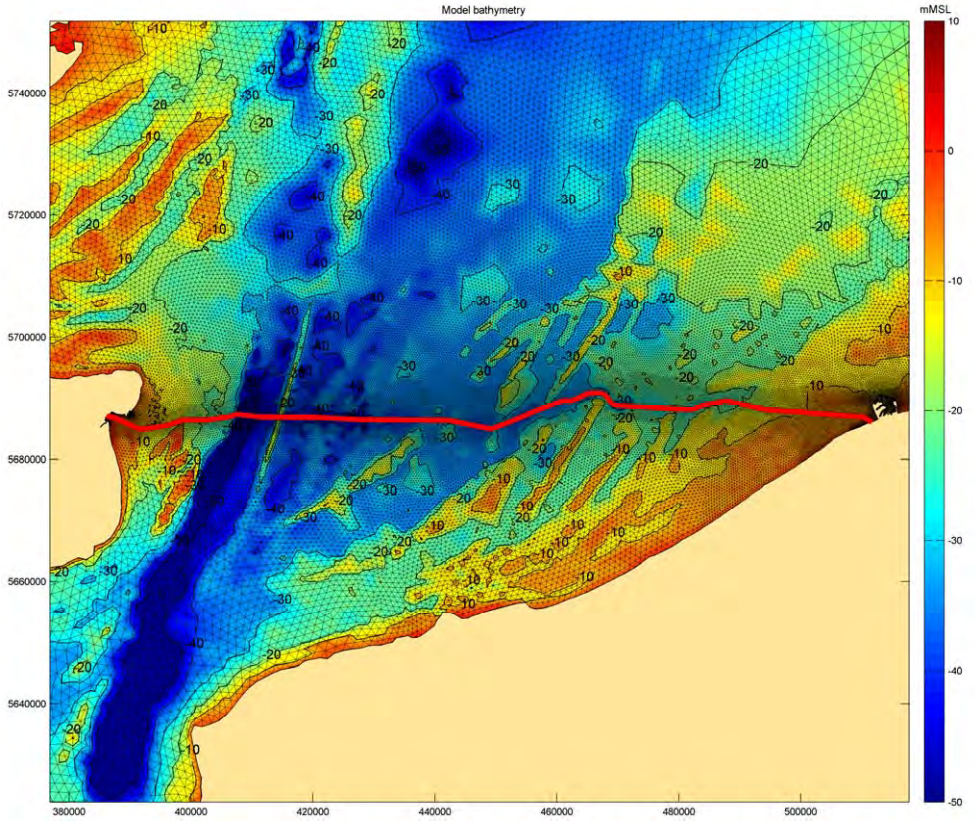


Figure 4 Model bathymetry and mesh – near cable route

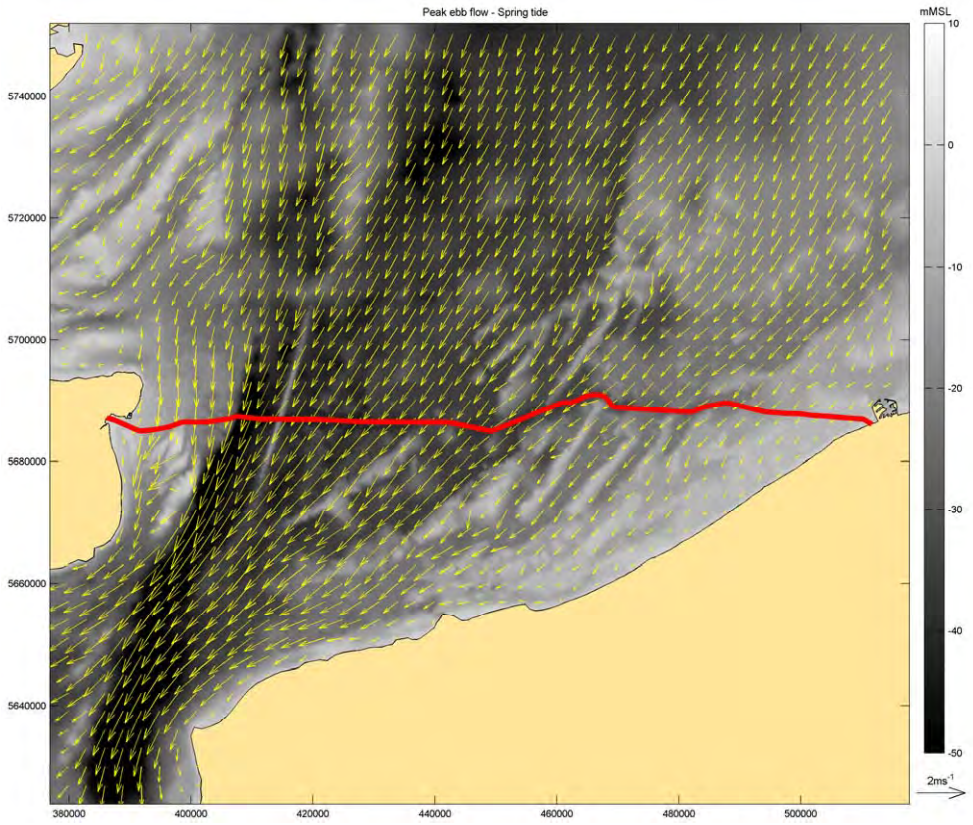


Figure 5 Peak ebb flow velocities (m/s scaled on vector length) – Spring tide

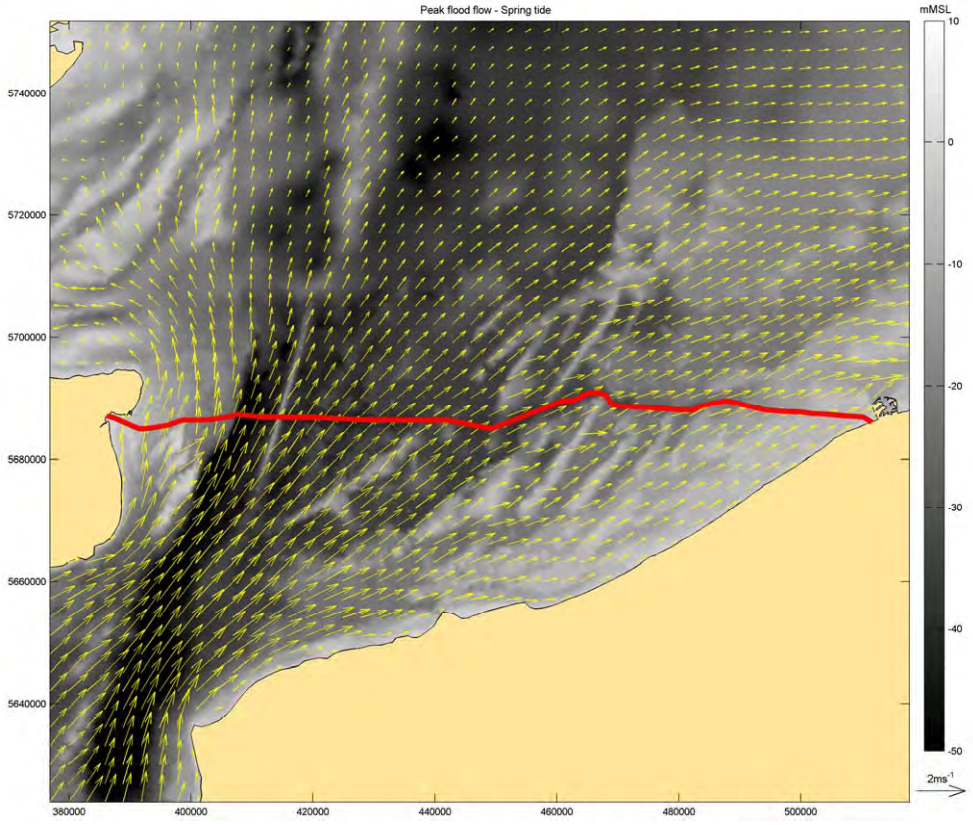


Figure 6 Peak flood flow velocities (m/s scaled on vector length) – Spring tide

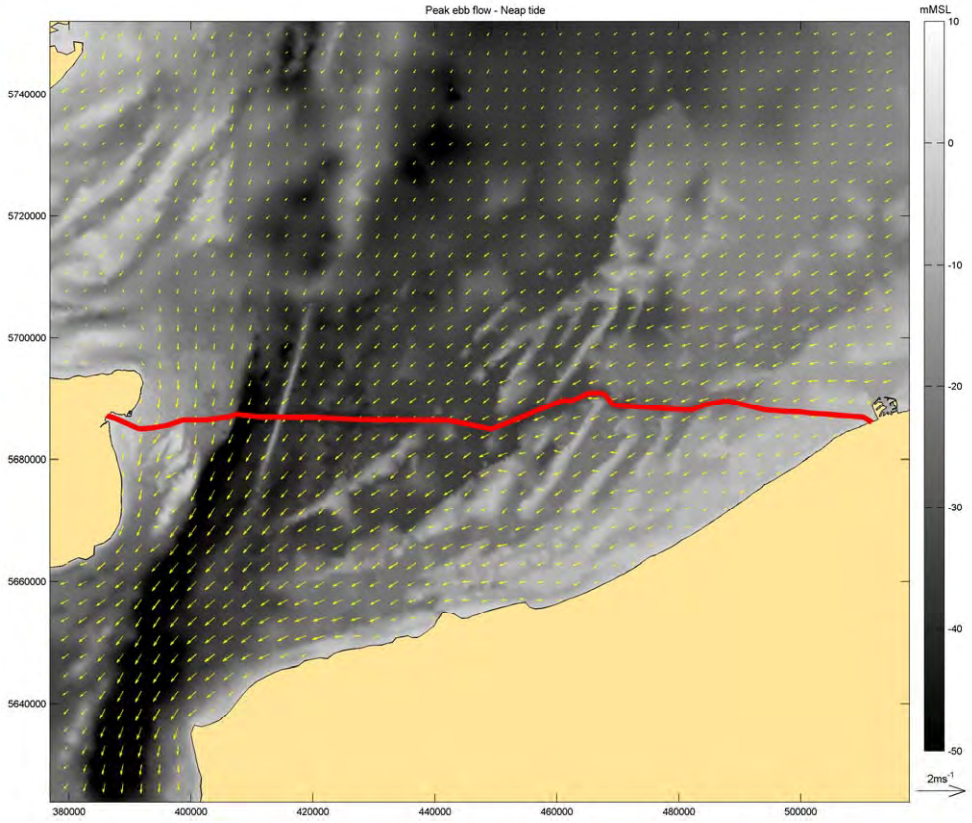


Figure 7 Peak ebb flow velocities(m/s scaled on vector length) – Neap tide

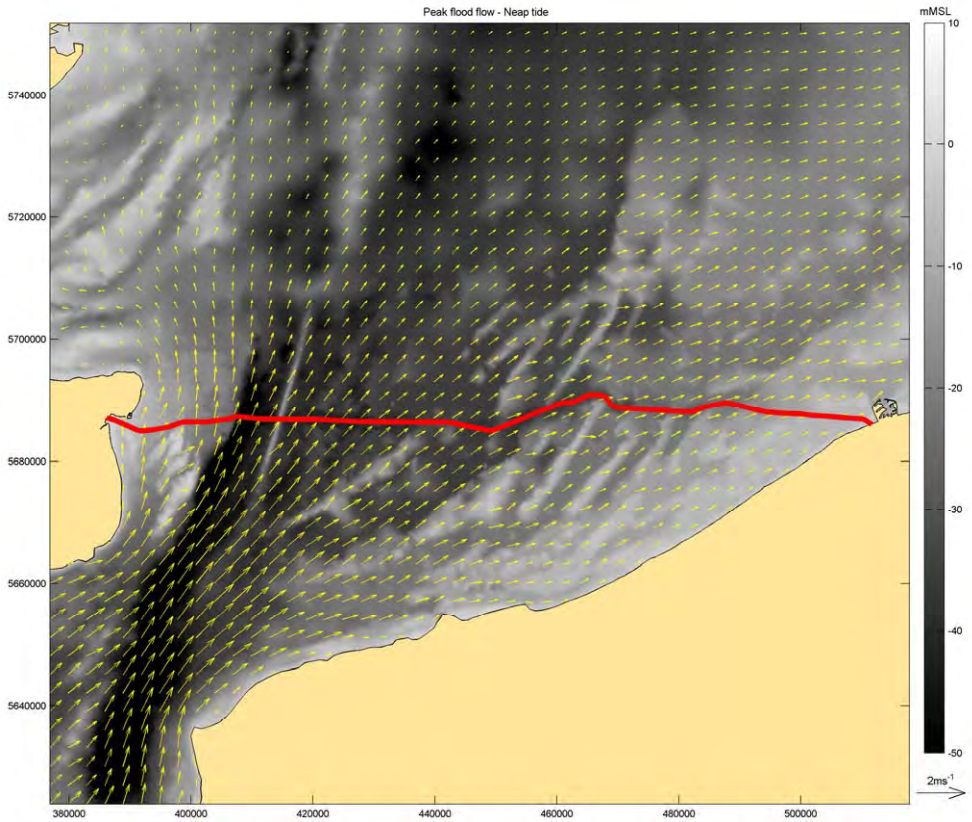


Figure 8 Peak flood flow velocities (m/s scaled on vector length) – Neap tide

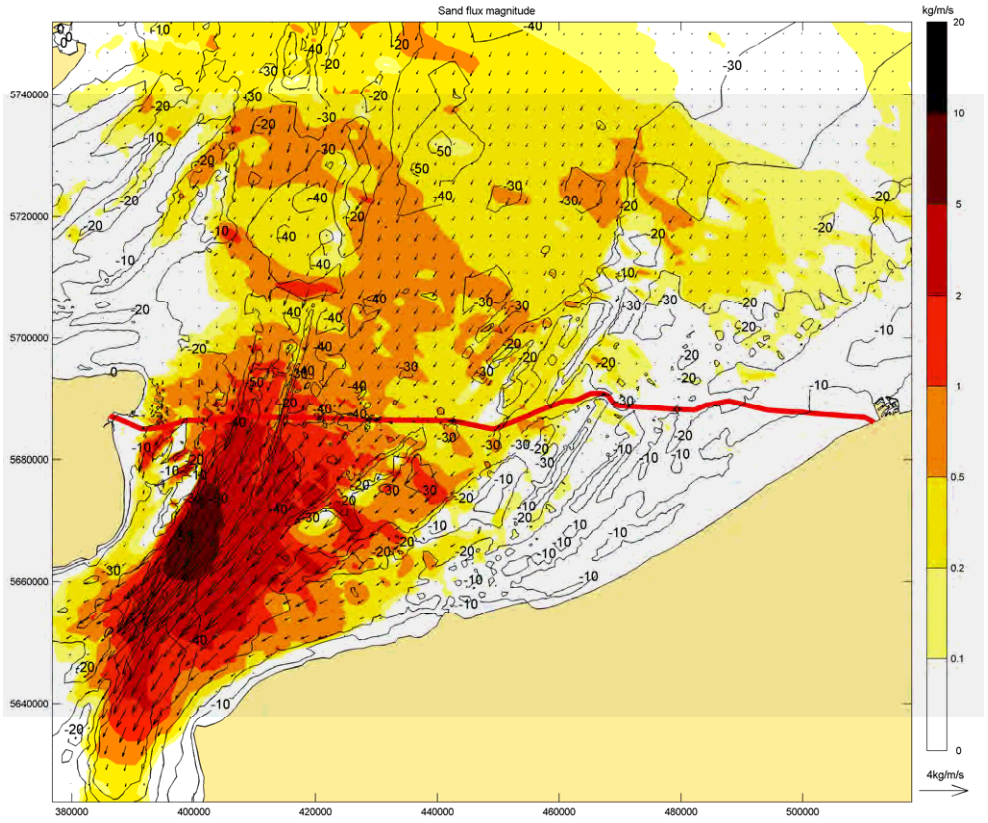


Figure 9 Peak ebb sand transport rates – Spring tide, 400 µm sand

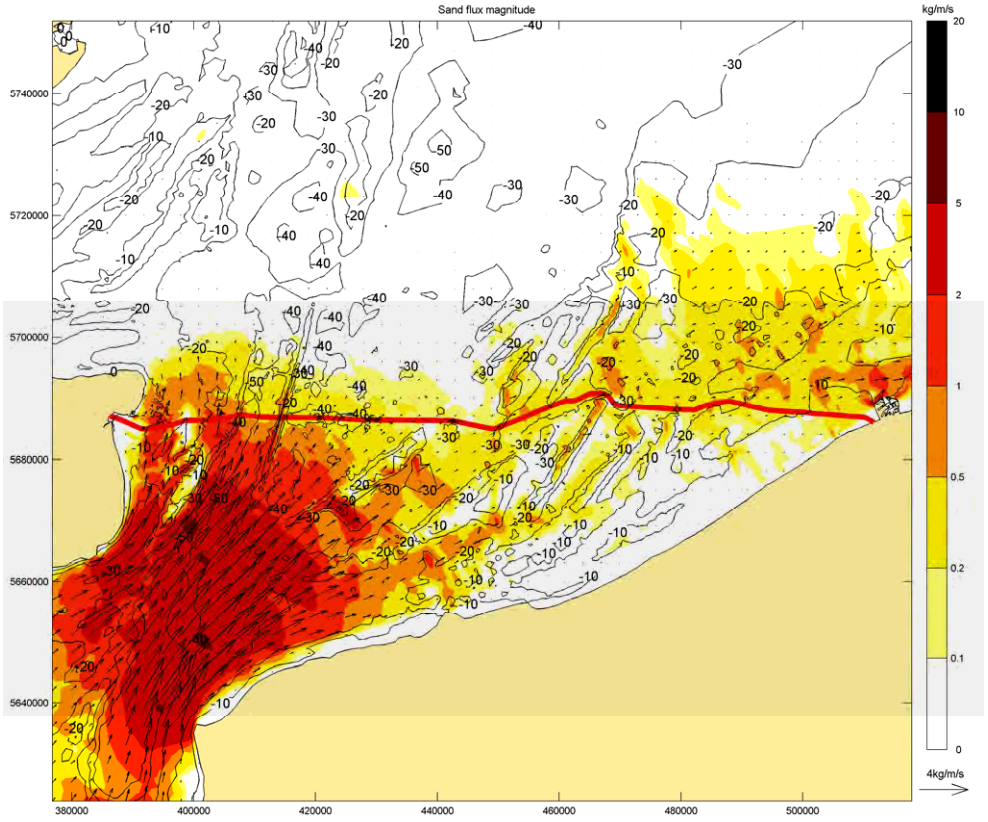


Figure 10 Peak flood sand transport rates – Spring tide, 400 µm sand

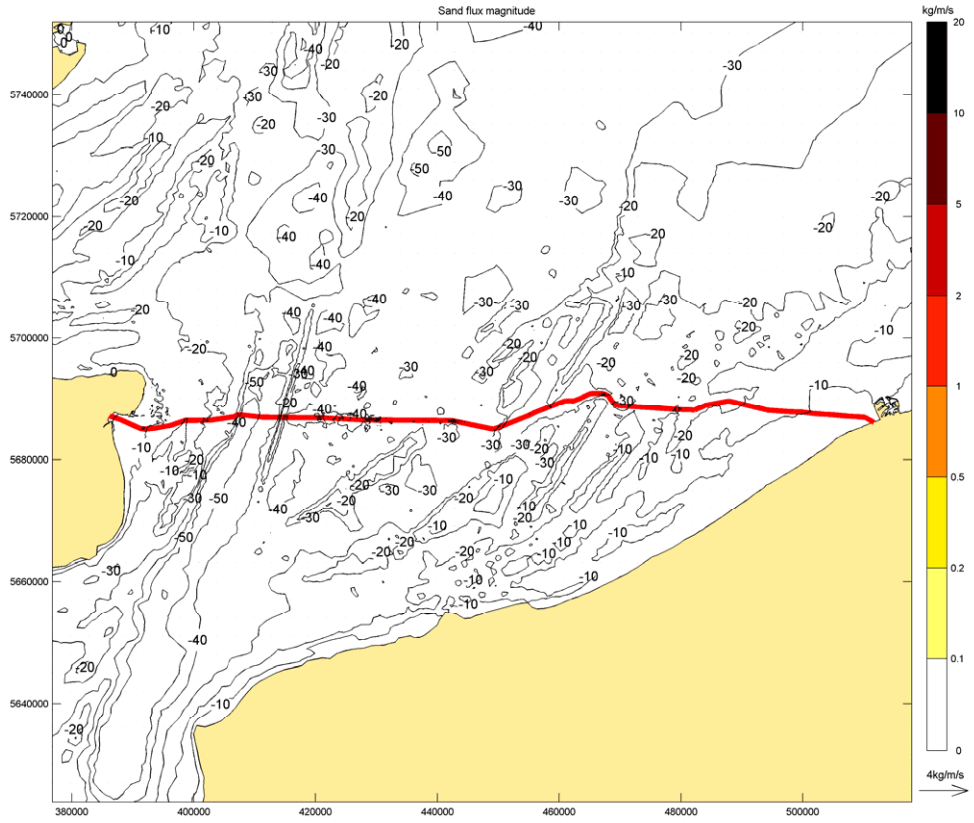


Figure 11 Peak ebb sand transport rates – Neap tide, 400 µm sand

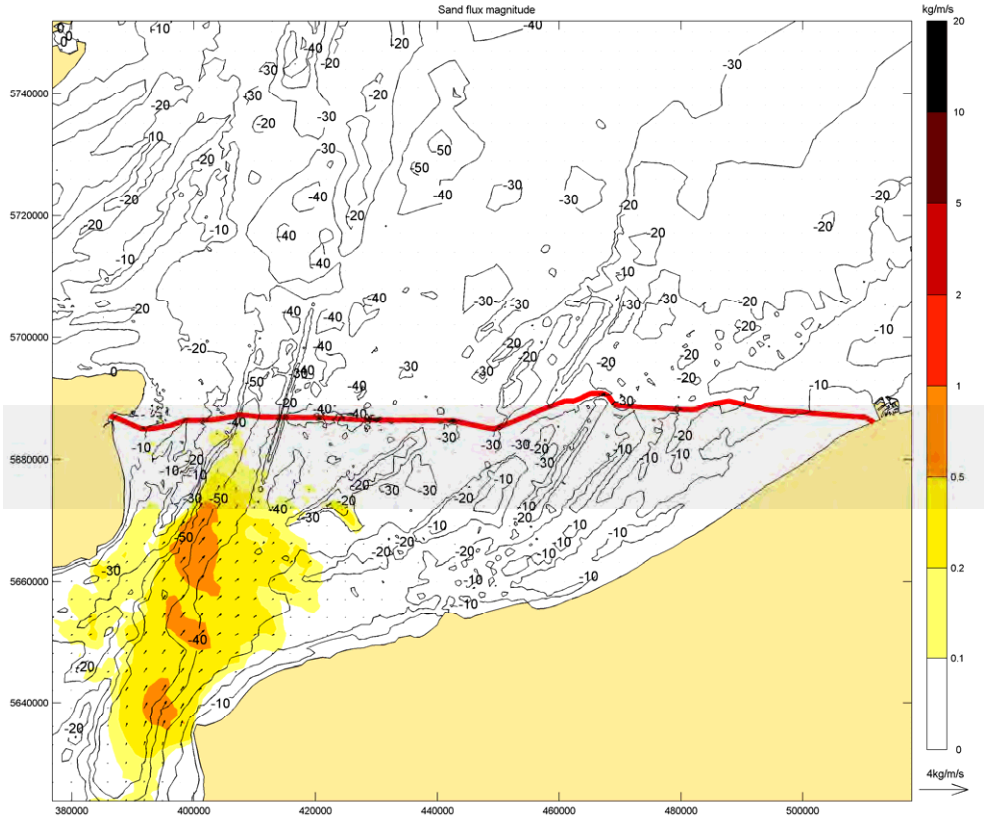


Figure 12 Peak flood sand transport rates – Neap tide, 400 µm sand

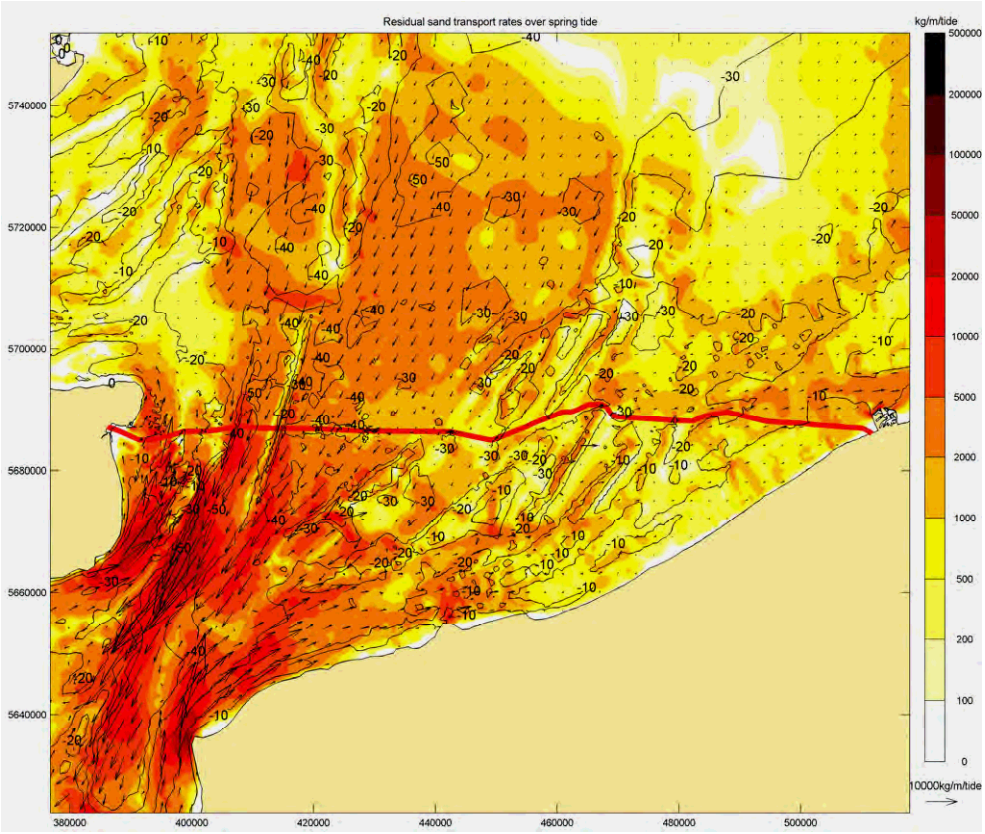


Figure 13 Residual sand transport rates over Spring tide – 400 µm sand

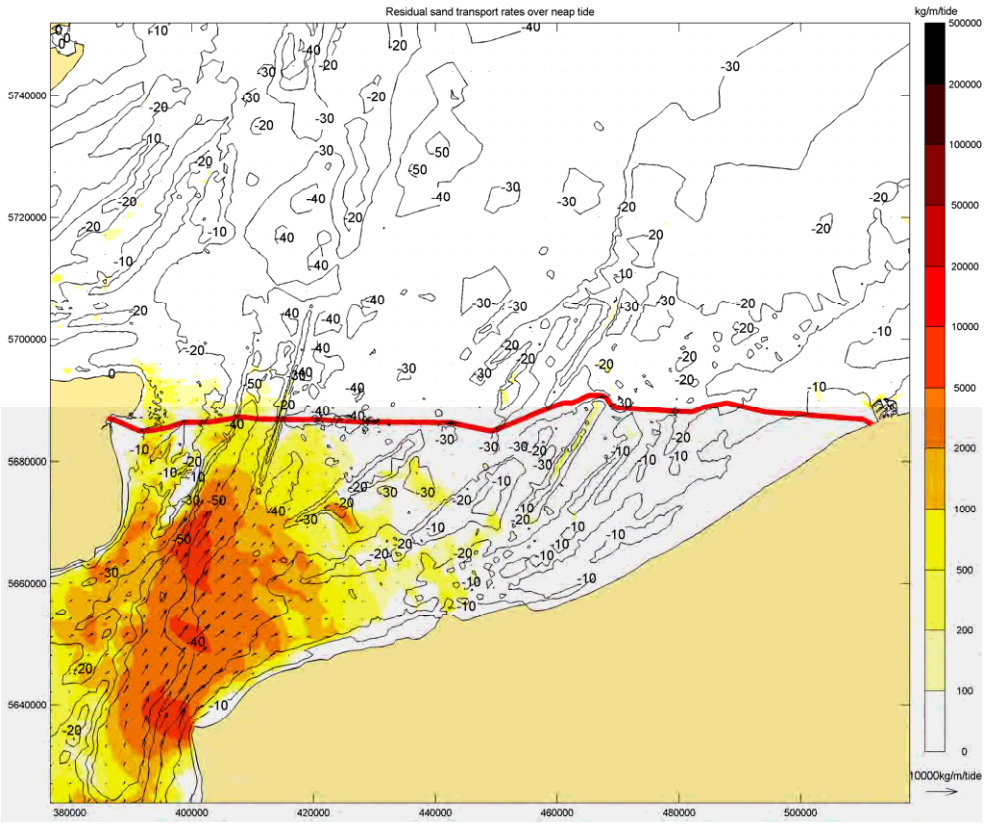


Figure 14 Residual sand transport rates over Neap tide – 400 µm sand

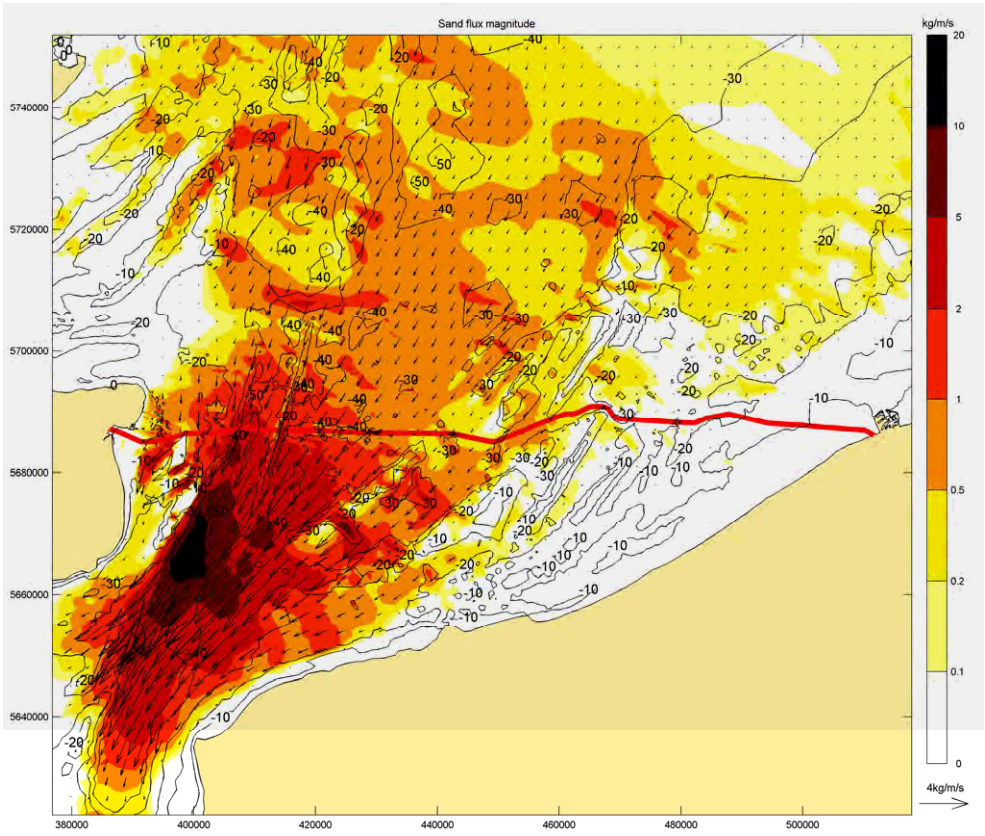


Figure 15 Peak ebb sand transport rates – Spring tide, 250 µm sand

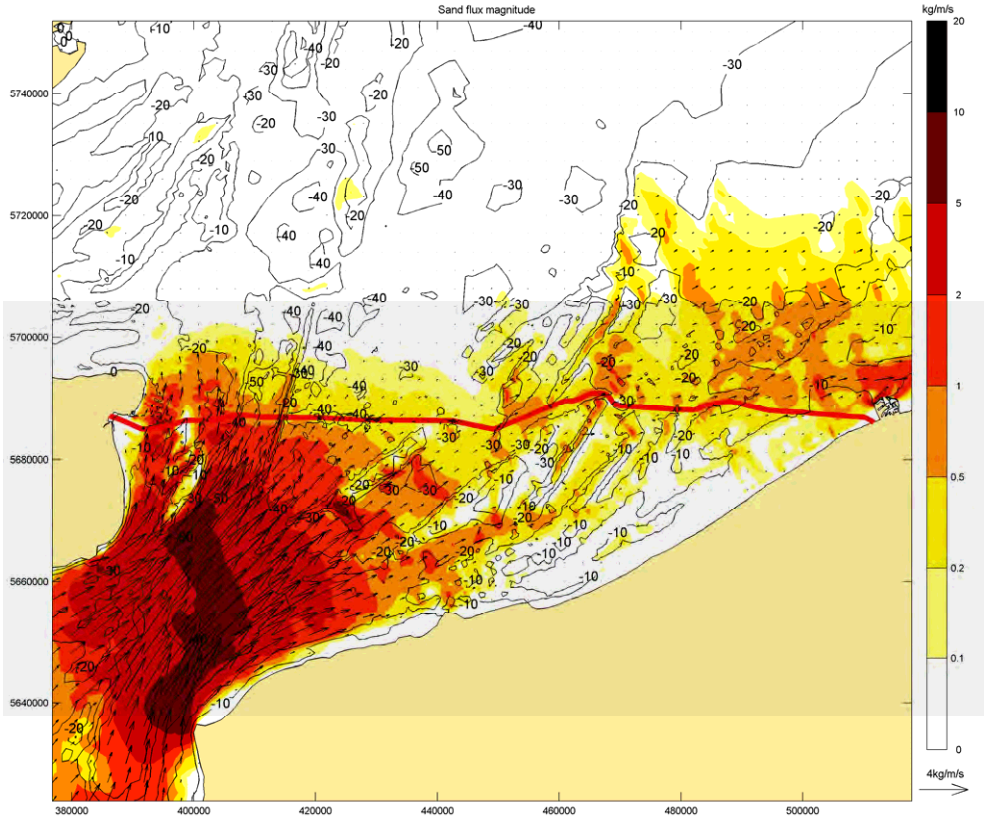


Figure 16 Peak flood sand transport rates – Spring tide, 250 µm sand

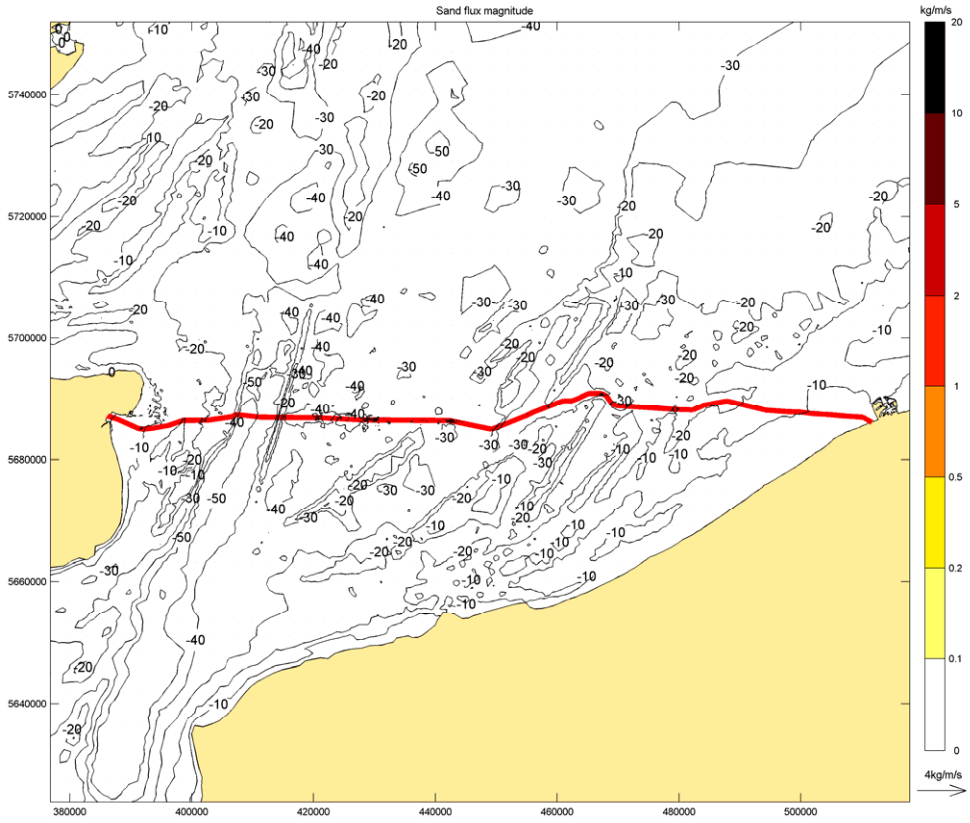


Figure 17 Peak ebb sand transport rates – Neap tide, 250 µm sand

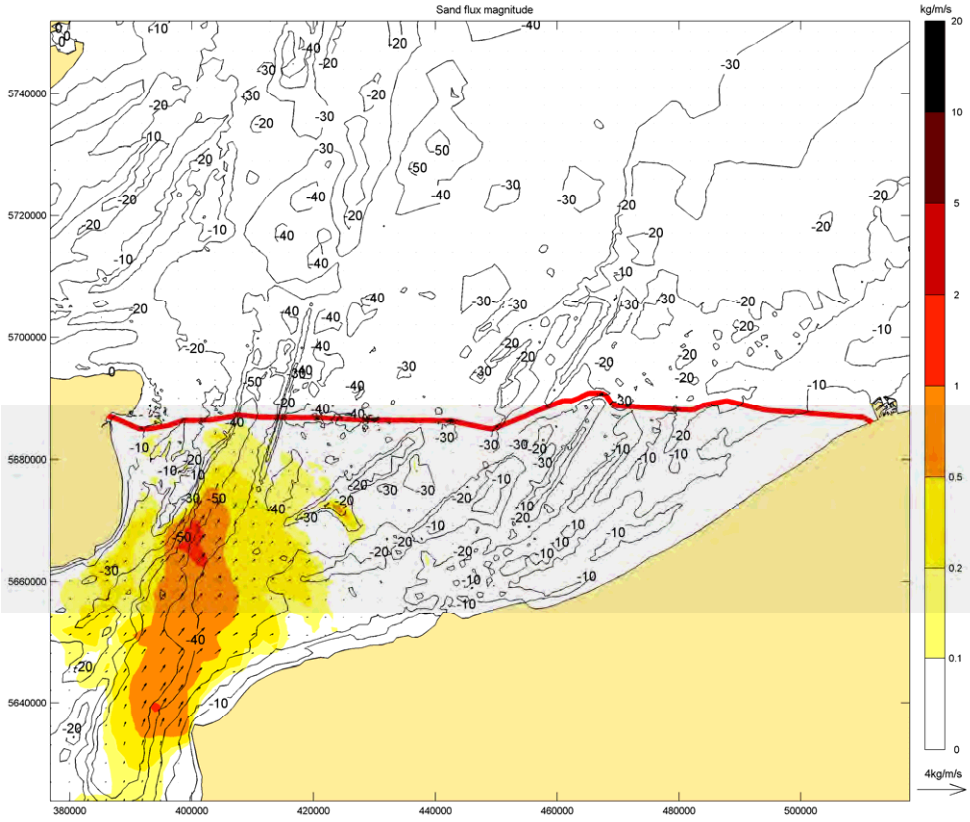


Figure 18 Peak flood sand transport rates – Neap tide, 250 µm sand

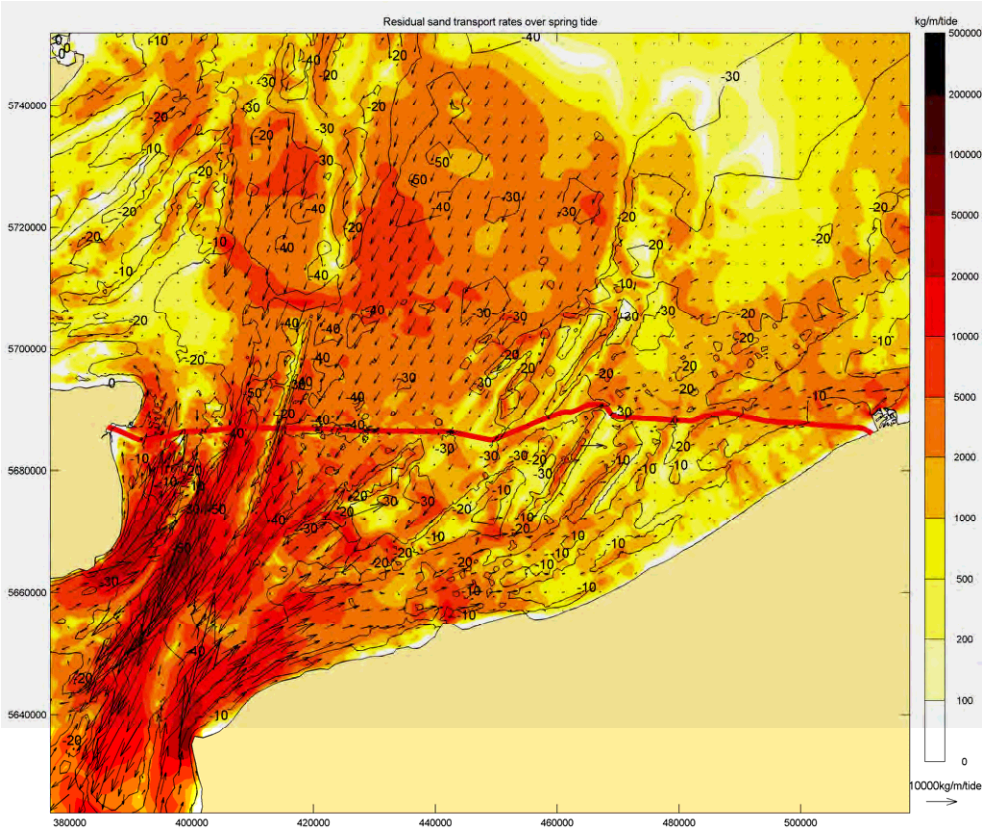


Figure 19 Residual sand transport rates over Spring tide – 250 µm sand

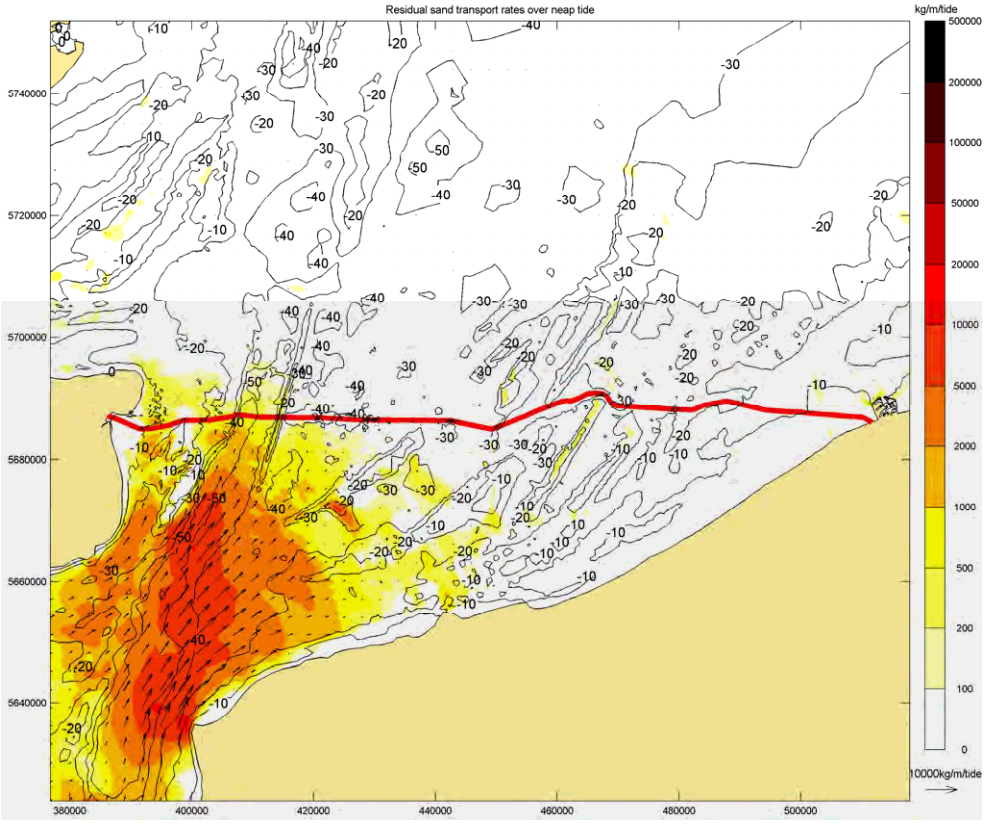


Figure 20 Residual sand transport rates over Neap tide – 250 µm sand

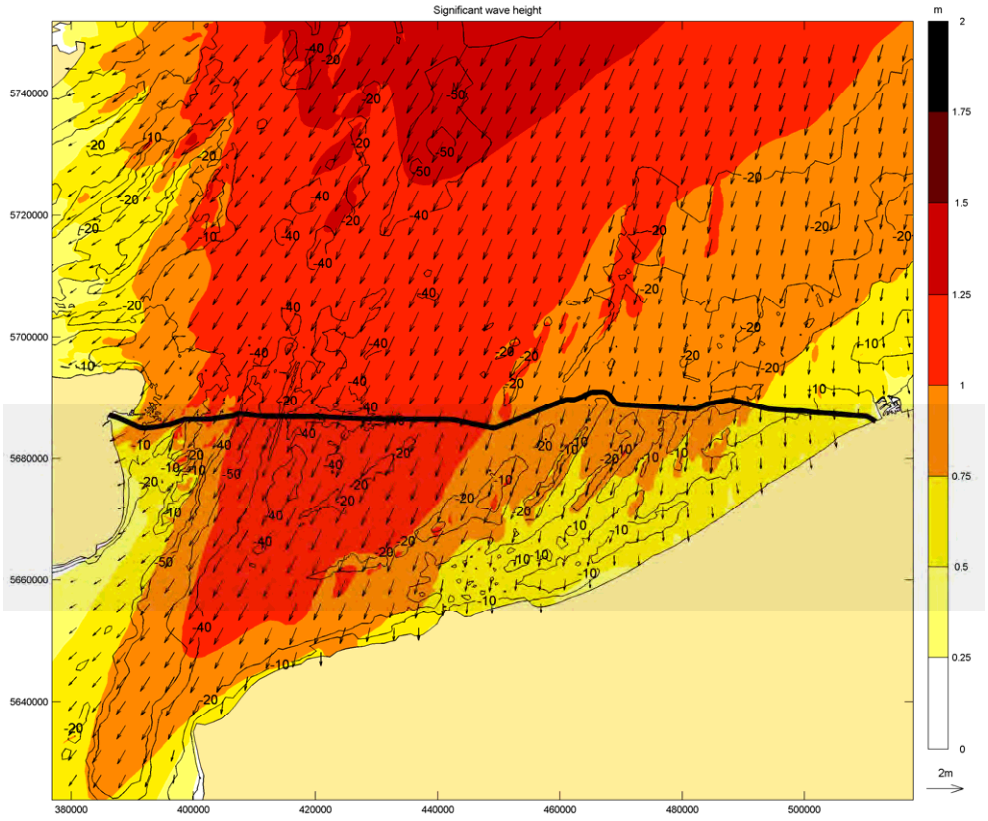


Figure 21 Wave height and direction for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N

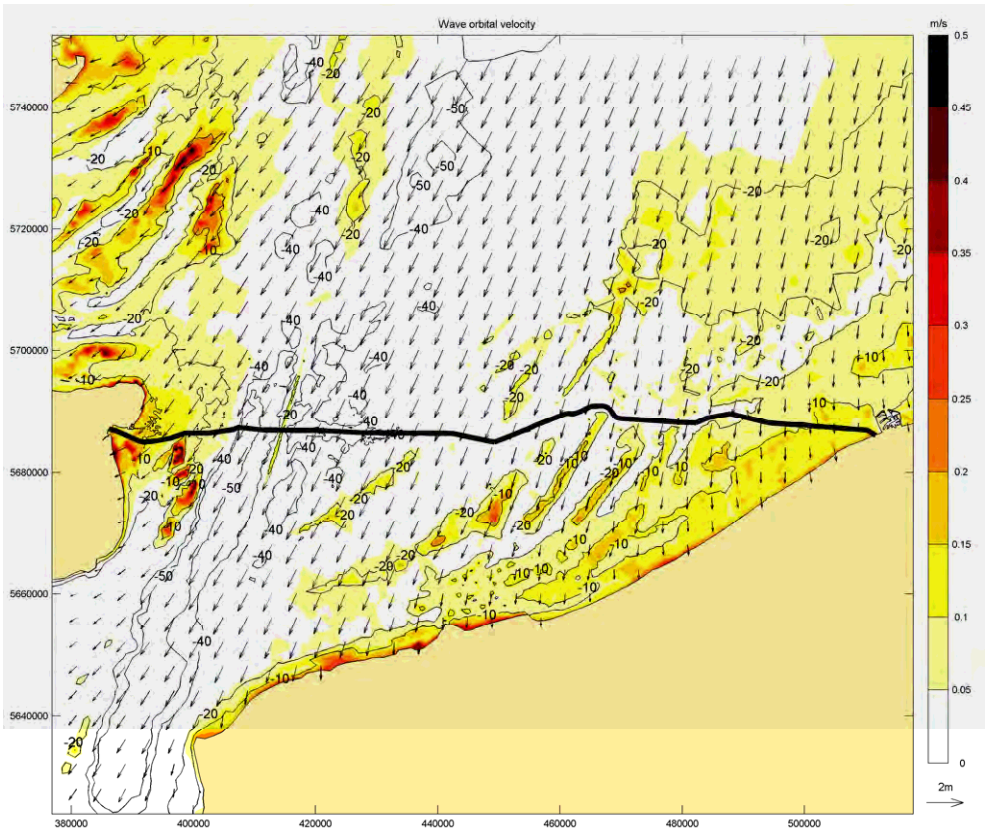


Figure 22 Wave orbital velocities for Hs = 2.0 m, Tp = 8.0s, Dir. = 135 °N

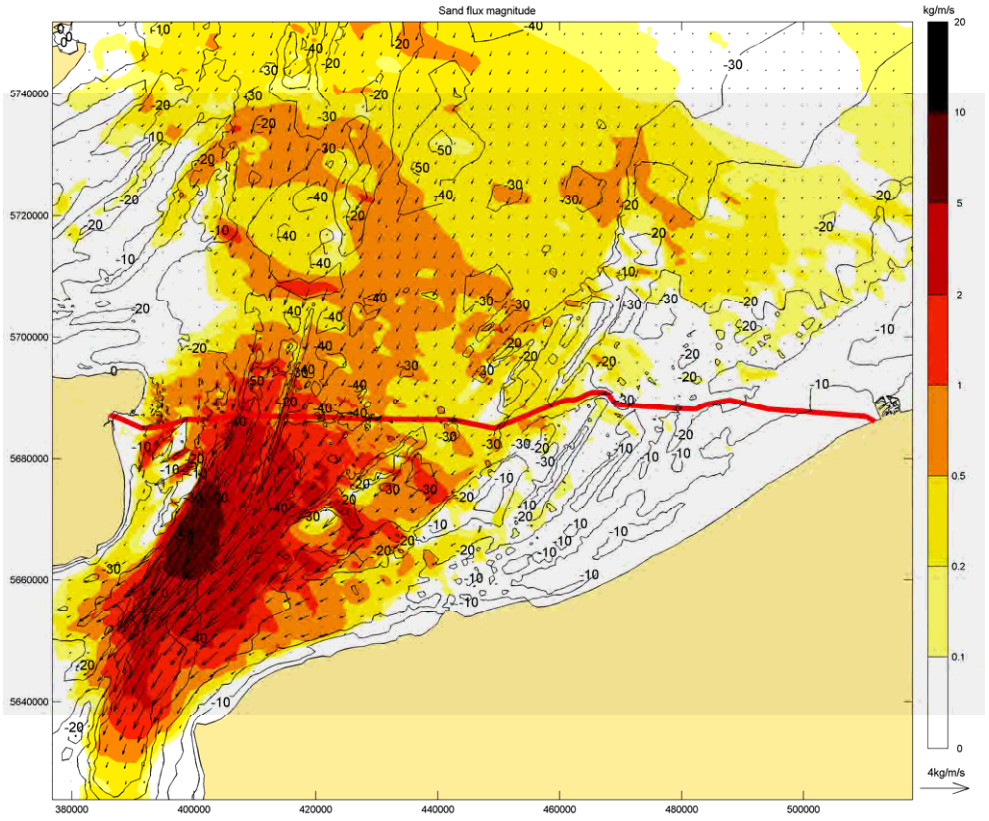


Figure 23 Peak ebb sand transport rates – Spring tide and waves, 400 µm sand

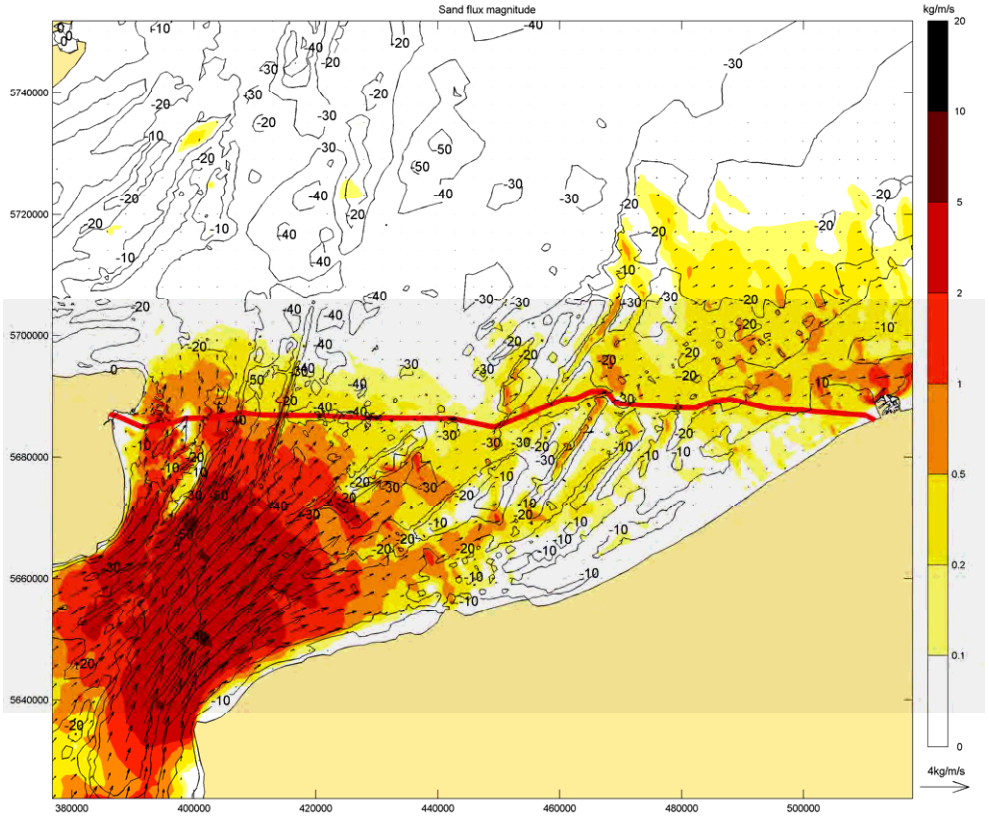


Figure 24 Peak flood sand transport rates – Spring tide and waves, 400 µm sand

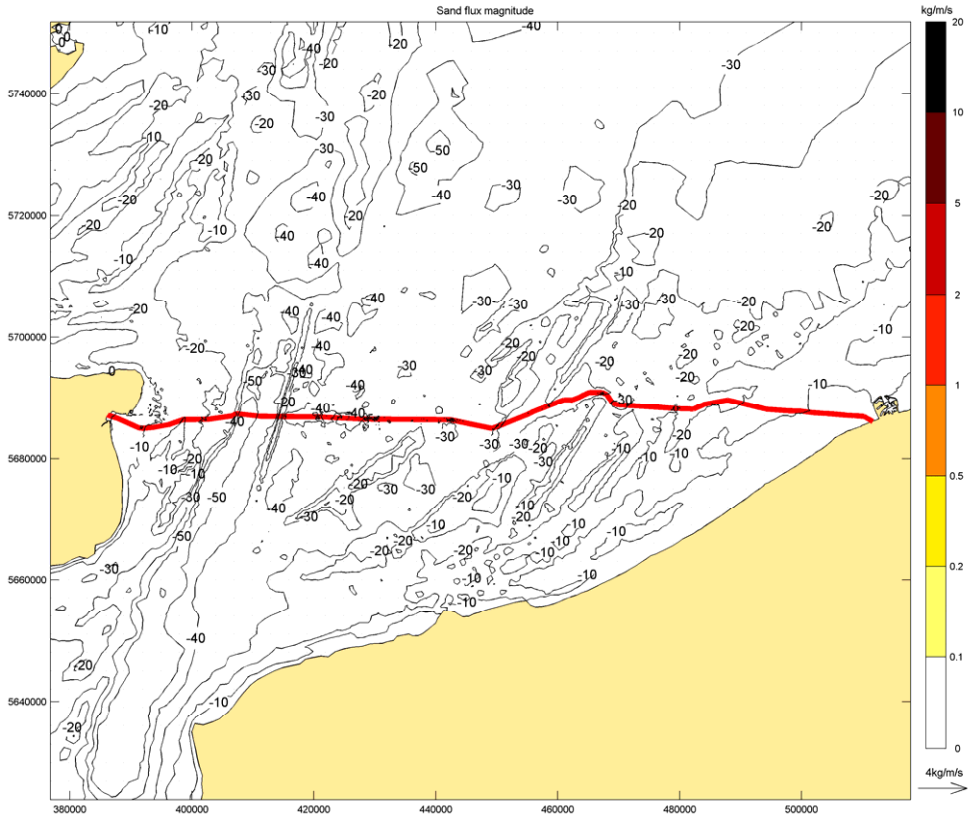


Figure 25 Peak ebb sand transport rates – Neap tide and waves, 400 µm sand

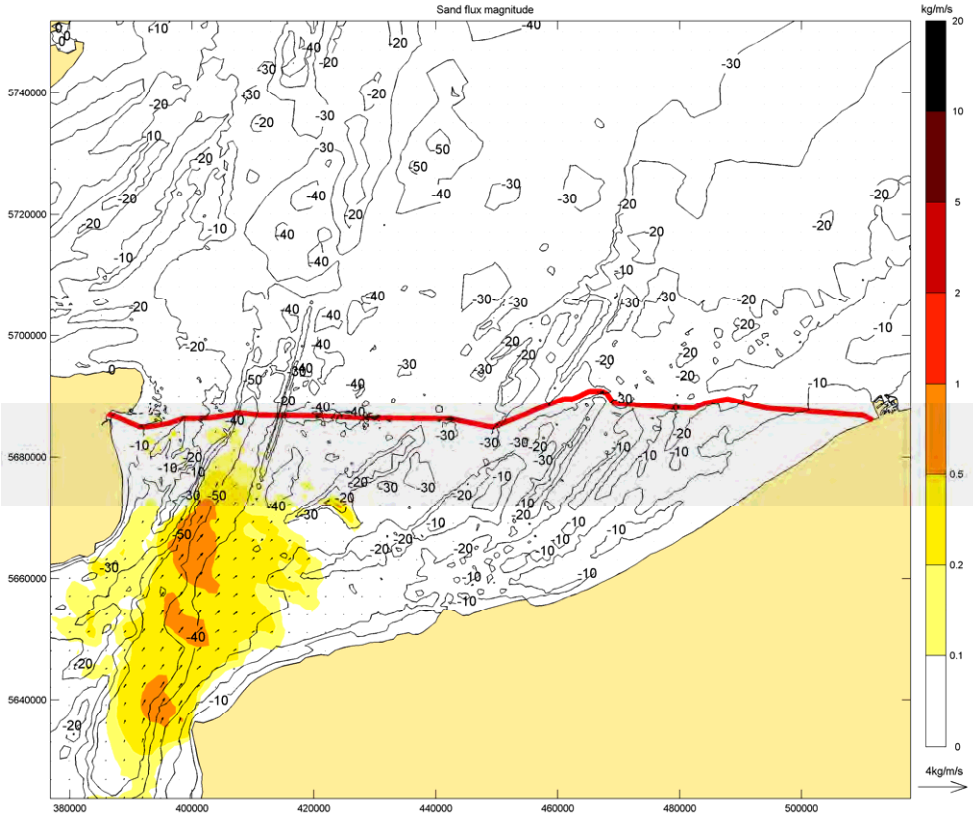


Figure 26 Peak flood sand transport rates – Neap tide and waves, 400 µm sand

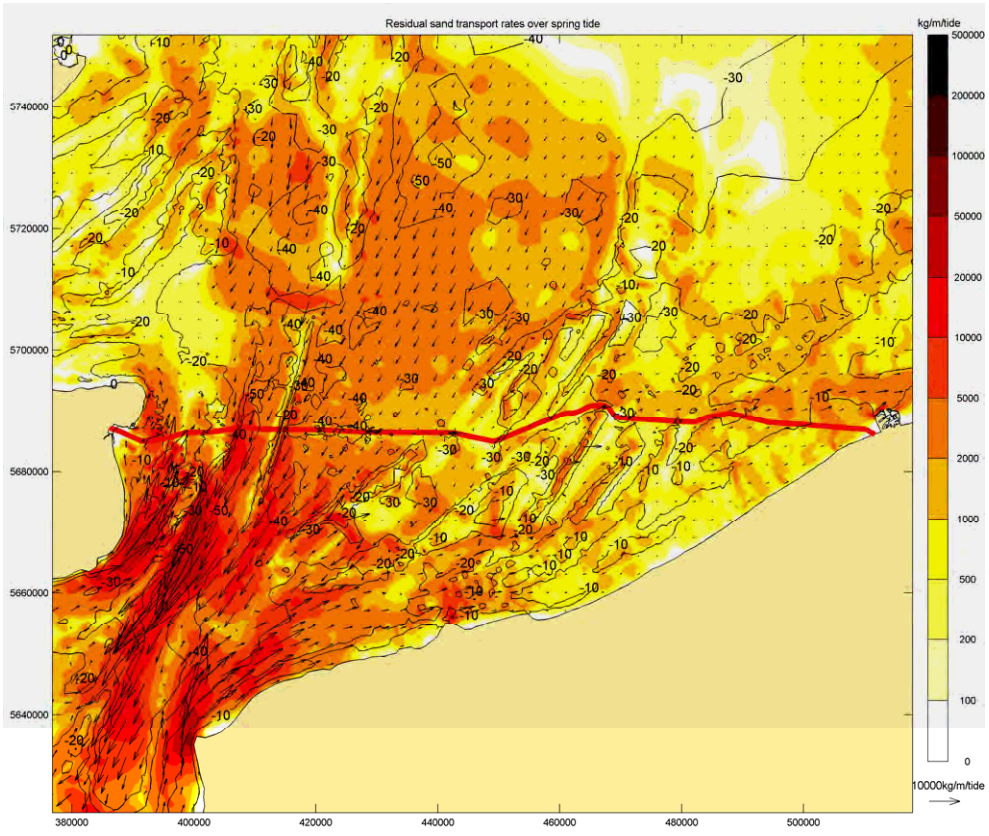


Figure 27 Residual sand transport rates over Spring tide, with waves – 400 µm sand

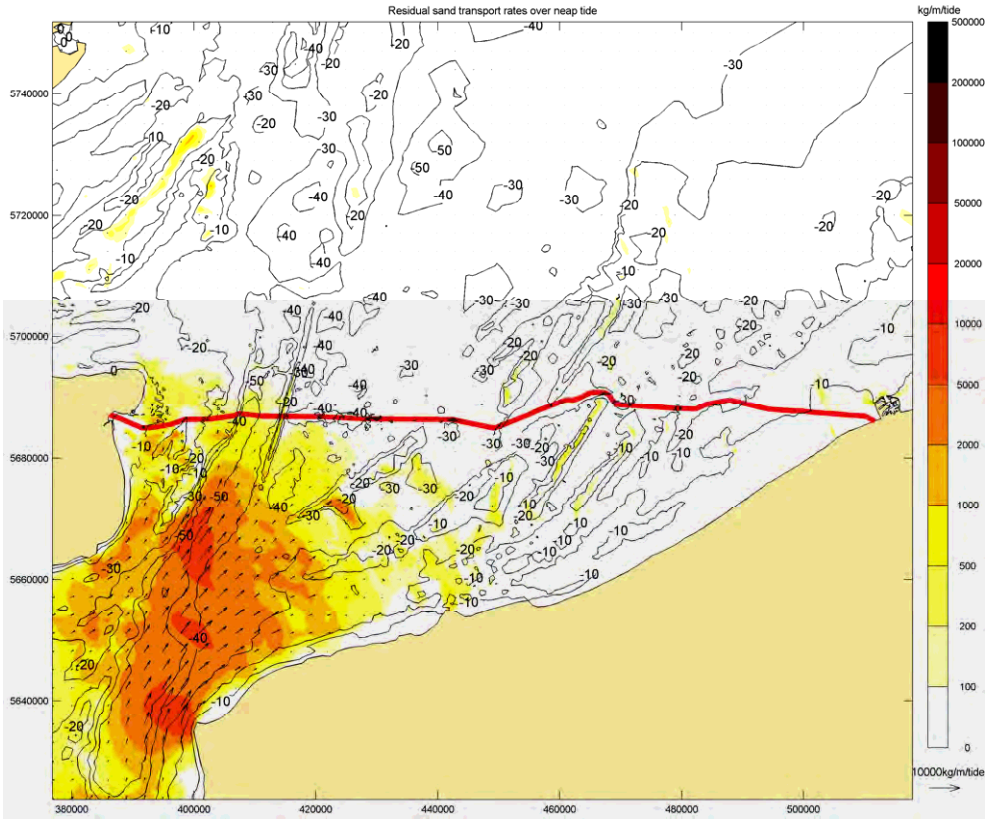


Figure 28 Residual sand transport rates over Neap tide, with waves – 400 µm sand

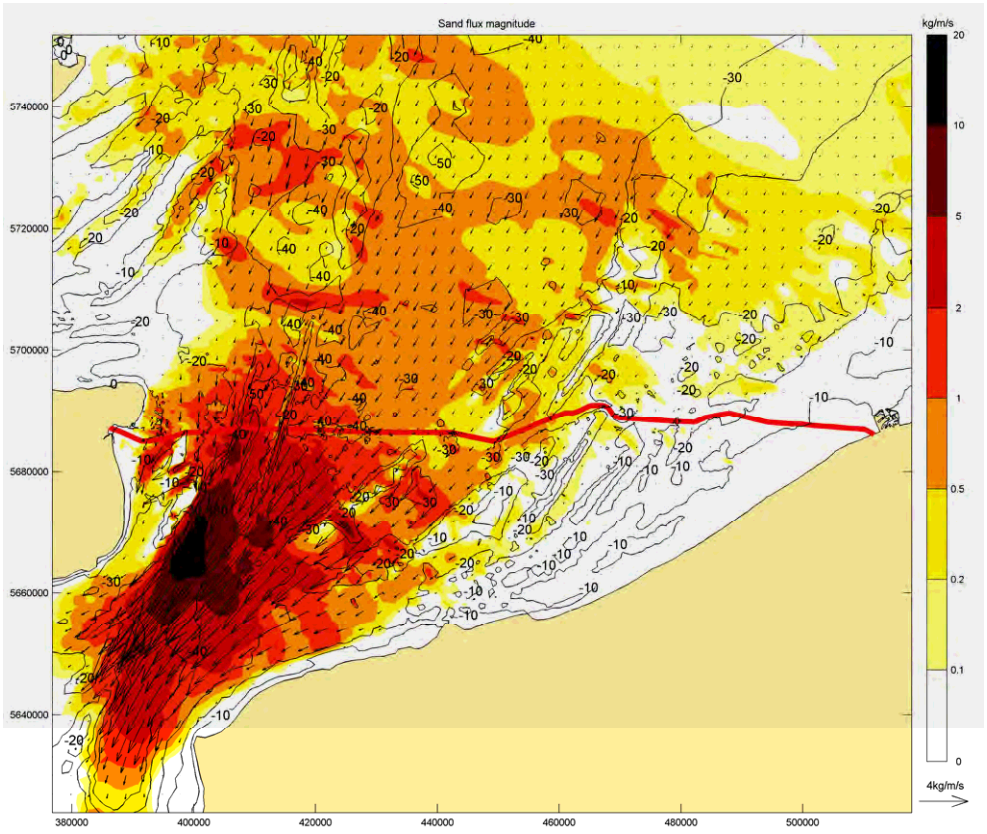


Figure 29 Peak ebb sand transport rates – Spring tide and waves, 250 µm sand

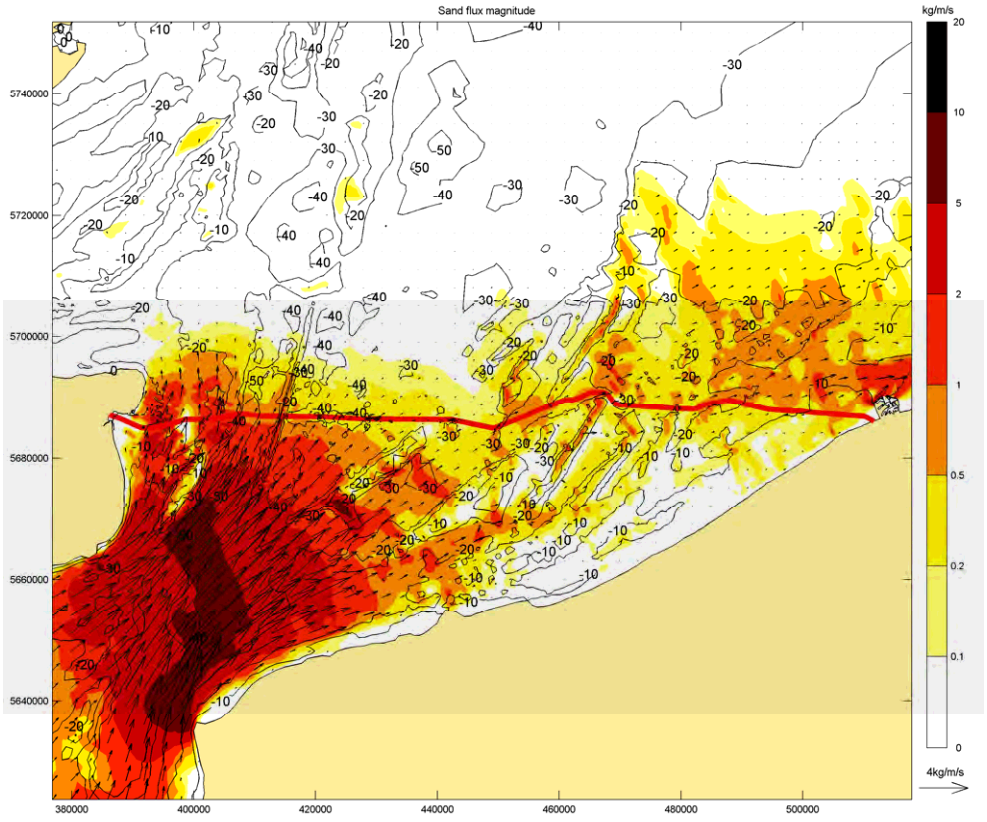


Figure 30 Peak flood sand transport rates – Spring tide and waves, 250 µm sand

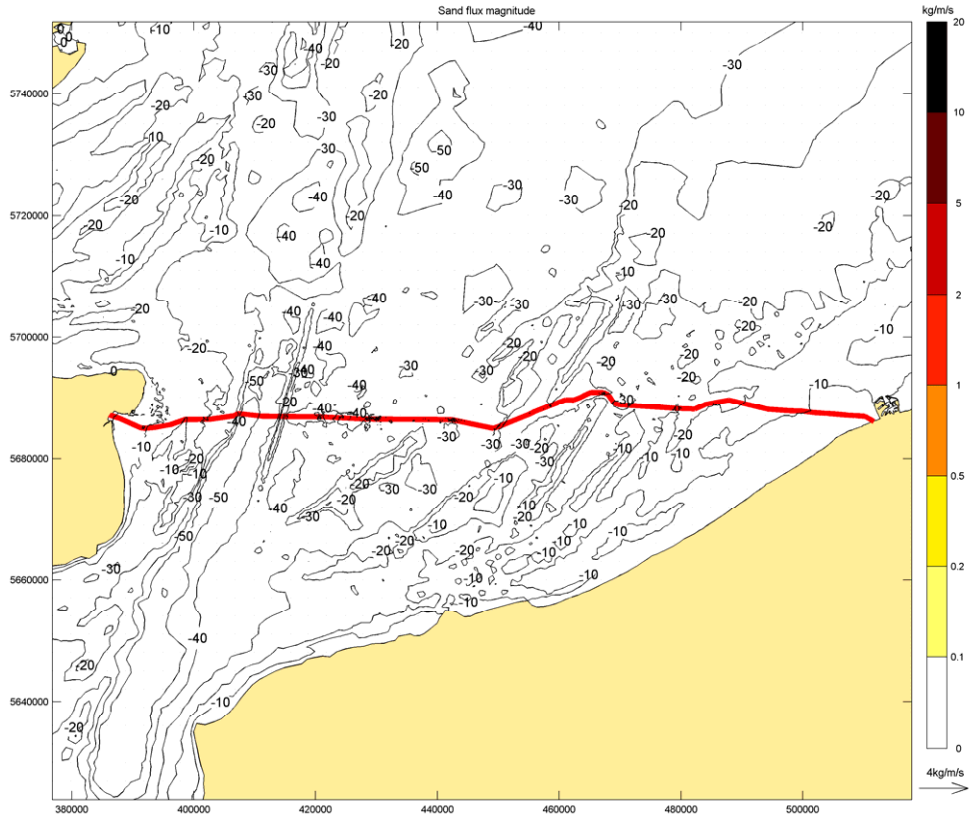


Figure 31 Peak ebb sand transport rates – Neap tide and waves, 250 µm sand

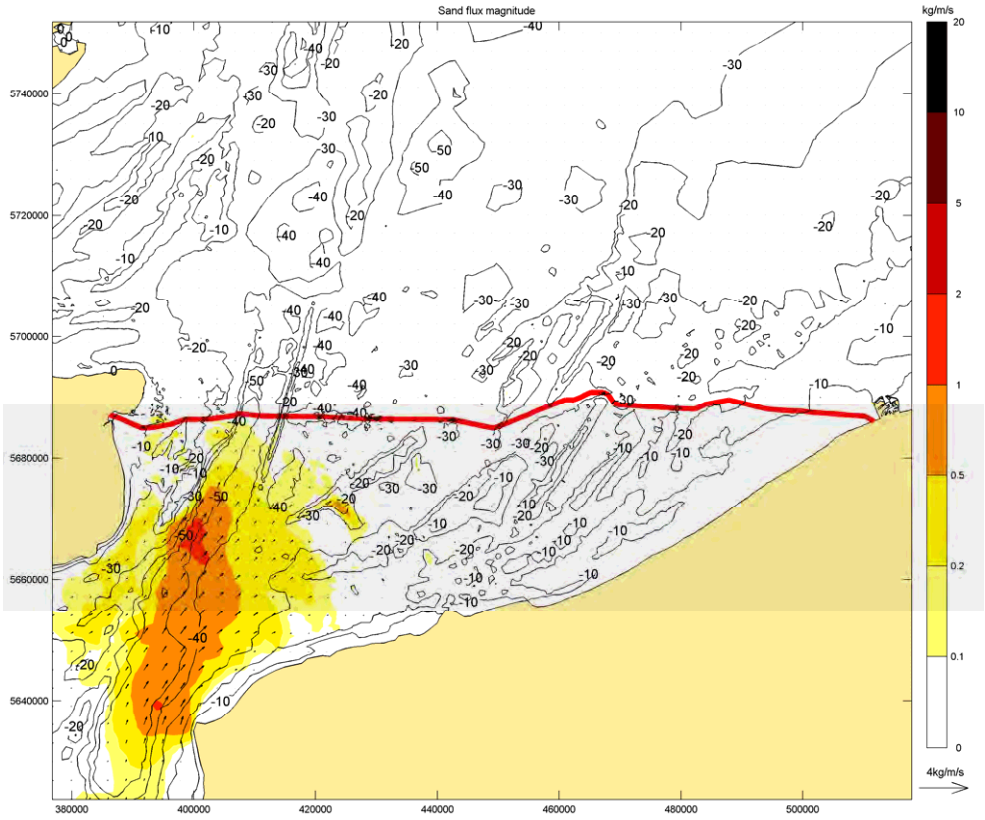


Figure 32 Peak flood sand transport rates – Neap tide and waves, 250 µm sand

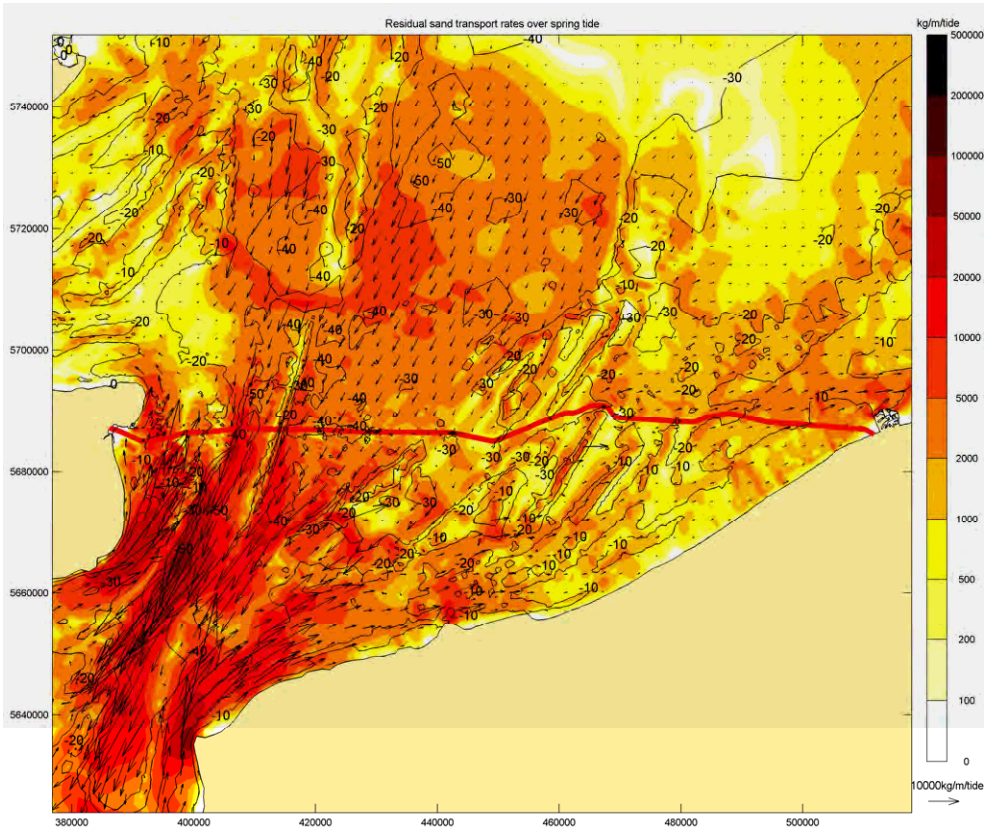


Figure 33 Residual sand transport rates over Spring tide, with waves – 250 µm sand

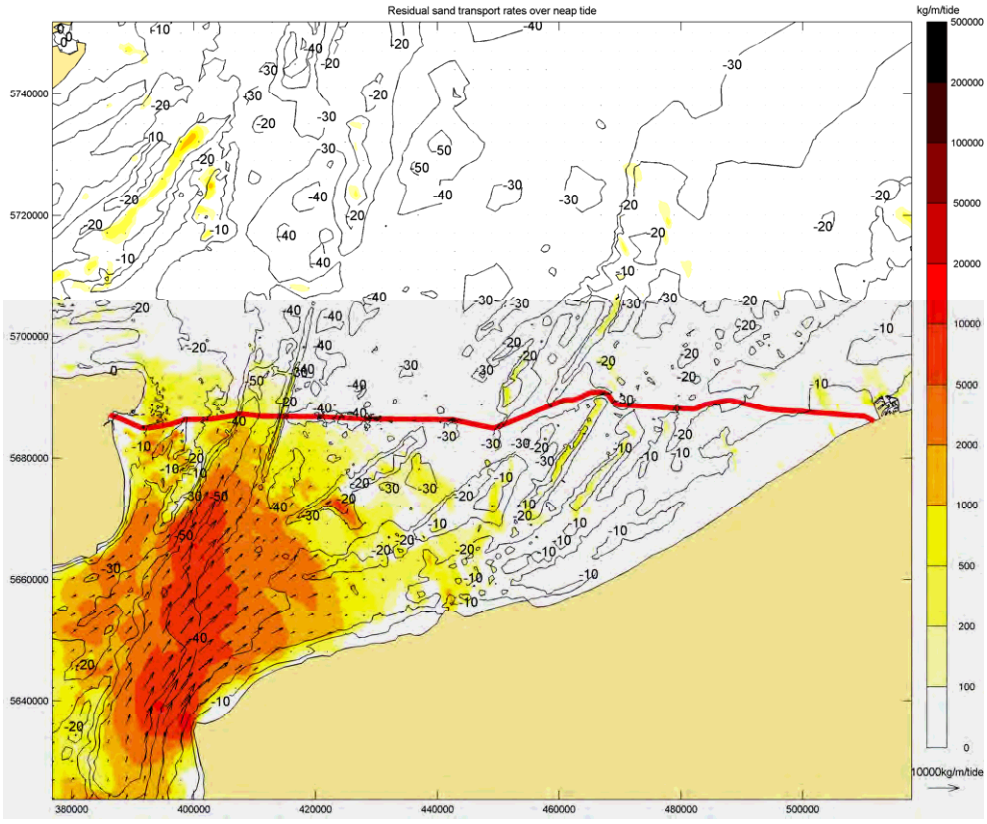


Figure 34 Residual sand transport rates over Neap tide, with waves – 250 µm sand

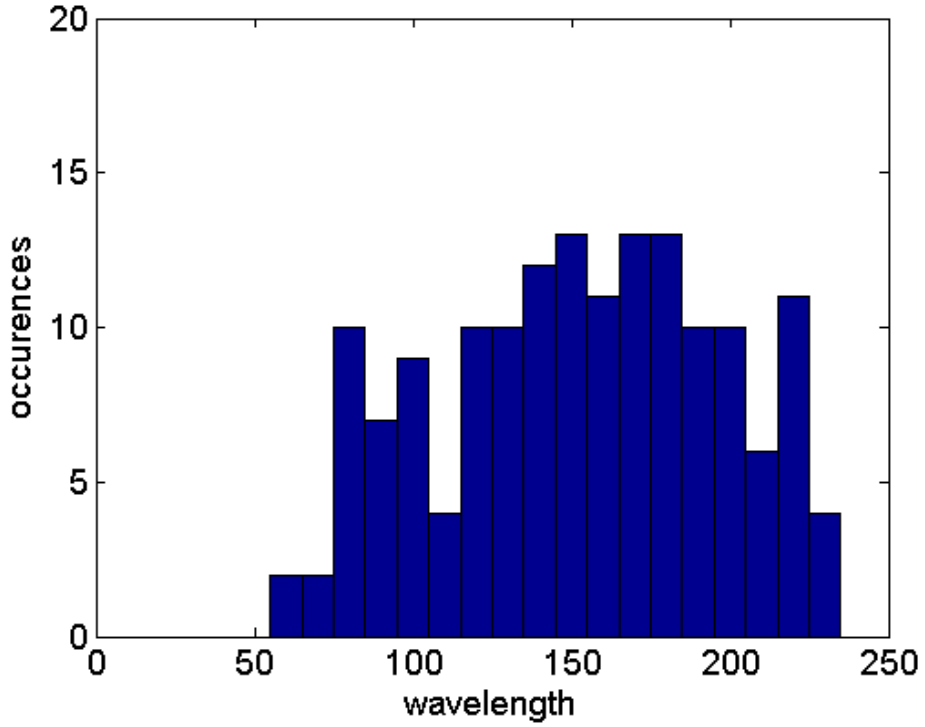


Figure 35 Frequency of occurrence of the median wavelengths (m) of bedforms along the cable

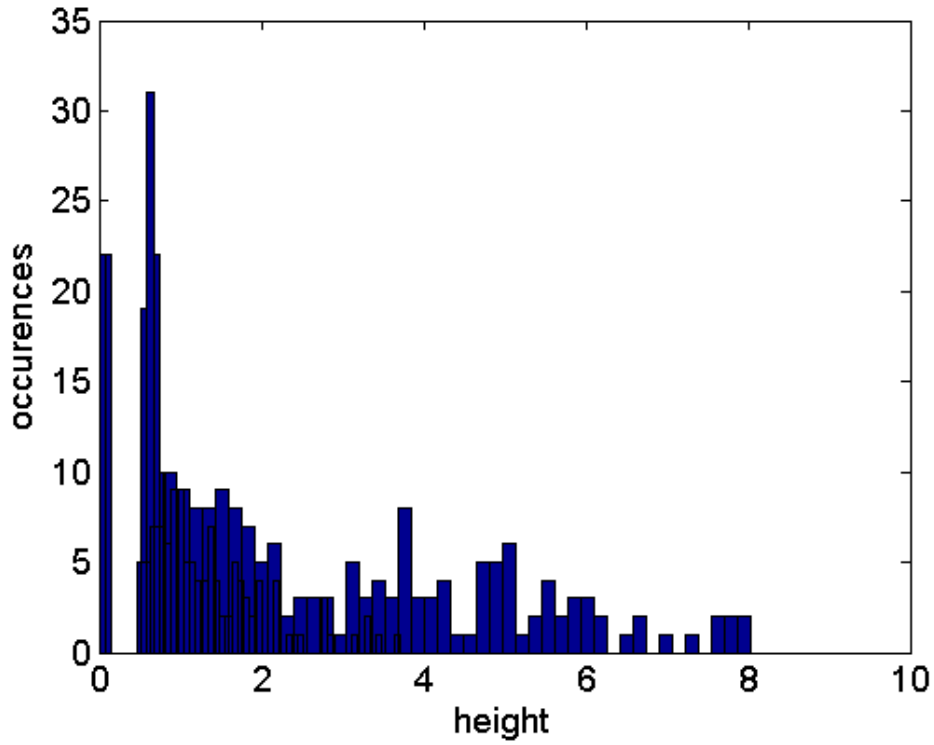


Figure 36 Frequency of occurrence of the median bedform height (m) along the cable

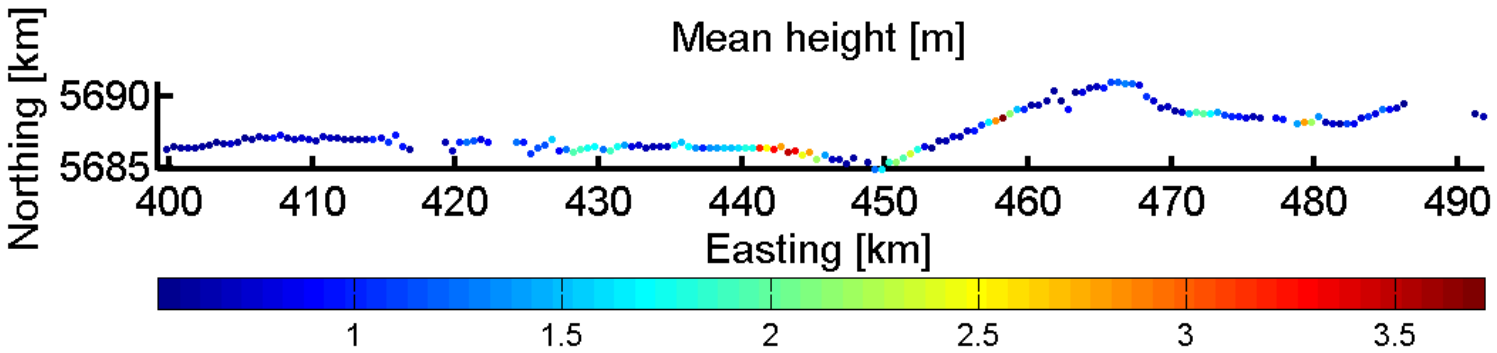


Figure 37 Mean height of bedforms along the cable corridor

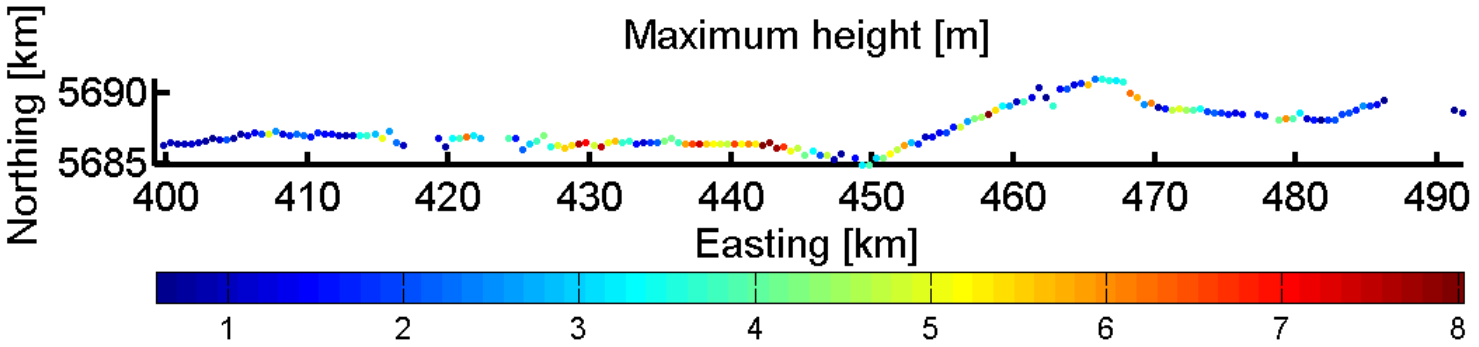


Figure 38 Maximum height of bedforms along the cable corridor

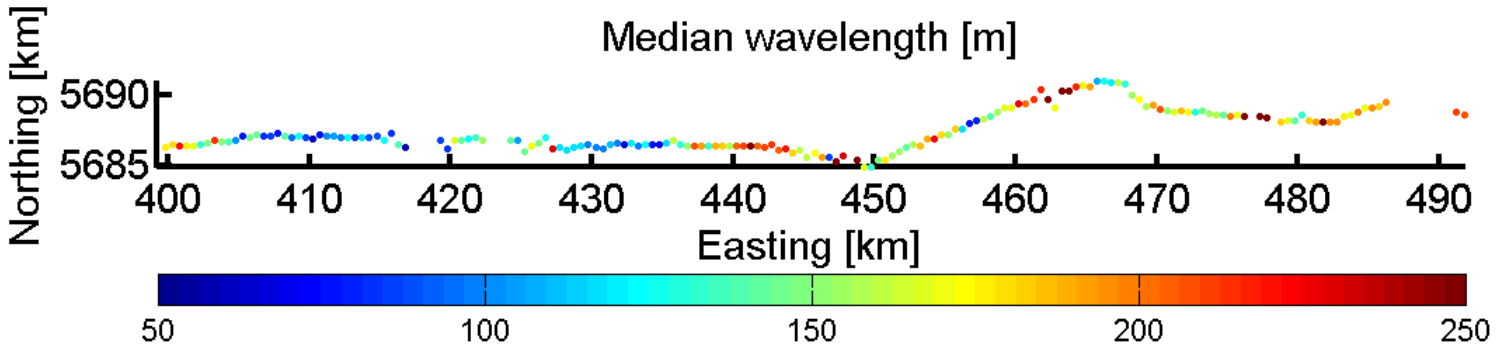


Figure 39 Bedform wavelength along the cable corridor

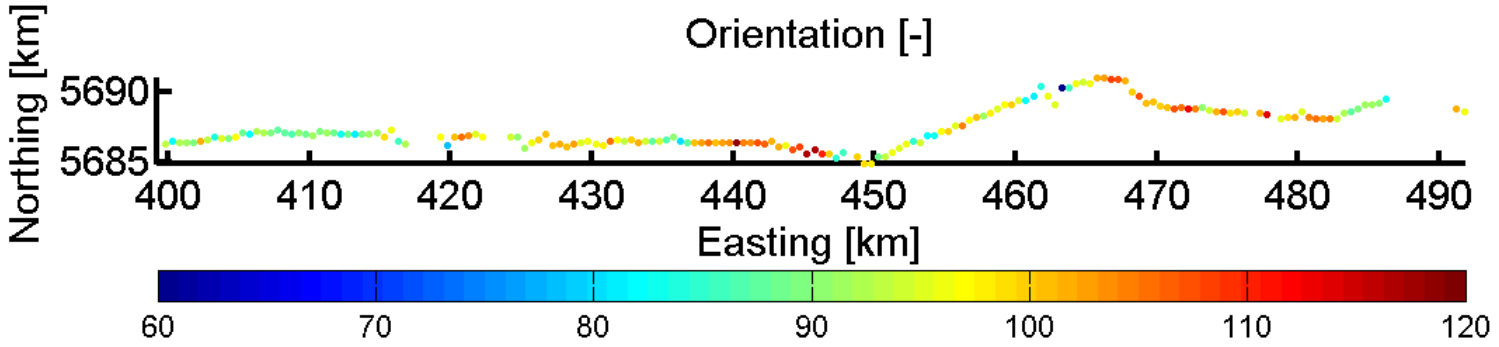


Figure 40 Bedform crest orientation in degrees with respect to north along the cable corridor

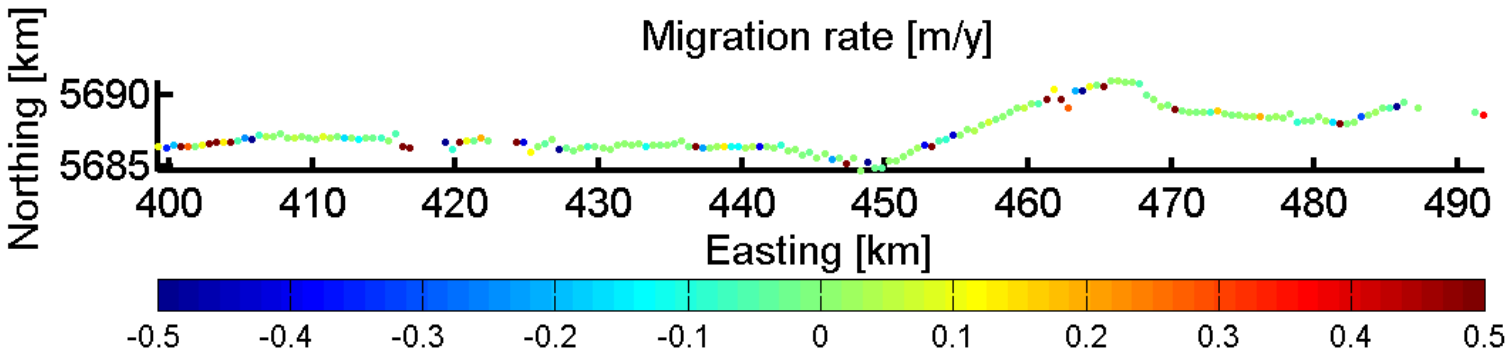


Figure 41 Bedform migration rate along the cable corridor

Project Nemo - UK to Belgium Interconnector

Plume Dispersion Modelling

Technical Note DDR4633-03

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Contents

1. Introduction 1
1.1 Background 1
1.2 Objectives 1
1.3 Report structure 1

2. Description of proposed trenching activities 1
2.1 Cable laying methodology 1
2.2 Ploughing 2
2.3 Jetting 2
2.4 Trailer suction hopper dredging 2

3. Flow modelling 3

4. Plume dispersion model 3

5. Description of modelled scenarios 4
5.1 Scenario 1 - Ploughing sand near Sabellaria area 4
5.2 Scenario 2 - Ploughing chalk 5
5.3 Scenario 3 - Ploughing sand at Goodwin Knoll 5
5.4 Scenario 4 - Trailer dredging at South Falls 5
5.5 Scenario 5 - Trailer dredging on Belgian Sand Banks 6
5.6 Scenario 6 - Ploughing mud near Zeebrugge 7
5.7 Scenario 7 - Jetting mud near Zeebrugge 7
5.8 Scenario 8 - Jetting sand in UK waters 8

6. Results 8
6.1 Scenario 1 - Ploughing sand near Sabellaria area 8
6.2 Scenario 2 - Ploughing chalk 8
6.3 Scenario 3 - Ploughing sand at Goodwin Knoll 9
6.4 Scenario 4 - Trailer dredging at South Falls 9
6.5 Scenario 5 - Trailer dredging on Belgian Sandbanks 9
6.6 Scenario 6 - Ploughing mud near Zeebrugge 10
6.7 Scenario 7 - Jetting mud near Zeebrugge 10
6.8 Scenario 8 - Jetting sand in UK waters 10

7. Conclusions 11

8. References 13

Tables

Table 1 Summary of predicted pre-sweep dredging cycle times at South Falls
Table 2 Summary of predicted pre-sweep dredging cycle times at sandbanks in Belgian territorial waters

Figures

Figure 1 Location of proposed cable route and cable laying sections for which plume dispersion simulations have been undertaken

Contents Continued

Figure 2 Location of proposed cable route in UK waters and cable laying sections for which plume dispersion simulations have been undertaken
Figure 3 Peak ebb flow velocities – Spring tide
Figure 4 Peak flood flow velocities – Spring tide
Figure 5 Overflow particle size distribution predicted by the TASS model for pre-sweeping at South Falls
Figure 6 Overflow sediment discharge predicted by the TASS model for pre-sweeping at South Falls
Figure 7 Seabed profile and pre-sweep dredge level for KP26 to KP29
Figure 8 Overflow particle size distribution predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29
Figure 9 Overflow sediment discharge predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29
Figure 10 Predicted increase in near-bed suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)
Figure 11 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)
Figure 12 Predicted increase in near-bed suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)
Figure 13 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)
Figure 14 Predicted increase in near-bed suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north
Figure 15 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north
Figure 16 Predicted increase in near-bed suspended sediment concentration above background, Scenario 6, ploughing mud
Figure 17 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 6, ploughing mud
Figure 18 Predicted increase in near-bed suspended sediment concentration above background, Scenario 7, jetting mud
Figure 19 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 7, jetting mud
Figure 20 Predicted deposition of fine sediment arising from jetting of mud, Scenario 7

Appendices

Appendix 1 SEDPLUME-RW technical description

1. Introduction

1.1 BACKGROUND

The Nemo Project concerns the laying of an HVDC electrical interconnector, which would allow the transfer of electrical power between the high voltage grid systems of Belgium and the United Kingdom (Figures 1 and 2). The proposed cable route runs from Richborough in Kent in the UK to Zeebrugge in Belgium. As part of the studies associated with the Environmental Impact Assessment for Project Nemo, an assessment of the impacts of fine sediment plumes arising from pre-sweep dredging of sandwaves, non-displacement ploughing and jetting associated with the laying of the cable has been undertaken.

1.2 OBJECTIVES

The objective of this assessment has been to evaluate the fine sediment plumes arising from pre-sweep dredging, non-displacement ploughing and jetting activities associated with cable installation. The modelling work has led to quantitative estimates of the increases in suspended sediment concentration and deposition of fine sediment from these activities.

1.3 REPORT STRUCTURE

The remainder of this report comprises a further seven chapters. The proposed operations are described in Chapter 2. Chapters 3 and 4 briefly describe the flow and plume dispersion models used to drive the plume dispersion and the plume dispersion model itself. Chapter 5 discusses the scenarios simulated by the plume dispersion model. Chapter 6 presents the results of the plume dispersion modelling, and the results of the study are discussed. The conclusions of the report are presented in Chapter 7.

2. Description of proposed trenching activities

2.1 CABLE LAYING METHODOLOGY

The methodology for the proposed cable lay is described in PMSS (2010). The main points from this reference, as regards the present study are as follows:

- In UK waters the trench for the cable will pass through substrates of sand, gravel, chalk and mud (near landfall).
- It is expected that non-displacement ploughing will be utilised to lay the cable in areas of chalk and mud. This type of plough is commonly used for the installation of telecommunications cables and is also used for power cables, umbilicals and other flexible products. A non-displacement plough uses a thin blade that slices through sedimentary seabed material without creating an open trench. This type of plough often causes minimal disturbance to the seabed surface.
- In some areas it may be that ploughing is unsuitable in which case jetting could be used.
- In areas with sandwaves pre-sweeping by dredging will be used to reduce the height of the sandwaves along the cable 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 cable. It also makes the protection afforded by burial more resistant to sandwave mobility and, therefore, more durable over time.

As agreed between PMSS and HR Wallingford at the Cable Routing Workshop the uppermost 2 m of the sandwave along the proposed cable route will need to be removed by trailer suction hopper dredger (TSHD). The dredging footprint will be 20 m at the bottom of the dredge (in order to enable ploughing to take place) and, assuming sideslopes of 1:5, 40 m at the surface.

2.2 PLOUGHING

Royal Haskoning (2002) describe the effects of non-displacement ploughing as causing the disturbance of 0.02 m^3 per metre of cable layed. This was used in the plume dispersion studies undertaken for Sheringham Wind Farm (Appendix 2 of Scira, 2006), assuming a cable laying speed of 0.05 m/s (based on industry advice). For chalk, for an assumed (dry) density of 2000 kg/m^3 this gives a sediment release rate of 2 kg/s.

2.3 JETTING

Jetting inevitably creates more disturbance than non-displacement ploughing. Reach (2007) describe plume dispersion studies for a cable laying jetting operation in Hong Kong with an assumption that 20 per cent of a trench cross-section of 1.75 m^2 would be disturbed by the jetting process and the speed of the jetting machine would be 300 m/hr (0.083 m/s). ASA (2005) describe similar studies for a cable laying operation near Cape Cod in the USA and assumed that 30 per cent of a trench cross-section of 3 m^2 would be disturbed by the jetting process and the speed of the jetting machine would be 91 m/hr (0.025 m/s). This latter study also assumed that any sand particles would quickly return to the bed and only the fine sediment particles (particles with a diameter greater than 63 μm) would form a plume in the water column.

Based on these previous studies, for the current study it is assumed that 25 per cent of the trench cross-section area of 3 m^2 is disturbed and that the jetting machine moves at 180 m/hr (0.05 m/s). For the muddy substrates which arise close to Zeebrugge (see Section 5.7) this results in a sediment release rate of about 40 kg/s. For the sandy substrates in UK territory, with very little fines content, the effect of jetting results in a lower release rate of about 2 kg/s or less.

2.4 TRAILER SUCTION HOPPER DREDGING

The process of loading the dredger entails pumping a mixture of solids and water from the seabed into the hopper of the dredger (which is usually partially full of water at the start of loading). The solids content in the pumped mixture is relatively low (approximately 25 per cent by volume) and so the vessel fills quickly with water while loading. In order to allow the vessel to load a full cargo of sand (and/or gravel) without becoming overloaded, the excess water in the hopper is returned overboard through overflow spillways which discharge through the hull of the dredger. The returned water also contains a proportion of suspended solids (typically fine sands and silt).

Once returned to the sea through the hull of the dredger, this sediment interacts with the ambient tidal currents, the boundary layer of the dredging vessel and the air bubbles entrained in the overflow discharge. As a result of this interaction the overflow tends to form two different plumes: a surface plume which contains around 15 per cent of the sediment discharged from the overflow (based on measurements undertaken by [redacted]

[redacted] in Hong Kong, *pers.comm.* [redacted], HR Wallingford, and more recent measurements undertaken by the EcoShape Project in Dutch waters, Aarninkhof *et al.*, 2010) which is released quickly into the water column, and a negatively buoyant dynamic plume, carrying most of the released sediment, which rapidly descends towards the bed mixing with the surrounding water as it does so. This dynamic plume usually impinges on the bed, collapsing onto the bed as a density current. This density current is at some point entrained into the overlying waters by tidal currents forming a passive plume, albeit more diffuse than the passive plume caused by the surface plume. Once passive plumes are formed they will be dispersed horizontally and vertically in the form of a plume by tidal flows and wave action and be advected by the tidal currents. The processes of advection and dispersion will continue until the sediment concentrations are reduced to close to background levels.

The requirements for the dredging associated with the proposed cable laying have been identified as follows:

- Dredging using a TSHD of size similar to the *Brabo* (11650 m^3, Clarkson Research Services Ltd., 2009).
- "Local" release of dredged sediment to reduce cycle times. In this study local has been assumed to be a location 1500 m from the point of dredging, close enough to keep the sediment in the vicinity of the sandbank system from where it was derived, but far enough away that the sediment will not return to the dredged area before the cable has been laid. The location has been chosen in the lee of the cable route with respect to the net direction of sand transport (see HR Wallingford, 2011a).

3. Flow modelling

The tidal flow modelling undertaken for the project is described in HR Wallingford (2011b). A brief description is presented here.

The model covers a large area of the Southern North Sea from Flamborough Head in the north and beyond the Strait of Dover to Plymouth in the south-west. The bathymetry for the model was locally improved and re-gridded to include information on the local bathymetry along the cable route. The model grid mesh size is about 20 km at the northern open boundary, 5 km in the English Channel and 100 m along the cable route which is appropriate for determining local flow fields and for use in the current plume modelling study. The model was driven using water levels at the boundary from near Flamborough Head across the North Sea to Europe and across the English Channel based on harmonic data from Primary ports and other published literature (the national British Oceanographic Data Centre (BODC) database).

The spring tide peak ebb and peak flood current patterns in the vicinity of the cable route are shown in Figures 3 and 4.

4. Plume dispersion model

The plume dispersion model used to simulate the dispersion of fine sediment from non-displacement ploughing and trailer dredging is the SEDPLUME-RW model developed by HR Wallingford. A description of the model is included in Appendix 1. The model

was run using the hydrodynamic output referred to in Chapter 3 and the assumption of a logarithmic velocity profile through the water column to track the 3 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 (SEDTRAIL-3D) which allows the representation of the moving sources and of the near-field mixing that occurs with trailer suction hopper dredgers (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 1DV model and calculates the magnitude and particle size distribution of the sediment flux out of the hopper in the overflow discharge.

For each scenario a similar number of particles were used for each model run, with the mass of each particle varying depending upon the source term for each scenario.

5. Description of modelled scenarios

In this report seven scenarios are modelled as follows:

- 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 - Pre-sweeping by TSHD for Belgian Sandbanks
- Scenario 6 - Ploughing mud close to Zeebrugge
- Scenario 7 - Jetting mud near Zeebrugge.

In addition, a further scenario will be evaluated based on the results above but without additional modelling:

- Scenario 8 – Jetting sand in UK waters

5.1 SCENARIO 1 - PLOUGHING SAND NEAR SABELLARIA AREA

There are 3 vibro-cores (104, 106, 107, see Appendix C of MMT 2010a) of *in situ* sediment in the area local to the Sabellaria reef with soil samples from a depth that corresponds to disturbance by ploughing. These vibro-core samples give the *in situ* sediment as being sandy with 2-3 per cent fines. A nearby grab sample (B39, see Appendix P of MMT, 2010b) also gives the fines content as 3 per cent fines. The fines content for the soil was therefore taken as 3 per cent for the purpose of the simulation.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre ploughed, at a (dry) density of 1700 kg/m^3, of which 3 per cent is fine material (< 63μm in diameter). The release of fine material is therefore 0.05 kg/s which is the release rate simulated in the plume dispersion model. It was assumed that sandy material disturbed by the plough falls straight back down on the bed and is not released into the water column. Fine sediment released into the water column was assumed to flocculate and have a constant settling velocity of 1 mm/s.

The release of fine material from the ploughing was represented as moving over a 3 km path from east to west at 0.05 m/s for a period of slightly less than 1½ tides.

5.2 SCENARIO 2 - PLOUGHING CHALK

In this scenario non-displacement ploughing was simulated through the chalk feature located on the cable path between KP114 and KP116.2.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of chalk ploughed, at a (dry) density of 2000 kg/m^3, of which 100 per cent is assumed to be released into the water column as fine material. This represents a worst case scenario. The release of chalk simulated in the plume dispersion model was 2 kg/s. Chalk released into the water column was assumed to have a settling velocity of zero mm/s for the purposes of the simulation.

The release of fine material from the ploughing was represented as moving over the 2.2 km extent of the chalk from east to west (as shown later in Figure 10) at 0.05 m/s, for a period of approximately 1 tide.

5.3 SCENARIO 3 - PLOUGHING SAND AT GOODWIN KNOLL

In this scenario non-displacement ploughing was simulated through the sandbank at Goodwin Knoll between KP117.6 and KP118.9.

The only source of data regarding the particle size distribution of the sediment that will be disturbed by the proposed ploughing at Goodwin Knoll is from one nearby grab sample (B43, see Appendix P of MMT, 2010b). However the fines content (i.e. content of particles less than 63 μm in diameter) indicated by this sample was zero per cent. It is not known whether this sample is representative so as a conservative case the fines content for the soil was taken as 3 per cent (as for the area adjacent to the Sabellaria) for the purpose of the simulation.

The plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of sand ploughed, at a (dry) density of 1700 kg/m^3, of which 3 per cent is assumed to be released into the water column as fine material. The release rate of the fine material simulated in the plume dispersion model was, therefore, 0.05 kg/s.

The release of fine material from the ploughing was represented as moving over a 1.3 km path from east to west at 0.05 m/s for a period of approximately 1 tide.

5.4 SCENARIO 4 - TRAILER DREDGING AT SOUTH FALLS

For the scenario of pre-sweeping at South Falls a dredger of the same characteristics as the *Brabo* was simulated dredging over a 1.5 km path. The dredger was assumed to

move at a speed of 1 m/s whilst dredging, and turning for 5 minutes at the end of every pass. The total dredge volume identified is about 90,000 m^3.

The *in situ* sediment appears to have a fines content (content of particles less than 63 μm) of 0 per cent (Grab B35 and VC-93; MMT, 2010a, b). Allowing for a small trace (0.1 per cent) of fines in the overflow discharge and when all of the sediment fractions are considered the TASS model predicts the total release of sediment in the overflow, including coarser fractions, to vary by up to 24 kg/s over the loading period. The results of the TASS overflow model are summarised in Figures 5 and 6. The median particle size in the overflow is predicted to be 280 μm.

A summary of the loading and cycle times involved in the pre-sweeping dredging is presented in Table 1. The TASS model predicts that on each loading period the hopper will fill with 8500 m^3 of dredged material. On this basis 11 loading cycles are required for the pre-sweep at South Falls and the whole operation (at this location) will take 24 hours. The whole 24 hour period of operations is reproduced in the simulation.

Table 1 Summary of predicted pre-sweep dredging cycle times at South Falls

Disposal time (mins)	5
Sailing (total) time (mins)	23.5
Dredging time (mins)	102
Cycle time (mins)	130.5

The disposal site for the dredging at South Falls is assumed to be 1500 m south of the proposed dredging. Whilst representative in terms of illustrating the effects of disposal, the location is not intended to signify a recommended area for disposal.

To reproduce the effects of the disposal on sediment plumes, only the fine fraction (diameter less than 63 μm) is modelled, which is represented by a release rate of 45 kg/s over the 5 minute period of disposal. This is because the plume produced by the coarser fractions is relatively brief. The dynamic plume caused by the release of the sediment from the hull of the dredger will plummet to the bed and pancake across the seabed with sand settling out as the density current moves radially outwards. The sand will deposit within 100 m of the point of release.

5.5 SCENARIO 5 - TRAILER DREDGING ON BELGIAN SAND BANKS

For the scenario of pre-sweeping on the Belgian Sandbanks a dredger of the same characteristics as the *Brabo* was simulated dredging over a 2.5 km path (see Figure 14). The dredger was assumed to move at 1 m/s, dredging when encountering sandbank features and turning for 5 minutes at the end of every pass. The total dredge identified is about 38,000 m^3.

The *in situ* sediment appears to have a fines content (content of particles less than 63 μm) of 1-10 per cent with an average of 3 per cent (Grabs B7, B17, Vibro-cores VC-15, VC-17; MMT, 2010a, b). The TASS model predicts the total release of sediment in the overflow, including coarser fractions, varies up to 87 kg/s over the course of loading, but is below 40 kg/s for most of the loading period. The results of the TASS overflow model are summarised in Figures 8 and 9. More than 80 per cent of the sediment discharged in the overflow is predicted to be less than 60 μm in diameter.

A summary of the loading and cycle times involved in the pre-sweeping dredging is presented in Table 2. The TASS model predicts that on each loading period the hopper will fill with 7,700 m^3 of dredged material. On this basis 5 loading cycles are required for the pre-sweep along this section of the cable route and the whole operation (at this location) will take 20 hours. The whole 20 hours period of operations is reproduced in the simulation.

Table 2 Summary of predicted pre-sweep dredging cycle times at sandbanks in Belgian territorial waters

Disposal time (mins)	5
Sailing (total) time (mins)	23.5
Dredging time (mins)	216
Cycle time (mins)	244.5

The disposal site for the dredging of this section is assumed to be 1500 m north of the proposed dredging. Whilst representative in terms of illustrating the effects of disposal, the location is not intended to signify a recommended area for disposal.

To reproduce the effects of the disposal on sediment plumes, only the fine fraction (diameter less than 63 μm) is modelled, which is represented by a release rate of 450 kg/s over the 5 minute period of disposal. This is because the plume produced by the coarser fractions is relatively brief. The dynamic plume caused by the release of the sediment from the hull of the dredger will plummet to the bed and pancake across the seabed with sand settling out as the density current moves radially outwards. The sand will deposit within 100m of the point of release.

5.6 SCENARIO 6 - PLOUGHING MUD NEAR ZEEBRUGGE

This scenario was concerned with the effects of non-displacement ploughing of mud between near Zeebrugge. A section of the cable route between KP3 and KP4 was selected to give an example of the potential effects of ploughing in this area. As before the plough was assumed to travel at 0.05 m/s disturbing 0.02 m^3 per metre of mud ploughed of which 100 per cent is assumed to be released into the water column as fine material. The dry density of the mud was assumed to be 1000 kg/m^3 which is a broad average of the values from vibro-cores in this stretch of the cable route (Tyrens, 2011). This represents a worst case scenario. The release of fines simulated in the plume dispersion model was 1 kg/s. Mud released into the water column was assumed to have a settling velocity of 0.5 mm/s for the purposes of the simulation.

The release of fine material from the ploughing was represented as moving over a 1 km path from east to west as shown later in Figure 16 at 0.05 m/s for a period of approximately half a tide.

5.7 SCENARIO 7 - JETTING MUD NEAR ZEEBRUGGE

This scenario reproduced the effects of jetting by repeating the simulation of Scenario 6 but with the higher rate of release that would result from the jetting process. As discussed in Section 2.3, the jetting process was assumed to disturb 25 per cent of the trench cross-section of 3 m^2 with the jetting machine travelling at 0.05 m/s. As in Section 5.6 the (dry) density of the mud substrate was taken as 1000 kg/m^3. This gives a release rate of about 40 kg/s. Mud released into the water column was assumed to have a settling velocity of 0.5 mm/s for the purposes of the simulation.

For consistency the release of fine material from the jetting was represented as moving over a 1 km path from east to west (see Figure 18) for a period of approximately half a tide.

5.8 SCENARIO 8 - JETTING SAND IN UK WATERS

As discussed in Section 2.3, the release rate corresponding to jetting in the sandy conditions of UK territorial waters, is about 2 kg/s or less. The release rate is much lower for these sandy substrates compared to the muddy conditions in Belgian territorial waters (see Section 5.7), 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 which, coincidentally, corresponds roughly with the release rate resulting from ploughing of chalk (see Section 5.2). On this basis we will use the result from simulation of chalk ploughing (Scenario 2) to give a reasonable approximation of the fine sediment plumes caused by jetting sand.

It is acknowledged that chalk released into the water column will not settle at slack water, unlike fine sediment, but the general results of Section 6 indicate that deposition from the proposed cable laying operations is generally negligible unless rates of release of sediment are many times higher than 2 kg/s. Therefore, it is reasonable to use Scenario 2 as a basis for evaluating the effects of the release of fine sediment arising from the jetting of sand.

6. Results

6.1 SCENARIO 1 - PLOUGHING SAND NEAR SABELLARIA AREA

The scenario of ploughing sand with 3 per cent 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 impacts of ploughing near the Sabelleria Spinosa reef is considered to be negligible.

6.2 SCENARIO 2 - PLOUGHING CHALK

Figures 10 and 11 show the *envelope* of predicted increases in near-bed (Figure 10) and depth-averaged (Figure 11) suspended sediment concentration 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. 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.

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 above background are less than 1 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable route. The peak predicted increase in concentration is about 20 mg/l.

Deposition of fine sediment is assumed to be negligible.

6.3 SCENARIO 3 - PLOUGHING SAND AT GOODWIN KNOLL

As for Scenario 1, the scenario with ploughing sand with 3 per cent 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 impact of ploughing at Goodwin Knoll in generating plumes is considered to be negligible.

6.4 SCENARIO 4 - TRAILER DREDGING AT SOUTH FALLS

Figures 12 and 13 show the *envelope* of predicted increases in near-bed (Figure 12) and depth-averaged (Figure 13) 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. The plume footprint is mainly due to the presence of fine material at the extremities of the plume but closer to the point of release the majority of the plume will be coarser, sandy material.

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

Figures 12 and 13 also show that the plume of fine material arising from a simulation of 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 coarser sediment released than fine sediment and concentration increases will be of the order of 1000's mg/l within one hundred metres of the point of disposal over a period of ten minutes or so 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.

6.5 SCENARIO 5 - TRAILER DREDGING ON BELGIAN SANDBANKS

Figures 14 and 15 show the *envelope* of predicted increases in near-bed (Figure 14) and depth-averaged (Figure 15) 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. The plume footprint is mainly due to the presence of fine material at the extremities of the plume, but closer to the point of release the majority of the plume will be coarser, sandy material.

The figures show that the footprint of impact extends up to 13 km NE and up to 11 km SW of the dredging but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur up to 7.5 km NW and up to 4 km SW of the dredging. Increases in suspended sediment concentration of more than 50 mg/l are predicted to be confined to the immediate vicinity of the dredging and up to 2 km from the point of disposal. Locations in the streamline of the dredging and disposal located at a distance of 1 km SW and NE of these locations are predicted to experience increases in (depth-averaged) suspended sediment concentration of more than 10 mg/l

for a total of no more than 20 minutes during the 20 hour period of dredging simulated. No deposition of fine material is predicted.

The peak predicted increase in concentration is in the region of 200 mg/l and arises from the disposal of material locally. Note, however, that this relates to fine sediment only and there will be considerably more coarser sediment released than fine sediment. Concentration increases will be of the order of 1000's mg/l within one hundred metres of the point of disposal over a period of ten minutes or so while these coarser particles settle to the bed.

Deposition of fine sediment is predicted to be less than 0.5 mm and so is considered to be negligible. 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.

6.6 SCENARIO 6 - PLOUGHING MUD NEAR ZEEBRUGGE

Figures 16 and 17 show the *envelope* of predicted increases in near-bed (Figure 16) and depth-averaged (Figure 17) suspended sediment concentration above background during the simulation of ploughing.

The figures show that the footprint of impact extends up to 5 km from the cable route but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur near the bed within 150 m of the cable route. The peak predicted increase in concentration is about 25 mg/l.

Deposition of fine sediment is predicted to be negligible.

6.7 SCENARIO 7 - JETTING MUD NEAR ZEEBRUGGE

Figures 18 and 19 show the *envelope* of predicted increases in near-bed (Figure 18) and depth-averaged (Figure 19) suspended sediment concentration above background during the jetting 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.

The figures show that the footprint of impact extends up to 12 km from the cable route but that at these distances the predicted increases in suspended concentration above background are less than 2 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur up to 10 km from the jetting Increases in suspended sediment concentration of more than 50 mg/l are predicted to occur within 250 m of the cable route. The peak predicted increase in near bed concentration is predicted to be of the order of a few hundred mg/l in the vicinity of the jetting itself.

The predicted deposition of fine sediment from the simulated jetting is shown in Figure 20. Deposition of fine sediment is predicted to be less than 0.1 mm except within 200 m of the dredge path. Within 100 m of the dredge path, deposition of up to 15 mm is predicted.

6.8 SCENARIO 8 - JETTING SAND IN UK WATERS

As discussed in Section 5.8, the effects of jetting of sand in UK waters broadly correspond to the effects of ploughing of chalk, as presented in Section 6.2.

On this basis it can be expected that the footprint of impact arising from the jetting of sand will extend up to 700 m from the cable route but that at these distances the predicted increases in suspended concentration above background will be less than 1 mg/l. Increases in suspended sediment concentration of more than 10 mg/l are predicted to occur within 100 m of the cable route. The peak predicted increase in concentration is about 20 mg/l. Deposition of fine sediment is assumed to be negligible.

Coarser sand disturbed by the jetting process will also be initially resuspended but will settle out close to the cable route.

7. Conclusions

The generation and dispersion of plumes arising from cable installation activities for Project Nemo. The cable laying operations has been investigated by the computational simulation of the dispersal of plumes arising from ploughing of sand and chalk and from pre-sweep TSHD dredging. The following conclusions have been made:

- The ploughing of the cable into sand at the Sabellaria area and at Goodwin Knoll is predicted to produce negligible increases in concentration and negligible deposition of fine sediment near Goodwin Knoll.
- The ploughing of the cable into chalk is predicted to result in minor (> 10 mg/l) increases in suspended sediment concentration within 100 m of the cable route. No deposition is predicted because the settling velocity of fine suspended chalk particles is very small.
- Pre-sweep dredging at South Falls is predicted to result in minor (> 10mg/l) increases in suspended sediment concentration within 250m of the cable route. No deposition of fine material is predicted. Sand disturbed by the dredging is predicted to settle within a few hundred metres of the cable route.
- Disposal of material dredged from South Falls is predicted to result in negligible plumes of fine sediment and negligible deposition of fine sediment. Sand disturbed by the dredging is predicted to settle within one hundred metres of the cable route. For a short time (of the order of 10 minutes) concentrations will be relatively high (100's to 1000's mg/l) within 100 m of the point of disposal while the coarse sediment released settles to the bed.
- Pre-sweep dredging of sandbanks in Belgian territorial waters and local disposal, is predicted to result in increases in suspended sediment concentration of more than 50 mg/l in the immediate vicinity of the dredging and up to 2 km from the point of disposal. Locations in the streamline of the dredging and disposal located at a distance of 1 km are predicted to experience increases in suspended sediment concentration of more than 10 mg/l for no more than a total of 20 minutes during the period of dredging. No deposition of fine material is predicted.
- Sand disturbed by the pre-sweep dredging and disposal of sandbanks in Belgian territorial waters is predicted to settle within a few hundred metres of the cable route and disposal location. For a short time (of the order of 10 minutes) concentrations will be relatively high (100's to 1000's mg/l) within 100 m of the point of disposal while the coarse sediment released settles to the bed.

- The ploughing of the cable into mud near Zeebrugge is predicted to result in minor (> 10 mg/l) increases in suspended sediment concentration within 150 m of the cable route. No deposition is predicted.
- The jetting of the cable into mud near Zeebrugge is predicted to result in moderate (> 50 mg/l) increases in suspended sediment concentration within 250 m of the cable route although smaller increases of up to 10 mg/l are predicted to occur up to 10 km away from the dredging. Deposition of the order of 10 mm is predicted within 100 m of the cable route but deposition is predicted to be negligible more than 200 m from the cable route.
- The jetting of the cable into sand in UK waters is expected to produce increases in suspended sediment concentrations similar to those of ploughing chalk, i.e. minor (> 10mg/l) increases in suspended sediment concentration within 100 m of the cable route. Deposition of fine sediment is assumed to be negligible on the basis of the modelling work undertaken for the other scenarios.
- Sand initially disturbed by the jetting process is predicted to settle close to the cable route.

8. References

Aarninkhof S.G.J., Spearman J.R.., de Heer A.F.M. & van Koningsveld M., 2010. Dredging-induced turbidity in a natural context status and future perspective of the TASS program, Proceedings of the 19th World Dredging Congress, 9 - 14 September 2010, Beijing, China.

ASA, 2005. Estimates of seabed scar recovery from jet plow cable burial operations and possible cable exposure on Horshoe Shoal from sand migration, Report prepared by ASA for Cape Wind Associates, ASA Report 5-128, October 2005.

Clarkson Research Services Ltd., 2009. Dredgers of the World 2009/2010 7th edition, Clarkson Research Services Ltd., London.

HR Wallingford, 2011a. Project Nemo – UK to Belgium Interconnector, Sand Transport Modelling and Bedform Analysis, HR Wallingford Technical Note DDR4633-02, March 2011.

HR Wallingford, 2011b. Project Nemo – UK to Belgium Interconnector, Tidal Flow Modelling, HR Wallingford Technical Note DDR4633-01, February 2011.

MMT, 2010a. Marine Survey Report, Project NEMO, Geophysical and Geotechnical Survey 2010, December 2010.

MMT, 2010b. Marine Survey Report, Project NEMO, Environmental Survey 2010, December 2010.

PMSS, 2010. Nemo – Project Description, Working Document, PMSS report, Version 1, October 2010.

Reach, 2007. Asia-America Gateway (AAG) Cable Network, South Lantau, Project Profile 2007, report prepared by Atkins and EGS for Reach Networks Hong Kong Ltd.

Royal Haskoning, 2002. Royal Haskoning Cromer OWF Environmental Statement, Prepared for Norfolk Offshore Wind.

Scira, 2006. Sheringham Shoal Offshore Wind Farm, EIA Coastal and seabed processes, Report prepared by HR Wallingford Ltd. for Scira Offshore Energy Ltd, Document number SCIRA-5-13-0-SE-RP-02452, Revision 6.0, February 2006.

Spearman, J., Bray, R. N., & Burt, T. N., 2003. Dynamic representation of trailer dredger source terms in plume dispersion modelling, CEDA Dredging days, November, 2003.

Tyrens, 2011. Geotechnical report, Tyrens, February 2011.

Figures

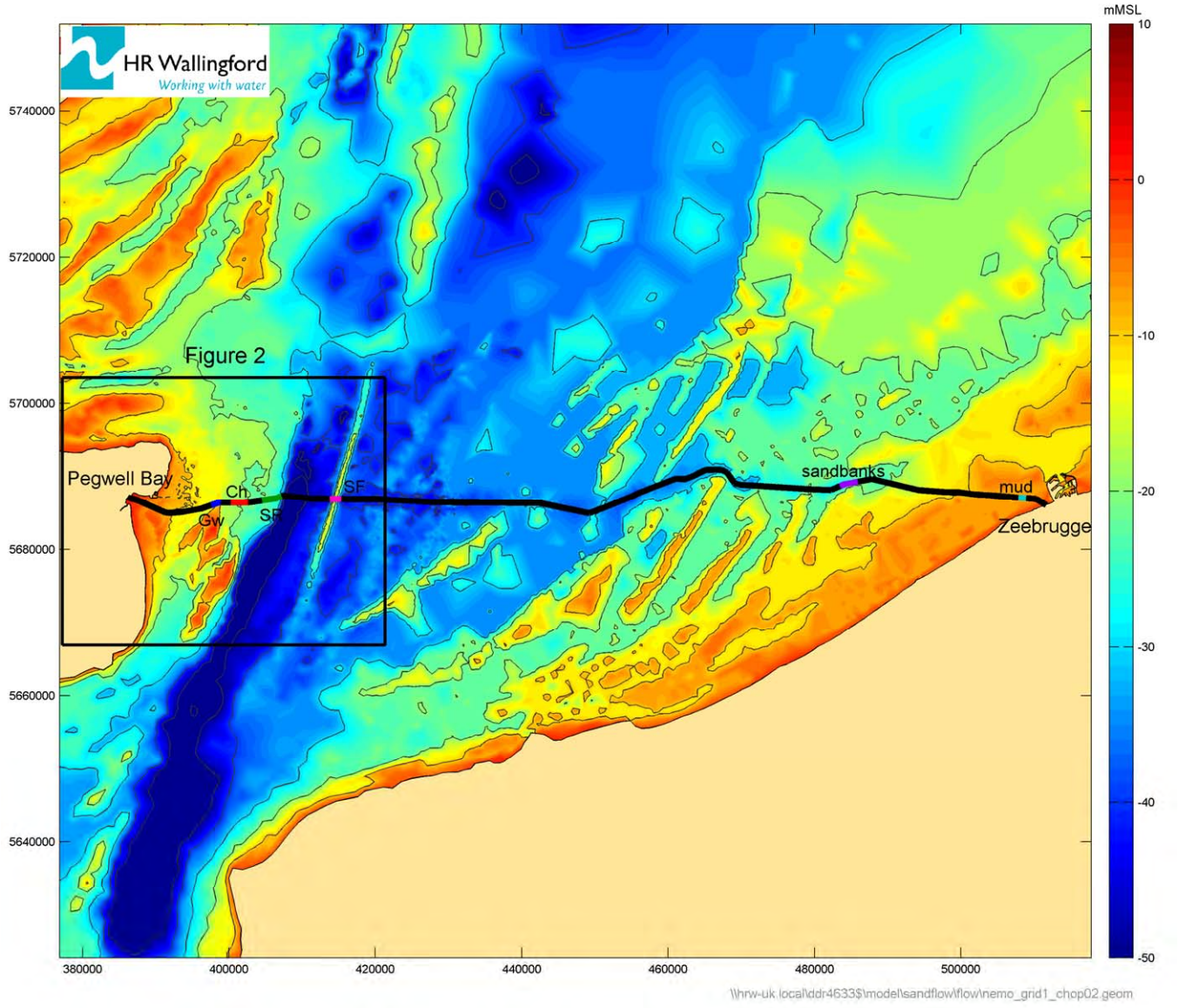


Figure 1 Location of proposed cable route and cable laying sections for which plume dispersion simulations have been undertaken

Gw: Goodwin Knoll. Ch: Chalk section. SR: Sabellaria Reef. SF: South Falls.
The area in the black rectangle is shown in more detail in Figure 2.

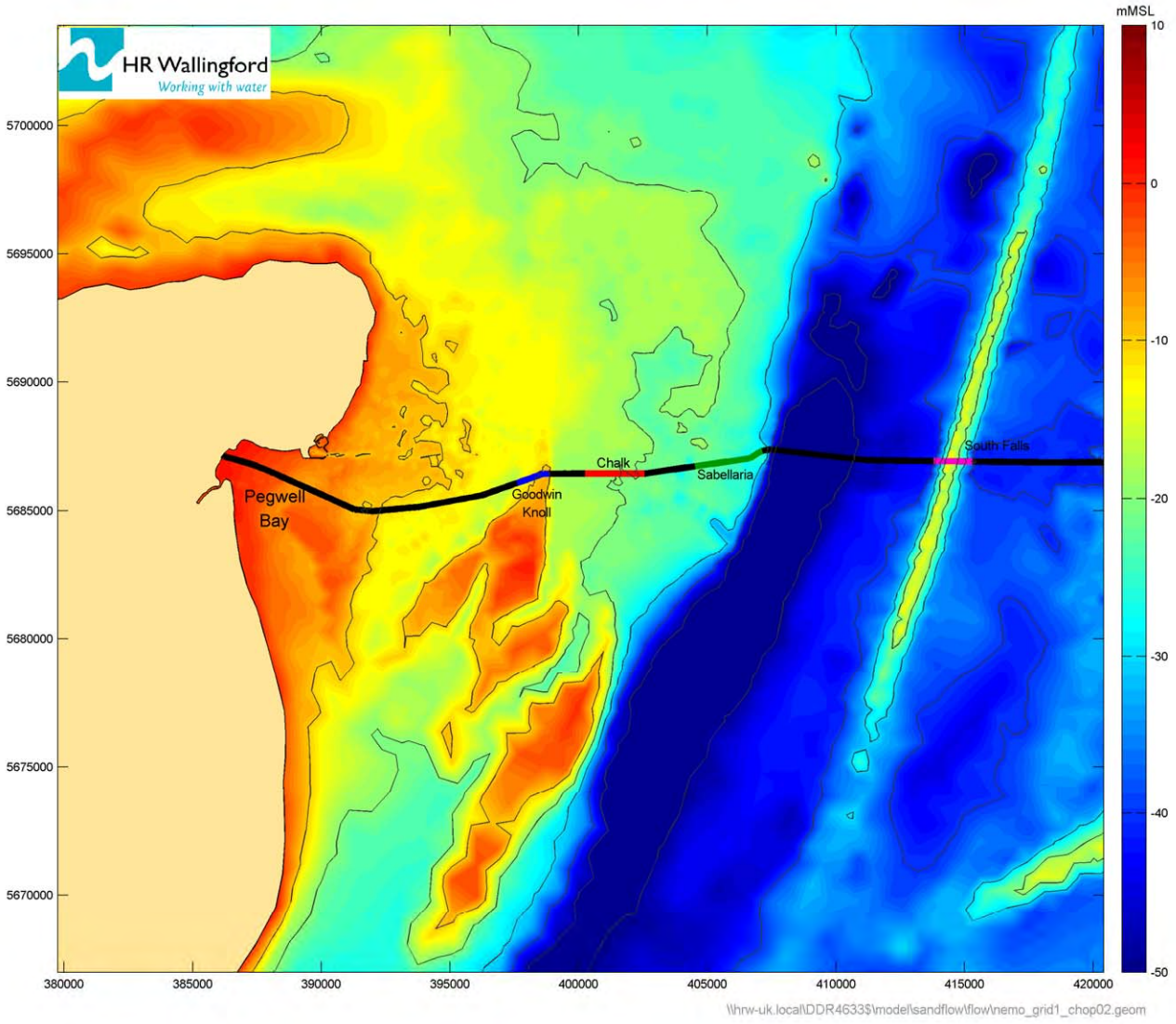


Figure 2 Location of proposed cable route in UK waters and cable laying sections for which plume dispersion simulations have been undertaken

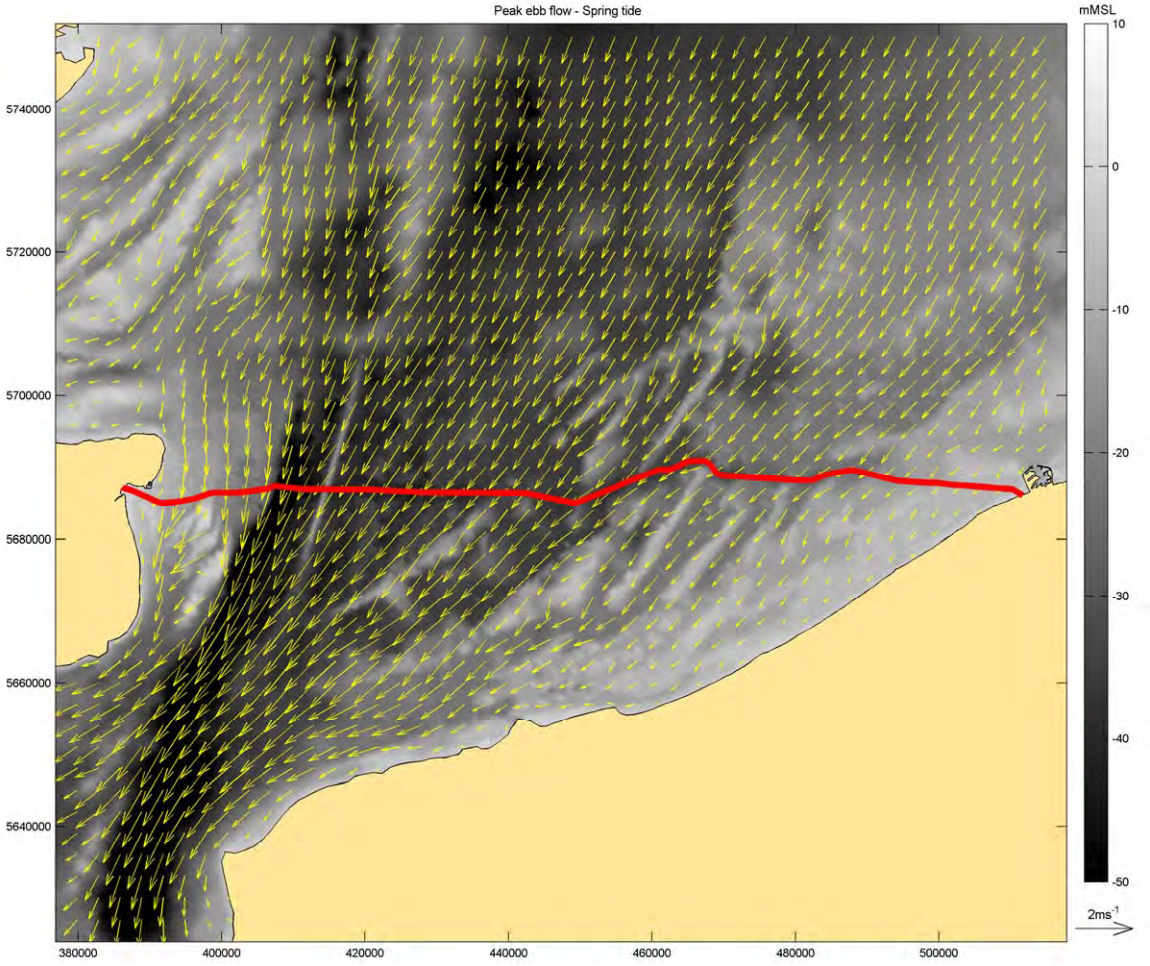


Figure 3 Peak ebb flow velocities – Spring tide

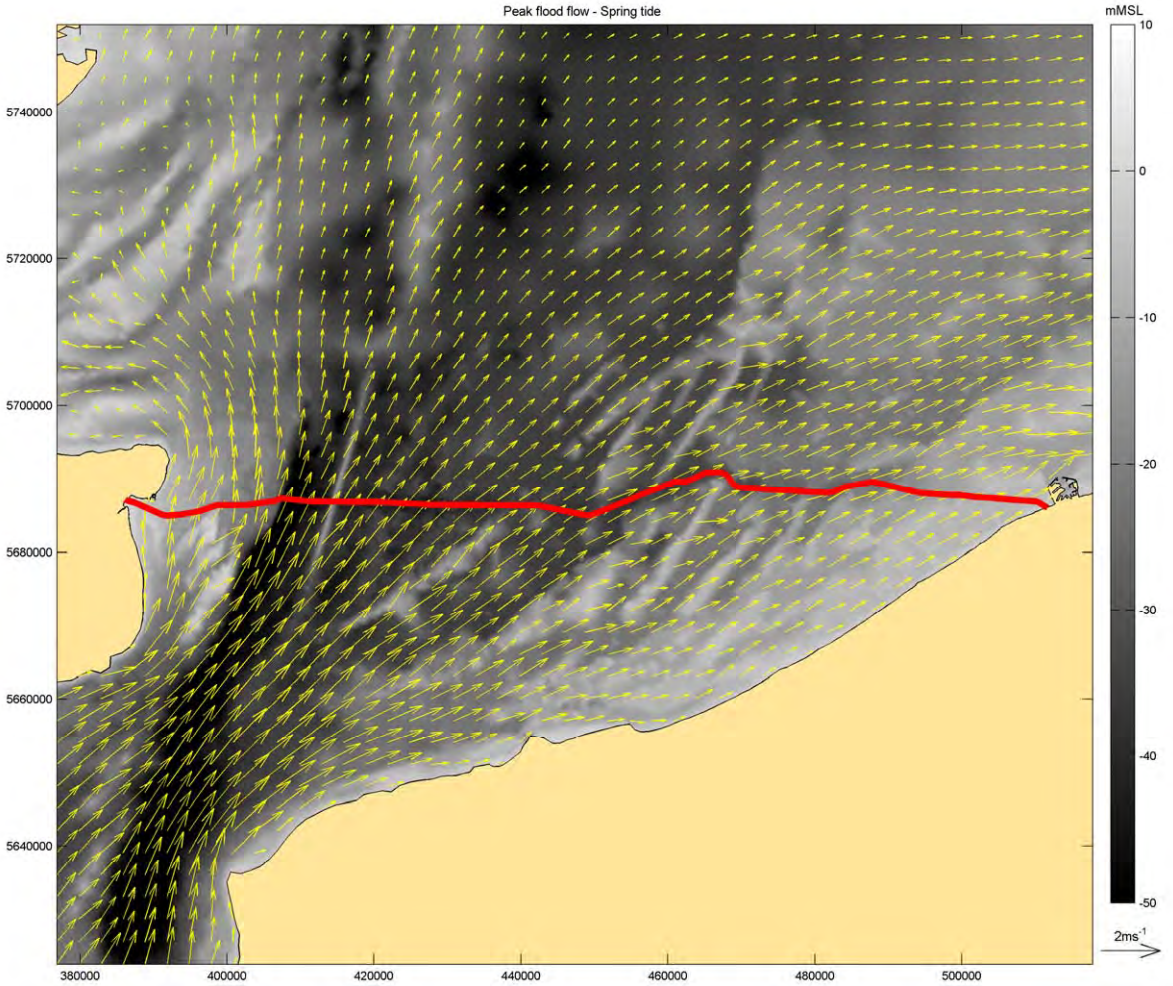


Figure 4 Peak flood flow velocities – Spring tide

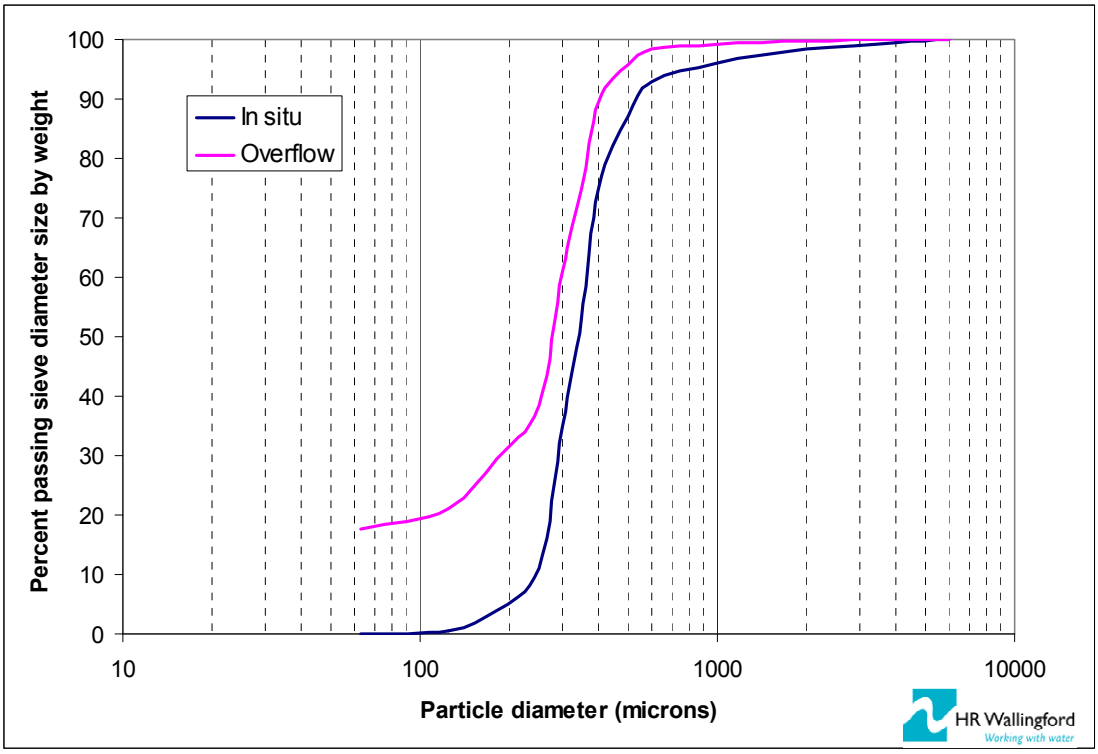


Figure 5 Overflow particle size distribution predicted by the TASS model for pre-sweeping at South Falls

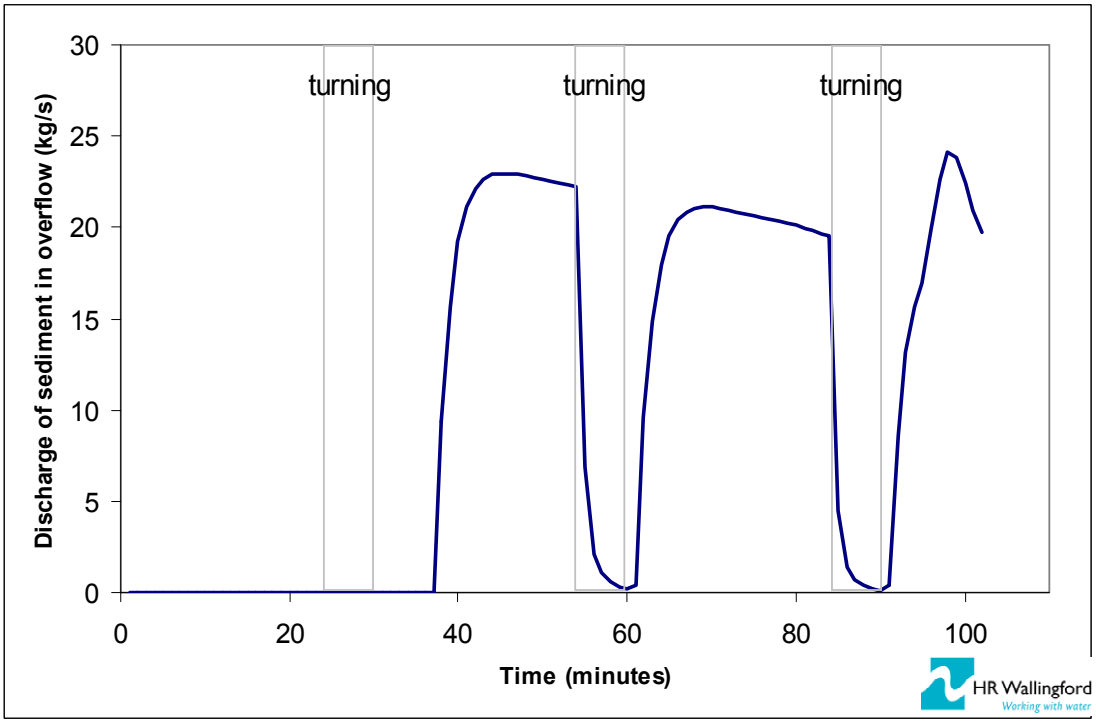


Figure 6 Overflow sediment discharge predicted by the TASS model for pre-sweeping at South Falls

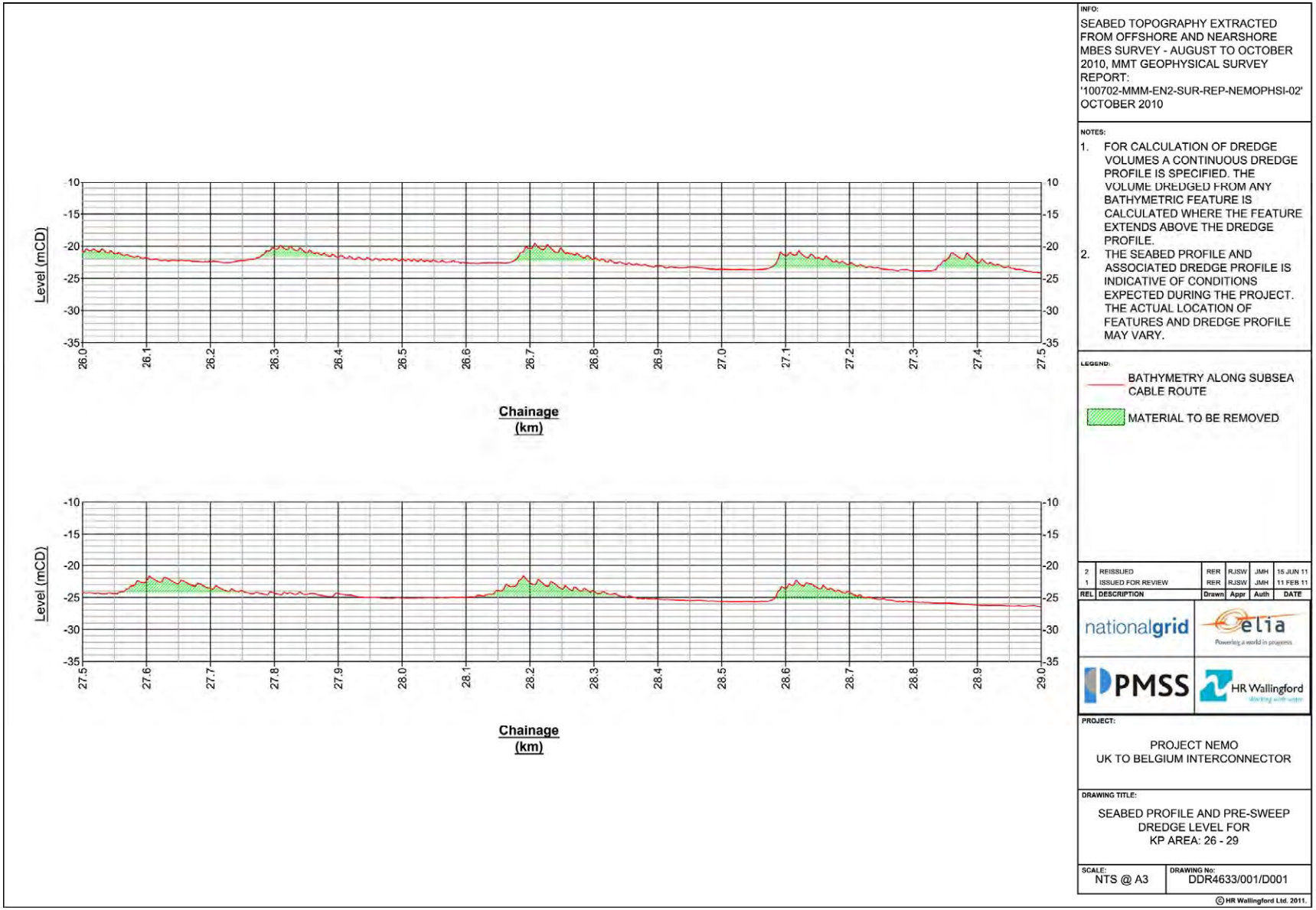


Figure 7 Seabed profile and pre-sweep dredge level for KP26 to KP29

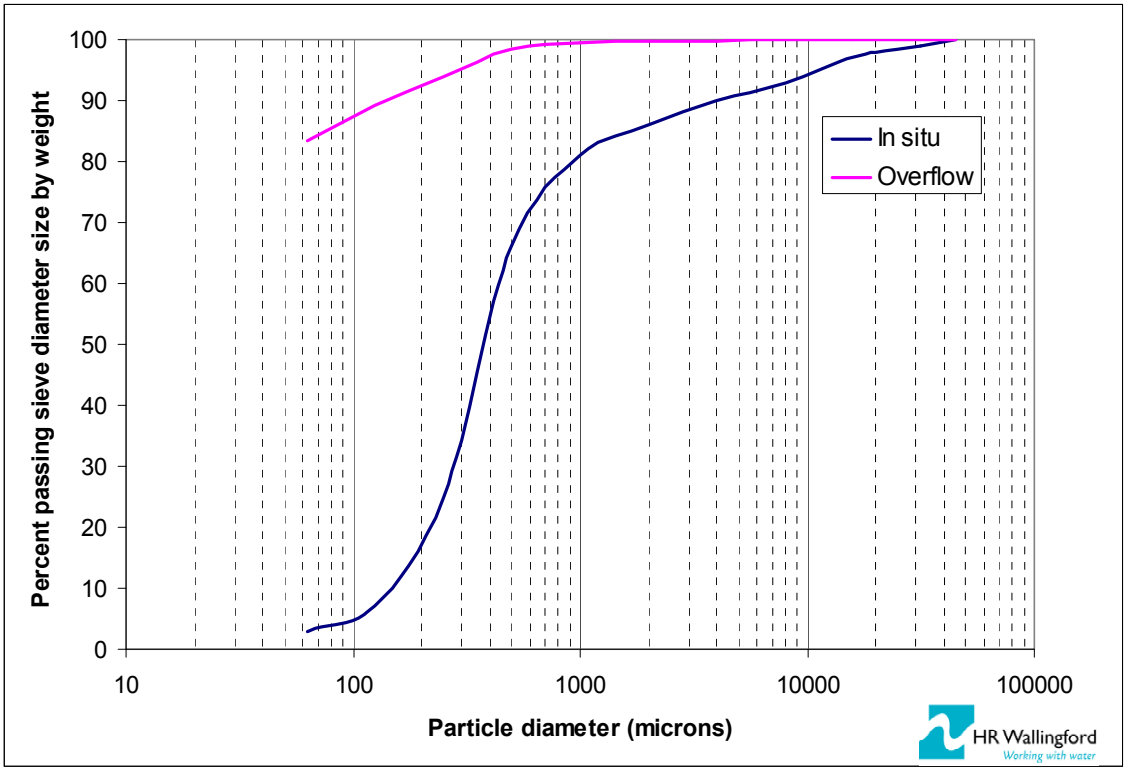


Figure 8 Overflow particle size distribution predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29

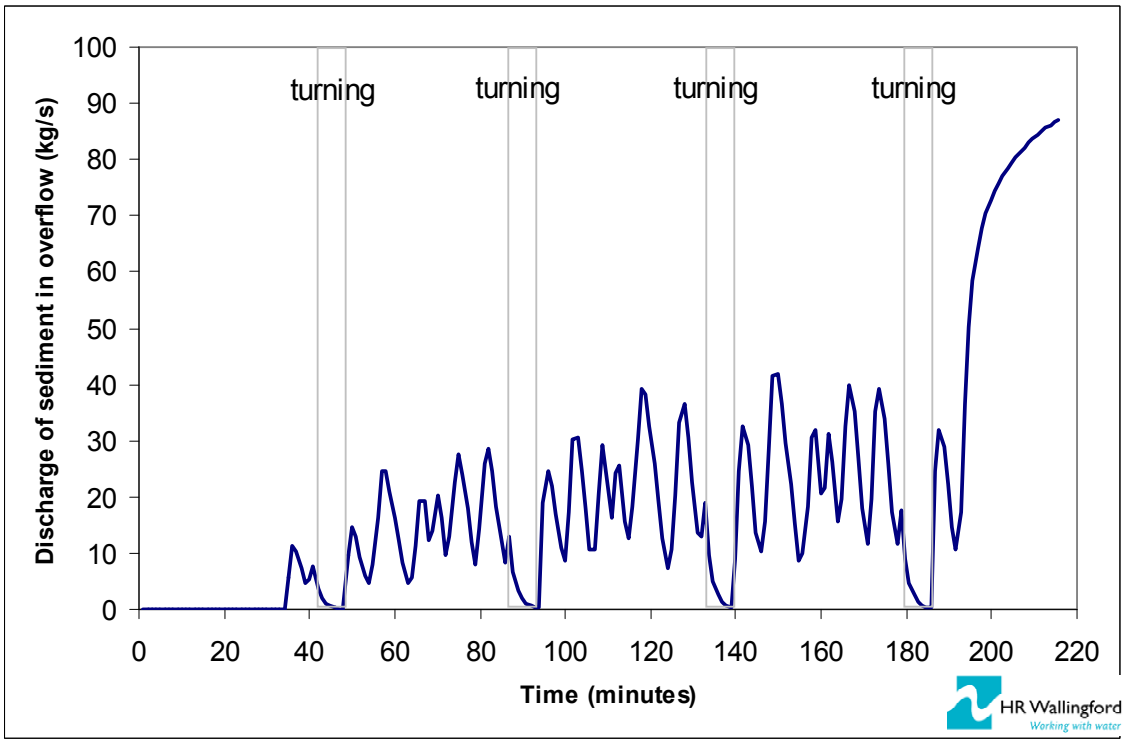


Figure 9 Overflow sediment discharge predicted by the TASS model for pre-sweeping on sandbanks in Belgian territorial waters between KP26 and KP29

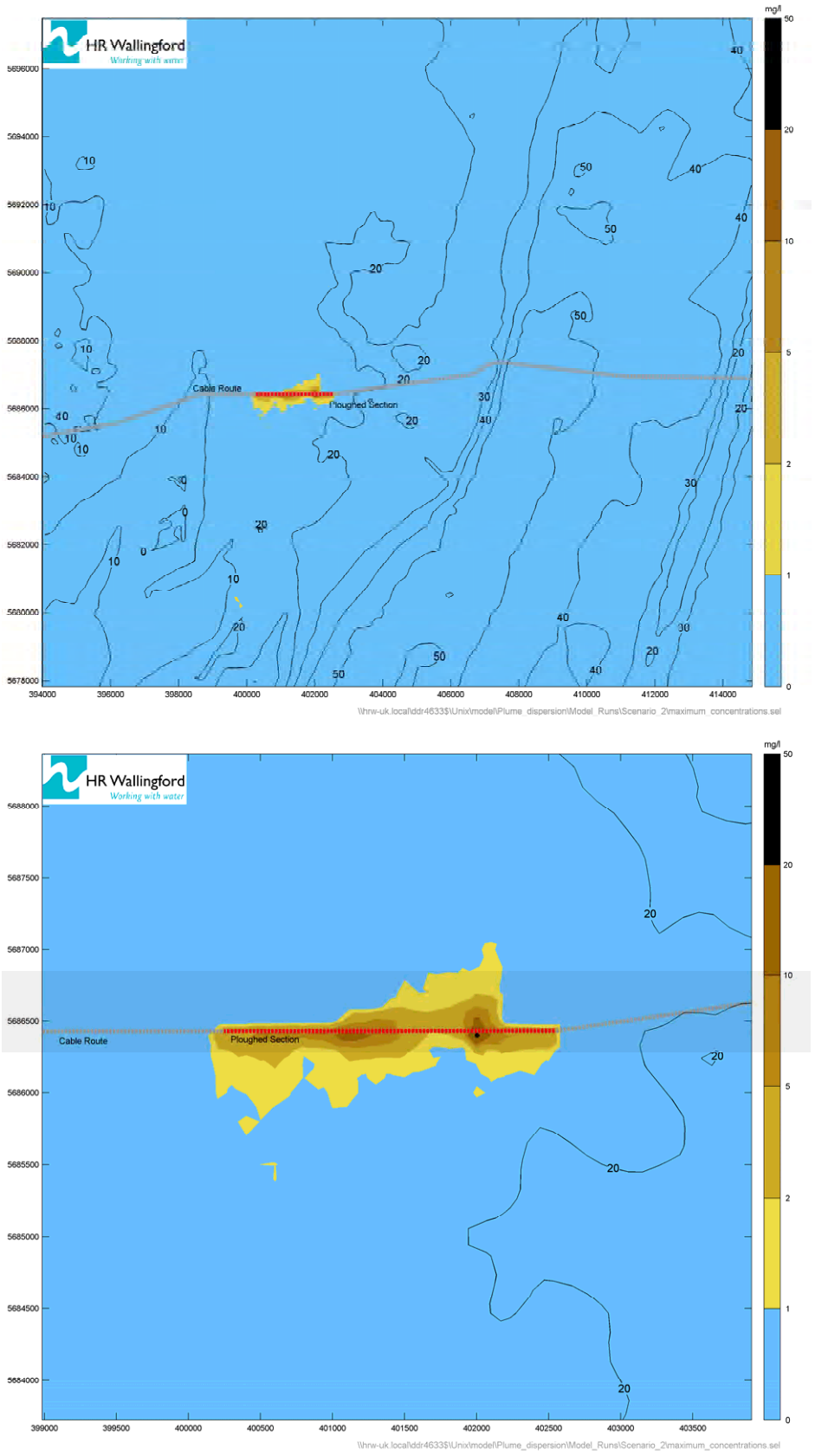


Figure 10 Predicted increase in near-bed suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)

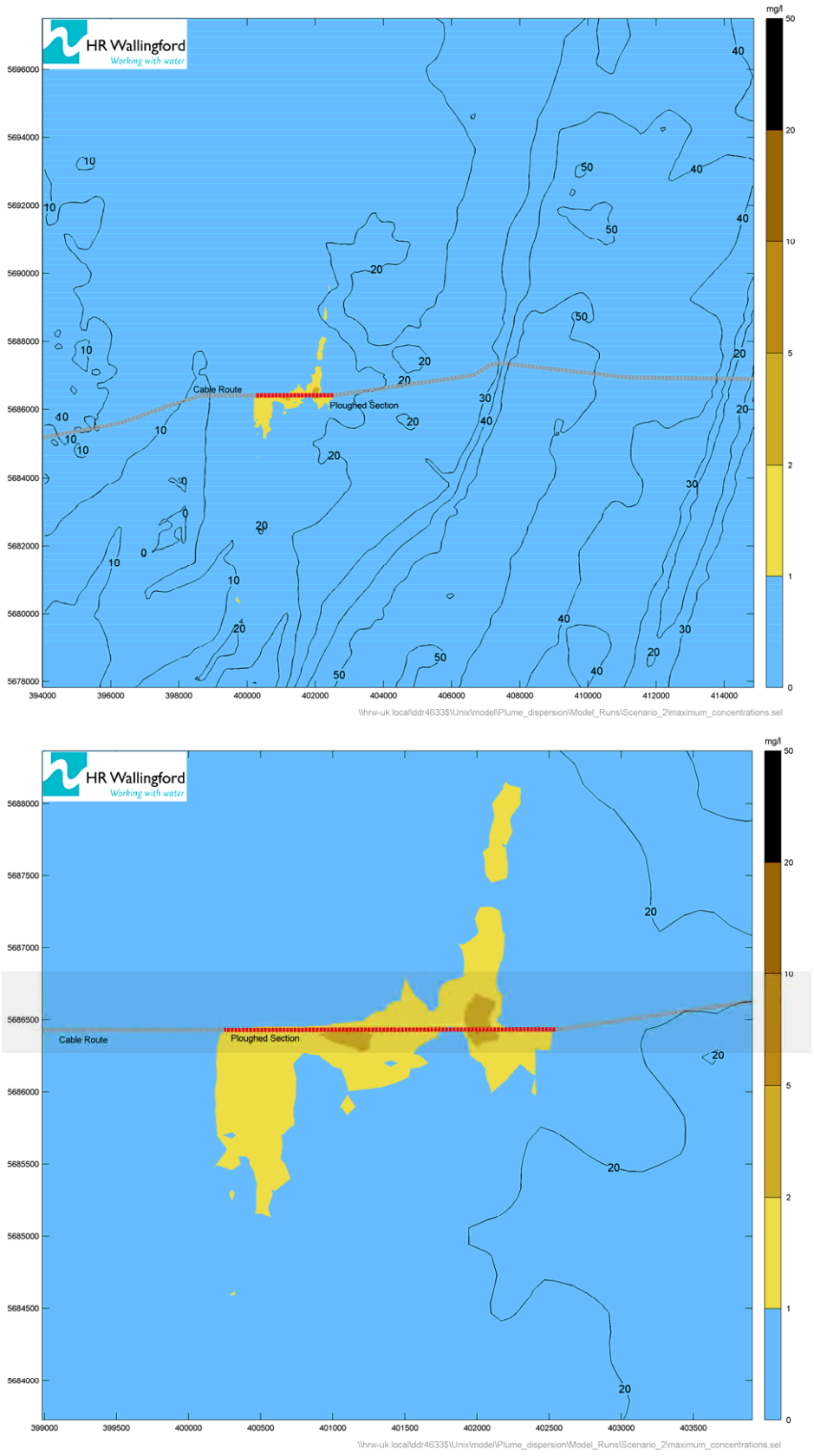


Figure 11 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 2, ploughing chalk (*Top*: Zoomed out view. *Bottom*: closer view)

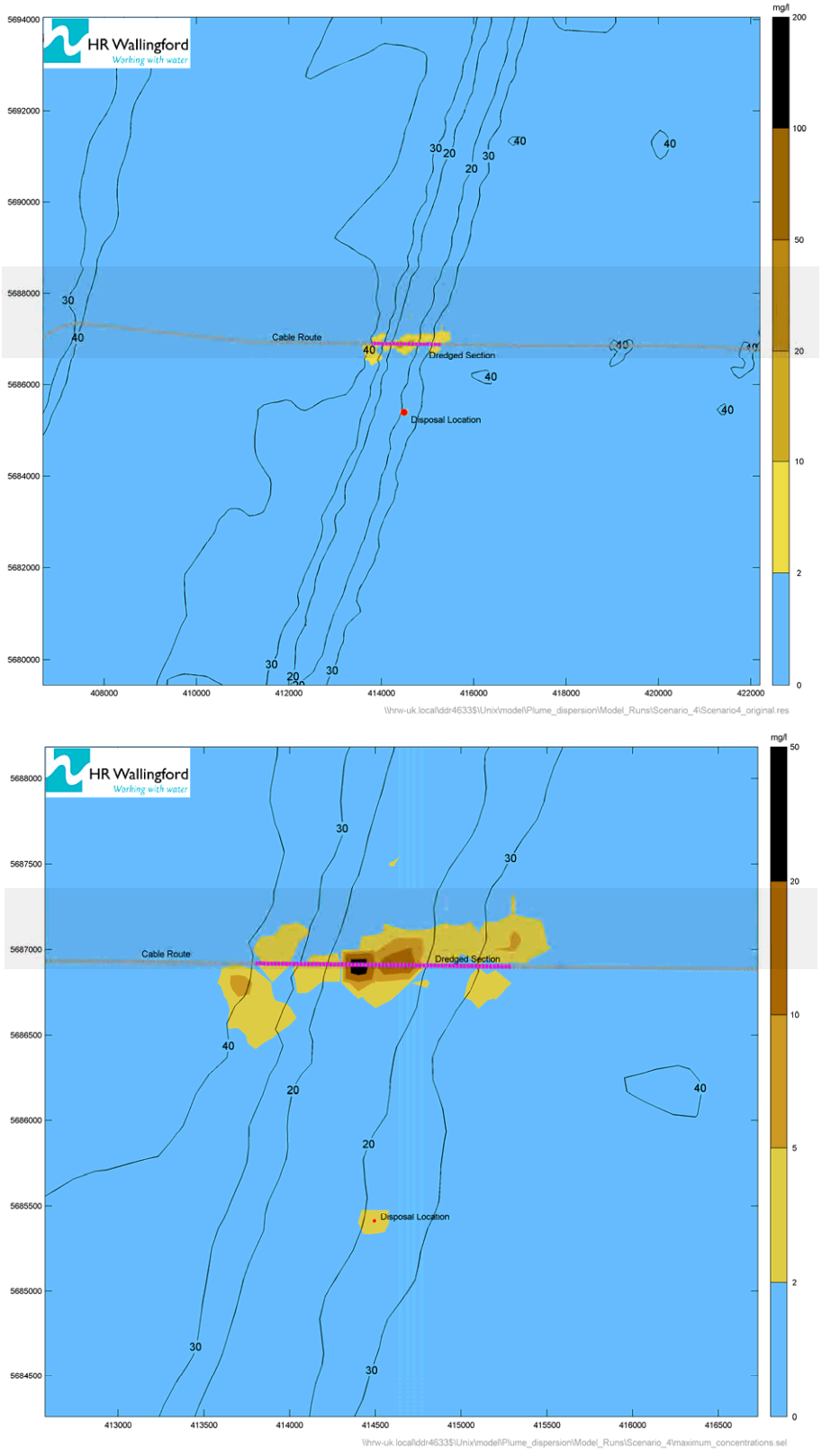


Figure 12 Predicted increase in near-bed suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)

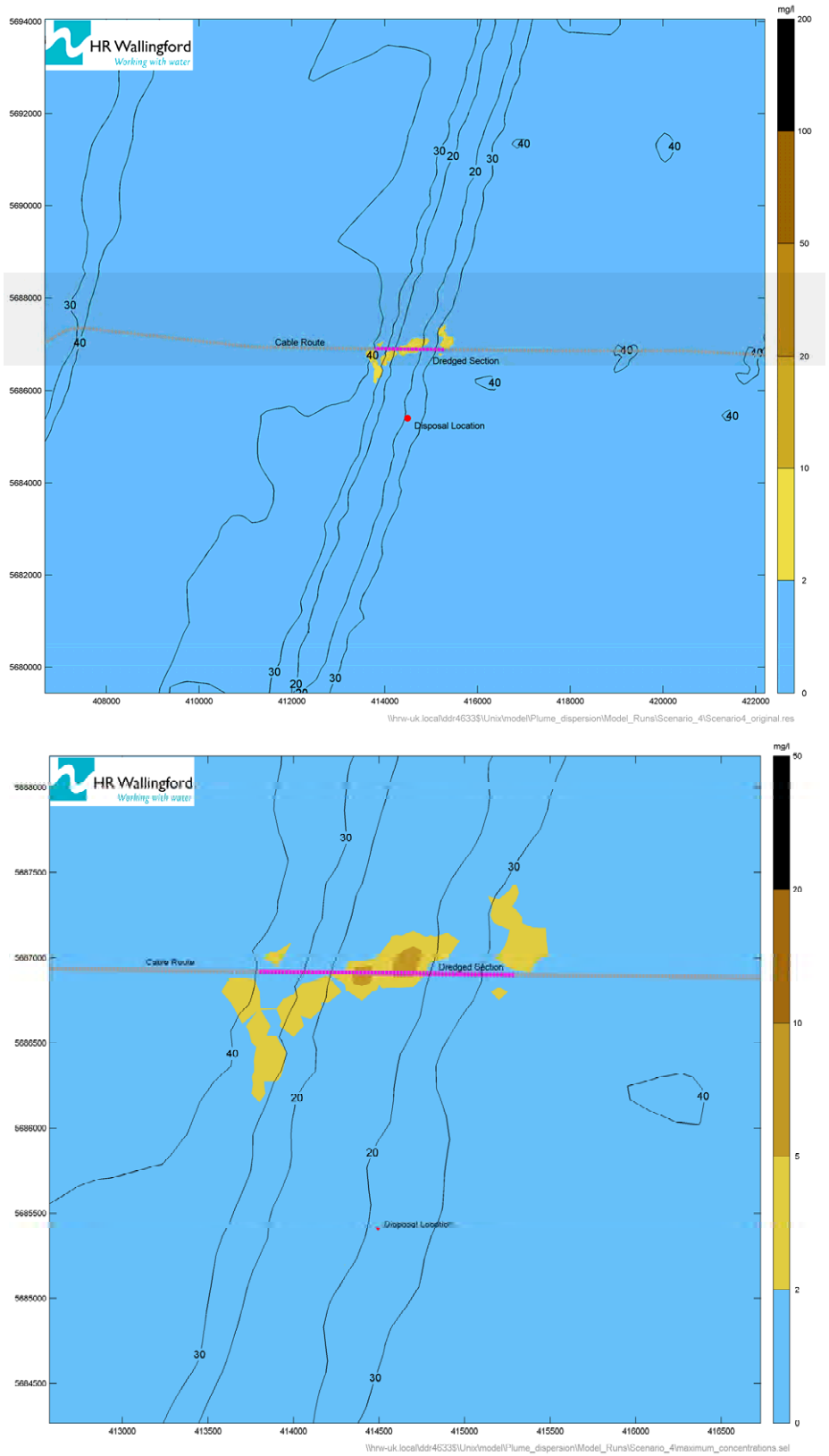


Figure 13 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 4, pre-sweep dredging at South Falls and disposal to the south (*Top*: Zoomed out view. *Bottom*: closer view)

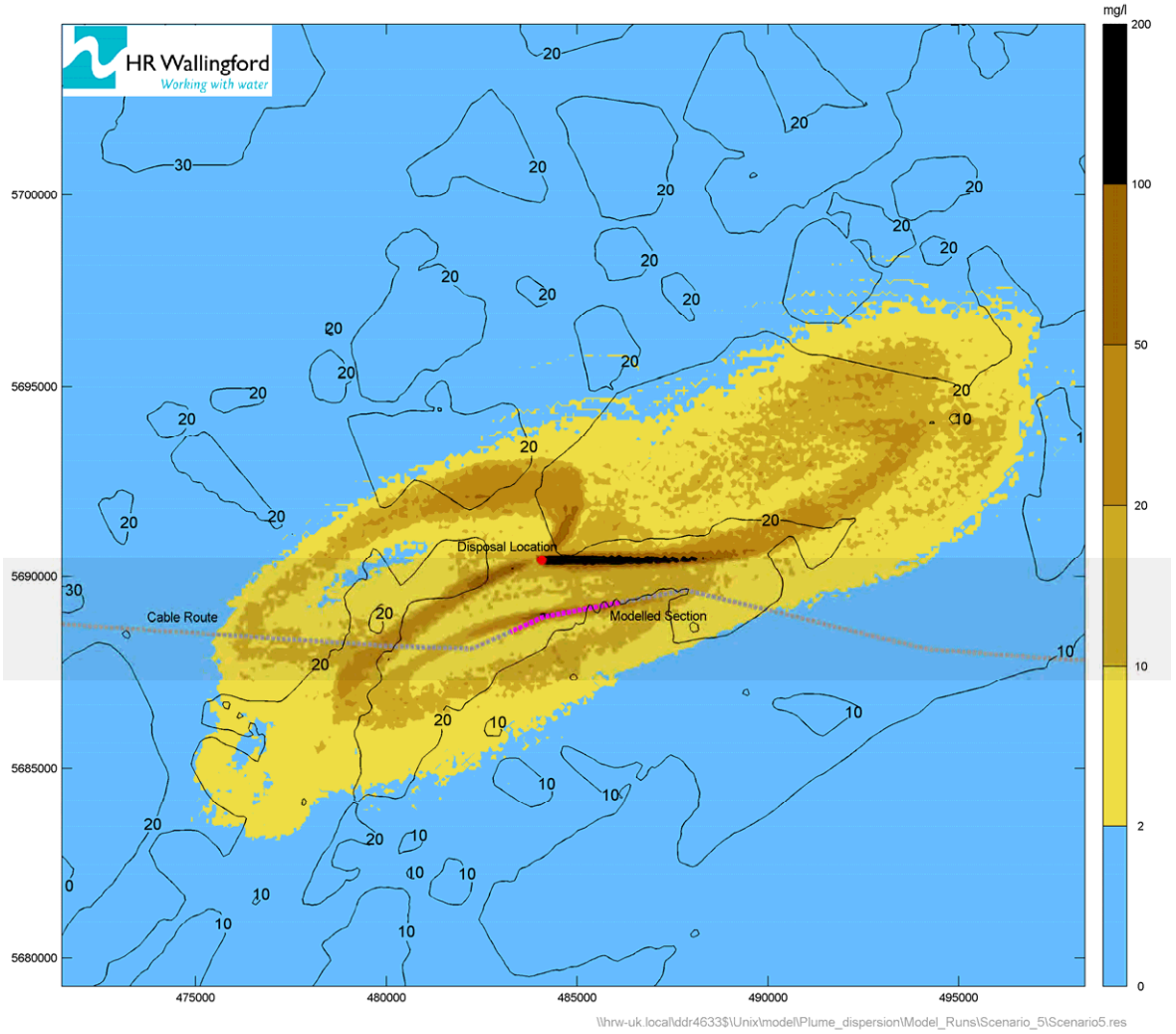


Figure 14 Predicted increase in near-bed suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north

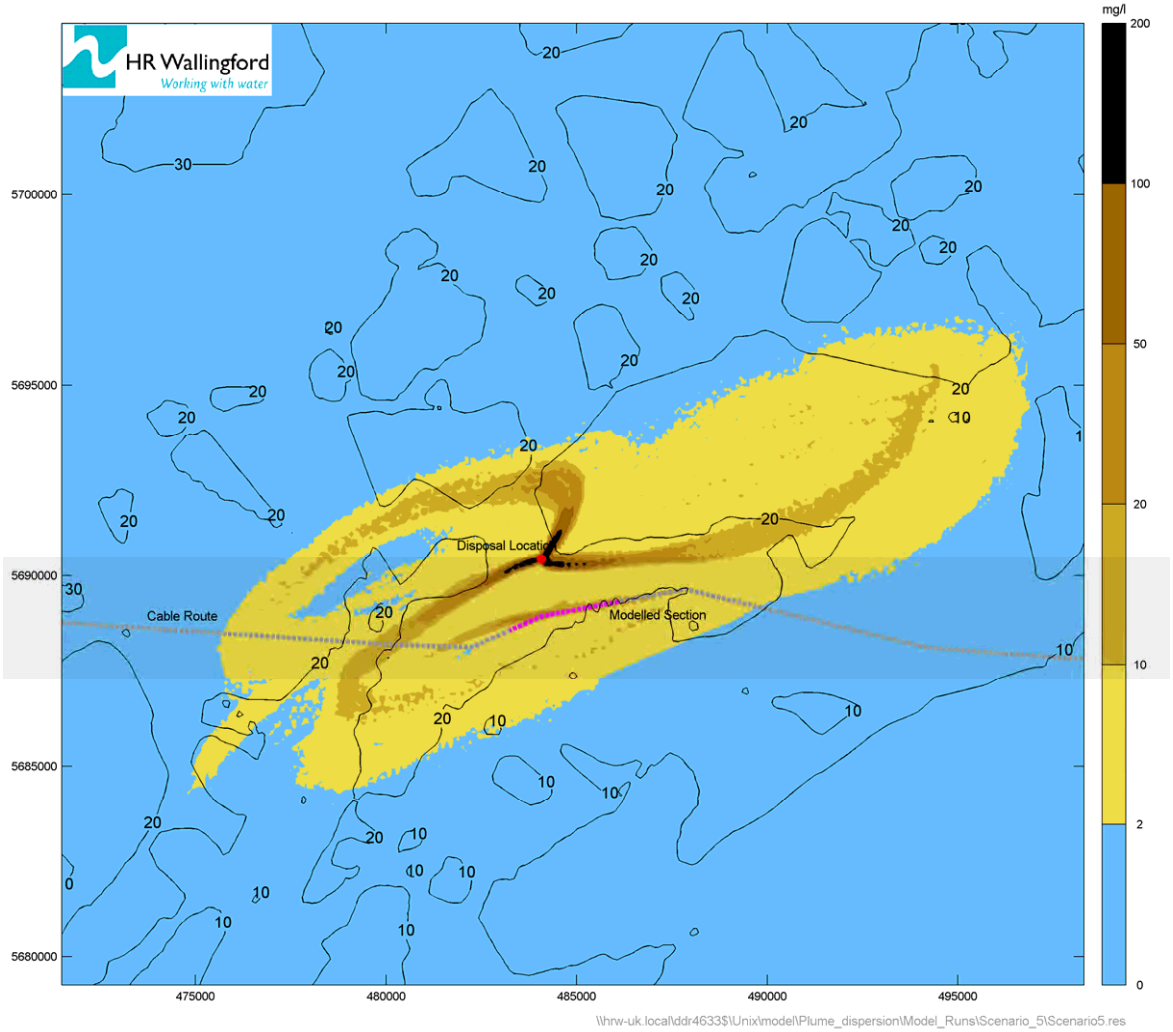


Figure 15 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 5, pre-sweep dredging of Belgian Sandbanks and disposal to the north

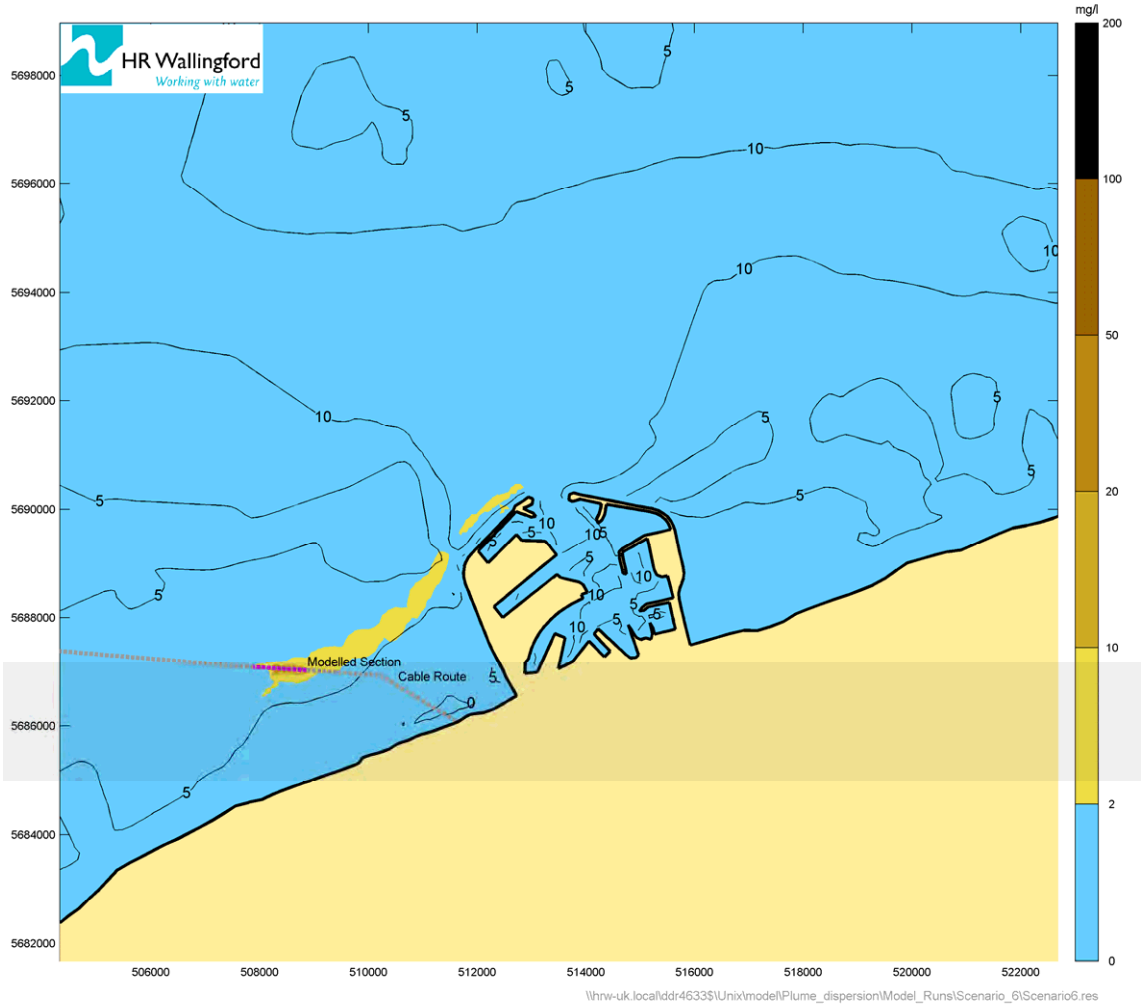


Figure 16 Predicted increase in near-bed suspended sediment concentration above background, Scenario 6, ploughing mud

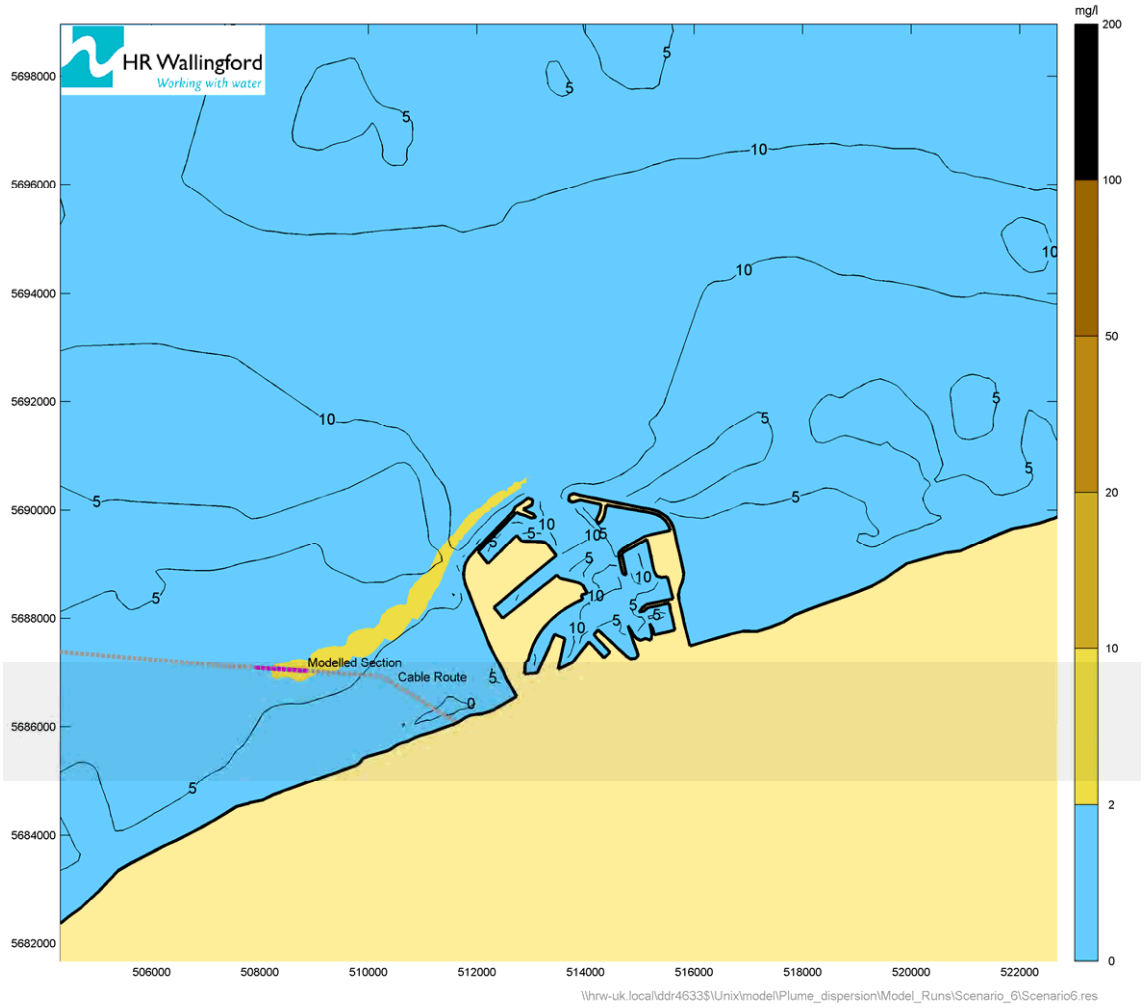


Figure 17 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 6, ploughing mud

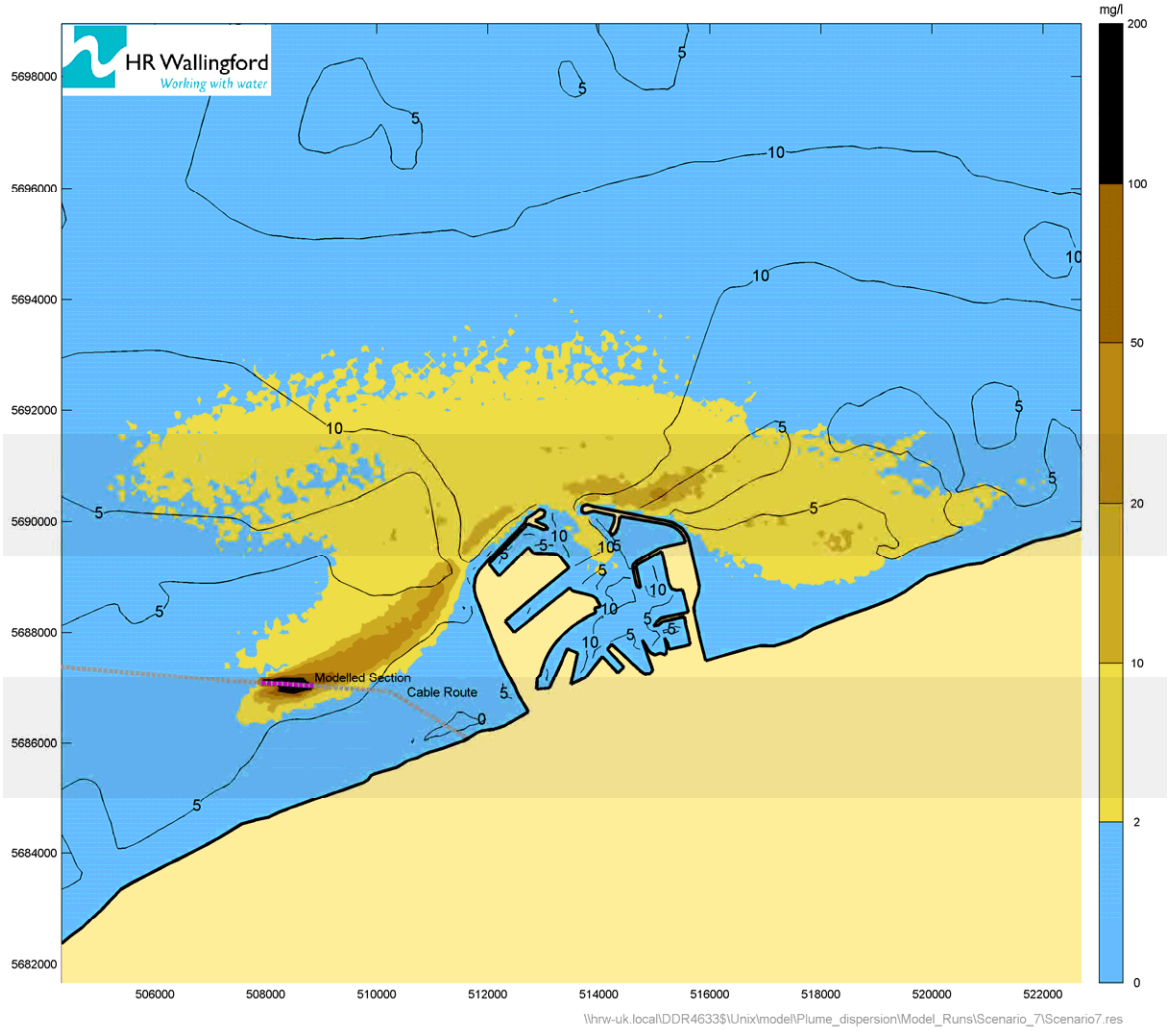


Figure 18 Predicted increase in near-bed suspended sediment concentration above background, Scenario 7, jetting mud

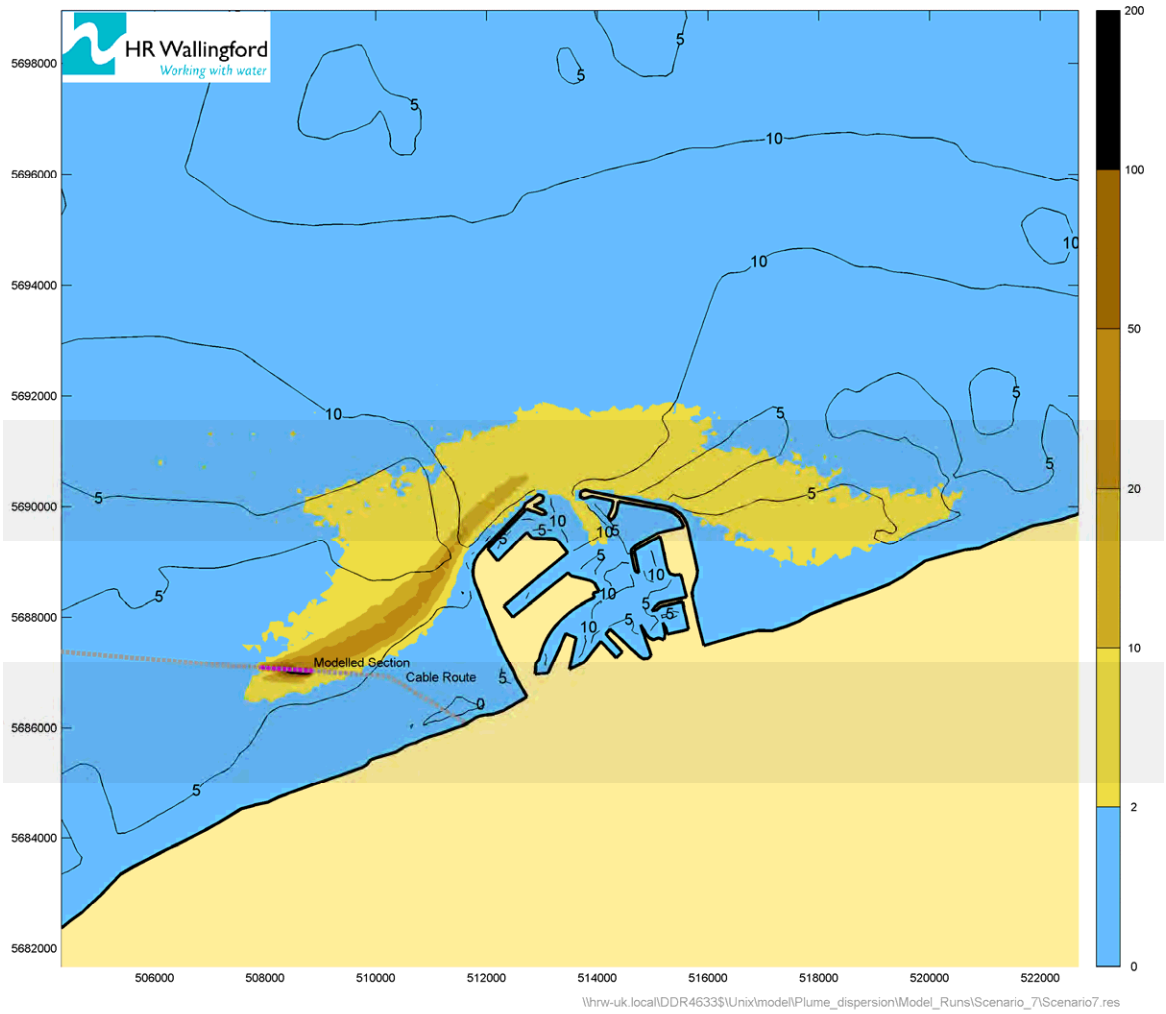


Figure 19 Predicted increase in depth-averaged suspended sediment concentration above background, Scenario 7, jetting mud

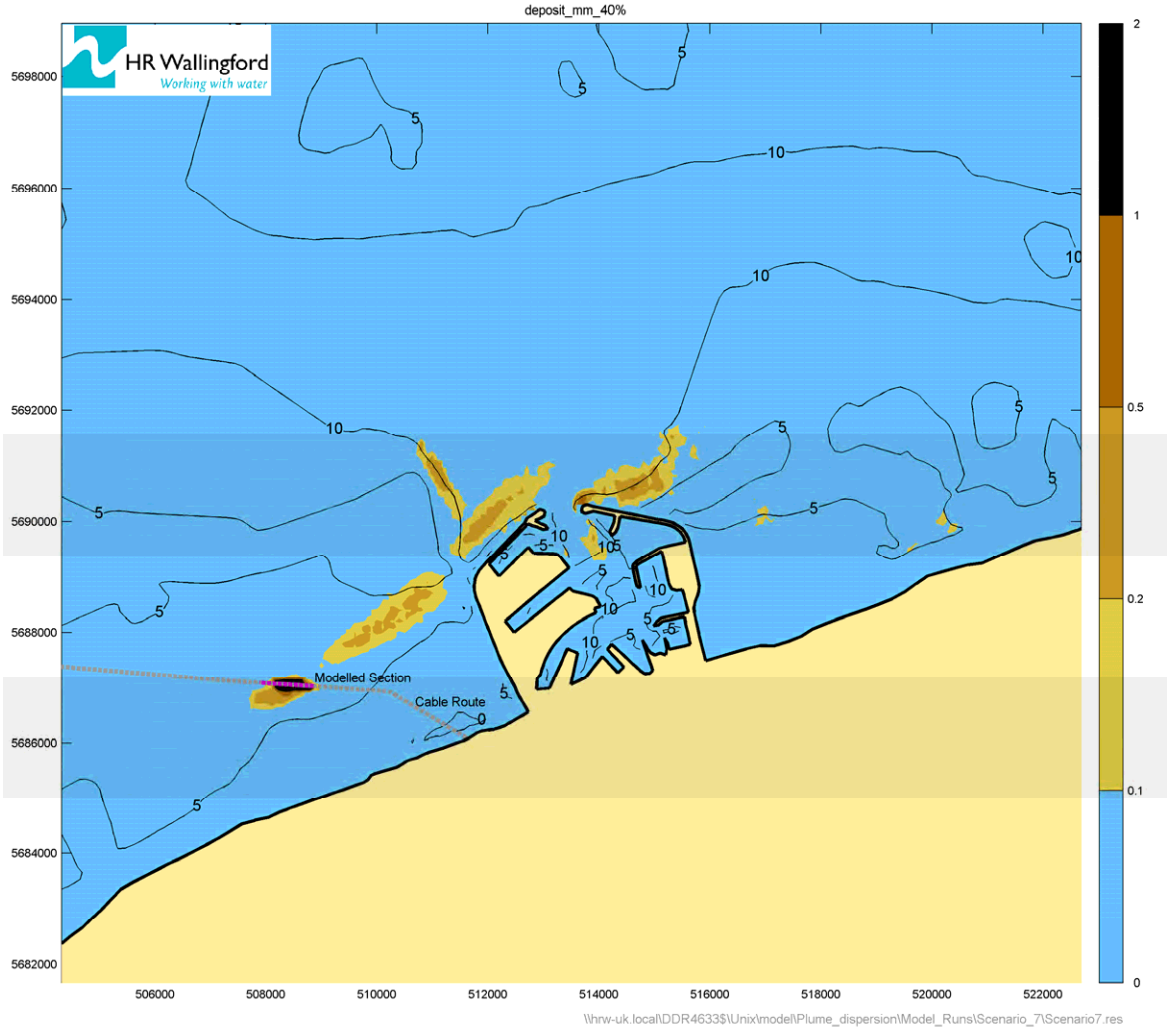


Figure 20 Predicted deposition of fine sediment arising from jetting of mud, Scenario 7

Appendices

Appendix 1 SEDPLUME-RW technical description

Flow in a coastal region consists of large-scale tidal motion, wind-driven currents and small-scale turbulent eddies. In order to model the dispersal of suspended mud in such a region, the effects of these flows on suspended mud plumes must be simulated. The random walk dispersal model, SEDPLUME, represents turbulent diffusion as random displacements from the purely advective motion described by the turbulent mean velocities computed by the depth-averaged free surface flow model, TELEMAC-2D.

Representation of mud disturbance

In SEDPLUME, the release of suspended mud in coastal waters is represented as a regular or intermittent discharge of discrete particles. Particles are released throughout a model run to simulate continuous mud disturbance or for part of the run to simulate mud disturbance over an interval during the tidal cycle, for instance to represent the resuspension of fine sediment during dredging operations. At specified sites a number of particles are released in each model time-step and, in order to simulate the release of suspended mud, the total mud released at each site during a given time interval is divided equally between the released particles. Particles can be released either at the precise coordinates of the specified sites, or distributed randomly, centred on the specified release sites. The particles can be released at the surface or evenly distributed through the water column. This allows the representation of the initial spreading of plumes of material released by a dredger, for example, but SEDPLUME results are generally fairly insensitive to the specified initial spreading radius.

Large scale advection

TELEMAC-2D simulates depth-averaged tidal flows in coastal waters. SEDPLUME converts the depth-averaged current TELEMAC-2D output into a 3D representation of tidal currents using the well-known logarithmic velocity profile:

$$U(z) = \frac{U_*}{\mathrm{K}} \ln\left(\frac{30.1z}{k_s}\right) \qquad (1)$$

where

U	=	current speed (ms^{-1})
U_*	=	friction velocity for a tidal current (ms^{-1})
K	=	von Karman's constant
z	=	distance above sea bed (m)
k_s	=	roughness length (m)

Each particle is then advected by the local flow conditions. Because the three dimensional structure of the flow is calculated by SEDPLUME, effects such as shear dispersion of plumes are automatically represented.

In the case of wind-driven currents, SEDPLUME assumes that the surface wind-driven current is parallel to the wind vector with a speed given by:

$$S = \alpha w \qquad (2)$$

where

S	=	surface wind-driven current speed (ms^{-1})
α	=	an empirical constant
w	=	wind speed at 10m above the sea surface (ms^{-1})

SEDPLUME uses this information to establish a parabolic velocity profile through depth due to wind which is superimposed upon the tidal current profile.

Turbulent diffusion

In order to simulate the effects of turbulent eddies on suspended mud plumes in coastal waters, particles in SEDPLUME are subjected to random displacements in addition to the ordered movements which represent advection by mean currents. The motion of simulated plumes is, therefore, a random walk, being the resultant of ordered and random movements. Provided the lengths of the turbulent displacements are correctly chosen, the random step procedure is analogous to the use of turbulent diffusivity in depth-averaged mud transport models. This is discussed in more detail below.

(a) Lateral diffusion

The horizontal random movement of each particle during a time-step of SEDPLUME consists of a displacement derived from the parameters of the simulation. The displacement of the particle in each of the orthogonal horizontal directions is calculated from a Gaussian distribution, with zero mean and a variance determined from the specified lateral diffusivity. The relationship between the standard deviation of the displacement, the time-step and the diffusivity is defined in Reference 1 as:

$$\frac{\Delta^2}{\Delta t} = 2D \qquad (3)$$

where
Δ = standard deviation of the turbulent lateral displacement (m)
Δt = time-step (s)
D = lateral diffusivity (m^2s^{-1}).

In a SEDPLUME simulation, a lateral diffusivity is specified, which the model reduces to a turbulent displacement using Equation (3). No directional bias is required for the turbulent movements, as the effects of shear diffusion are effectively included through the calculated depth structure in the mean current profile.

(b) Vertical diffusion

Whilst lateral movements associated with turbulent eddies are satisfactorily represented by the specification of a constant diffusivity, vertical turbulent motions can vary significantly horizontally and over the water depth, so that vertical diffusivities must be computed from the characteristics of the mean flow field, rather than specified as constants. In neutral conditions, the vertical diffusivity, K_z, is given by:

$$K_z = 0.16\, h^2 \left(1 - \frac{h}{d}\right) \frac{\partial u}{\partial z} \qquad (4)$$

where
h = height of particle above the bed
d = water depth
0.16 = (von Karman constant)^2
u = current speed
z = vertical coordinate

The value of the vertical diffusivity is calculated at each particle position, then a vertical turbulent displacement is derived for each particle from its K_z value using an equation analogous to (3) for the lateral turbulent displacement.

(c) Drift velocities

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \quad (5)$$

A particle undergoes a random walk as follows:

where x^n is the position of the particle at time t^n, A is the advection velocity at timestep $n-1$ and B is a matrix giving the diffusivity. ξ is a vector of three random numbers, each drawn from a normal distribution with unit variance and zero mean. In the case of SEDPLUME, B is diagonal, with the first two entries equal to $\sqrt{(2D)}$ (as introduced in the previous section) and the third diagonal entry being equal to the local value of $\sqrt{(2K_z)}$.

The movement of a particle undergoing a random walk as described in equation (5) can be described by the Fokker-Planck equation in the limit of a very large number of particles and a very short timestep, where we introduce subscripts i,j and k running over the three coordinate directions:

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \quad (6)$$

The probability density function $f(x,t|x_0,t_0)$ is the probability of a particle which starts at position x_0 at time t_0 being at position x at time t.

Equation (6) can be compared with the advection-diffusion equation for the concentration of a pollutant, c:

$$x^n = x^{n-1} + A(x^{n-1},t^{n-1})\Delta t + B(x^{n-1},t^{n-1})\sqrt{\Delta t}\ \xi^n \quad (7)$$

where K_{ik} is the eddy diffusion matrix, diagonal in our case but not necessarily so. Thus identifying f with c, we can see that the two equations are equivalent provided that we take the advection velocity as:

$$A_i = u_i + \frac{\partial}{\partial x_k} K_{ik} \quad (8)$$

In the case of SEDPLUME, the diffusivity varies only in the vertical and is constant in the horizontal, so the horizontal advection velocity is simply the flow velocity (assuming that the relatively small effects of changing water depth can be neglected). However, when considering the movement of particles in the vertical it is important to include the gradient of the diffusivity (often referred to as a drift velocity) in the advection step. If this term is omitted then particles tend to accumulate in regions of low diffusivity, which in our case means at the surface and at the bed.

This subject is discussed in considerably more detail in References 2, 3, 4, and 5.

Sedimentation processes

(a) Settling

In SEDPLUME, the settling velocity (w_s) of suspended mud is assumed to be related to the mud concentration (c) through an equation of the form:

$$w_s = \max(w_{\min}, Pc^Q) \quad (9)$$

where w_{min}, P and Q are empirical constants. Having computed a suspended mud concentration field, as described subsequently in this section, a settling velocity can be computed in each output grid cell from Equation (7) and used to derive a downward displacement for each particle during each time-step of a model simulation. This displacement is added vectorially to the other computed ordered and random particle displacements. Note that there is a specified minimum value of w_s. This results in settling velocities being constant at low suspended mud concentrations, as indicated by recent research at HR. (Reference 6).

(b) Deposition

SEDPLUME computes bed shear stresses from the input tidal flow fields using the rough turbulent equation, based on a bed roughness length input by the user. If the effects of storm waves on mud deposition and erosion at the sea bed are to be included in a model simulation, a bed shear stress associated with wave orbital motions, computed from the results of mathematical wave model simulations, is added to that resulting from the simulated tidal currents (Reference 7). Where the computed bed stress, τ_b, falls below a specified critical value, τ_d, and the water is sufficiently deep, then deposition is assumed to occur. Mud deposition is represented in SEDPLUME by particles approaching the sea bed becoming inactive when τ_b is below τ_d. Whilst active particles in the water column contribute to the computed suspended mud concentration field, as described subsequently in this appendix, inactive particles contribute to the mud deposit field.

In shallow areas, where tidal currents are sufficiently weak to allow mud accretion, normal wave action can prevent mud deposition. This effect is included empirically in SEDPLUME, by specifying a minimum water depth below which deposition does not occur.

(c) Erosion

The erosion of mud deposits from the sea bed is represented in SEDPLUME by inactive particles returning to the water column (becoming active) when τ_b exceeds a specified erosional shear strength, τ_e. The number of particles which become re-suspended in each cell of the output grid in each time-step of a simulation is determined by the equation:

$$\frac{\partial m_e}{\partial t} = M(\tau_b - \tau_e) \quad (10)$$

where
m_e is the mass eroded (kg)
t is time (s)
M is an empirical erosion constant.

Computation of suspended mud concentrations

In SEDPLUME-RW, suspended mud concentrations are computed on the TELEMAC-2D or TELEMAC-3D grid which can be designed to resolve the essential features of relatively small-scale plumes. In each SEDPLUME grid cell a concentration is derived by dividing the total suspended mud represented by all the active particles in that cell by the volume of the cell.

The model is most suited to simulating detailed distributions of suspended mud and mud deposits near areas of dredging-related activity over a few tidal cycles. The far-field effects of dredging-related activity can be simulated using other models in use at HR Wallingford.

References

1. H B Fischer, E J List, R C Y Koh, J Imberger and N H Brooks, 1979. Mixing in Inland and Coastal Waters. New York : Academic. 483 pp.
2. A S Monin and A M Yaglom. "Statistical Fluid Mechanics". MIT Press, Cambridge, Massachusetts, 1971.
3. A F B Tompson and L W Gelhar. "Numerical simulation of solute transport in three-dimensional randomly heterogeneous porous media". Water Resources Research, Vol 26 pp2541-2562, October 1990.
4. K N Dimou and E E Adams. "A random-walk particle tracking model for well-mixed estuaries and coastal waters". Estuarine, Coastal and Shelf Science, Vol 37, pp99-110, 1993.
5. B J Legg and M R Raupach. "Markov-chain simulation of particle dispersion in inhomogeneous flows: the mean drift velocity induced in a gradient in Eulerian velocity variance". Boundary Layer Meteorology Vol 24, pp3-13, 1982.
6. HR Wallingford. Port and Airport Development Strategy - Enhancement of the WAHMO Mathematical Models. Calibration of the North West New Territories Coastal Waters Mud Transport Model for Normal Wet and Dry Season Conditions. Report EX 2266, January 1991.
7. HR Wallingford. Port and Airport Development Strategy - Enhancement of the WAHMO Mathematical Models. Testing of the North West New Territories Coastal Waters Mud Transport Model for Storm Wave Conditions in the Wet Season. Report EX 2267, January 1991.

Project Nemo – UK to Belgium Interconnector

Modelling of Trench Infill Rates

Technical Note DDR4633-04

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Contents

1. Introduction 1

2. Trench infill calculations using SEDFLUX 1

3. Trench infill assumptions. 2

4. Results 2
   4.1 Discussion 3
   4.2 Conclusion 4

5. References 4

Figures

Figure 1 Assumed trench profile 2
Figure 2 Infill rates at 20 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm) 2
Figure 3 Infill rates at 40 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm) 3
Figure 4 Infill rates at 60 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm) 3

1. Introduction

An assessment of the potential trench infill associated with offshore cable laying operations as part of Project Nemo was made using HR Wallingford's standard trench infill model based on SEDFLUX using bathymetric and hydrodynamic information representative for the cable route. This approach gives estimates of the amount of sediment depositing in the open trench due to suspended and bedload transport.

2. Trench infill calculations using SEDFLUX

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.

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
- 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 uniform 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 we calculate the transport rates at a location far away from the trench with the transport rates on the slopes of the channel. The differences in the transport then determine the infill rate of the channel.

This approach has been validated against data from a field experiment near Scheveningen, the Netherlands by Svasek (1965), also in Ribberink *et al*. (2005), where a wide pit was dredged at a location with an 8 m water depth and the morphological change was measured.

3. Trench infill assumptions.

For the calculations, it is assumed that an almost 2m deep trench is created and the resulting spoil is dumped in berms on either side of the trench (Figure 1).

The sediment transport calculations undertaken using SEDFLUX are done for a number of combinations, based on the bathymetry of the cable route and the local flow conditions:

1. 0.75m/s tidal velocity over a 20 m deep location
2. 1.1m/s tidal velocity over a 40 m deep location
3. 1.5m/s tidal velocity over a 60 m deep location

For all locations a 0.1m/s residual current is assumed and waves are varied with heights of 0.5 m, 1 m and 2 m. The median sediment grain sizes are varied between 0.2 mm and 0.5 mm at all locations. The infill calculations assume sediment is available on the seabed to be transported into the trench.

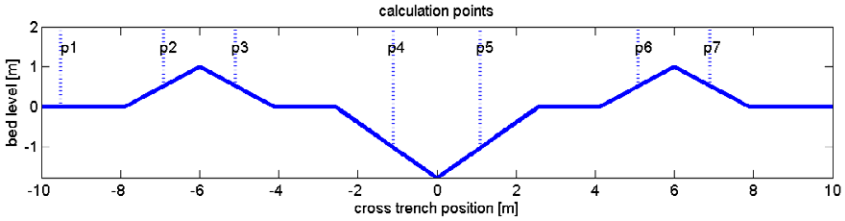


Figure 1 Assumed trench profile

4. Results

Infill rates are calculated in kg/day and in m^3/day per metre run of trench. The results are shown in Figures 2 to 4.

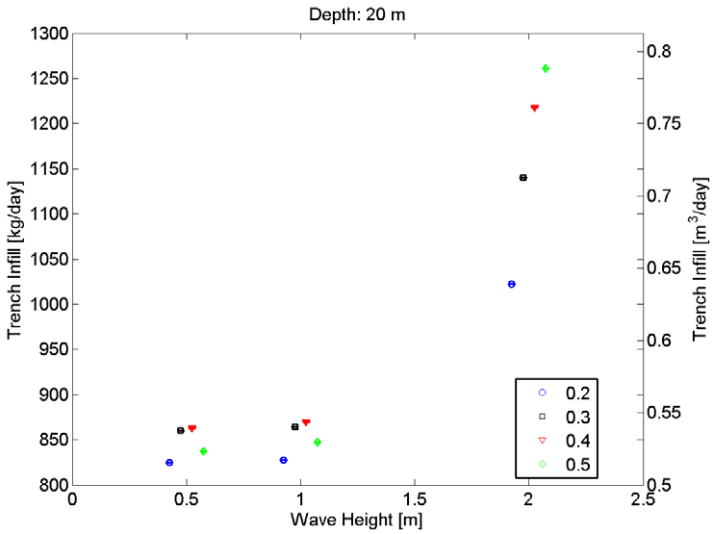


Figure 2 Infill rates at 20 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

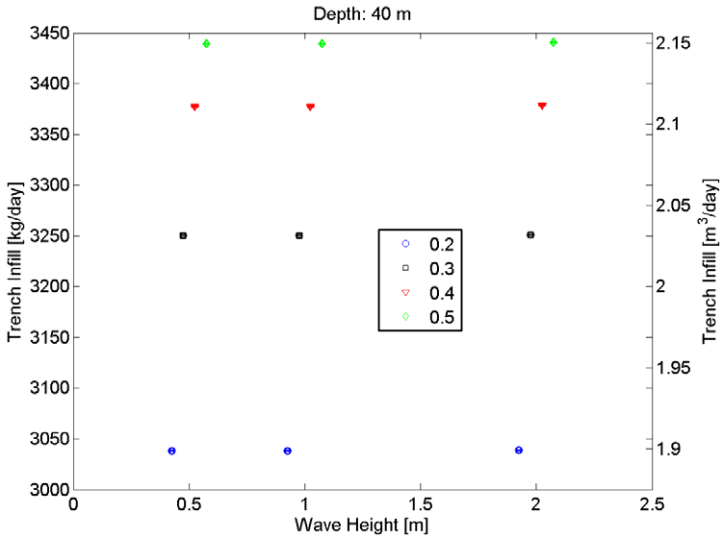


Figure 3 Infill rates at 40 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

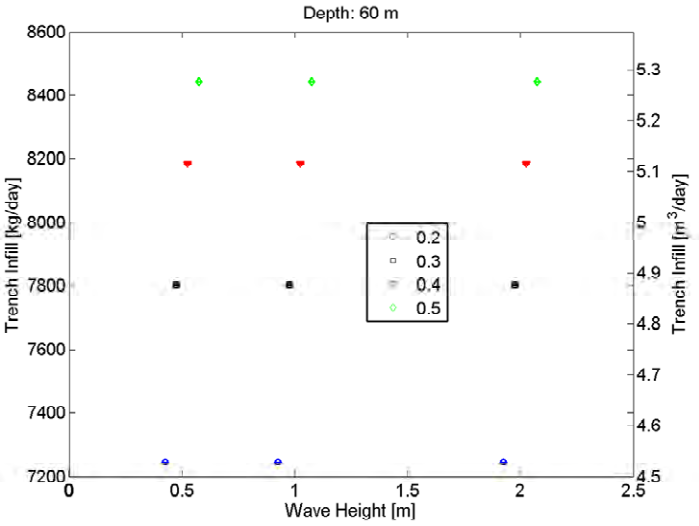


Figure 4 Infill rates at 60 m water depth, for a range of sediment sizes (the symbols represent sediment in the range from 0.2 mm to 0.5 mm)

4.1 DISCUSSION

The SEDFLUX calculations give the initial trench infill rates. These values are only valid whilst the slopes and depths at the reference points remain unaltered. As long as the cumulative infill is less than 10-20 % 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 because the effect of the trench depth on the local flow and transport will be reduced.

This implies that for some of the cases considered here, the initial estimates are no longer valid after the first day. Therefore, the infill rates, and in particular the higher valued ones, should only be considered as indications of the initial rate of infill and cannot be extrapolated to estimate the time it takes for the trench to fill completely.

4.2 CONCLUSION

For all conditions the infill rates are sufficiently high in areas of mobile sand to result in the trenches being filled within a period of few weeks. The higher depth-averaged tidal velocities in the deeper water depths result in higher infill rates in those areas. At those locations where sediment is not readily available to be transported on the seabed the rates of infill will be lower than predicted.

5. References

Ribberink, J.S., Roos, P.C. & Hulscher, S.J.M.H. (2005). Morphodynamics of trenches and pits under the influence of currents and waves - Simple engineering formulas. In: *Coastal Dynamics Conference*. ASCE Publications.

Svasek, J.N. (1965). *Behaviour of a trial dredged trench in the sea bed of the North Sea near Scheveningen*. The Hague: Rijkswaterstaat, the Netherlands.

van Rijn, L.C. (1993). *Principles of Sediment Transport in Rivers, Estuaries and Coastal Seas*. Aqua Publications, Amsterdam.

Project Nemo – UK to Belgium Interconnector

Pre-Sweep Dredging of Sandwaves

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Contents

1. Introduction 1

2. Identification of pre-sweep areas 1

3. Calculation of pre-sweep dredge volumes 5

4. Use of results 6

5. References 7

Tables
Table 1 Locations and quantity of sediments to be dredged from each location 6

Figures
Figure 1 Bathymetry and dredge locations along the cable route 3
Figure 2 Example of pre-sweep profile through sandwaves 5

Appendix 1
Pre-sweep long profiles

1. Introduction

Project Nemo concerns the installation of an HVDC interconnector between UK and Belgium. Along sections of the cable route pre-sweeping of mobile sandwaves has been identified as a requirement (PMSS, 2010). This is required to facilitate the subsequent burial of the cable to the required depth of installation to reduce the risk of cable exposure from sandwave migration.

This report documents the estimated pre-sweep dredging volumes of sand required as input to the environmental assessment.

2. Identification of pre-sweep areas

The operations report (PMSS, 2010) identified the requirement for pre-sweep dredging of areas of sandwaves along the pipeline route. It is expected this dredging will be performed by a suitable Trailing Suction Hopper Dredger (TSHD).

The geophysical survey in 2010 (MMT, 2010) mapped out the seabed profile in a 500 m wide corridor along the proposed route. Some slight alterations in the course were implemented by PMSS resulting from analysis of this survey. The pre-sweep calculations were based on this survey. The locations have been summarised on Figure 1. Only the crests of sandwaves will be removed, so the locations shown in Figure 1 contain many smaller areas, rather than being contiguous dredging.

Two types of requirement for dredging were identified:

Firstly, to facilitate the subsequent burial of the cable in sand to the required depth of installation, thereby reducing the likelihood of cable exposure due to sandwave migration. The functional description for this requirement has been defined as “Protect cable from sandwave mobility”.

Secondly, removal of significant veneer of sand material overlying bedrock (chalk or clay), thereby facilitating the installation in the underlying material. The functional description for this requirement has been defined as “Allow effective installation”.

The route workshop held by PMSS and HR Wallingford on 1 November 2010 confirmed the locations for pre-sweeping on the basis of these two requirements.

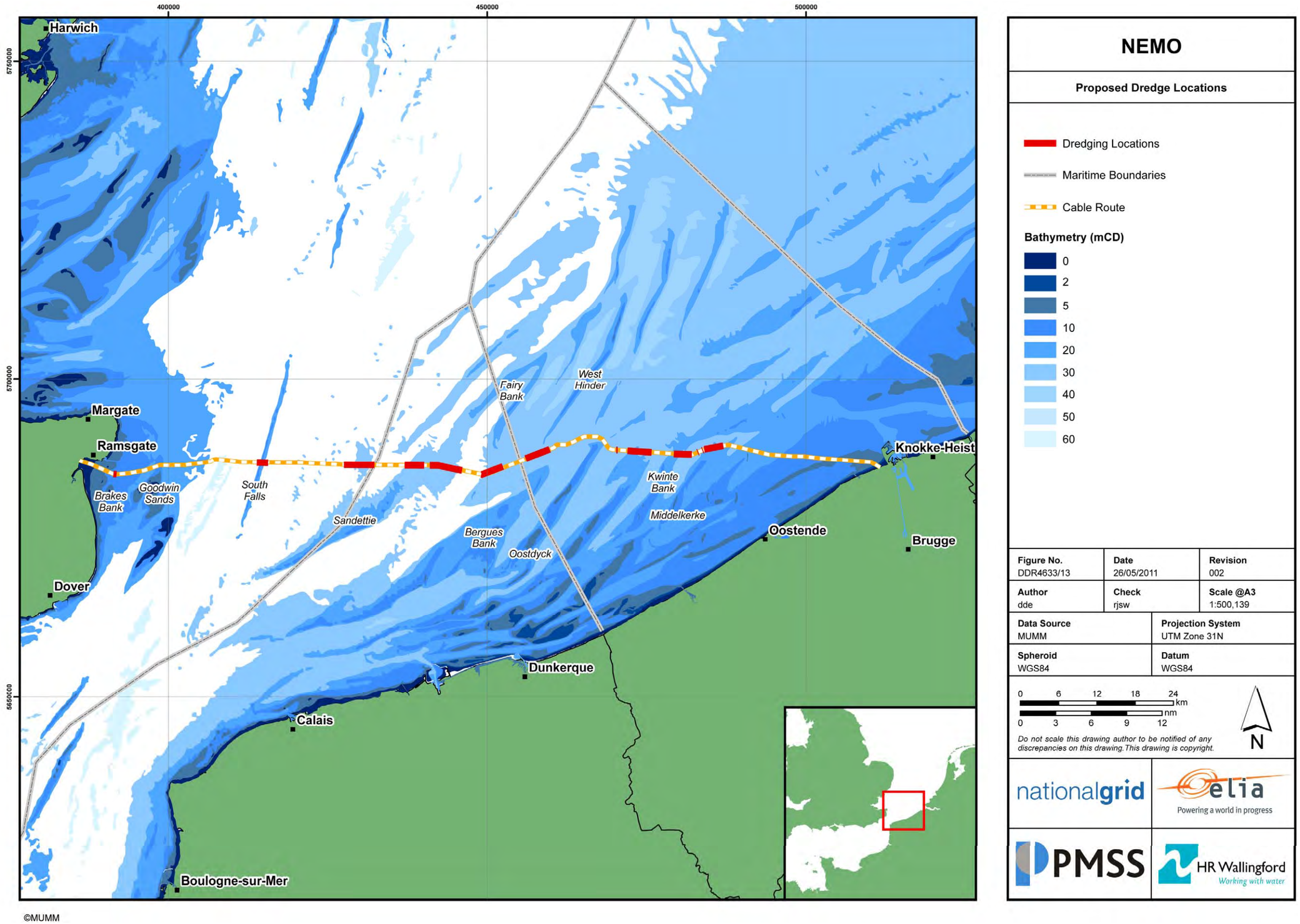


Figure 1 Bathymetry and dredge locations along the cable route

3. Calculation of pre-sweep dredge volumes

For the calculation of pre-sweep dredge volumes the larger sandwaves were identified in the long section as per the routing workshop. The dredge cross-section was determined as follows:

- 2 m vertical depth of dredging
- 20 m bottom width of dredging
- 1:5 side slopes.

The calculations were done in AutoCAD by determining the dredge cut line which meets the requirement to pre-sweep the top off each required sandwave. The 2 m cut line was defined below the mean level of the crest of the sandwave (which had smaller bedforms on it) rather than from the crest of the smaller bedforms. This ensured the dredging related to the form of the larger bedform which could be expected to move on the long-term. Of course the smaller bedforms are included in the dredge volume where they exist in the seabed profile. The AutoCAD Civil application for determining dredge volumes was used to calculate the 3D volumes. An example of the 3D nature of the calculations is shown in Figure 2 based on the pre-sweep profile and using the 2010 survey results. The dredge profile is depicted as "Areas cut" out of the crests of the sandwaves.

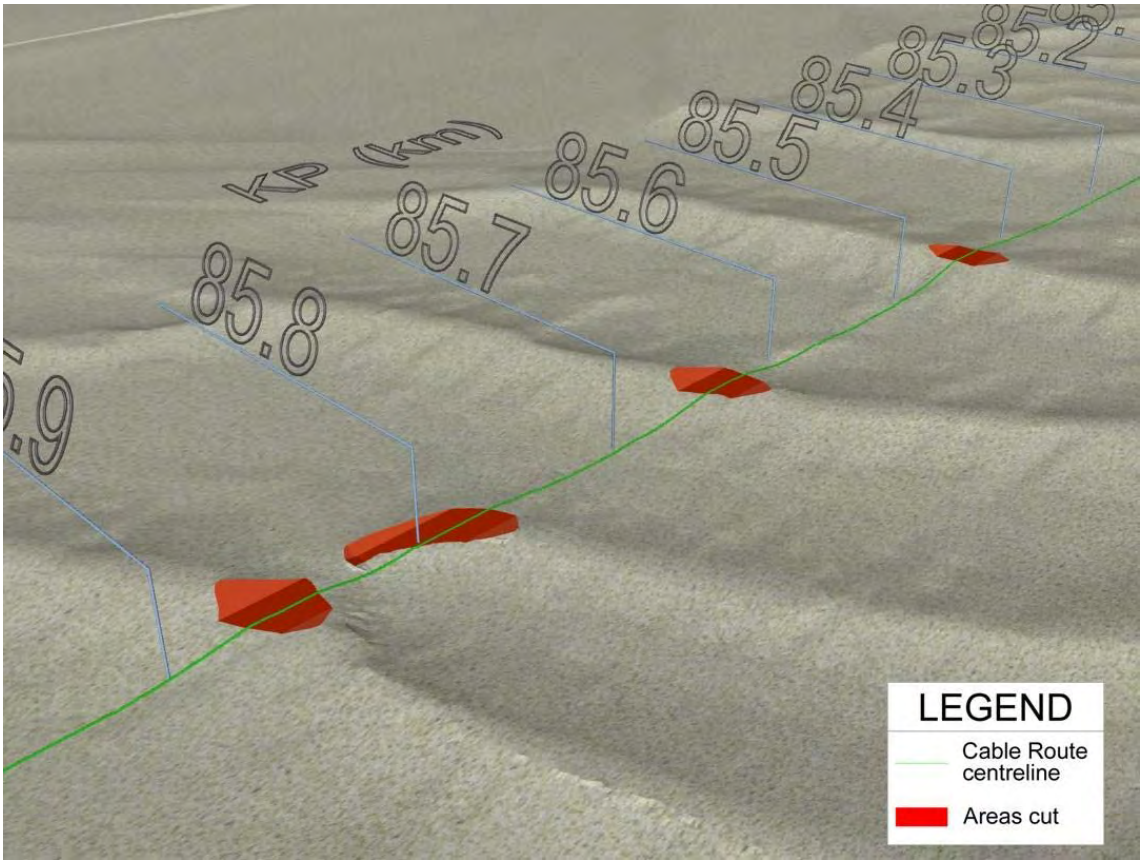


Figure 2 Example of pre-sweep profile through sandwaves

The results of the calculations are summarised in Table 1.

Table 1 Locations and quantity of sediments to be dredged from each location

KP (km from Belgian landfall)	Longitude (°E)	Latitude (°N)	Easting (m)	Northing (m)	Volume (m^3)	Purpose
26 - 29	2.77979	51.35257	484,665	5,689,057	38,273	Protect cable from sandwave 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 sandwave mobility
37.5 - 41.25	2.61177	51.34873	472,963	5,688,678	20,479	Protect cable from sandwave 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 sandwave 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 sandwave 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 ave mobility
74.5 - 77.5	2.11854	51.32572	438,583	5,686,417	32,614	Protect cable from sandwave mobility
82.3 - 87	1.99369	51.32529	429,883	5,686,480	24,470	Protect cable from sandwave mobility
99 - 100.75	1.77564	51.32706	414,694	5,686,908	93,138	Protect cable from sandwave mobility
123 - 123.5	1.44542	51.30614	391,638	5,685,017	1,170	Allow effective installation
Total quantity of dredging calculated					384,794	

4. Use of results

The results of this assessment have been used to inform the overall pre-sweeping dredging volumes of sand for the project and as input to the assessment of plume dispersion from TSHD operations (HR Wallingford, 2011).

The seabed profile at the time of installation and the KP locations of pre-sweeping may not correspond to those given within this report due to any further adjustments in cable route within the corridor, and also due to the movement of bed features in the period since the 2010 survey used in this study. Therefore, the estimated volume of dredging could vary from the figures quoted in Table 1. Based on the trench profile defined in Section 3, our estimate of the variability in volume for planning purposes is expected to be about ±10 per cent.

For engineering purposes the pre-sweep dredging profile and volumes should be confirmed with:

1. Analysis of the in-survey obtained prior to the cable installation work
2. The contractors proposed method of dredge operation, equipment specification and tolerances.

5. References

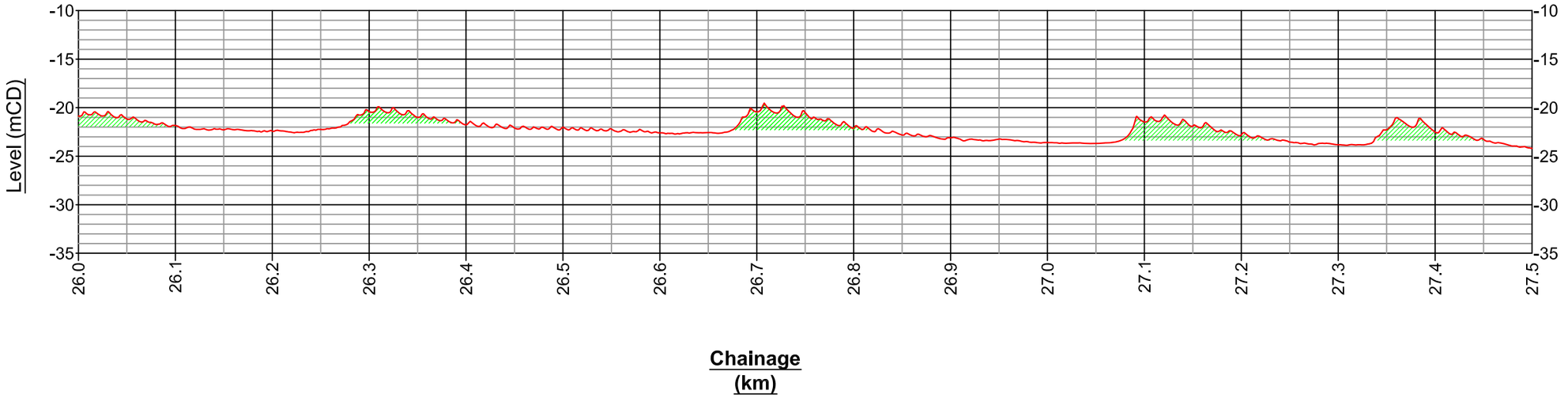
HR Wallingford (2011). Project Nemo – UK to Belgium Interconnector. Plume Dispersion Modelling. HR Wallingford Technical Note DDR4633-03, June 2011 (Release 3.0).

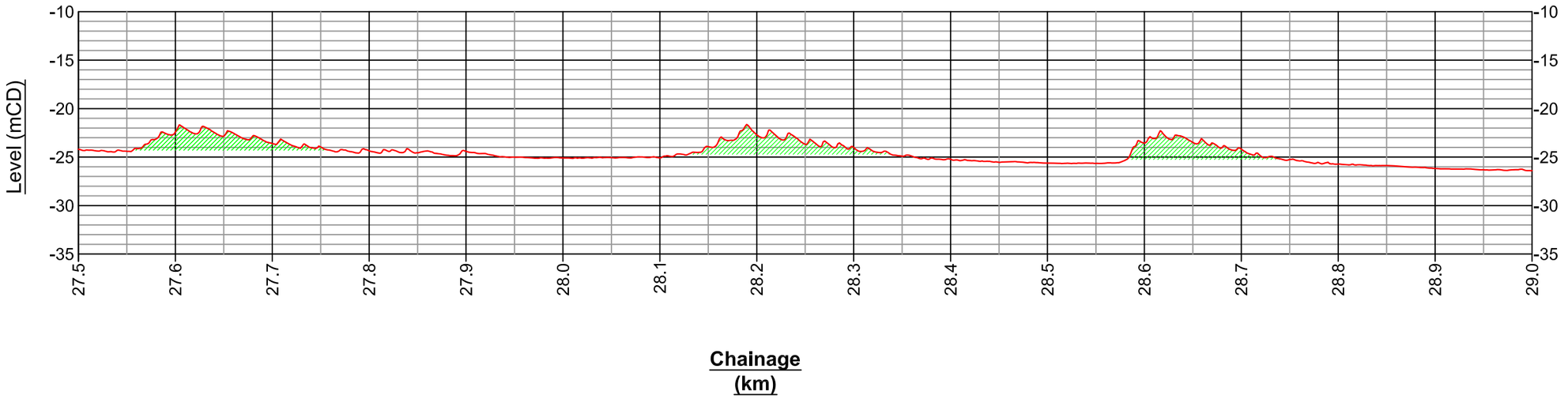
MMT (2010). Marine Survey Report, Project NEMO, Geophysical and Geotechnical Survey 2010, December 2010.

PMSS (2010). Nemo – Project Description, Working Document, PMSS report, Version 1, October 2010.

Appendix 1

Pre-sweep long profiles





INFO:

SEABED TOPOGRAPHY EXTRACTED FROM OFFSHORE AND NEARSHORE MBES SURVEY - AUGUST TO OCTOBER 2010, MMT GEOPHYSICAL SURVEY REPORT: '100702-MMM-EN2-SUR-REP-NEMOPHSI-02' OCTOBER 2010

NOTES:

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LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

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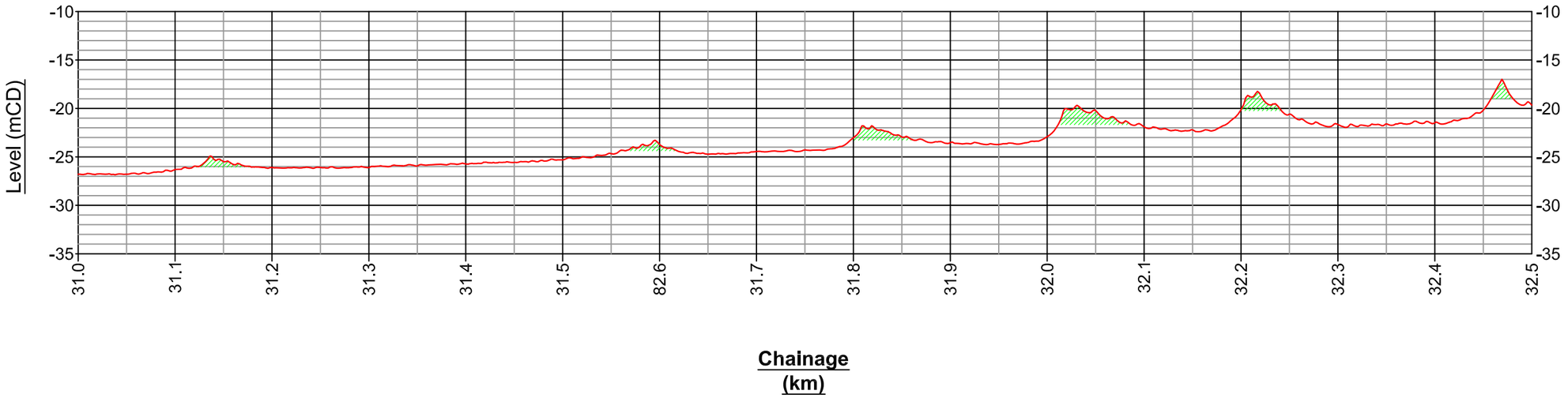
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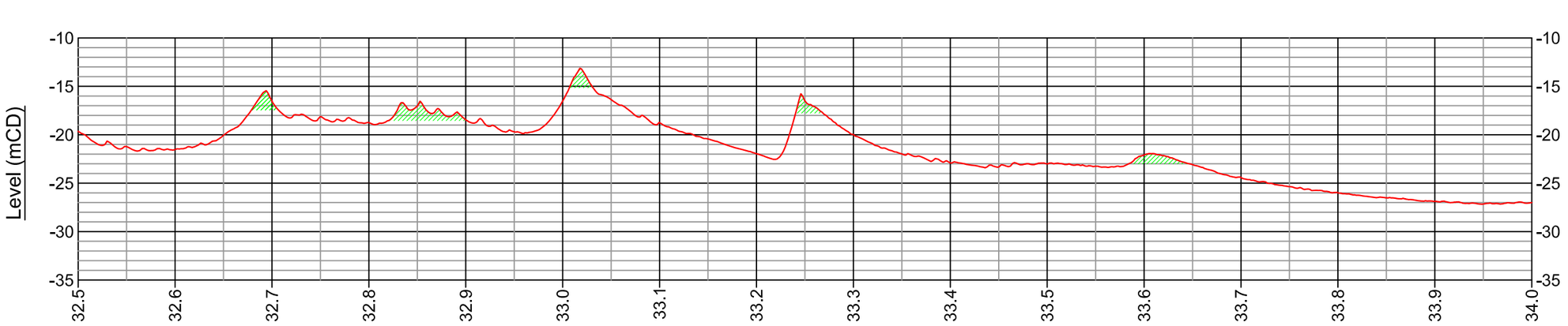
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SCALE: NTS @ A3

DRAWING No: DDR4633/001/D001

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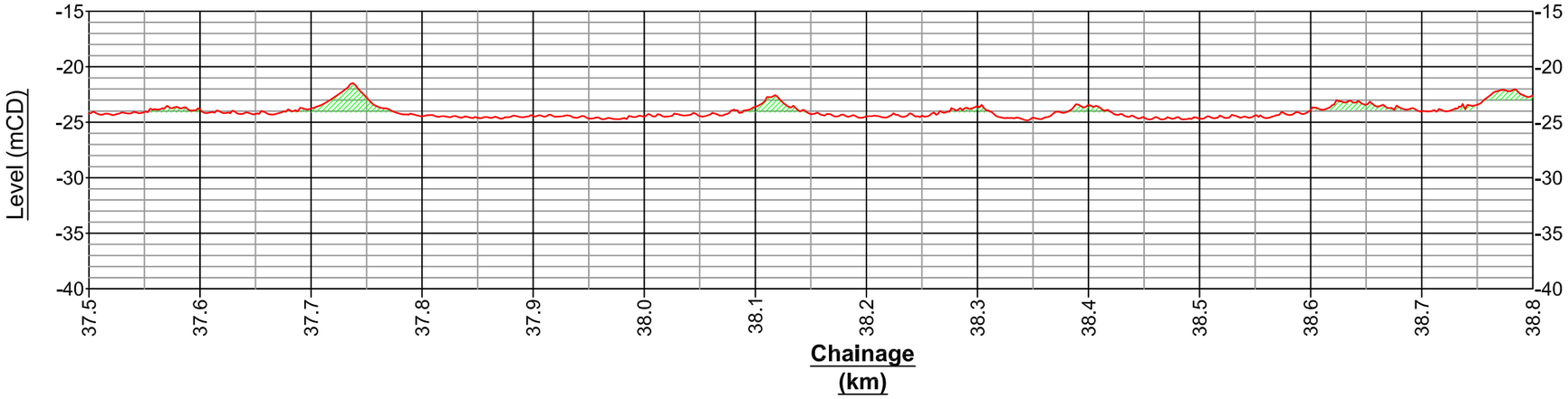
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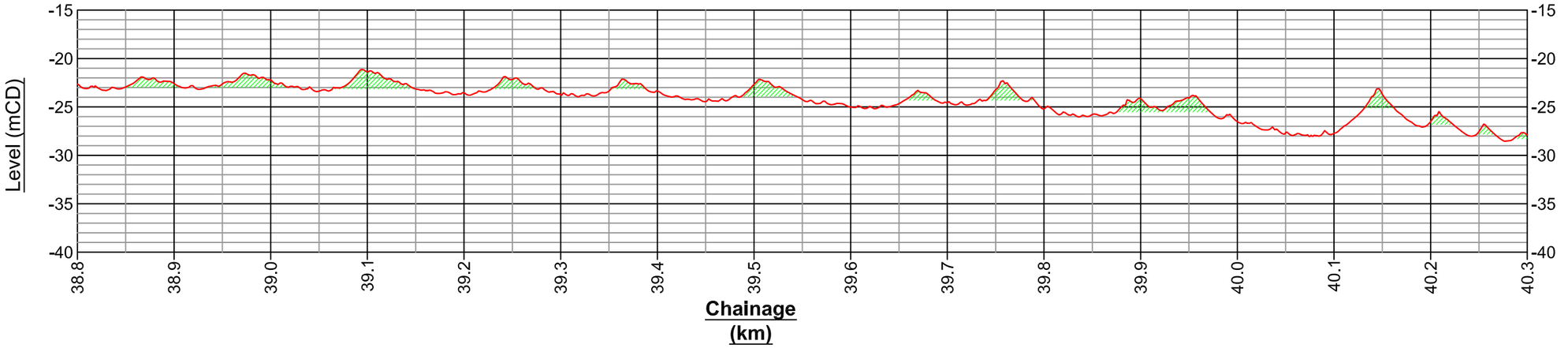
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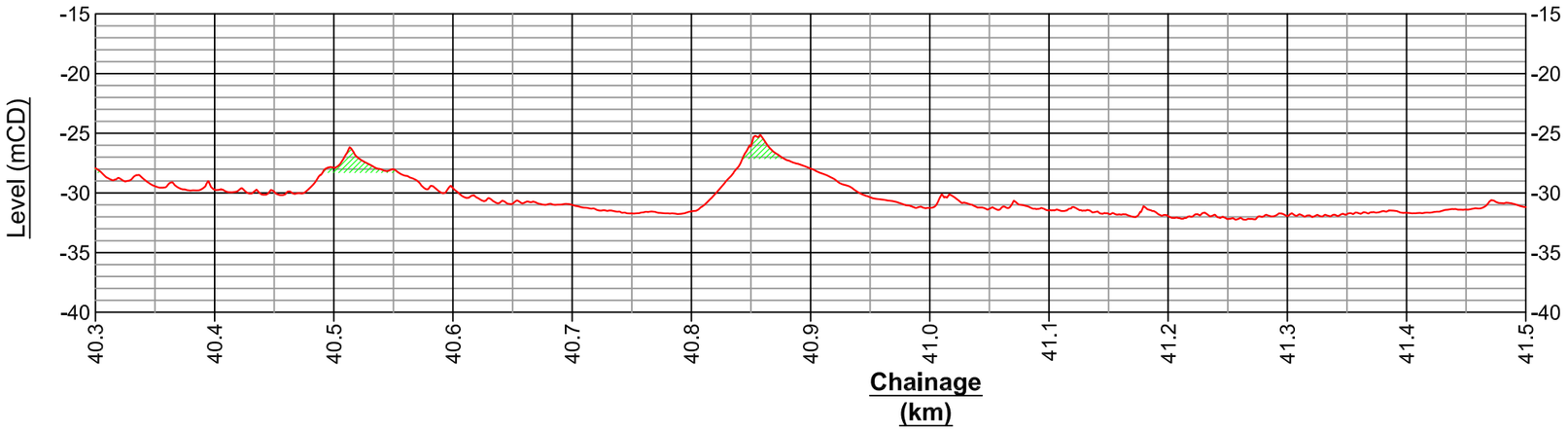
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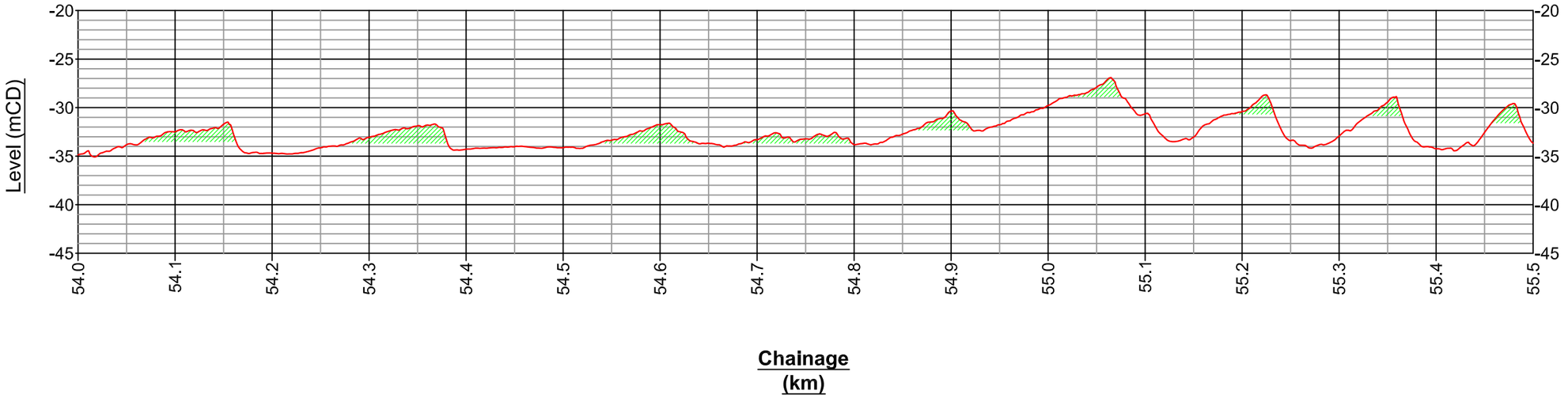
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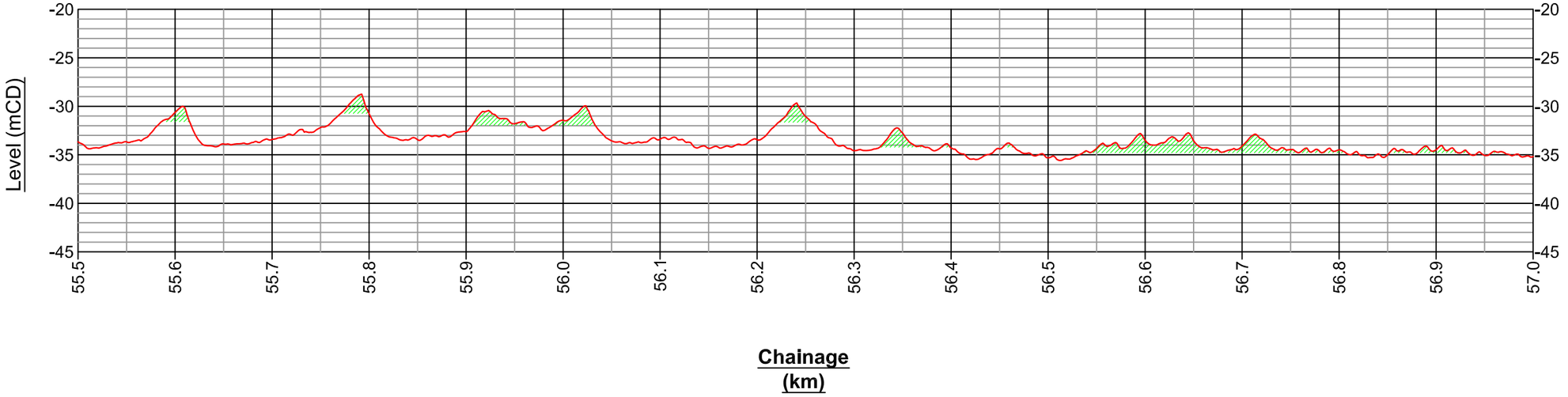
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SCALE: NTS @ A3

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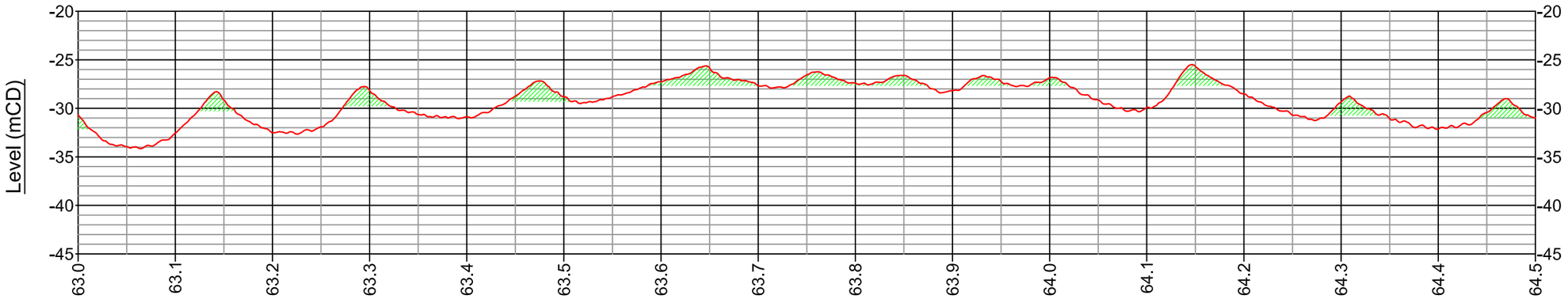
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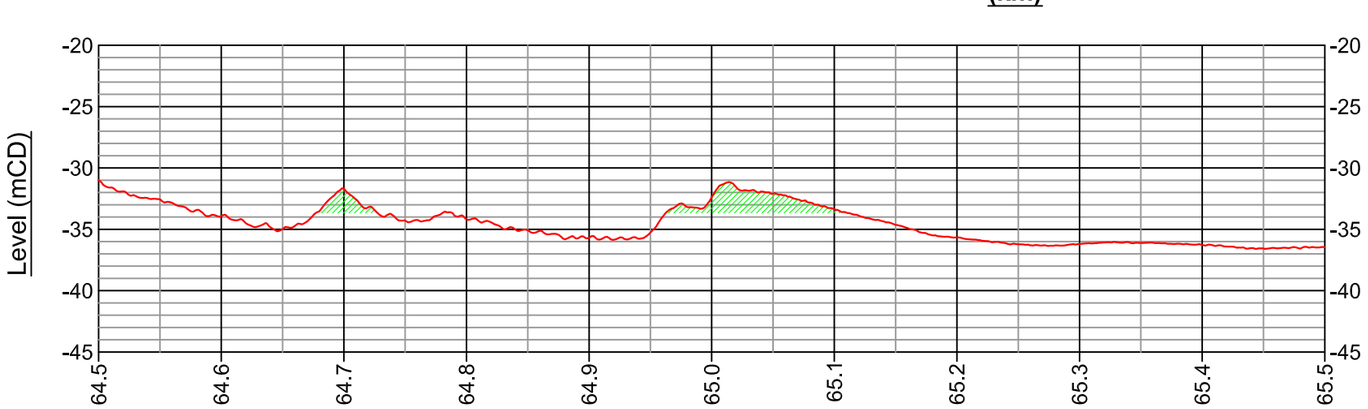
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Chainage (km)



Chainage (km)

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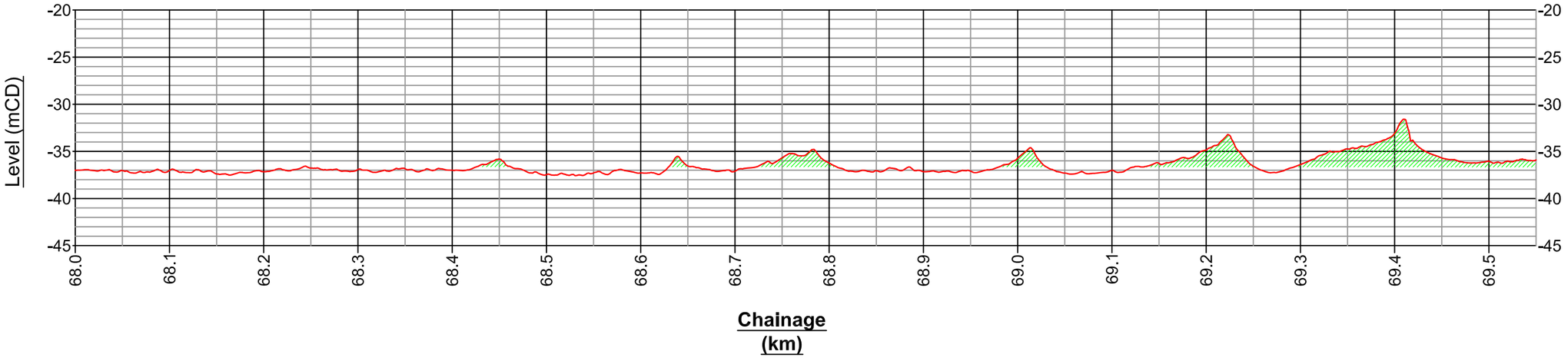
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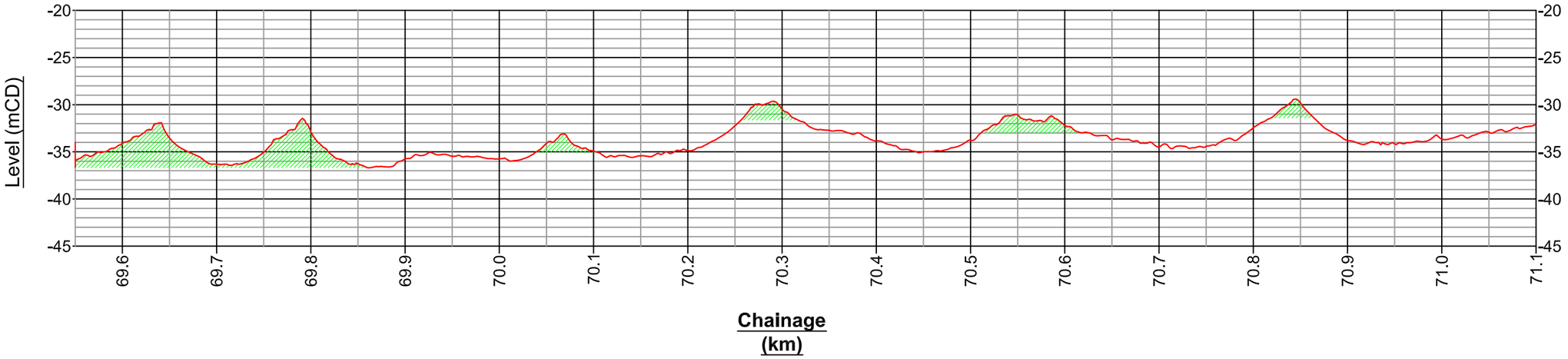
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SCALE: NTS @ A3

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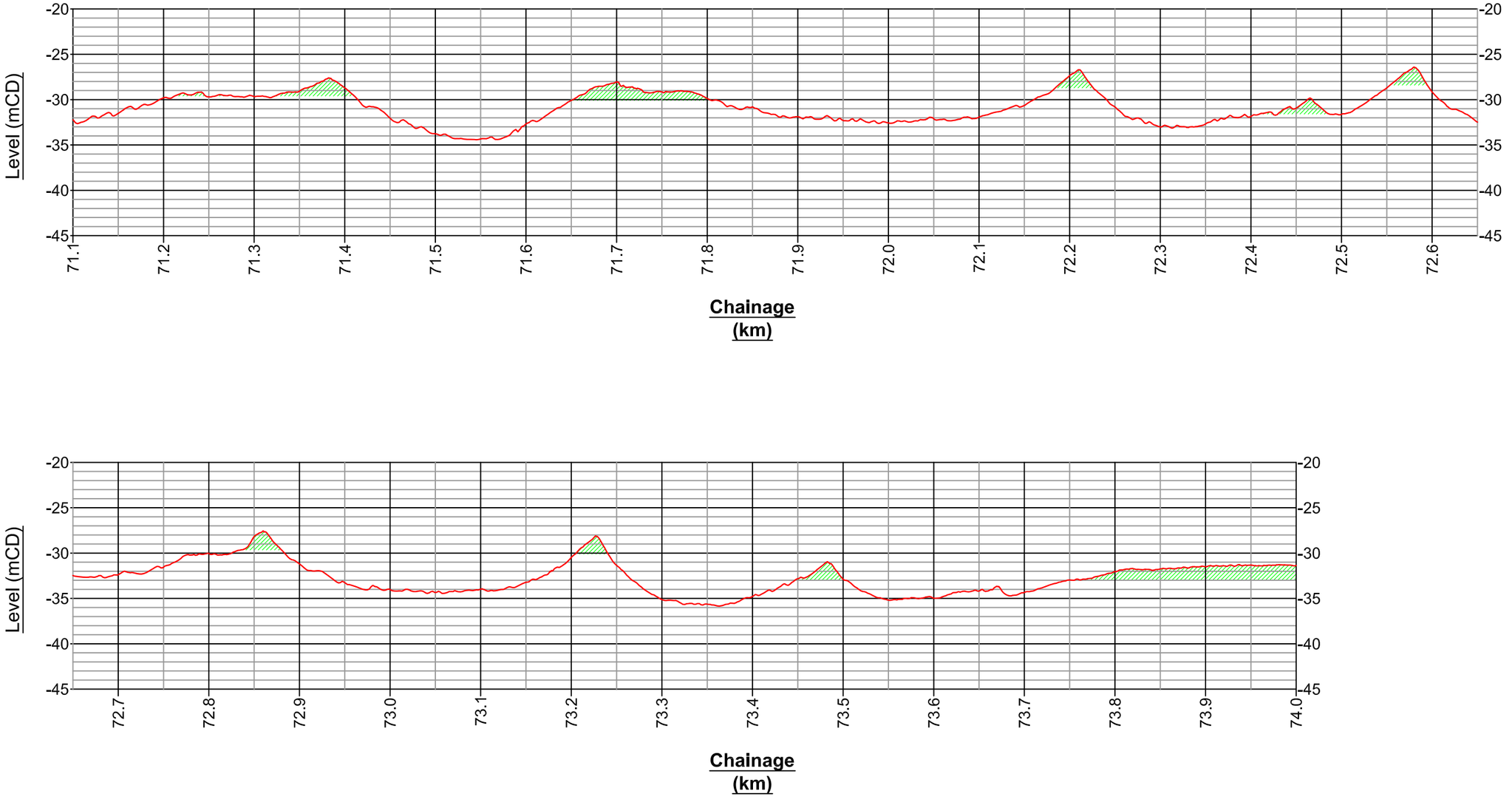
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SCALE: NTS @ A3

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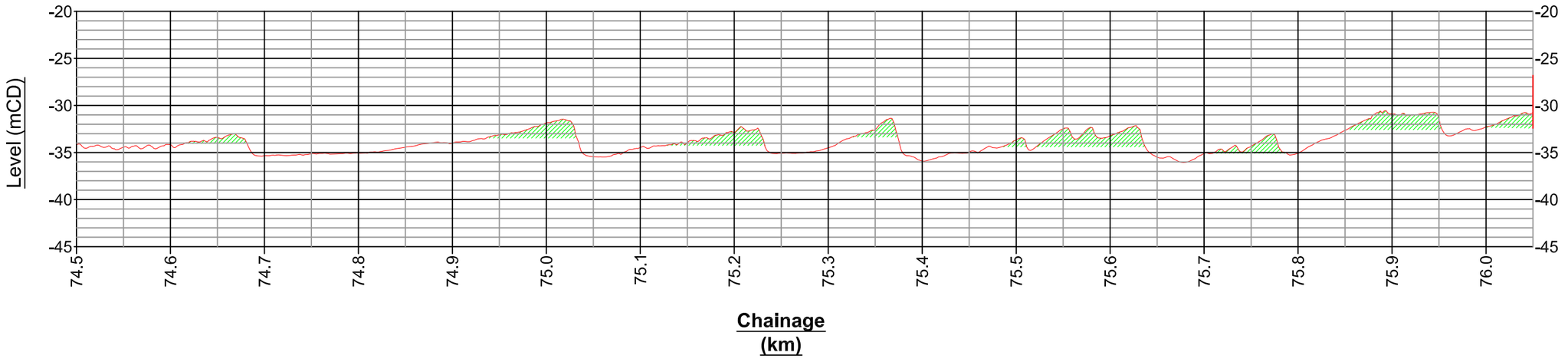
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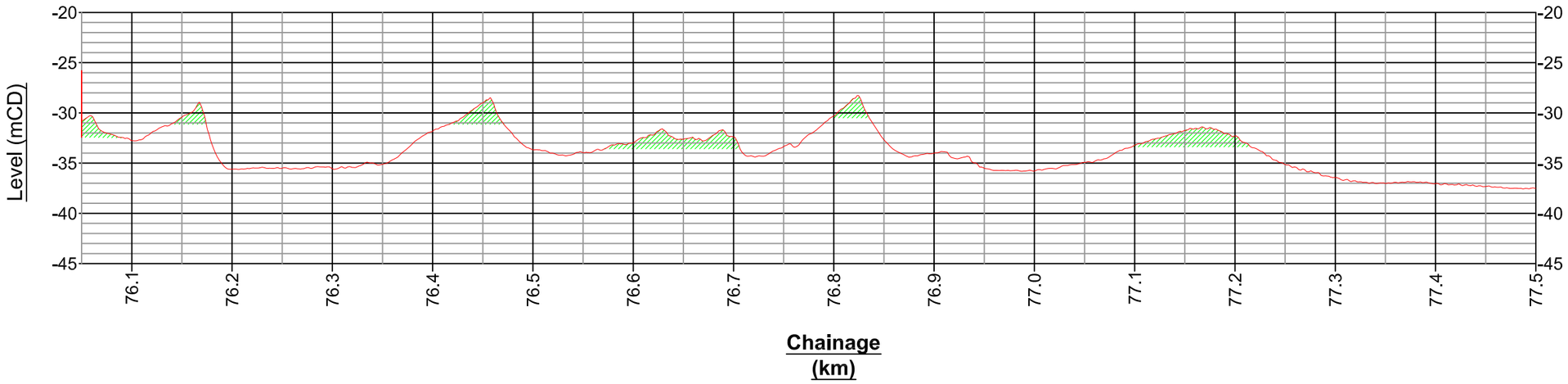
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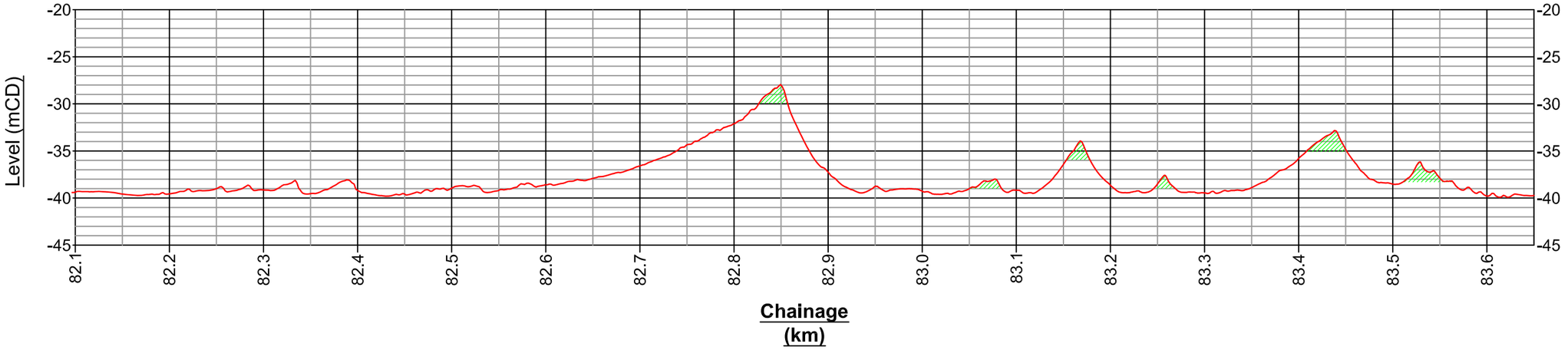
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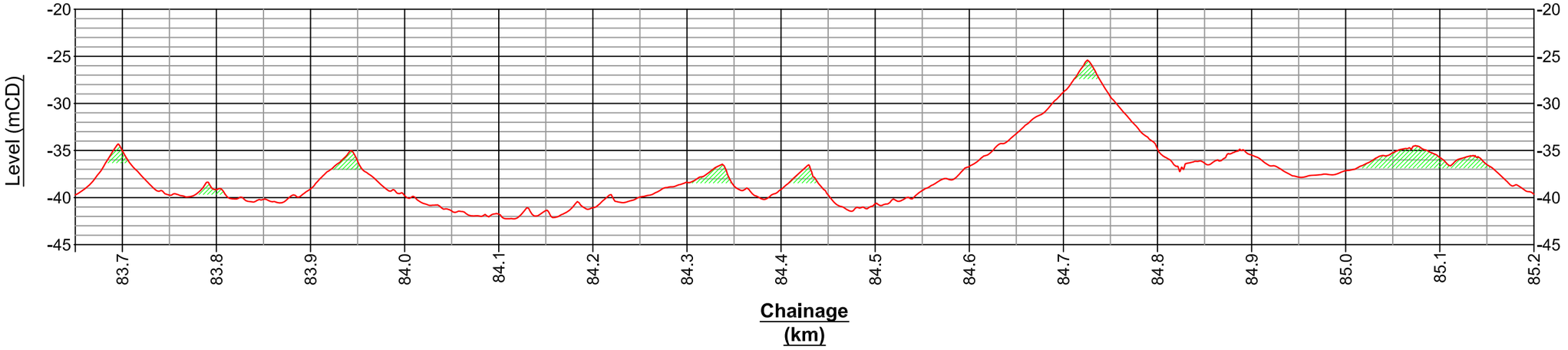
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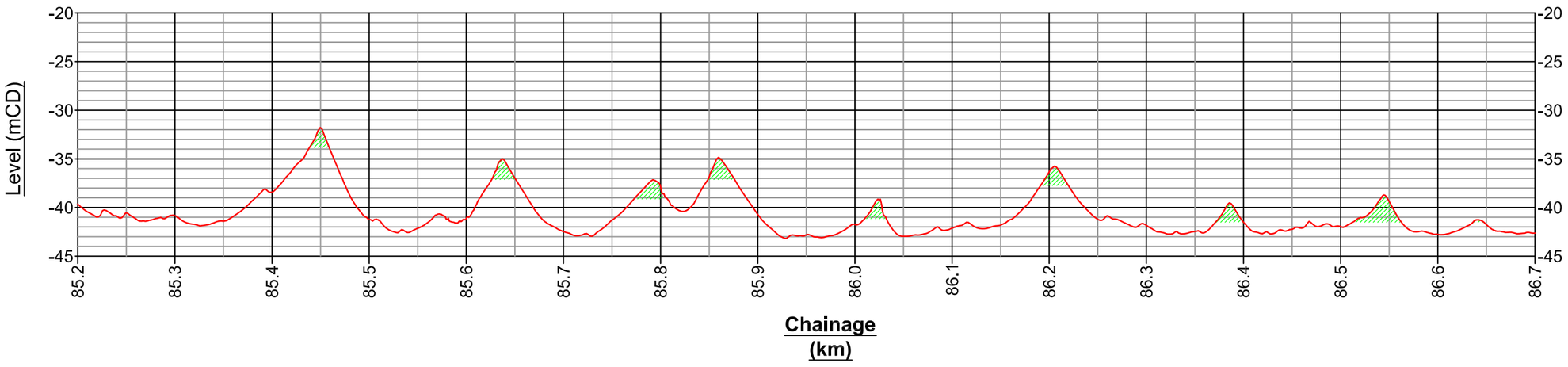
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MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

nationalgrid

elia Powering a world in progress

PMSS

HR Wallingford Working with water

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PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

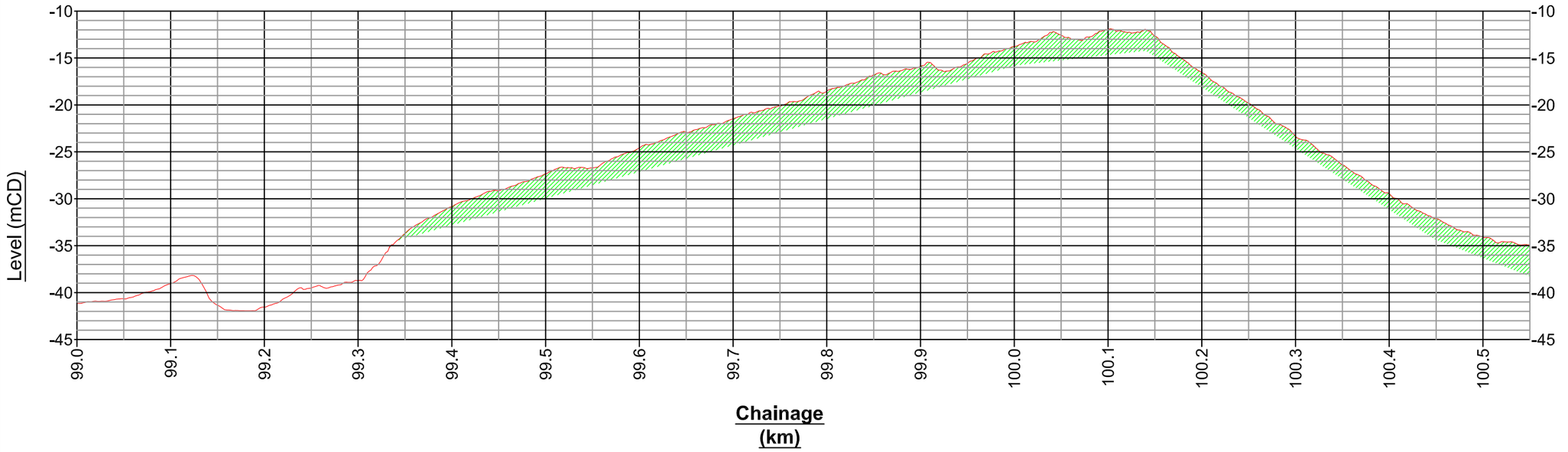
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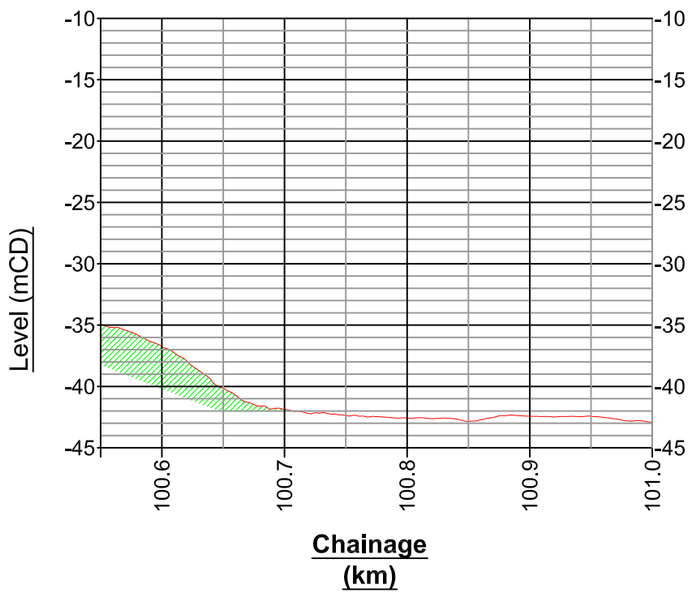
SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR
KP AREA: 83.7 - 86.7

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D009

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INFO:

SEABED TOPOGRAPHY EXTRACTED FROM OFFSHORE AND NEARSHORE MBES SURVEY - AUGUST TO OCTOBER 2010, MMT GEOPHYSICAL SURVEY REPORT: '100702-MMM-EN2-SUR-REP-NEMOPHSI-02' OCTOBER 2010

NOTES:

1. FOR CALCULATION OF DREDGE VOLUMES A CONTINUOUS DREDGE PROFILE IS SPECIFIED. THE VOLUME DREDGED FROM ANY BATHYMETRIC FEATURE IS CALCULATED WHERE THE FEATURE EXTENDS ABOVE THE DREDGE PROFILE.
2. THE SEABED PROFILE AND ASSOCIATED DREDGE PROFILE IS INDICATIVE OF CONDITIONS EXPECTED DURING THE PROJECT. THE ACTUAL LOCATION OF FEATURES AND DREDGE PROFILE MAY VARY.

LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
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1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

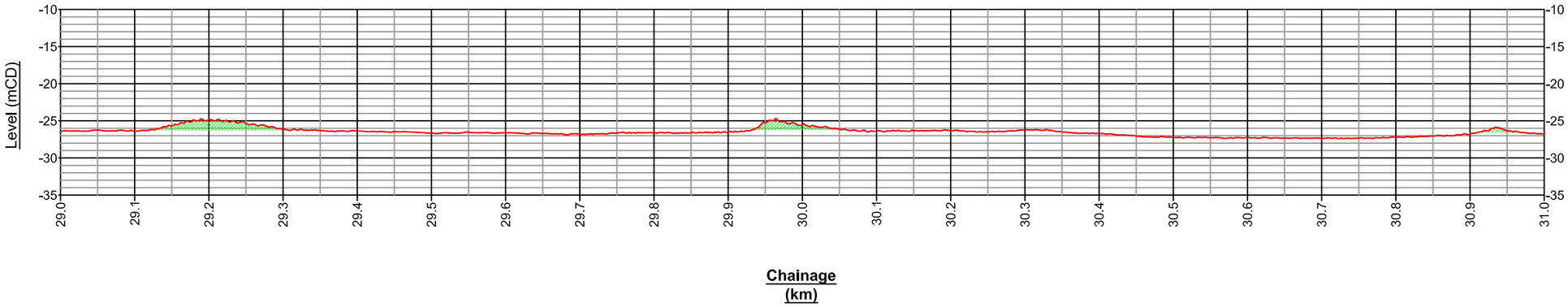
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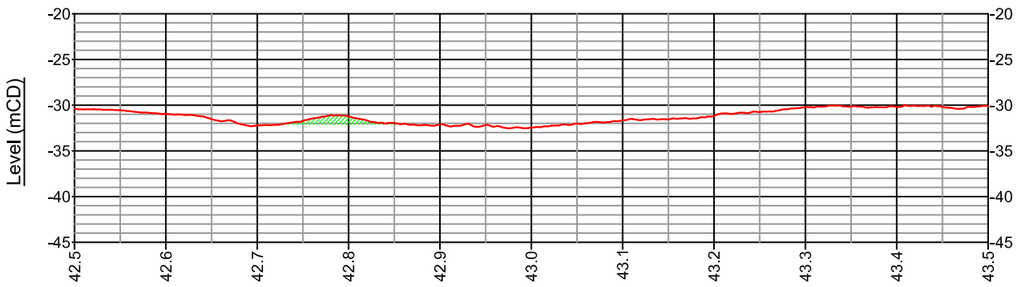
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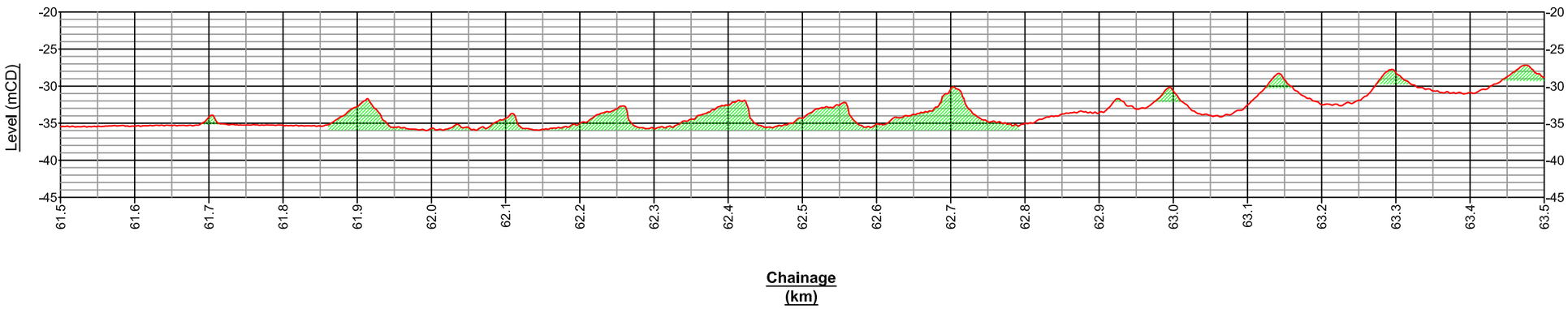
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DRAWING No: DDR4633/001/D010

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INFO:

SEABED TOPOGRAPHY EXTRACTED FROM OFFSHORE AND NEARSHORE MBES SURVEY - AUGUST TO OCTOBER 2010, MMT GEOPHYSICAL SURVEY REPORT: '100702-MMM-EN2-SUR-REP-NEMOPHSI-02' OCTOBER 2010

NOTES:

1. FOR CALCULATION OF DREDGE VOLUMES A CONTINUOUS DREDGE PROFILE IS SPECIFIED. THE VOLUME DREDGED FROM ANY BATHYMETRIC FEATURE IS CALCULATED WHERE THE FEATURE EXTENDS ABOVE THE DREDGE PROFILE.
2. THE SEABED PROFILE AND ASSOCIATED DREDGE PROFILE IS INDICATIVE OF CONDITIONS EXPECTED DURING THE PROJECT. THE ACTUAL LOCATION OF FEATURES AND DREDGE PROFILE MAY VARY.

LEGEND:

BATHYMETRY ALONG SUBSEA CABLE ROUTE

MATERIAL TO BE REMOVED

REL	DESCRIPTION	Drawn	Appr	Auth	DATE
2	REISSUED	RER	RJSW	JMH	15 JUN 11
1	ISSUED FOR REVIEW	RER	RJSW	JMH	11 FEB 11

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PROJECT:

PROJECT NEMO
UK TO BELGIUM INTERCONNECTOR

DRAWING TITLE:

SEABED PROFILE AND PRE-SWEEP DREDGE LEVEL FOR
KP AREA: 29 - 31 , 42.5 - 43.5 & 61.5 - 63.5

SCALE: NTS @ A3

DRAWING No: DDR4633/001/D011

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Appendix 8: Winter Bird Survey

UK –BELGIUM INTERCONNECTOR
PROJECT NEMO

WINTER BIRD SURVEY

(Doc Ref: TEP 1430.01.024 r1)
February 2010

Prepared by TEP for:

National Grid International Limited
National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Written:	Checked:	Approved:
TR	IJG	IJG

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CONTENTS PAGE

1.0 EXECUTIVE SUMMARY 1
Introduction 1
Methods 1
Results 1
2.0 INTRODUCTION 3
3.0 SITE DESCRIPTION 4
Sandwich Bay and Hacklinge Marshes SSSI 5
Thanet Coast and Sandwich Bay SPA 5
Further updates in the Wetland Bird Survey Report 2007-08 5
4.0 METHODS 6
Winter Bird Survey 6
5.0 RESULTS 7
Wader and Wildfowl Numbers and Distributions 7
6.0 IMPLICATIONS AND RECOMMENDATIONS 13
The Ornithological Importance of the Pegwell Bay 13
The Findings of the 2008-09 Winter Bird Survey 13
Recommendations 15
7.0 REFERENCES 16

APPENDICES

Appendix 1: Desktop survey data and protected site citations
Appendix 2: Survey dates and times 2008-2009
Appendix 3: Pegwell Bay winter bird survey total counts 2008 - 2009

FIGURES

Figure 1: Aerial photograph illustrating site context

DRAWINGS

G1430.01.001 Winter bird survey visit 1 – November 2008
G1430.01.002 Winter bird survey visit 2 – December 2008
G1430.01.003 Winter bird survey visit 3 – January 2009
G1430.01.004 Winter bird survey visit 4 – February 2009 #1
G1430.01.005 Winter bird survey visit 5 – February 2009 #2
G1430.01.006 Winter bird survey visit 6 – March 2009
G1430.01.007 Winter bird survey visit 7 – May 2009

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake winter bird surveys to investigate the ornithological interest of the area known as Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an interconnector cable within the Bay.

1.2 The Sandwich Bay and Hacklinge Marshes SSSI is designated for its nationally important numbers of grey plover and sanderling during the winter period and nationally important numbers of ringed plover during the migration periods. The Thanet Coast and Sandwich Bay SPA supports a migratory turnstone population of European importance.

1.3 The Thanet Coast and Sandwich Bay Ramsar site supports nationally important numbers of greenshank during the migration periods. The 5-year peak mean average counts for lapwing and golden plover within Pegwell Bay (03/04 – 07/08) exceeds the national GB thresholds for these species.

Methods

1.4 The winter bird survey entailed two surveyors mapping wader and wildfowl distributions within the Pegwell Bay on an hourly basis for a complete tide cycle, i.e. high to low tide or low to high tide. Survey visits were undertaken once a month from November 2008 to March 2009 and May 2009 with an additional visit being undertaken in February (six visits).

Results

1.5 The most numerous birds species recorded during the winter bird survey included lapwing and golden plover followed by dunlin and oystercatcher. None of the birds observed within the Pegwell Bay survey area were recorded at numbers exceeding GB thresholds, as defined by the BTO, in winter 2008-09.

1.6 The winter bird survey identified a number of specific areas within the Pegwell Bay which are regularly used by certain specific wader and wildfowl species or a wide range of species for roosting and/or feeding activities. These included the following areas:

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

Implications and Recommendations

1.7 Survey findings and existing desktop information contained within the Pegwell Bay Reports strongly indicate that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February (lapwing, golden plover, turnstone and grey plover) and also in May (turnstone, sanderling and

grey plover). It is recommended construction related activities on the mudflats of the Pegwell Bay avoid these periods where project timescales allow.

1.8 It is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance.

1.9 It is strongly recommended that the sensitive areas described in paragraph 1.6 above are avoided during cable laying activities regardless of time of year since these areas are likely to be of importance for birds throughout the year. Survey findings indicate that the proposed cable laying works would have the least impact on wader and wildfowl if they are restricted to the north half of the Bay.

1.10 The area of shore known as Cliffsend is a turnstone high tide roost of some importance throughout much of the year. Any proposed works in this location should be undertaken in as short a timeframe as possible.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake a winter bird survey to investigate the ornithological interest of the area known as Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an interconnector cable within the Bay.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the winter bird survey involves undertaking monthly visits to Pegwell Bay during winter 2008-09 (November 2008 to March 2009) during which wader and wildfowl bird distributions were mapped every hour for a full tide cycle. The winter bird survey focussed on inter-tidal areas to the north of the River Stour the interconnector cable is only being considered to the north of the River Stour to avoid the need to cross the river on land.

3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh located immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of the Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. The Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay itself.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also covered as a part of the Pegwell Bay winter bird survey.

Figure 1: Aerial photograph illustrating site context



Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods. Waders regularly recorded include dunlin, oystercatchers, curlew and redshank. Grey plover and sanderling overwinter in nationally important numbers, whilst ringed plover occurs in nationally important numbers during migration. Wildfowl that occur on the site include mallard, shelduck and Brent goose. Many of the birds use more that one habitat within the area, for example with birds feeding on the mudflats and roosting on the saltmarsh and grazing marsh.

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The Thanet Coast and Sandwich Bay SPA qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the migratory species, turnstone. The SPA as a whole is used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn.

3.8 The Ramsar citation sheet confirms that the Thanet Coast and Sandwich Bay Ramsar site supports:

- Nationally important numbers of **ringed plover** during the migration periods (649 individuals representing an average of 2% of the GB population – 5 year peak mean 1998/9-2002/3);
- Nationally important numbers of **greenshank** during the migration periods (35 individuals representing an average of 5.8% of the GB population – 5 year peak mean 1998/9-2002/3);
- Nationally important numbers of **red-throated diver** during the winter period (57 individuals representing an average of 1.1% of the GB population – 5 year peak mean 1998/9-2002/3).

3.9 Citation sheets for all designated sites described are included in Appendix 2.

Further updates in the Wetland Bird Survey Report 2007-08

3.10 The 5-year peak mean average count for golden plover within the Pegwell Bay (03/04 – 07/08) is 6,125 birds, which exceeds the national GB threshold of 4,000 birds.

3.11 The 5-year peak mean average count for lapwing within the Pegwell Bay (03/04 – 07/08) is 11,105 birds, which exceeds the national GB threshold of 6,200 birds.

4.0 METHODS

Winter Bird Survey

4.1 The ornithology survey was undertaken by TEP Ornithology Manager Tim Ross MIEEM CEnv and experienced ornithologists Mike Walker and Lee Greenhough MIEEM.

4.2 The winter bird survey entailed two surveyors mapping wader and wildfowl distributions in Pegwell Bay on an hourly basis for a complete tide cycle, i.e. high to low tide or low to high tide. Survey visits were undertaken once a month from November 2008 to March 2009 and May 2009 with an additional visit being undertaken in February to target the mid-winter period when birds are most sensitive to disturbance (six visits). Survey days were chosen to ensure that three surveys were undertaken as the tide was going out (high to low tide) and three surveys were undertaken as the tide was coming in (low to high tide). The precise timing of winter bird surveys on each survey day are given in Appendix 3 along with the weather conditions prevalent on survey days.

4.3 Detailed maps of wader and wildfowl distribution for three different times for each survey day have been provided in this report (3 maps per survey visit). Each of these three maps is representative of either (1) high tide (2) mid-tide or (3) low tide (see Drawings G1430.01.001 to G1430.01.006). Flocks of birds were given a reference number and colour coded according to the size of the flock. Large flocks (over 1,000 birds) are coloured red; medium-sized flocks (over 100 birds) are coloured orange; and small flocks (under 100 birds) are coloured green.

4.4 Ecology survey undertaken in Pegwell Bay have all been undertaken with the kind assistance of the Kent Wildlife Trust who issued a survey works permit to TEP.

5.0 RESULTS

Wader and Wildfowl Numbers and Distributions

November 2008

5.1 The distribution of waders and wildfowl on 19th November 2008 is illustrated in drawing G1430.01.001.

5.2 The most numerous bird recorded at this time was golden plover (2,850 birds) followed by lapwing (2,560 birds) and dunlin (1,090 birds). According to the Pegwell Bay bird report the number of golden plovers recorded in winter 2008-09 (peak count 1,590 birds) during November 2008 was well down on previous years. However it is clearly apparent that 1,590 was not the peak count in November since 2,850 golden plovers were recorded by TEP ecologists.

Low tide

5.3 At low tide (10.25 hrs) the majority of birds were feeding or roosting on the mid and lower shore parts of Pegwell Bay although more than half of the birds were observed close to the River Stour. The largest flock of birds, which was comprised of 1,600 golden plovers and 700 lapwings (Flock 23), was recorded on the mid shore approximately 200 metres to the north of the River Stour.

5.4 One medium-sized flock of birds was observed on the uppershore immediately to the south of the former hoverpad (Flock 13 - 150 golden plovers). A number of bait diggers were working on the upper shore at low tide and this may have displaced some birds at some stage. According to the Pegwell Bay bird report the golden plovers had been displaced from their usual roosting places on the mudflats as a result of disturbance from bait diggers.

5.5 The golden plover was recorded in three large flocks comprised of at least 1,000 birds (Flocks 14, 20 and 23) located either across the midshore but especially near the River Stour. The lapwing was recorded in three medium-sized flocks which were sometimes a part of a larger flock of birds (flocks 4, 21 and 23). Dunlin was also recorded in three medium-sized flocks (flocks 9, 18 and 19), which were located either near the sandy area at the north end of the bay or on the mudflats on the north bank of the River Stour.

Mid tide

5.6 At mid tide the majority of birds was either on the upper shore near the former hoverpad (Flocks 7, 8, 11 and 12 – mostly lapwing, golden plover and dunlin) or on the mudflats on the north or south banks of the River Stour (Flocks 26 and 28 – mostly lapwing with some oystercatcher and dunlin). One other medium-sized flock was comprised of 165 curlews (Flock 20).

High tide

5.7 At high tide (15.43 hrs) the vast majority of birds was near Shellness on the south side of the River Stour with medium-sized flocks of oystercatcher, lapwing and golden plover being recorded (Flocks, 4, 5 and 6). A separate medium-sized flock of just 150 lapwings was also recorded around the main gulley on the saltmarsh on the north side of the River Stour. Counts at high

tide strongly indicate that large numbers of birds which use the Pegwell Bay at low tide leave the bay once the tide has come in.

December 2008

5.8 The distribution of waders and wildfowl on 12th December 2008 is illustrated in drawing G1430.01.002.

5.9 The most numerous bird recorded at this time was golden plover (1,380 birds) followed by lapwing (1,321 birds) and dunlin (751 birds). Counts obtained on 12th December were much lower than those given in the Pegwell Bay bird report which states that peak counts were 3,700 for golden plover, 9,000 for lapwing and 1,240 for dunlin. Survey conditions were moderately good on 12th December indicating that many birds may have been absent from the Pegwell Bay and using other inter-tidal areas in the area.

High tide

5.10 At high tide (09.58 hrs) the vast majority of birds was again observed near Shellness on the south side of the River Stour (Flocks 6 and 7 – mostly lapwing and oystercatcher). Another medium-sized flock of birds, mainly comprised of lapwing with smaller numbers of wigeon and shelduck (Flock 1), was recorded on the strip of saltmarsh immediately east of the country park.

Mid tide

5.11 At mid tide the majority of birds was on mudflats on the upper shore, especially near the country park and near the River Stour. Large numbers of birds were observed immediately east of the bird hide on the country park with three separate flocks of lapwing being recorded, totalling 1,840 lapwing along with 200 dunlin. A medium-sized flock of birds was also present on the upper shore to the north and to the south of the former hoverpad (flocks 7 and 13) where 500 dunlin and 220 lapwing were counted.

Low tide

5.12 The low tide count on 12th December 2008 was undertaken between 14.00hrs and 15.00hrs, which was approximately two and a half hours prior to actual low tide (17.41 hrs). Therefore it is likely that the bird distribution on this count was not fully representative of low tide.

5.13 The majority of birds at this time were still located on the mudflats of the uppershore due east of the bird hide (flocks 4 and 5) where 2,760 golden plover, 525 lapwings and 278 dunlin were present. The largest flock of lapwings was on the mudflats of the uppershore to the north of the hoverpad indicating that lapwings had gradually been moving from the south part of the Pegwell Bay, near the bird hide, to the north part. Many smaller flocks of birds including dunlin, bar-tailed godwit, oystercatcher and shelduck were beginning to move to the north half of the mid shore area at this time.

January 2009

5.14 The distribution of waders and wildfowl on 8th January 2009 is illustrated in drawing G1430.01.003.

5.15 The most numerous bird recorded at this time was golden plover (350 birds) followed by oystercatcher (162 birds) and dunlin (165 birds). Counts obtained on 8th January 2009 were much lower than those given in the Pegwell Bay bird report which states that peak counts were 2,200 for golden plover, 720 for oystercatcher and 1,310 for dunlin. Survey conditions were poor due to the presence of much fog over the Pegwell Bay which affected the ability of the surveyors to record birds at low tide on the south half of the bay. However it is highly likely that many of the waders present in the locality were not in the survey area on 8th January.

High tide

5.16 At high tide (07.45 hrs) the vast majority of birds was observed on the east edge of the saltmarsh located immediately to the east of the country park (Flocks 1 and 3 – mostly golden plover and dunlin). The reason for the different high tide bird distribution on 8th January is unclear but could be related to the foggy conditions providing cover for the birds to roost near the country park. It is also possible that the reduction of disturbance from walkers may have enabled the birds to roost in this different location.

Mid tide

5.17 At mid tide the majority of birds was widely dispersed across the exposed mudflats although there were some larger flocks located both on the tideline and just east of the saltmarsh. The larger flock of birds on the tideline (Flock 19) was made up predominately of oystercatcher and wigeon although some curlew, bar-tailed godwit and dunlin were also present. The flocks nearer to the saltmarsh included a flock of lapwing (Flock 16) near the saltmarsh to the east of the bird hide. A mixed flock of predominately dunlin (Flock 21) was located just to the east of the fisherman's path through the saltmarsh.

Low tide

5.18 At low tide (15.16 hrs) the majority of birds was feeding or roosting on the north bank of the River Stour near the tideline (Flock 10 – predominately oystercatcher and teal) or on the tideline itself (Flock 14 – a mixture of wigeon, dunlin, oystercatcher, curlew, bar-tailed godwit and two grey heron). A separate flock made up mostly of dunlin was feeding and roosting just outside the saltmarsh located to the north of the former hoverpad.

5.19 It is likely that the presence of bait diggers at the centre of the Pegwell Bay on 8th January was influencing bird distributions to some degree. Only very small numbers of sanderling, oystercatcher and redshank were observed feeding within 200 metres of the bait diggers.

<u>February 2009</u>

5.20 The distribution of waders and wildfowl on 12th and 13th February 2009 are illustrated in drawings G1430.01.004 and G1430.01.005.

5.21 The most numerous bird recorded on 12th February was lapwing (4,709 birds) followed by oystercatcher (1,158 birds) and dunlin (502 birds). The following day on 13th February the most numerous bird was lapwing (3,447 birds) followed by golden plover (1,700 birds) and dunlin (550 birds). On both days

reasonable numbers of wigeon were also recorded (330 birds followed by 275 birds).

5.22 Lapwing counts obtained on 12th and 13th February were lower than those given in the Pegwell Bay bird report which states that the peak count for February 2009 was in excess of 8,000 birds. Golden plover and dunlin counts were also much lower than those recorded in the Pegwell Bay bird report, which were 3,140 golden plover and 1,060 dunlin. However the count of 1,158 oystercatcher on 12th February was much higher than the peak count of 510 oystercatcher recorded in the bird report. Numbers of wigeon recorded during the survey were similar to the peak count of 360 wigeon recorded in the bird report.

High tide

5.23 At high tide on the 12th February (13.04 hrs) the vast majority of birds was observed on saltmarsh and grazing marsh on the south bank of the River Stour (Flocks 3, 4 and 5 – 2,907 lapwings). A smaller flock of 170 lapwings was located within the larger area of saltmarsh on the north side of the River Stour. A medium-sized flock of 600 oystercatcher (Flock 7) was recorded roosting at Shellness.

5.24 At high tide on the 13th February (13.45 hrs) large flocks of birds were again observed on the saltmarsh and grazing marsh on the south side of the River Stour although considerably fewer lapwing were recorded and golden plover were the dominant species (Flock 1 – 850 golden plover, 300 curlew and 158 lapwing). A medium-sized flock of lapwing (Flock 3 – 350 birds) was present in place of the oystercatchers in the same location the previous day. In addition to this a large mixed flock of 1,400 birds (Flock 6 – predominately lapwing and dunlin with some bar-tailed godwit and grey plover) was present just to the east of the saltmarsh at the north end of the country park. At one stage a large flock of 3,650 birds (Flock 5 – mostly lapwing with some golden plover) was observed flying in large arcs over the large area of saltmarsh to the north of the Stour.

Mid tide

5.25 At mid tide on the 12th of February large numbers of birds were still roosting or feeding immediately east of the saltmarsh at the south end of the bay. The largest aggregation of birds was roosting on the north bank of the River Stour (Flock 6), birds present including 1,100 oystercatcher. Three medium-sized flocks were also present in this general location (Flocks 7, 9, 10 – a combined total of 1,840 lapwing). Two other medium-sized flocks were in different locations on the mudflats near the saltmarsh edge to the north (Flock 18 – 122 dunlin with smaller numbers of grey plover and knot) and to the south (Flock 22 – 300 lapwing) of the former hoverpad. Finally a dispersed flock of wigeon was present on the sea just to the south of the River Stour (Flocks 1 and 2 – combined total of 330 wigeon).

5.26 At mid tide on the 13th February 2009 the distribution of the larger flocks of birds had shifted northward by approximately 500 metres so that the majority of birds were on the mudflats just east of the country park (Flocks 3 to 6 – 1,500 lapwing and 1,500 golden plover with 150 dunlin). A flock of 400

roosting oystercatcher had moved from Shellness just south of the River Stour. Lapwing and bar-tailed godwit medium-sized flocks were feeding in the centre of the bay (Flocks 8 and 9 – 155 lapwing and 170 bar-tailed godwit). Flocks of wigeon were on the sea (Flock 12) with 120 dunlin and smaller numbers of other waders feeding on the tideline at the north end of the bay as the tide was coming in.

Low tide

5.27 At low tide on 12th February 2009 (0750 hrs – surveyed between 08.30 and 09.30 hours) the vast majority of birds was roosting on the large area of saltmarsh at the south end of the bay (Flocks 1, 2, 3 and 4 – 2,300 lapwings). Small and moderate-sized flocks were also roosting or feeding on the mudflats on the periphery of saltmarsh east of the country park (Flocks 5 and 6 – 345 lapwing and 450 golden plover). A number of small flocks or groups of birds was observed across the intertidal mudflats on both sides of the River Stour. It is not clear why the majority of birds was not feeding on the mudflats at low tide. It is possible that the birds had not yet left their night time roosts since sunrise was at approximately 0714 hrs on the 12th February 2009.

5.28 At low tide on 13th February 2009 (08.29 hrs – surveyed between 08.45 and 09.45 hours, the majority of birds was observed on the mudflats, either along the tideline at the north end of the bay or just beyond the saltmarsh to the east of the country park. The large flock on the tideline consisted predominately of lapwing along with several hundred dunlin, oystercatcher and curlew along with smaller numbers of knot and shelduck (Flock 18). The two large flocks east of the country park included 2,650 lapwing and 1,700 golden plover (Flocks 4 and 5). Three medium-sized flocks were observed in the centre of the Bay; birds present including 650 lapwing, 250 dunlin, 1432 knot and 42 grey plover (Flocks 1, 15 and 16). A flock of 130 oystercatcher was observed on the tideline immediately south of the Stour.

March 2009

5.29 The distribution of waders and wildfowl on 24th March 2009 is illustrated in drawing G1430.01.006.

5.30 The most numerous bird recorded at this time was curlew (208 birds) followed by oystercatcher (150 birds) and redshank (48 birds). Survey conditions on 24th March were good with little wind and good visibility. No lapwings or golden plover were present at Pegwell Bay on 24th March 2009.

5.31 Counts obtained on 24th March 2009 were generally equal to half of the peak counts stated in the Pegwell Bay Bird Report 2009. The peak counts for curlew, oystercatcher and redshank in March 2009 were 340 curlew, 370 oystercatcher and 125 redshank.

High tide

5.32 At high tide on the 24th March (10.01 hrs – observed 10.00 hrs to 11.00hrs) the majority of birds were roosting in a dense flock on the saltmarsh and adjacent grassland on the south bank of the Stour (Flock 1 – 156 curlew and 42 shelduck). Smaller groups on the main area of saltmarsh to the north of the Stour included mostly curlew (Flock 2 – 90 curlew).

Mid tide

5.33 At mid tide (observed 13.00 hrs to 14.00 hrs) the majority of the curlew roosting on the saltmarsh on the south bank of the Stour had not yet moved onto the exposed mudflats (Flock 2 – 121 curlew and 28 shelduck). Numerous small flocks of birds had moved into the bay to feed including 100 oystercatcher and much smaller numbers of shelduck, curlew, dunlin and redshank. Other small aggregations of birds were present on the east fringes of the saltmarsh at the south end of the bay, including 75 oystercatcher and much smaller numbers of curlew, bar-tailed godwit, Brent geese (7 birds) and shelduck.

Low tide

5.34 At low tide (16.54 hrs – observed 15.00 hrs to 16.00 hrs) birds were widely dispersed across much of the bay. Birds appeared to favour the areas of mudflats just north of the Stour and also east of the saltmarsh on the upper shore. Nearly all of the birds using the saltmarsh on the south bank of the Stour had left this area, with the exception of 13 shelduck and smaller numbers of curlew and Brent geese (3 birds).

May 2009

5.35 The distribution of waders and wildfowl on 7th May 2009 is illustrated in drawing G1430.01.007.

5.36 The most numerous bird recorded at this time was oystercatcher (185 birds) followed by shelduck (76 birds) and sandwich tern (43 birds). Counts obtained on 7th May were comparable with those given in the Pegwell Bay bird report which states that peak counts were 151 for oystercatcher and 103 for shelduck although the peak count for sandwich tern was 140 terns on 18th May.

5.37 Spring migrants on 7th May were only recorded in very low numbers with 1 grey plover and 6 ringed plover being recorded. According to the Pegwell Bay Bird Report the peak count for grey plover was 70+ birds on 15th May. The spring passage of ringed plover occurred between 12th and 21st May, with a peak count of 420 birds being recorded on 14th May.

High tide

5.38 At high tide (10.51 hrs) the vast majority of birds was observed near Shellness on the south side of the River Stour (Flock 2 – mostly oystercatcher and sandwich tern). Small numbers of individuals of redshank, curlew, oystercatcher and grey plover were observed within the large area of saltmarsh on both sides of the Stour.

Mid tide

5.39 At mid tide the majority of birds was on mudflats on the tideline, especially within the north half of the Bay where 148 oystercatcher were observed (Flock 10). Small numbers of sanderling (29 birds), dunlin, ringed plover, bar-tailed godwit, curlew and shelduck were also observed along the tideline. Very small numbers of oystercatcher, shelduck and redshank continued to use the large area of saltmarsh at mid tide.

Low tide

5.40 The low tide count on 7th May 2009 was undertaken between 15.30hrs and 16.30hrs, which was approximately one and a half hours prior to actual low tide (17.58 hrs). Therefore it is likely that the bird distribution on this count was not fully representative of low tide.

5.41 The majority of birds at this time were still on the mudflats of the mid shore rather than moving onto the lower shore with the receding tide (Flock 8 – 116 oystercatcher, 43 sandwich terns and 6 bar-tailed godwits). A small group of 43 shelduck had remained on the upper shore to the east of the country park. Several small groups of birds were observed on the south bank of the Stour including dunlin (24 birds) and smaller numbers of curlew, shelduck, oystercatcher and cormorant.

6.0 IMPLICATIONS AND RECOMMENDATIONS

The Ornithological Importance of the Pegwell Bay

6.1 The Sandwich Bay and Hacklinge Marshes SSSI is partly designated because it supports nationally important numbers of grey plover and sanderling during the winter period and nationally important numbers of ringed plover during the migration periods. The Thanet Coast and Sandwich Bay SPA qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the migratory species, turnstone.

6.2 The Thanet Coast and Sandwich Bay Ramsar site supports nationally important numbers of greenshank during the migration periods. In addition to this, the 5-year peak mean average counts for lapwing and golden plover within Pegwell Bay (03/04 – 07/08) exceeds the national GB threshold of 6,200 and 4,000 birds respectively.

The Findings of the 2008-09 Winter Bird Survey

Wader peak counts in winter 2008-09

6.3 None of the birds observed within the Pegwell Bay survey area in winter 2008-09 were recorded at numbers exceeding GB thresholds, as defined by the BTO.

6.4 It is accepted that since wildfowl and wader counts were only undertaken once each survey month, and twice in February 2009, it is unlikely that monthly peak counts were recorded during survey days. It is known that monthly peak counts within the Pegwell Bay Bird Report often exceeded those recorded during survey days. References to peak counts within the Pegwell Bay Bird Reports have occasionally been included to provide more insight into establishing at which times the Pegwell Bay supports large numbers of birds during the typical year. However the detailed information on wader and wildfowl distribution gather during the winter 2008-09 survey has been invaluable in identifying sensitive locations within the Pegwell Bay. These locations should be avoided, where possible, during future cable laying related activities.

6.5 The Pegwell Bay bird populations will be most sensitive to disturbance during certain periods in the year, especially the winter months October to February during which large numbers of important wader species are present (lapwing, golden plover, turnstone and grey plover). The main migratory species which use the Pegwell Bay (turnstone, sanderling and grey plover) tend to peak during the spring migration in May although a more prolonged ringed plover/turnstone autumn migration occurs over several weeks in August and also September.

6.6 This information strongly indicates that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May. It is recommended construction related activities on the mudflats of the Pegwell Bay avoid these periods where timescales allow. Furthermore it is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance.

Wader and wildfowl distribution in winter 2008-09

6.7 It is clearly apparent from the findings of the 2008-09 winter bird survey that although waders and wildfowl make use of the majority of the mudflats and saltmarsh within the Pegwell Bay, certain areas are especially important for feeding and roosting. Each of these sensitive areas is described below.

Mudflats near the north bank of the River Stour

6.8 The areas of mudflat along the north bank of the River Stour are regularly used by large flocks of waders and wildfowl during mid tide and low tide periods. It is recommended that no works are undertaken within 500 metres (minimum) of the north bank of the River Stour to ensure that birds feeding and roosting in this location are not displaced or prevented from feeding.

Large area of saltmarsh located immediately to the east of Stonelees

6.9 The large area of saltmarsh located immediately to the east of the area known as Stonelees is regularly used at high tide by medium-sized flocks of curlew and lapwing. The east extremity of this area, adjacent to the River Stour, also functions as an important roost site for oystercatcher during the mid tide period. It is also known that this large area of saltmarsh is used by breeding redshank during the period April to July.

Saltmarsh and grazing marsh located on the south bank of the River Stour

6.10 The saltmarsh and grazing marsh located on the south bank of the River Stour functions as the main roost site for a range of wader and wildfowl species during high tide, species including golden plover, lapwing, curlew, wigeon and shelduck among other.

Shellness

6.11 The area of sandy/shingle shore known as Shellness on the south bank of the River Stour is an important roosting site for a range of wader species including oystercatcher, lapwing, golden plover and dunlin.

Mudflats located to the east of the bird hide at the south end of the Pegwell Bay country park

6.12 The mudflats to the east of the bird hide at the south end of the Pegwell Bay country park are regularly used by a wide range of wader and wildfowl species for both roosting and feeding. This area is especially important at the stage after high tide when the first areas of mudflats are becoming exposed. This area was subject to intensive management works during the year previous to the survey during which large areas of cordgrass *Spartina* sp. were mown providing access to new areas of mudflats for feeding.

6.13 During the winter 2008-09 survey there was some evidence to suggest that the areas of mudflats near the former hoverpad are sometimes used by roosting golden plover at any time during the tide cycle (see Drawing G1430.01.001 – November 2008). However local ornithologists note that the use of this location during states of the tide other than high tide is uncharacteristic suggesting that the birds were being displaced from the mudflats by bait diggers (Pegwell Bay Bird Report, 2009).

Recommendations

6.14 This information strongly indicates that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May. It is recommended construction related activities on the mudflats of the Pegwell Bay avoid periods October to February and May where timescales allow. Furthermore it is strongly advised that no construction activities are undertaken in February when wintering birds will be especially sensitive to losing valuable feeding time due to disturbance (Stillman and Goss-Custard, 2002).

6.15 It is strongly recommended that the sensitive areas described above are avoided during cable laying activities regardless of time of year since these areas are likely to be of importance for birds throughout the year. Considering all of these sensitive areas as a whole strongly indicates that the cable laying activities proposed would be less disturbing for the birds if the works are undertaken in the north half of the Pegwell Bay.

6.16 It should be noted that the area of shore known as Cliffsend is a turnstone high tide roost of some importance throughout much of the year. Therefore any proposed works in this location should be undertaken in as short a timeframe as possible.

7.0 REFERENCES

HOLT, C.; AUSTIN, G.; CALBRADE, N.; MELLAN, H.; THEWLIS, R.; HALL, C.; STROUD, D.; WOTTON, S.; AND MUSGROVE*, A*. (2009) *Waterbirds in the UK 2007/08 - The Wetland Bird Survey,* WEBS.

MILTON, P., (2008) Pegwell *Bay Report 2007 and 2008.*

MILTON, P., (2008) Pegwell *Bay Report 2009.*

STILLMAN, R. A. AND GOSS-CUSTARD, J. D. 2002. *Seasonal changes in the response of oystercatchers Haematopus ostralegus to human disturbance*. – J. Avian. Biol. 33: 358–365.

UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

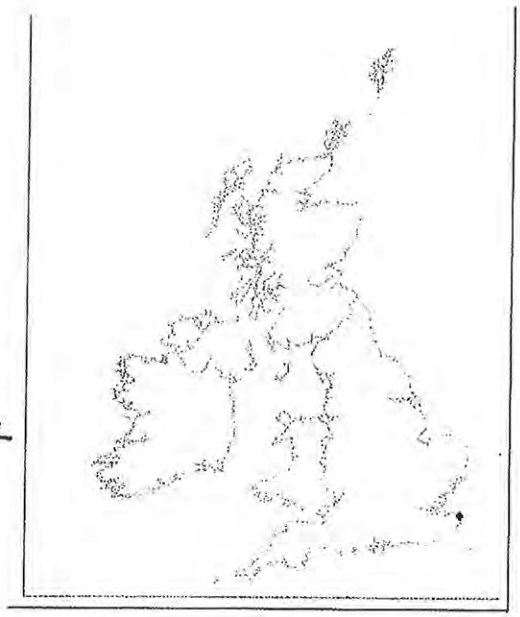
APPENDIX 1
Desktop Information and protected site citations

SPA description

(information as published 2001)

Thanet Coast and Sandwich Bay

Country	England
Unitary Authority	Kent
SPA status	Classified 28/07/1994
Latitude	51 18 18 N
Longitude	01 22 47 E
SPA EU code	UK9012071
Area (ha)	1870.16
Component SSSI/ASSIs	Sandwich Bay to Hacklinge Marshes Thanet Coast



Thanet Coast and Sandwich Bay SPA is located at the north-eastern tip of Kent in southern England. It is a coastal site consisting of a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh. The site holds important numbers of Turnstone *Arenaria interpres*, and is also used by large numbers of migratory birds as they make landfall in Britain in spring or depart for continental Europe in autumn.

Qualifying species
For individual species accounts visit the Species Accounts section

This site qualifies under **Article 4.2** of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:

Over winter;

Turnstone *Arenaria interpres*, 940 individuals representing at least 1.3% of the wintering Western Palearctic - wintering population (5 year peak mean 1991/2 - 1995/6)

Note:

Many designated sites are on private land: the listing of a site in these pages does not imply any right of public access.

Note that sites selected for waterbird species on the basis of their occurrence in the breeding, passage or winter periods also provide legal protection for these species when they occur at other times of the year.

COUNTY: KENT SITE NAME: SANDWICH BAY AND HACKLINGE MARSHES

DISTRICTS: THANET/DOVER

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: THANET DISTRICT COUNCIL/DOVER DISTRICT COUNCIL

National Grid Reference: TR 353585 Area: 1756.5 (ha.) 4338.6 (ac.)

Ordnance Survey Sheet 1:50,000: 179 1:10,000: TR 35 NE, NW, SE, SW; TR 36 SW, SE

Date Notified (Under 1949 Act): 1951 Date of Last Revision: 1981

Date Notified (Under 1981 Act): 1984 (part) 1985 (part) 1990 Date of Last Revision: 1994

Other Information:
Parts of the site are listed in 'A Nature Conservation Review' and in 'A Geological Conservation Review'[2]. The nature reserve at Sandwich Bay is owned jointly by the Kent Trust for Nature Conservation, National Trust and Royal Society for the Protection of Birds. The site has been extended to include a Kent Trust designated Site of Nature Conservation Interest known as Richborough Pasture and there are several other small amendments.

Reasons for Notification:
This site contains the most important sand dune system and sandy coastal grassland in South East England and also includes a wide range of other habitats such as mudflats, saltmarsh, chalk cliffs, freshwater grazing marsh, scrub and woodland. Associated with the various constituent habitats of the site are outstanding assemblages of both terrestrial and marine plants with over 30 nationally rare and nationally scarce species, having been recorded. Invertebrates are also of interest with recent records including 19 nationally rare[3], and 149 nationally scarce[4] species. These areas provide an important landfall for migrating birds and also support large wintering populations of waders, some of which regularly reach levels of national importance[5]. The cliffs at Pegwell Bay are also of geological interest.

Biological Interest
The sand dunes which stretch from the mouth of the River Stour to Deal comprise the most outstanding botanical habitat within the site. The dunes and associated dune slacks and coastal grassland support a distinctive flora with species including crown garlic *Allium vineale*, viper's bugloss *Echium vulgare*, sea holly *Eryngium maritimum* and restharrow *Ononis repens*, whilst the nationally

rare[3] lizard orchid *Himantoglossum hircinum* and bedstraw broomrape *Orobanche caryophyllacea* have their largest British colonies here. Many continental species have been recorded from the dunes and the dune grassland also support a high diversity of clover *Trifolium* species and many other leguminous plants.

The dunes support a diversity of invertebrates many of which are associated with warm dry conditions and include the nationally rare[3] carthusian snail *Monacha cartusiana* and the nationally scarce[4] grey bush cricket *Platycleis albopunctata.* The nationally rare[3] moths restharrow *Aplasta ononaria*, pygmy footman *Eilema pygmaeola pygmaeola* and brightwave *Idaea ochrata* have also been recorded, whilst one of the damp hollows supports the only British colony of the moth *Stigmella zelleriella*, the larvae of which mine in leaves of creeping willow *Salix repens var. argentea.*

The chalk coastline around Pegwell Bay comprises a considerable diversity of cliff and cave habitats which support a range of marine algal communities. The area is the type locality for one algal genus and three species new to science *Chrysonema, C. littorale*; *Chrysotila lamellosa, Chrysotila stipitata* and is one of the sites where Anand (1937) undertook pioneer ecological investigations. Typical chalk-cliff zonation comprises a 'Chrysophyte' zone (mainly *Apistonema carterae*) at supralittoral levels. *Enteromorpha* spp. and other green algae and the lichen *Arthropyrenia halodites* at upper littoral levels; a turf of small filamentous red, brown and green algae is predominant at lower levels. The caves contain 'Chrysophyte' communities with species such as *Chrysonema litorale* and *Thallochrysis littoralis*, together with other typical cave species such as *Pilinia rimosa* and *Pseudendoclonium submarinum.*

Foreshore algal communities are typical of wave-washed shores, low in species diversity, although a unique feature (not seen on other chalk platforms in southeast England) of lower littoral levels is the dense population (zone-forming) of the Sand-Mason worm *Lanice conchilega* forming a bank extending for 100 m by the Ramsgate Western Esplanade.

The saltmarsh comprises a diversity of characteristic plants dominated by salt-marsh grasses such as *Puccinellia maritima* and common cord-grass *Spartina anglica.* Other abundant species include sea purslane *Halimione portulacoides*, sea aster *Aster tripolium*, sea lavender *Limonium vulgare* and the nationally scarce[4] golden samphire *Inula crithmoides.* South of the River Stour saltmarsh grades into the sand dune system; this is the only Kent site for the long-bracted sedge *Carex extensa*, and also provides suitable conditions for a dense growth of the nationally scarce[4] sharp rush *Juncus acutus.* Below the cliff at Cliffsend Point, where freshwater springs emerge at the foot of the cliff, the saltmarsh grades into a swampy type of vegetation where common reed *Phragmites australis* and common reedmace *Typha latifolia* predominate.

Further inland, the grazing marsh and associated dykes provide suitable conditions for a wide range of plants and animals. The grassland is dominated by

grasses such as meadow barley *Hordeum secalinum*, meadow foxtail *Alopecurus pratensis* and crested dog's tail *Cynosurus cristatus*. Some of the more uncommon broadleaved herbs that have been recorded, especially narrow leave bird's-foot-trefoil *Lotus tenuis*, adder's tongue *Ophioglossum vulgatum*, strawberry clover *Trifolium fragiferum* and divided sedge *Carex divisa*[4]. A more unusual vegetation type found within the site is the relict fen vegetation. This is found in and around the dykes of the farmland and in the marshes at Hacklinge. Fen plants such as ragged robin *Lychnis flos-cuculi*, bog pimpernel *Anagallis tenella* and greater spearwort *Ranunculus lingua* occur here, most of these are now scarce in Kent. In addition the dykes contain a number of scarce aquatic plants including whorled water-milfoil *Myriophyllum verticillatum*[4], fen pondweed *Potamogeton coloratus*[4] and river water-dropwort *Oenanthe fluviatilis*[4]. This area is also the only known locality in SE England for least bur-reed *Sparganium minimum*. The wet alder wood at Ham Brooks also contains uncommon plants including great fen-sedge *Cladium mariscus*.

The ornithological interest of Sandwich Bay and Hacklinge Marshes is centred on the large numbers of waders and wildfowl which use the area in winter and during the Spring and Autumn migrations. Dunlin *Calidris alpina* is usually the most common wader present, found particularly on the mudflats where the rich invertebrate fauna also attracts a wide range of other common species such as oystercatcher *Haematopus ostralegus*, curlew *Numenius arquata*, and redshank *Tringa totanus*. Grey plover *Plurialis squatarola* and sanderling *Calidris alba* both overwinter in nationally important numbers[5], whilst ringed plover *Charadrius hiaticula* also occurs in nationally important numbers[5] during migration. Wildfowl that occur on the site include mallard *Anas platyrhynchos*, shelduck *Tadorna tadorna* and occasionally brent goose *Branta bernicla*.

Many of the birds use more than one habitat, some for example feed on the mudflats at low tide and then move up to roost on the saltmarsh or grazing marsh.

Breeding birds include ringed plover, oystercatcher and little tern *Sterna albifrons*, a species specially protected by law and listed on Schedule 1 of the Wildlife and Countryside Act 1981. Inland areas are also of interest supporting two nationally rare species of breeding birds.

Geological Interest

Parts of the site are also of geological interest. The 16" shell bed at the base of the Reculver Silts (Thanet Formation) contains an important fish fauna. This is preserved as disarticulated fish debris, including a diversity of identifiable shark teeth. There is no other Thanetian site in Western Europe with this diversity of fauna which includes many, as yet, undescribed species plus the earliest records of other known Tertiary forms. The outcrop has very great significance because it is the only outcrop which shows the bottom living fish assemblage which was subsequently destroyed by the North Sea volcanicity, for the ash falls by these volcanoes brought about an extinction event. Interesting conclusions can be drawn from this local extinction and the later recolonisation of the area; for example unspecialised, bottom living sharks survive across the event, presumably because

a stock that was living elsewhere at the time was able to migrate back to this part of the basin and recolonise.

At Pegwell Bay the Upper Chalk is overlain by the basal Tertiary beds of the Thanet Sands. The junction is marked by the celebrated 'Bull-head Bed', an *in situ* weathering residue of unabraded flint nodules. This is a key section showing a demonstrable and regionally significant unconformity. 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.

1 '*A Nature Conservation Review*': edited by D A Ratcliffe. Cambridge University Press 1979.

2 *A Geological Conservation Review*: in preparation.

3 Species regarded as 'rare' in Britain (recorded from 1–15 10 × 10 km squares) and listed in *British Red Data Books.*

4 Species regarded as 'scarce' in Britain (recorded from 16–100 10 × 10km squares).

5 *Wildfowl and Wader Counts* 1988–1989. D G Salmon et al, Wildfowl Trust 1989.

APPENDIX 2
Survey dates and times 2008 - 2009

Appendix 2: **Survey dates and times 2008 - 2009**

Date	Count period	Surveyors	Weather	High tide time	Low tide time
19/11/2008	1030-1530hrs	TR & MW	Dry, cold*, good visibility.	15.40hrs: 5.83 metres	10.25hrs: 1.52 metres
12/12/2008	0900-1500hrs	TR & MW	Dry, mild*, moderate visibility, overcaste 3/8.	09.58hrs: 6.65 metres	17.41hrs: 1.08 metres
08/01/2009	0830-1430hrs	TR & MW	Dry, mild, foggy, poor visibility in afternoon.	07.45hs: 5.94 metres	15.16hrs: 1.69 metres
12/02/2009	0830-1645hrs	TR & LG	Dry, cold, good visibility, wind force 3-4.	13.04hrs: 7.04 metres	07.50hrs: - 0.01 metres
13/02/2009	0845-1645hrs	TR & LG	Dry, cold, moderate visibility, overcaste 6/8, wind force 2.	13.45hrs: 6.84 metres	08.29hrs: 0.19 metres
24/03/2009	0900-1600hrs	TR & LG	Dry, mild, wind force 1, overcaste 7/8, good visibility.	10.01hrs: 5.70 metres	16.54hrs: 1.40 metres
07/05/2009	0930-0630	TR & LG	Dry, warm, wind force 1, good visibility.	10.51hrs	17.58hrs

TR = [redacted] MIEEM, CEnv; MW = [redacted]; LG = [redacted] AIEEM.

*Cold means that the temperature was generally 5 degrees Celsius or lower. Mild means that the temperature was generally above 5 degrees Celsius.

APPENDIX 3
Pegwell Bay winter bird survey total counts 2008 - 2009

Appendix 3 - Pegwell Bay winter bird survey total counts 2008-09 - WADERS

Date	Period	Time	OC	RK	SS	DN	KN	BA	GP	L	CU	GV	TT	RP
19/11/2008	1030-1530hrs	Low	112	29	0	1090	70	0	2850	1869	165	29	0	0
		Mid	227	83	0	826	130	0	710	2560	261	15	0	0
		High	624	0	0	0	0	0	750	1150	20	0	0	0
12/12/2008	0900-1500hrs	High	103	12	0	30	0	0	0	715	98	0	0	0
		Mid	76	16	37	741	65	79	600	1242	70	46	0	0
		Low	61	9	63	751	1	31	1380	1321	18	19	0	0
08/01/2009	0830-1430hrs	High	40	71	0	140	0	0	350	45	35	0	0	0
		Mid	151	6	0	146	0	30	0	0	30	58	0	19
		Low	162	1	6	165	0	10	0	0	31	12	0	0
12/02/2009	0830-1645hrs	Low	51	16	0	76	0	0	450	2945	68	0	0	0
		Mid	1158	12	0	502	69	1	220	1400	32	97	0	0
		High	600	3	0	0	0	0	0	4709	50	0	2	0
13/02/2009	0845-1645hrs	Low	454	18	0	550	0	0	1700	3447	291	54	0	0
		Mid	465	12	7	340	45	170	1500	1694	90	190	70	1
		High	0	0	0	500	400	150	850	3100	370	250	0	0
24/03/2009	0900-1600hrs	High	0	0	0	0	0	0	0	0	156	0	0	0
		Mid	150	12	0	5	0	0	0	0	208	0	0	0
		Low	14	21	0	0	0	0	0	0	88	0	0	4
07/05/2009	0930-1630hrs	High	167	5	0	25	1	10	0	0	3	1	0	0
		Mid	185	4	29	22	0	22	0	0	2	0	0	6
		Low	136	0	0	24	0	6	0	0	5	0	0	0

OC=oystercatcher, RK = redshank, SS = sanderling, DN = dunlin, KN = knot, BA = bar-tailed godwit, GP = golden plover, L = lapwing, CU = curlew, GV = grey plover, TT = turnstone, RP = ringed plover. Monthly peak counts for the survey are highlighted in red.

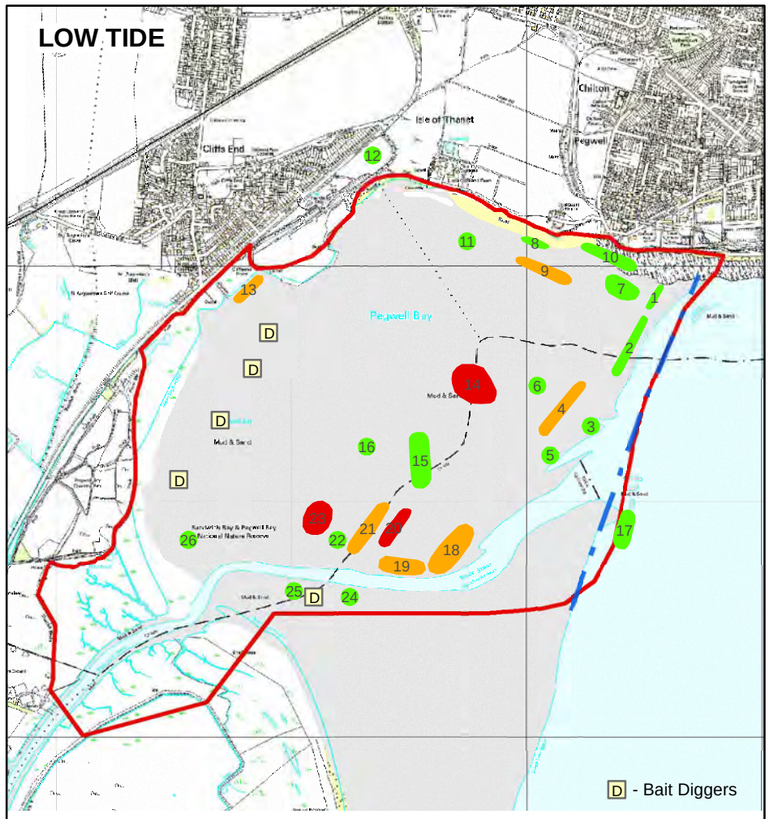
Appendix 3 - Pegwell Bay winter bird survey total counts 2008-09 - WILDFOWL & OTHER SPECIES

Date	Period	Time	T	SU	WN	NB	MA	BG	RH	ET	CA	TE
19/11/2008	1030-1530hrs	Low	0	43	50	0	0	1	0	0	4	0
		Mid	0	64	37	0	5	16	0	1	5	0
		High	0	29	0	0	0	0	0	0	0	0
12/12/2008	0900-1500hrs	High	0	50	90	0	0	1	0	0	0	0
		Mid	100	20	0	0	0	0	0	0	0	0
		Low	0	25	0	0	0	0	0	0	0	0
08/01/2009	0830-1430hrs	High	12	36	0	0	7	0	0	1	0	0
		Mid	0	13	81	0	7	0	4	0	0	0
		Low	13	15	45	0	16	0	0	0	0	0
12/02/2009	0830-1645hrs	Low	15	4	0	0	0	0	0	0	0	0
		Mid	0	12	330	0	0	0	0	0	7	0
		High	60	2	0	0	0	6	0	0	0	0
13/02/2009	0845-1645hrs	Low	0	56	0	0	0	11	0	0	0	0
		Mid	0	20	275	0	0	2	0	0	46	0
		High	4	6	0	0	0	8	0	0	0	0
24/03/2009	0900-1600hrs	High	0	42	0	1	0	3	0	0	3	0
		Mid	0	40	0	0	0	1	0	0	0	0
		Low	0	48	0	0	0	3	0	0	0	0
07/05/2009	0930-1630hrs	High	0	41	0	0	0	0	0	0	0	37
		Mid	0	8	0	0	0	0	0	3	1	5
		Low	0	76	0	0	0	0	0	0	2	43

T = teal, SU = shelduck, WN = wigeon, NB = spoonbill, MA = mallard, BG = Brent goose, RH = red-throated diver, ET = little egret, CA = cormorant.
TE = sandwich tern.

DRAWINGS

LOW TIDE

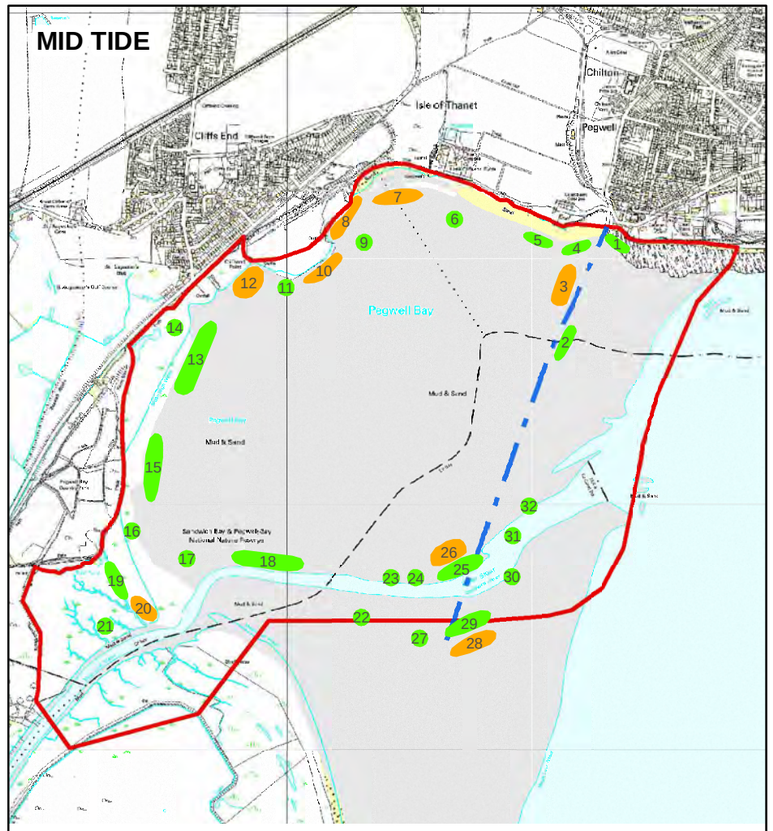


19-11-08 – Low tide (10:26) surveyed 10:30 – 11:30

Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	OC	14		
2	GV	5		
2	CU	26		
2	DN	20		
2	All sp.	65		
3	RK	8		
3	CU	5		
3	GV	3		
3	OC	1		
3	All sp.	17		
4	L	500		
5	GV	10		
5	CU	9		
5	RK	7		
5	CA	4		
5	All sp.	30		
6	SU	30		
7	CU	28		
7	DN	10		
7	All sp.	38		
8	DN	30		
8	CU	1		
8	All sp.	31		
9	CU	3		
9	DN	250		
9	All sp.	253		
10	OC	75		
11	CU	3		
12	L	18		
13	GP	150		

Flock number	Species	Count	Time	Additional notes
14	GP	1000		Increasing to 1900 birds.
14	RK	2		
14	CU	1		
14	OC	2		
14	SU	7		
14	All sp.	1012		
15	L	51		
16	OC	2		
17	WN	50		
18	RK	12		
18	CU	10		
18	DN	320		
18	KN	70		
18	GV	11		
18	All sp.	423		
19	DN	360		
19	CU	4		
19	BG	1		
19	All sp.	365		
20	GP	1100		Same birds as location 14.
21	L	600		
21	OC	13		
21	CU	3		
21	All sp.	616		
22	SU	6		
23	L	700		
23	GP	1600		
23	All sp.	2300		
24	CU	4		
25	OC	5		
26	CU	3		

MID TIDE

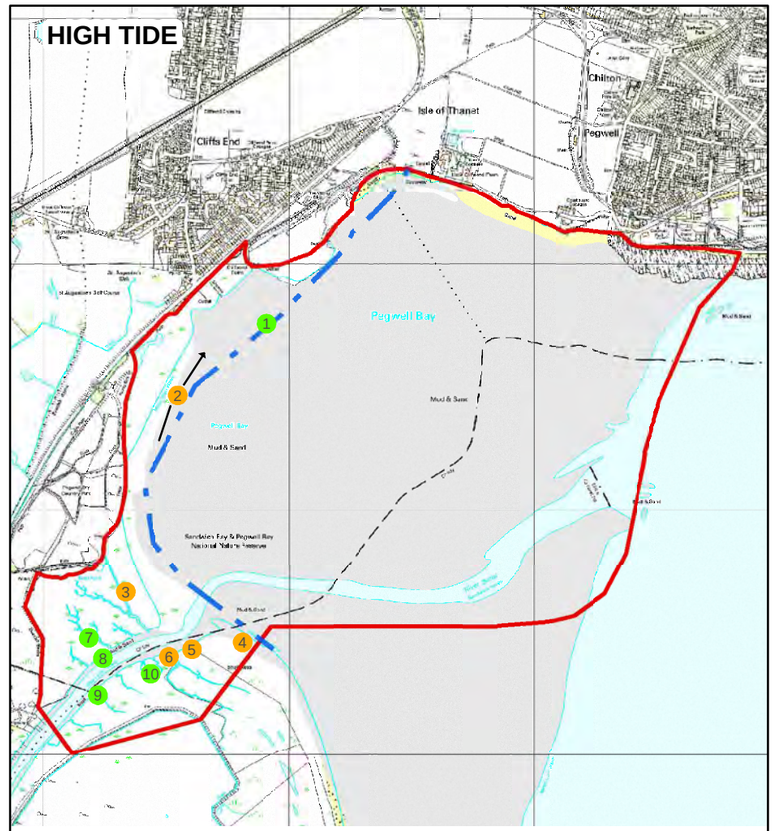


19-11-08 – Mid tide surveyed 12:30 – 13:30

Flock number	Species	Count	Time	Additional notes
1	OC	25		
2	SU	28		
2	BG	12		
2	All sp.	40		
3	CU	18		
3	DN	230		
3	All sp.	248		
4	DN	85		
4	GV	3		
4	All sp.	88		
5	GV	6		
5	CU	5		
5	All sp.	11		
6	GV	2		
6	CU	1		
6	OC	1		
6	All sp.	4		
7	DN	280		
7	GV	2		
7	All sp.	282		
8	L	160		
9	GV	2		
9	CU	2		
9	OC	5		
9	All sp.	9		
10	GP	530		
10	L	50		
10	All sp.	580		
11	OC	10		
11	RK	10		
11	All sp.	20		
12	L	440		
12	GP	180		
12	All sp.	620		
13	L	160		
13	OC	15		
13	CU	2		
13	DN	10		
13	All sp.	187		
14	SN	1		
15	L	650		Flushed at 13:15.
16	OC	16		

Flock number	Species	Count	Time	Additional notes
17	RK	7		
18	RK	55		
18	DN	1		
18	BG	1		
18	All sp.	57		
19	CU	33		
20	CU	165		
21	ET	1		
22	CU	1		
22	SU	5		
22	All sp.	6		
23	CU	11		
23	RK	11		
23	All sp.	22		
24	CU	23		
25	WN	37		
25	MA	5		
25	All sp.	42		
26	L	1100		
26	OC	155		
26	All sp.	1255		
27	KN	60		
28	DN	220		
29	KN	70		
30	CA	2		
31	SU	31		
31	BG	3		
31	All sp.	34		
32	CA	3		

HIGH TIDE



19-11-08 – High tide (15:43) surveyed 15:30 – 16:30

Flock number	Species	Count	Time	Additional notes
1	SG	70	15:39	
2	L	320	15:40	FLYING - northwards.
2	L	300	16:00	FLYING - northwards.
2	All sp.	620		
3	L	150		
4	OC	620		
5	GP	550		
6	GP	200		
6	L	230		
6	All sp.	430		
7	L	40	16:24	
8	SU	29		
9	L	90	16:19	FLYING - northeast.
10	OC	4	16:15	Flew in.
10	L	20	16:15	Flew in.
10	CU	20	16:15	Flew in.
10	All sp.	44	16:15	Flew in.

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Title: Winter Bird Survey Visit 1 - 19/11/2008

Map No. G1430.01.001

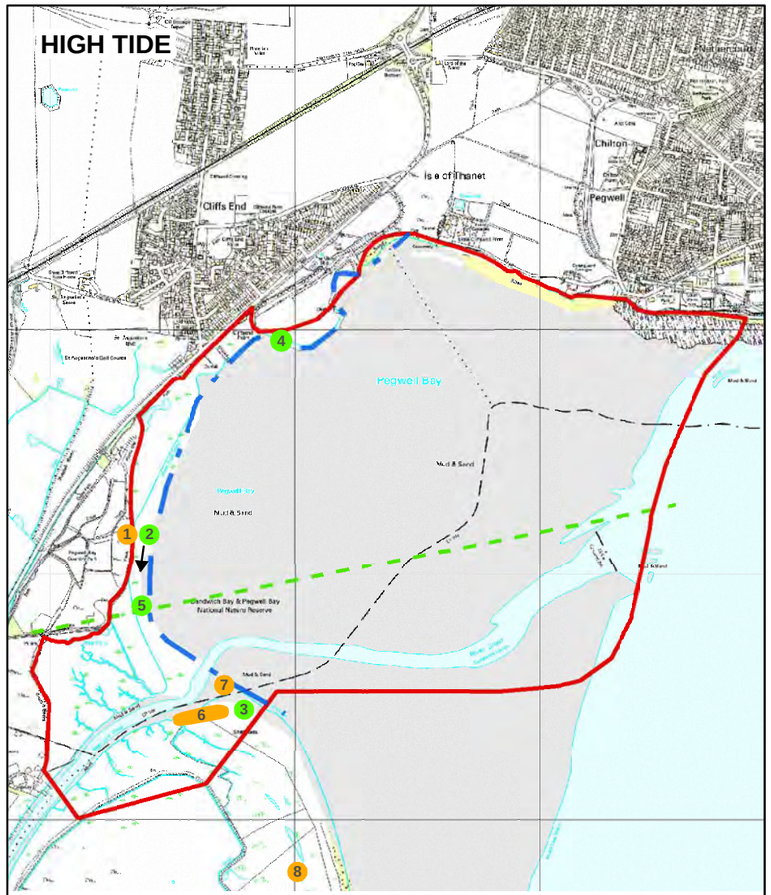
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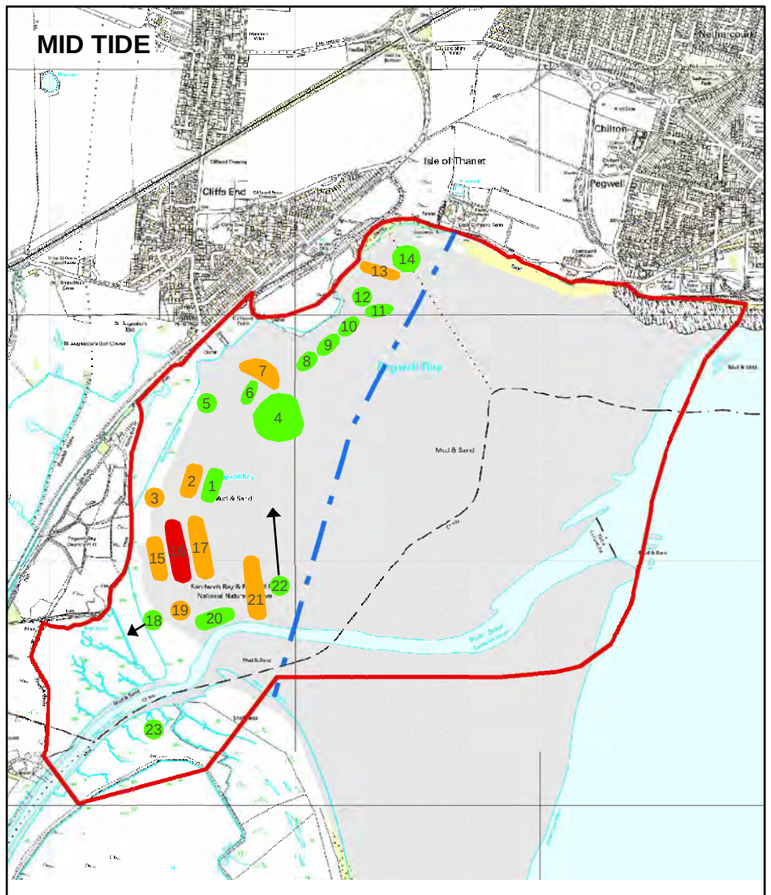
HIGH TIDE



12/12/2008 – High tide (09:58) surveyed 09:00 – 10:00

Flock number	Species (sp.)	Count	Time
1	CU	38	09:09
1	L	205	09:09
1	SU	50	09:09
1	WN	90	09:09
1	DN	10	09:09
1	SN	2	09:09
1	All sp.	395	09:09
2	L	95	09:10
2	SN	2	09:10
2	All sp.	97	09:10
3	L	60	09:12
4	L	240	
4	CU	20	
4	All sp.	260	
5	CU	40	
6	OC	3	
6	L	460	
6	BG	1	
6	AV	1	
6	DN	10	
6	RK	12	
6	All sp.	487	
7	OC	100	
7	DN	10	
7	All sp.	110	
8	L	450	

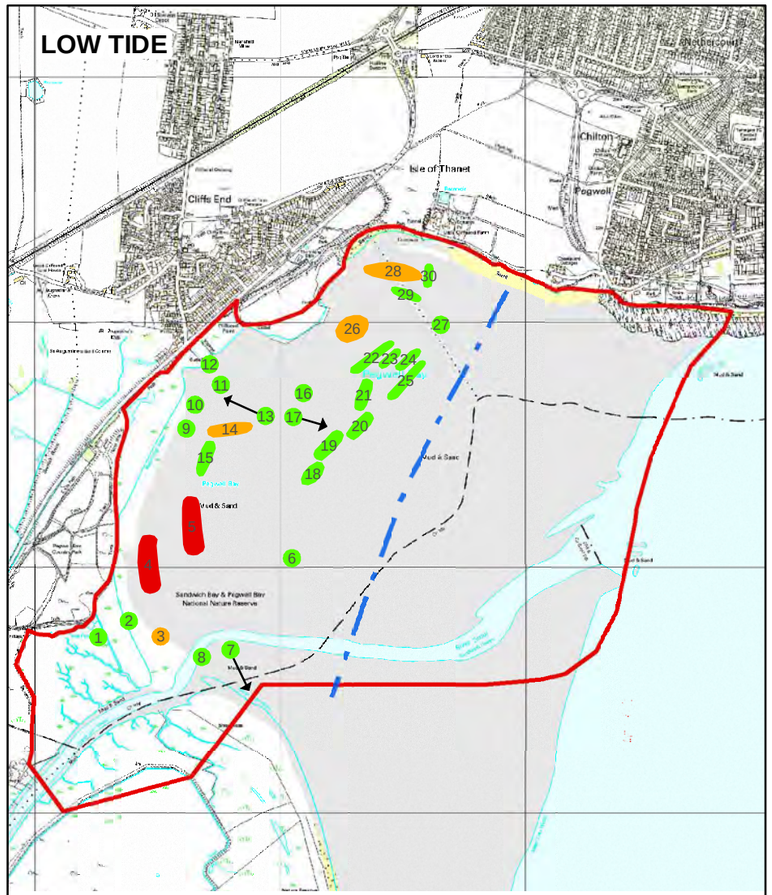
MID TIDE



12/12/2008 – Mid tide 13:00 – 14:00

Flock number	Species	Count	Time	Additional notes
1	SS	32		
2	GP	600		
3	L	7		
4	DN	20		
4	SU	20		
4	BA	9		
4	OC	3		
4	KN	5		
4	CU	14		
4	All sp.	71		
5	DN	9		
5	GV	1		
5	SS	3		
5	All sp.	13		
6	CU	45		
6	GV	3		
6	All sp.	48		
7	DN	500		
7	L	120		
7	All sp.	620		
8	BA	10		
8	SS	1		
8	All sp.	11		
9	BA	60		
10	SU	12		
11	OC	20		
12	OC	12		
13	L	100		
13	CU	1		
13	All sp.	101		
14	OC	28		
15	L	250		
16	L	1380		
17	DN	200		
17	OC	5		
17	L	5		
17	All sp.	210		
18	SS	1		
18	RK	2		
18	All sp.	3		
19	RK	5		
19	DN	12		
19	L	260		
19	KN	12		
19	OC	3		
19	GV	5		
19	All sp.	297		
20	DN	17		
20	GV	2		
20	RK	4		
20	All sp.	23		
21	GV	35		
21	KN	60		
21	OC	5		
21	RK	5		
21	DN	28		
21	All sp.	133		
22	CU	10	13:39	FLYING north.
23	T	100		

LOW TIDE



12/12/2008 – Low tide (17:41) surveyed 14:00 to 15:00

Flock number	Species	Count	Time	Additional notes
1	RK	1	14:59	
2	ET	1		
3	OC	6	14:10	
3	RK	3	14:10	
3	L	212	14:10	
3	CU	1	14:10	
3	DN	5	14:10	
3	All sp	229	14:10	
4	L	280	14:05	
4	DN	190	14:05	
4	GP	1380	14:05	
4	CU	2	14:05	
4	RK	1	14:05	
4	All sp.	1853	14:05	
5	GP	1380		Same birds as location 4.
5	OC	6		
5	L	245		
5	DN	88		
5	All sp.	1719		
6	OC	6	14:15	
6	CU	2	14:15	
6	GV	17	14:15	
6	RK	2	14:15	
6	DN	30	14:15	
6	All sp.	57	14:15	
7	SS	60		
8	ET	1	14:59	
9	OC	3		
10	DN	8		
11	RK	2		
12	OC	4		
13	DN	50		
14	DN	190		
15	OC	5		
16	OC	2		
17	DN	40		
18	BA	31		
19	SU	13		
20	OC	4		
21	SS	3		
22	OC	12		
23	DN	23		
23	KN	1		
23	All sp.	24		
24	SU	12		
25	CU	5		
26	GV	2		
26	DN	70		
26	L	24		
26	All sp.	96		
27	OC	6		
28	L	560		
29	CU	5		
29	DN	40		
29	All sp.	45		
30	CU	3		
30	OC	11		
30	All sp.	14		
31	SS	13	14:40	

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Title: Winter Bird Survey Visit 2 - 12/12/2008

Map No. G1430.01.002

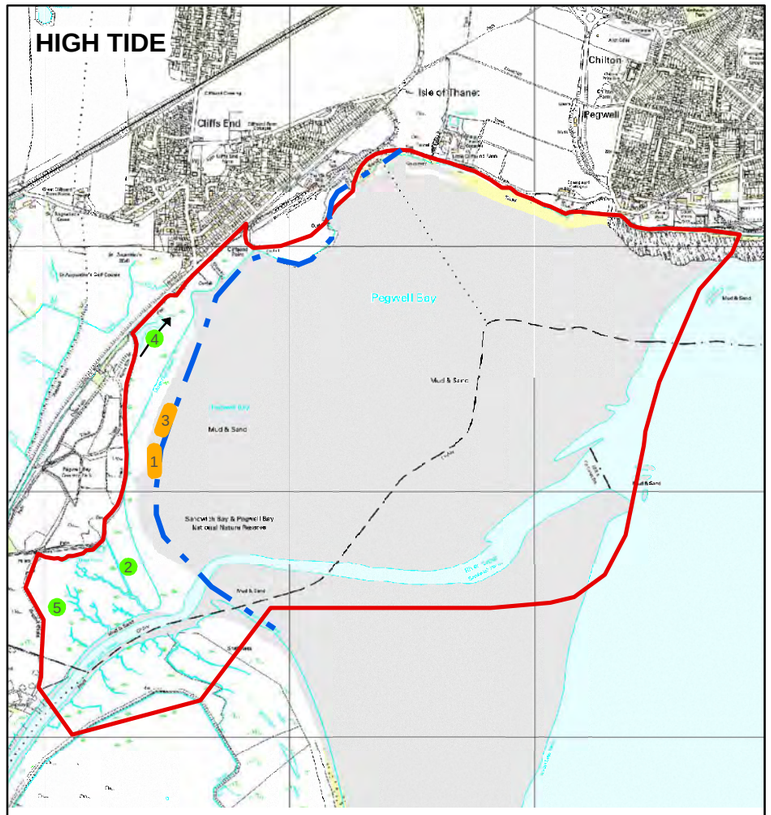
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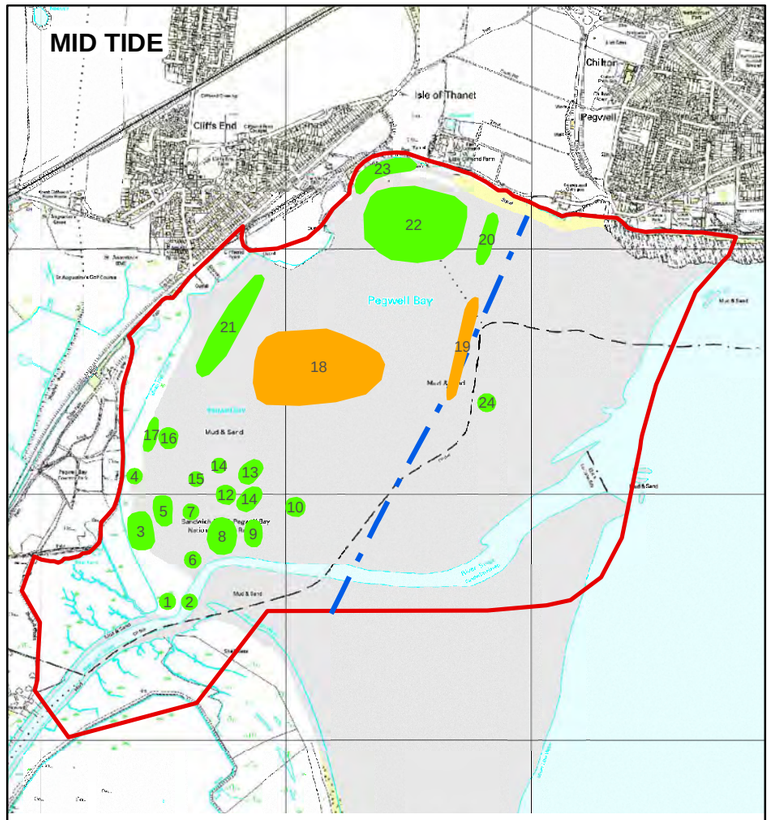
HIGH TIDE



08-01-09 – High tide (07:45) surveyed at 08:30 to 09:30.

Flock number	Species	Count	Time	Additional notes
1	SD	20	08:40	
1	DN	40	08:40	
1	OC	20	08:40	
1	CU	20	08:40	
1	RK	30	08:40	
1	L	30	08:40	
1	GP	300	08:40	
1	All sp.	460	08:40	
2	T	12	08:50	
3	SD	16	09:13	
3	DN	100	09:13	
3	L	15	09:13	
3	GP	50	09:13	
3	OC	20	09:13	
3	CU	15	09:13	
3	RK	40	09:13	
3	All sp.	256	09:13	
4	ET	1	09:30	FLYING – northwards.
5	RK	1	09:16	
5	MA	7	09:04	Flew up and southwards.
5	All sp.	8		

MID TIDE

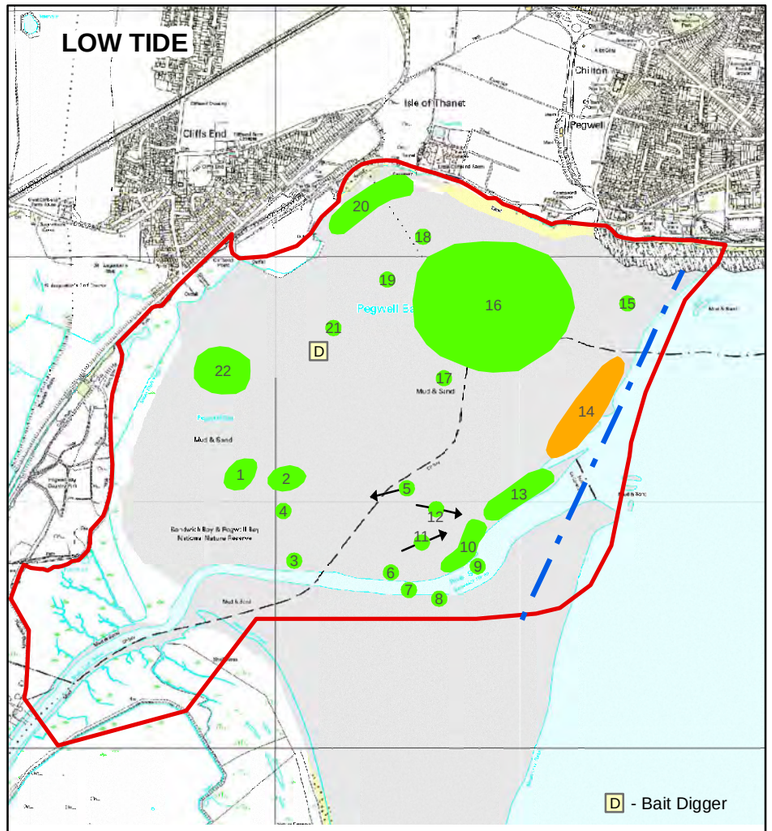


08-01-09 – Mid tide surveyed at 11:30 to 12:30.

Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	SU	4		
3	GV	19		
3	DN	6		
3	All sp.	25		
4	SU	1		
5	DN	6		
5	GV	19		
5	All sp.	26		
6	WN	2		
7	RK	3		
8	DN	9		
8	RP	19		
8	All sp.	28		
9	WN	7		
9	MA	7		
9	All sp.	14		
10	SU	7		
11	DN	50		
12	BA	10		
12	CU	5		
12	All sp.	15		
13	GV	18		
14	OC	5		
15	OC	1		
16	L	70		
17	L	16		
17	DN	5		
17	All sp.	21		
18	OC	10		
18	RK	1		
18	All sp.	11		
19	WN	62		
19	OC	85		
19	CU	18		
19	BA	20		
19	DN	20		
19	All sp.	205		
20	OC	14		
20	CU	6		
20	WN	10		
20	All sp.	30		

Flock number	Species	Count	Time	Additional notes
20	OC	14		
20	CU	6		
20	WN	10		
20	All sp.	30		
21	OC	5		
21	GV	2		
21	DN	50		
21	RK	2		
21	All sp.	119		
22	OC	17		
23	SU	1		
23	OC	14		
23	All sp.	15		
24	RH	4		Swimming south.

LOW TIDE



08-01-09 – Low tide (15:16) surveyed at 13:30 to 14:30.

Flock number	Species	Count	Time	Additional notes
1	OC	6		
2	DN	33		
3	DN	5		
3	OC	2		
3	CU	1		
3	All sp.	8		
4	CU	1		
5	RK	1		Flew up and then went southwest.
6	CU	1		
7	OC	3		
7	CU	1		
7	MA	16		
7	All sp.	20		
8	SU	15		
9	WN	13		
10	DN	8		
10	T	13		
10	OC	21		
10	WN	5		
10	All sp.	47		
11	WN	7		FLYING – east.
12	DN	20		FLYING – southeast.
13	OC	15		
13	GV	12		
13	All sp.	27		
14	WN	20		
14	DN	25		
14	OC	20		
14	CU	25		
14	H	2		
14	BA	10		
14	All sp.	102		

Flock number	Species	Count	Time	Additional notes
15	OC	4		
16	OC	20		
17	SS	3		
18	CU	1		
19	OC	2		
20	SU	2		
20	DN	74		
20	OC	2		
20	CU	1		
20	All sp.	79		
21	SS	3		
21	OC	2		
21	RK	1		
21	All sp.	6		
22	OC	30		

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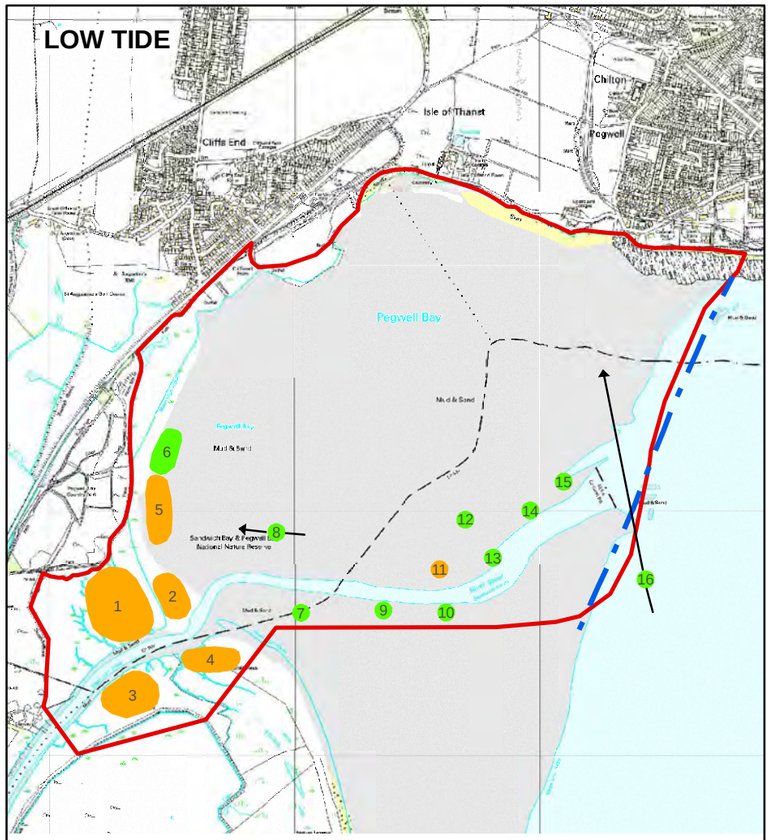
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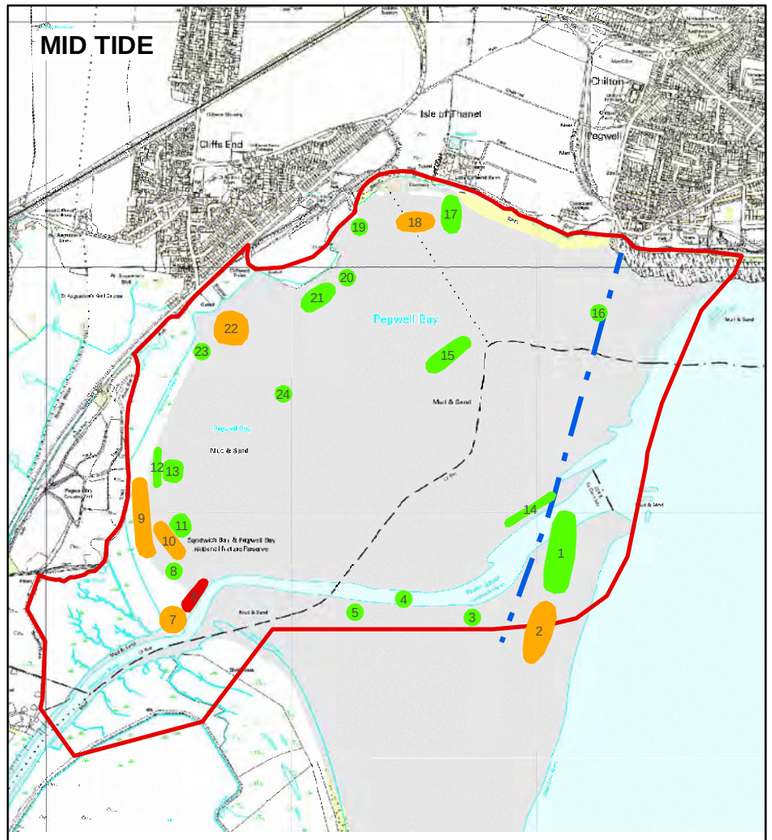
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12-02.09 – High tide surveyed at 12:30 to 13:30.

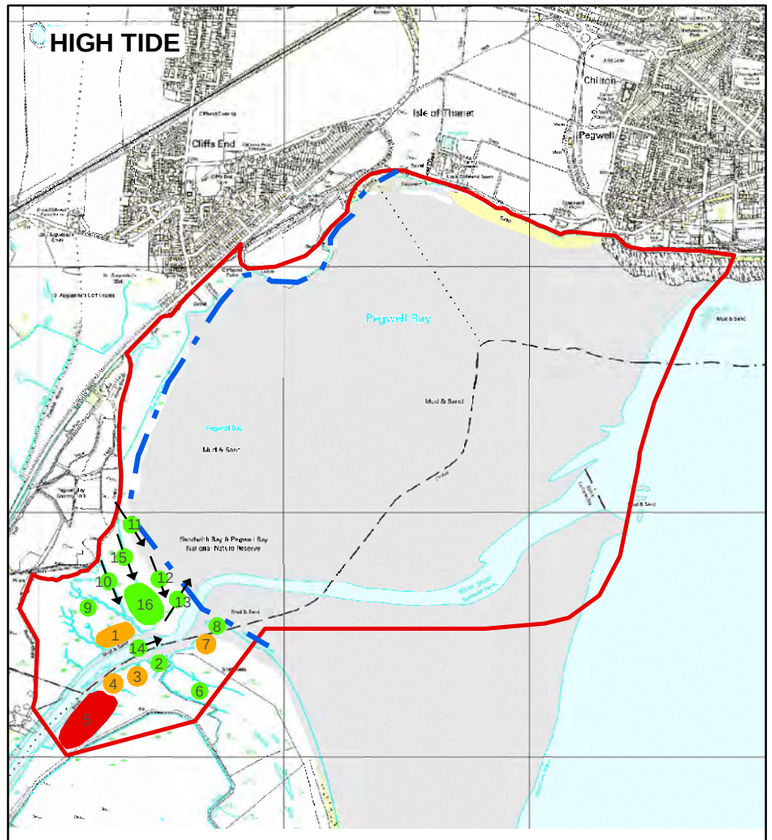
Flock number	Species	Count	Time	Additional notes
1	L	60	12:41	
1	L	110	13:28	Flew in from the North.
1	All sp.	170	13:28	
2	CU	50	12:46	
2	L	18	12:46	
2	All sp.	68		
3	L	250	12:47	Flew onto saltmarsh at location 3.
4	L	300	12:48	
5	L	2350	12:53	
5	SD	2		
5	BG	5		
5	All sp/	2357		
2,3,4,5	L	1400		Flushed up. Several hundred L fly across to 1.
2,3,4,5	GP	1000		Flushed up.
6	L	30	12:47	
7	OC	600		
8	TT	2		
8	RK	3		
8	All sp.	5		
9	L	12	12:38	
10	L	55	13:16	
11	L	67	13:20	FLYING – southeast.
12	L	32	13:02	FLYING – south.
13	BG	1	12:50	FLYING – north.
14	T	60		Flushed up and flew northeast.
15	L	15	13:09	FLYING – southeast
16	L	<10		Various movements of small flocks.



12-02-09 – Mid tide surveyed at 10:45 to 11:45

Flock number	Species	Count	Time	Additional notes
1	WN	80		
2	WN	250		
3	CU	1		
4	OC	8		
5	OC	2		
6	OC	1100		
7	L	300		
8	CU	30		
9	L	800		
10	L	740		
11	GV	2		
11	KN	1		
11	OC	4		
11	BA	1		
11	RK	3		
11	CU	1		
11	DN	2		
11	All sp.	14		
12	GV	10		
12	OC	1		
12	All sp.	11		
13	Gv	10		
13	OC	1		
13	All sp.	11		
14	OC	43		
15	KN	12		
15	DN	18		
15	All sp.	30		
16	CA	3		
16	SU	9		
16	All sp.	72		

Flock number	Species	Count	Time	Additional notes
17	RK	6		
17	CA	4		
17	GP	12		
17	All sp.	22		
18	GP	30		
18	KN	16		
18	DN	122		
18	All sp.	168		
19	RP	1		
20	RK	3		
21	DN	320		
21	KN	25		
21	GV	48		
21	All sp.	565		
22	L	300		
22	GP	8		
22	All sp.	308		
23	SU	3		
24	GV	35		



12-02-09 – Low tide (07:50) surveyed at 08:30 to 09:30

Flock number	Species	Count	Time	Additional notes
1	L	500	08:39	Flushed and flew northwards.
2	L	650	09:12	300 L flushed soon afterwards.
3	L	750	09:14	Flushed soon afterwards.
4	L	400	08:40	250 L flushed soon afterwards.
5	GP	450		
5	L	300		
5	RK	15		
5	All sp.	765		
6	L	45		
6	OC	1		
6	CU	1		
6	All sp.	47		
7	RK	1		
7	OC	1		
7	All sp.	2		
8	DN	26		FLYING - northwest.
9	CU	1		
9	SD	4		
9	All sp.	5		
10	DN	50	08:53	FLYING - west.
11	L	300	09:10	FLYING - east.
12	T	15		FLYING - east
13	CU	2		
13	OC	30		
13	All sp.	32		
14	CU	10		
15	CU	4		
15	OC	19		
15	All sp.	23		
16	CU	50		Flying northwards.

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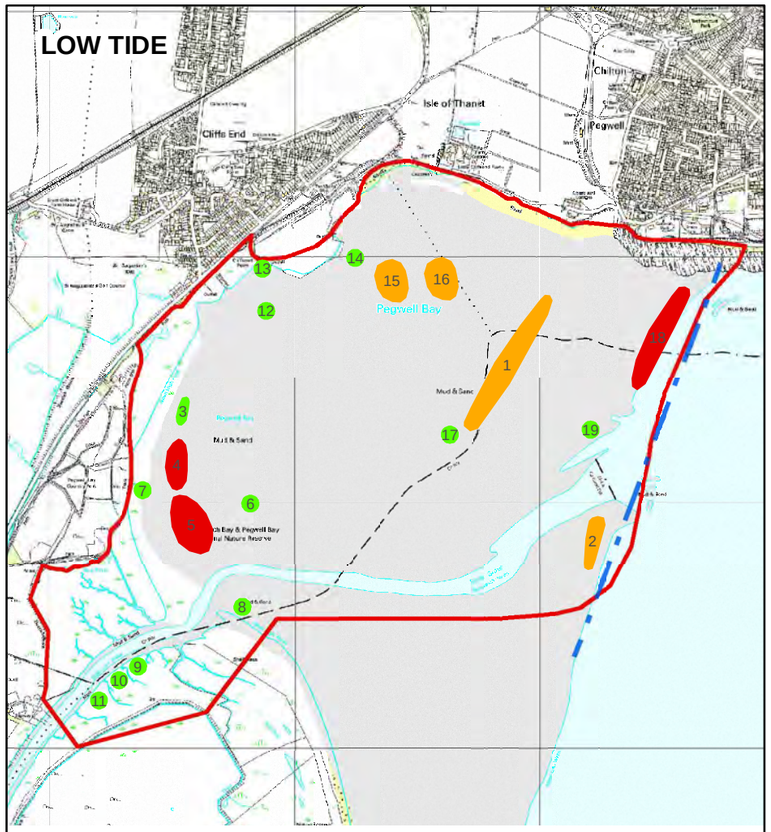
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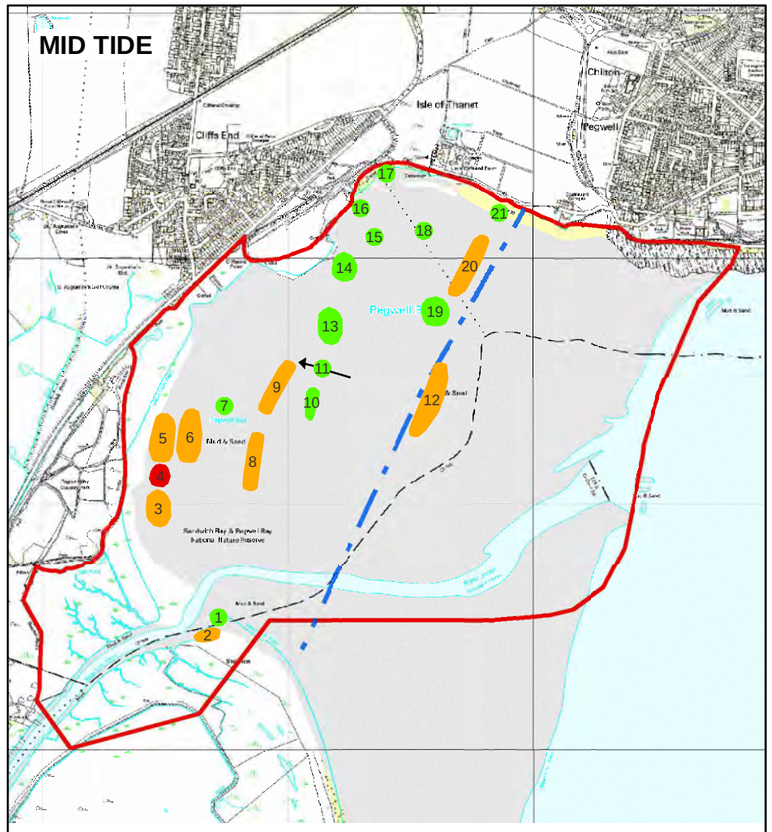
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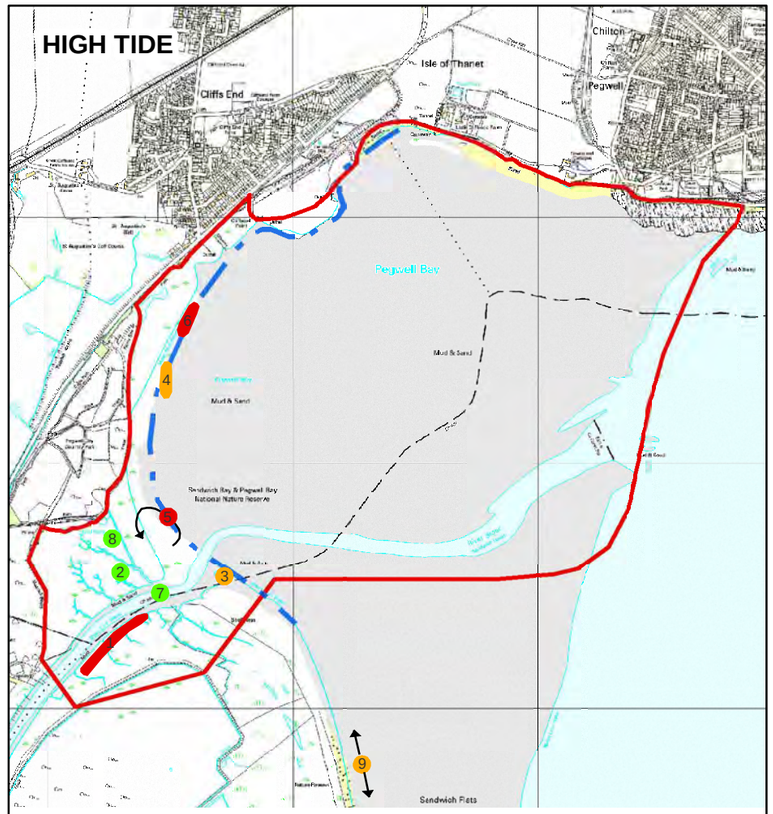
13-02-09 – Low tide (08:30) surveyed 08:45 – 09:45

Flock number	Species	Count	Time	Additional notes
1	L	650		
2	OC	130		
3	L	60		
3	RK	1		
3	All sp.	61		
4	L	850		
4	GP	1460		
4	DN	10		
4	All sp.	2520		
5	L	1800		
5	GP	240		
5	All sp.	2040		
6	CU	6		
6	OC	4		
6	All sp	10		
7	RK	5		
8	SU	12		
8	CU	1		
8	All sp.	13		
9	SU	14		
10	CU	35		
11	BG	11		
12	GV	12		
13	L	60		
14	RK	14		
15	GV	42		
15	DN	270		
15	All sp.	312		
16	KN	142		
17	CU	7		
18	DN	270		
18	SU	13		
18	KN	88		
18	OC	320		
18	CU	242		
18	L	677		Same birds as in loc. 1.
18	All sp.	1610		
19	SU	17		



13-02-09 – Mid tide surveyed 11:30 to 12:30

Flock number	Species	Count	Time	Additional notes
1	CU	90		
1	L	5		
1	All sp.	95		
2	OC	400		
3	L	700		
4	GP	1500		
5	L	800		
6	DN	180		
6	GV	30		
6	OC	5		
6	All sp.	215		
7	KN	10		
8	L	155		
9	BA	170		
10	SU	20		
11	BG	2		Flew southwards.
12	WN	275		Mostly on the sea.
13	GV	45		
14	DN	40		
14	GV	18		
14	All sp.	58		
15	RK	12		
16	L	34		
17	TT	70		
18	GV	42		
19	CA	46		
19	RP	1		
19	BA	5		
19	All sp.	52		
20	OC	60		
20	KN	35		
20	GV	55		
20	DN	120		
20	All sp.	270		
21	SS	7		



13-02-09 – High tide (13:45) surveyed 13:45 – 14:45

Flock number	Species	Count	Time	Additional notes
1	L	148	13:52	
1	CU	300	13:56	
1	BG	8	13:56	
1	SU	6	13:56	
1	L	148	14:04	Flushed.
1	GP	850	14:18	
1	All sp.	1312		
2	CU	70	13:58	
3	L	350	14:04	Flushed.
4	L	130		Flew in.
5	GP	550		FLYING - Circling flight.
5	L	3100		FLYING - Circling flight.
5	All sp.	3650		FLYING - Circling flight.
6	L	500	14:37	
6	GV	250	14:37	
6	DN	500	14:37	
6	BA	150	14:37	
6	All sp.	1400	14:37	
7	T	4	13:58	In river channel.
8	CU	1	13:41	Flew southwards.
9	KN	400	14:07	FLYING - Circling flight.

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Map No. G1430.01.005

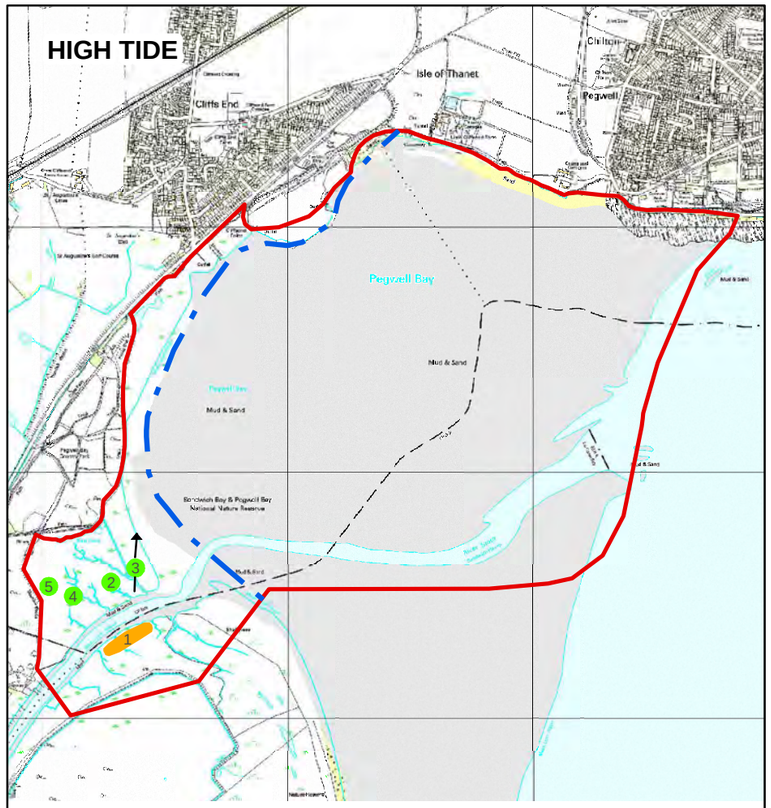
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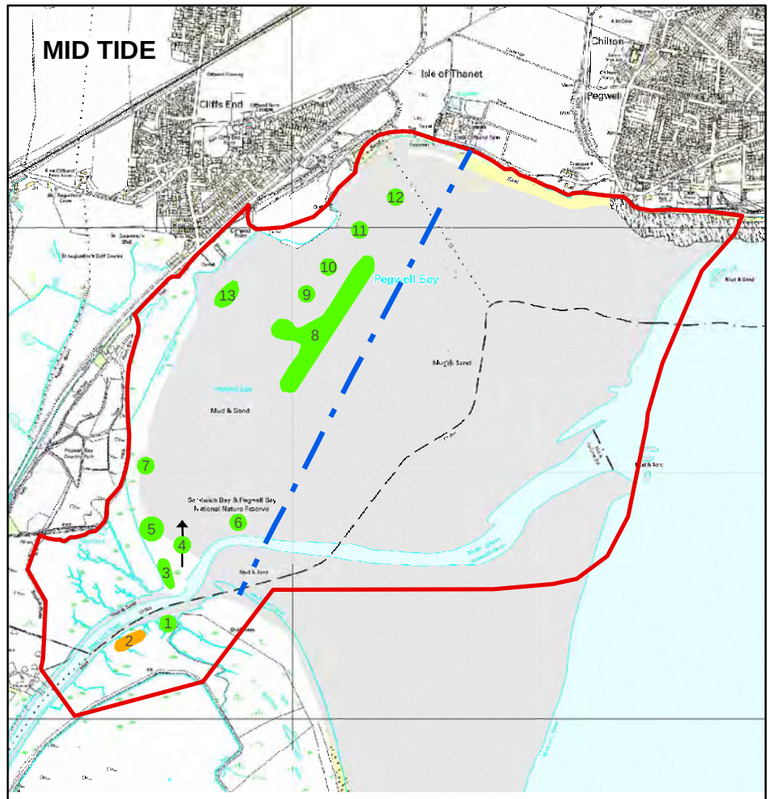
HIGH TIDE



24-03-09 – High tide (10:01) surveyed 10:00 – 11:00

Flock number	Species	Count	Time	Additional notes
1	SU	42	10:46	
1	NB	1	10:46	
1	CU	156	10:46	
1	BG	3	10:46	
1	All sp.	202	10:46	
2	CU	90	10:14	Moved to location 1.
3	CA	2		FLYING - northwards.
4	MR	1	10:39	FLYING - southwards.
5	K	1	10:10	FLYING -Hovering.

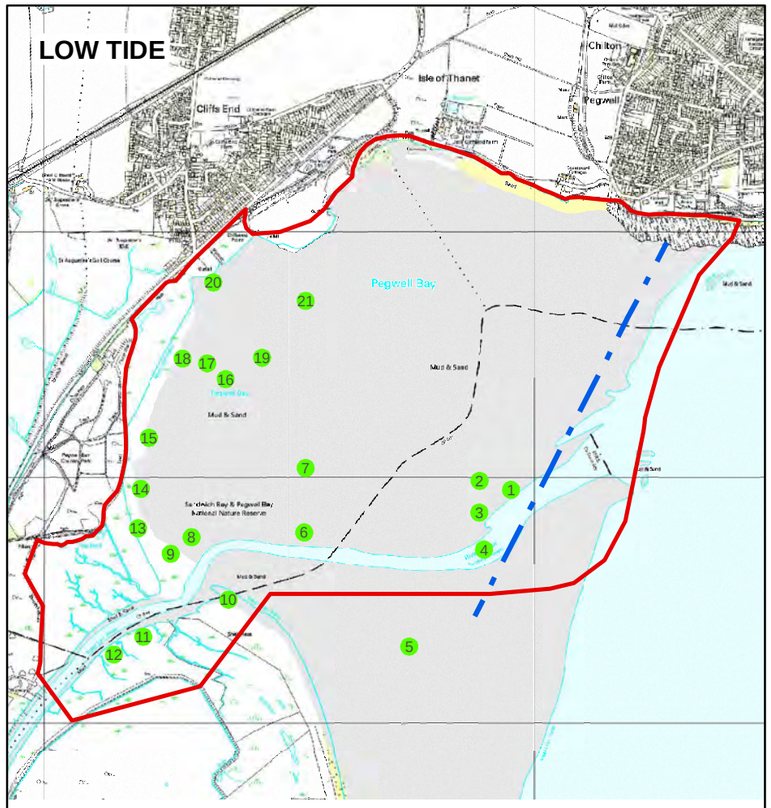
MID TIDE



24-03-09 – Mid tide surveyed 13:00 – 14:00

Flock number	Species	Count	Time	Additional notes
1	SU	7		
2	CU	121		
2	SU	28		
2	All sp.	149		
3	OC	75		Gradually flock broke up with birds flying to centre of Pegwell bay.
4	CU	65		FLYING - north to centre of Pegwell bay.
5	BG	7		
5	CU	1		
5	SU	1		
5	All sp.	9		
6	BA	1		
6	CU	2		
6	All sp.	3		
7	RK	2		
8	OC	75		
9	SU	4		
10	CU	19		
11	OC	25		
12	SV	7		
13	DN	5		
13	RK	10		
13	All sp.	15		

LOW TIDE



24-03-09 – Low tide (16:54) surveyed 15:00 – 16:00

Flock number	Species	Count	Time	Additional notes
1	OC	10		
2	CU	5		
3	SU	3		
3	CU	1		
3	All sp.	4		
4	SU	2		
5	OC	4		
5	CA	1		
5	All sp.	5		
6	SU	9		
6	CU	1		
6	All sp.	10		
7	CU	7		
8	SU	1		
9	CU	10		
10	CU	1		
11	SU	13		
11	CU	2		
11	BG	3		
11	All sp.	18		
12	CU	3		
13	SU	1		
14	RK	1		
14	SU	2		
14	All sp.	3		
15	SU	2		
16	RK	15		
17	SU	13		
18	RP	4		
19	RK	1		
20	DN	5		
20	SU	2		
20	RK	4		
20	All sp.	11		

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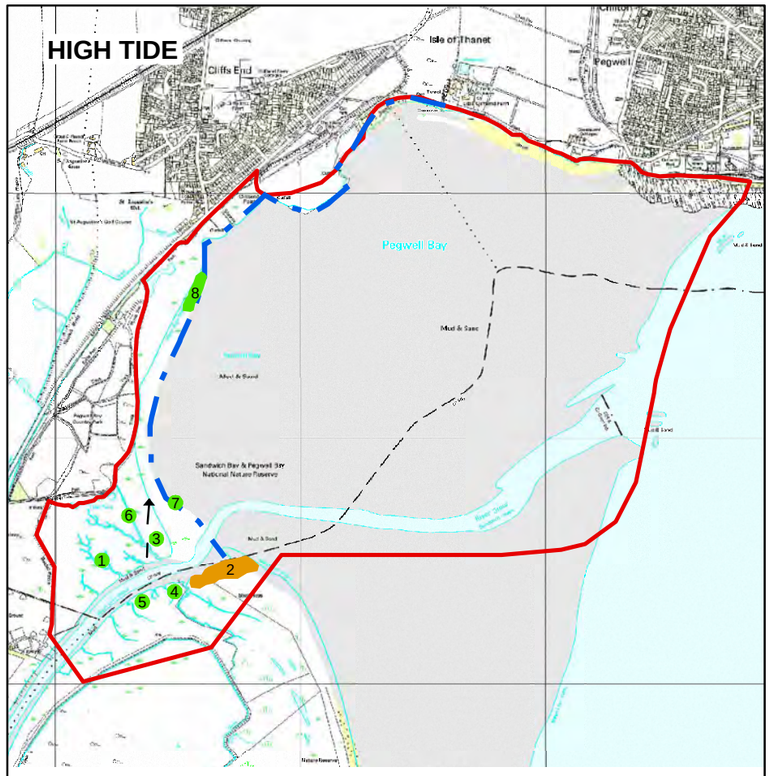
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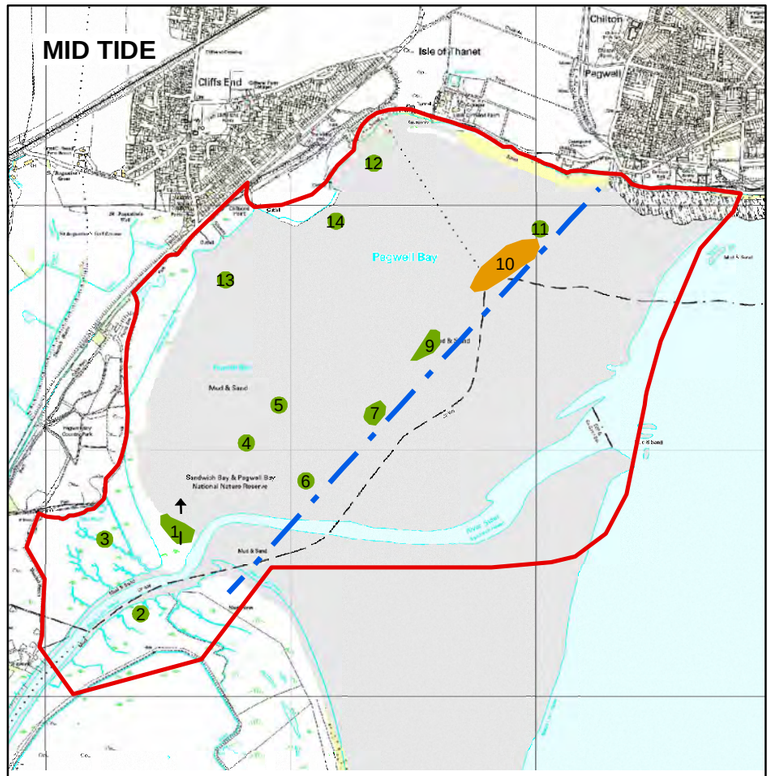
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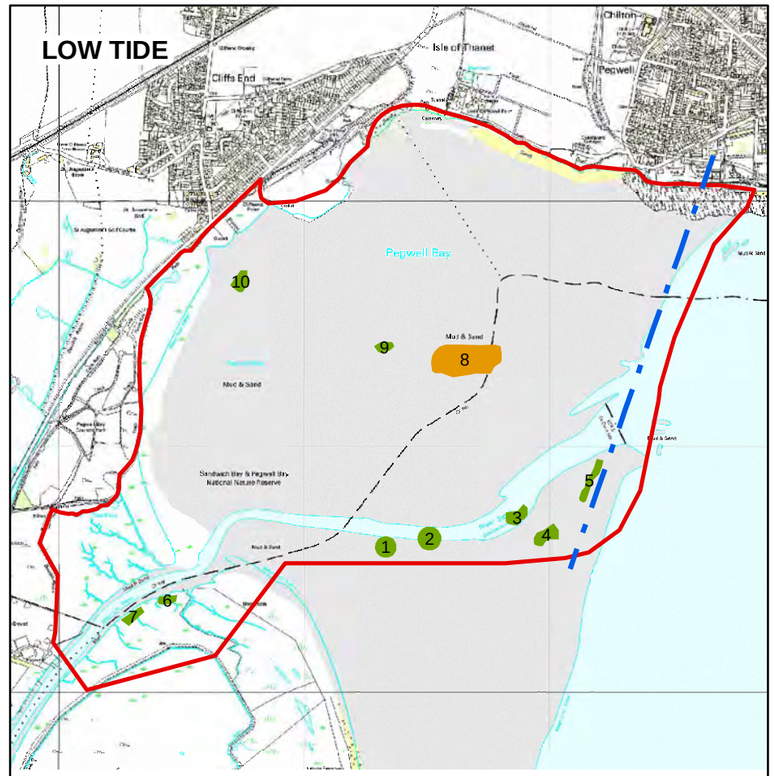
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07-05-09 – High tide (10.51) surveyed 10:30 – 11:30

Flock number	Species	Count	Time	Additional notes
1	RK	1	10:31	Standing on post
2	OC	166	10:35	
2	TE	37	10:35	
2	SU	2	10:35	
2	DN	15	10:35	
2	BA	10	11:00	
2	KN	1	11:00	
2	All sp.	231		
3	RK	3	10:42	Fly in.
3	DN	10	11:12	Fly in.
3	All sp.	13		
4	CU	3	10:43	Fly in.
5	OC	1	10:45	
6	RK	1	10:55	Fly into gulley.
7	GV	1	11:30	
8	SU	39	11:30	

07-05-09 – Mid tide surveyed 13:30-14:30

Flock number	Species	Count	Time	Additional notes
1	OC	32	13:54	
1	RK	1	13:54	
1	CU	1	13:54	
1	All sp.	34	13:54	
2	OC	3		
2	SU	3		
2	All sp.	6		
3	RK	3		
4	TE	5	13:50	FLYING
5	RP	3		
6	SU	1		
6	BA	4		
6	All sp.	5		
7	OC	2		
7	DN	15		
7	BA	6		
7	All sp.	23		
8	CA	1		
9	SS	29		
9	RP	3		
9	DN	7		
9	BA	12		
9	All sp.	51		
10	OC	148		
11	SU	2		
11	CU	1		
11	All sp.	3		
12	SU	2		
13	ET	2		
14	ET	1		

07-05-09 – Low tide (17:58) surveyed 15:30-16:30

Flock number	Species	Count	Time	Additional notes
1	CU	1		
2	SU	14		
3	DN	24		
3	SU	2		
3	OC	1		
3	All sp.	27		
4	OC	15		
5	SU	4		
5	CA	2		
5	All sp.	6		
6	OC	4		
6	SU	4		
6	All sp.	8		
7	SU	9		
8	OC	116		
8	BA	6		
8	TE	43		
8	All sp.	165		
9	CU	4		
10	SU	43		

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Appendix 9: Inter-tidal Sediment and Invertebrate Surveys

UK – BELGIUM INTERCONNECTOR
PROJECT NEMO

INTER-TIDAL SEDIMENT AND INVERTEBRATE SURVEYS

(Doc Ref: TEP 1430.01.027)

September 2010

Prepared by TEP for:

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CONTENTS PAGE

1.0 EXECUTIVE SUMMARY 1
Introduction 1
Methods 1
Results 1

2.0 INTRODUCTION 3

3.0 SITE DESCRIPTION 4
Sandwich Bay and Hacklinge Marshes SSSI 4
Thanet Coast and Sandwich Bay SPA 5

4.0 METHODS 6
Inter-tidal Sediment and Invertebrate Surveys 6

5.0 RESULTS 8
Sediment and biotope classification of Pegwell Bay 8

6.0 DISCUSSION 12
The value of the Pegwell Bay as a feeding area for waders 12

7.0 IMPLICATIONS AND RECOMMENDATIONS 15

8.0 REFERENCES 16

APPENDICES

Appendix 1: PSA results
Appendix 2: Inter-tidal invertebrate results

FIGURES

Figure 1: Aerial photograph illustrating site context
Figure 2: Biotope map and sampling locations (green circles) in Pegwell Bay
Figure 3: Dendogram showing percentage similarity between invertebrate communities from each sample station in Pegwell Bay using average values from 5 replicates.
Figure 4: MDS plot of similarity of invertebrate communities from sample stations in Pegwell Bay using mean values from 5 replicates.

DRAWINGS

G1430.01.012 Pegwell Bay inter-tidal sediment and invertebrate surveys: sampling locations A to O
G1430.01.014 Pegwell Bay inter-tidal invertebrate total abundance distribution
G1430.01.015 Pegwell Bay inter-tidal invertebrate species richness distribution

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake inter-tidal sediment and invertebrate surveys to investigate the value of the onshore environment of Pegwell Bay as a feeding resource for waders and wildfowl. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay. TEP commissioned the Centre for Marine and Coastal Studies (CMACS) to assist with surveys and analysis.

1.2 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods.

Methods

1.3 Detailed intertidal sediment and invertebrate surveys of the Pegwell Bay north of the River Stour were undertaken in 2009 by ecologists from TEP and CMACS on 13th and 14th August 2009.

1.4 In total four transects were taken at right angles to the shoreline associated with Cliffs End and the A256 (Transects 1 to 4). Along each transect four sample points were identified which represented the upper, mid-upper, mid-lower and lower shore.

Results

1.5 A total of 42 taxa were recorded across all sites. Most of the species sampled were polychaetes (19 taxa), followed by crustaceans (15 taxa) and molluscs (4 taxa). The average total abundance across all sampling locations was 3,930 individuals per m^2 and the average species richness was 13 species.

1.6 The shore at Pegwell Bay was dominated by well sorted medium to very fine sands which made up at least 75% of the sediment.

1.7 Four separate biotopes were identified by analysing the sediment and invertebrate survey results. These were as follows:

- The mid shore : '*Cerastoderma edule* and polychaetes in littoral muddy sand' (LS.LSa.MuSa.CerPo)
- The upper shore : '*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand' (part) (LS.LSa.MuSa.BatCare)
- The north eastern end of the shore : '*Nephtys cirrosa* dominated littoral fine sand' (LS.LSa.FiSa.PoNcir)
- Lower shore adjacent to north bank of River Stour : '*Cerastoderma edule* and polychaetes in littoral muddy sand' (part) LS.LSa.MuSa.CerPo).

1.8 A range of prey species associated with various wader birds were recorded during the 2009 invertebrate survey including catworms *Nephtys* sp., amphipods *Corophium sp.,* common cockles *C. edule,* sandworms *Hediste* sp*.,*

laver spire shell *H. ulvae,* sand mason worm *Lanice conchilega,* Baltic tellin *M. balthica* and the polychaete *Scoloplos armiger*.

1.9 The polychaete *P. armiger* and the common cockle *C. edule* were widespread and fairly abundant and were found to be particularly abundant at mid shore in the southern half of the Pegwell Bay (Sampling location B) indicating that this location is an important feeding area for waders.

1.10 A number of invertebrates taken by waders were either not recorded during the August 2009 survey or were recorded at low abundances, such as the amphipod *Corophium* sp. and the laver spire shell *Hydrobia ulvae*.

1.11 The amphipod *Bathyporeia sarsi* was the most abundant invertebrate at Pegwell Bay being recorded at every sampling location and being particularly abundant on the upper shore. It is not clear how important *B. sarsi* is as a prey item for waders on the Pegwell Bay although it is known that this species is favoured by some species of fish.

Implications and Recommendations

1.12 Overall it is likely that the patchy distribution of inter-tidal invertebrate prey species within the Pegwell Bay is likely to be influencing the distribution of the principal feeding wader flocks to some extent e.g. sampling location B provides a valuable feeding area for most wader species. However invertebrate prey items were found to be present in all sampling locations across the Pegwell Bay indicating that the waders are generally not dependent on a specific location within the Pegwell Bay for feeding.

1.13 The widespread distribution of various annelid species and the common cockle *C. edule* will help to ensure that waders displaced from parts of the Pegwell Bay affected by the proposed cable development will be able to feed elsewhere within the Bay during the period of cable laying activities.

1.14 It is recommended that the proposed cable laying activities avoid the mudflats near to sampling location B which represents an important feeding area for waders within the Pegwell Bay.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake sediment and invertebrate surveys to investigate the value of the onshore environment of Pegwell Bay as a feeding resource for waders and wildfowl. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay. TEP commissioned the Centre for Marine and Coastal Studies (CMACS) to assist with surveys and analysis.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the sediment and invertebrate surveys involved collecting sediment and invertebrate core samples at five high to low tide transects located across the Pegwell Bay north of the River Stour. Analysis of these samples facilitated the production of a sediment and biotope classification map illustrating the distribution of different sediment types and invertebrate fauna communities across the Pegwell Bay. This information may then be used to determine how variations in inter-tidal sediment and invertebrate types within the Pegwell Bay influence the behaviour and distribution of waders and wildfowl using the Pegwell Bay as a feeding resource. This information can then be used to predict the effects of the proposed development on feeding waders within the Pegwell Bay.

3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1 below.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also included as a part of the Pegwell Bay winter bird survey.



Figure 1: Aerial photograph illustrating site context

Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods (further details including site citations are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (further details are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.8 Citation sheets for all designated sites described are included in Appendix 2 of TEP report '1430.01.024 Winter Bird Survey'.

4.0 METHODS

Inter-tidal Sediment and Invertebrate Surveys

4.1 Detailed intertidal sediment and invertebrate surveys of the Pegwell Bay north of the River Stour were undertaken by ecologists from TEP and CMACS on 13th and 14th August 2009. These specific dates in August were chosen to undertake the survey because the low tides on these dates were known to have a longer duration and extend further down the beach profile, thus revealing a greater amount of inter-tidal shore, as compared to other dates in August.

4.2 In total four transects were taken at right angles to the shoreline associated with Cliffs End and the A256 (Transects 1 to 4). Along each transect four sample points were identified which represented the upper, mid-upper, mid-lower and lower shore. The grid references for each sampling location are given in Table 1 below. The locations of each of the transects and sampling locations is illustrated in Drawing G1430.01.012.

4.3 Only two locations were sampled on Transect 4 (Upper and mid-shore) since it was not possible to collect samples from the lower shore for Transect 4. The lower shore sample locations were located close to the north bank of the River Stour where ground conditions were very poor posing a safety risk to surveyors.

Table 1: Grid references for each of the sites sampled.

Transect Profile	Sample location reference	Section of shore	Distance from MHWL to Site Location (metres)	Grid Reference
1	M	Upper	337	TR35620 64185
1	L	Mid-Upper	619	TR35864 64053
1	J	Mid-lower	924	TR36115 63879
1	I	Lower	1263	TR36385 63681
2	H	Upper	93	TR35140 63893
2	G	Mid-Upper	483	TR35458 63674
2	F	Mid-lower	869	TR35776 63453
2	E	Lower	1253	TR36091 63234
3	D	Upper	429	TR34971 63516
3	C	Mid-Upper	703	TR35160 63313
3	B	Mid-lower	962	TR35320 63116
3	A	Lower	1327	TR35603 62877
4	N	Upper	193	TR34590 63306
4	O	Mid	433	TR34756 63136

Note: MHWL = Mean High Water Level.

4.4 Samples were taken from the 14 locations at grid references listed in Table 1. These were identified using a handheld global positioning system (GPS) device accurate to a few metres.

4.5 Five replicate sediment cores were taken at each sample point, making a total of 70 samples. The corer used had an area of 0.01m^2 and cores were taken to a depth of 15 cm. Therefore, in total 70 replicates were taken.

4.6 Once collected all samples were fixed on site using 10% buffered formalin mixed with seawater. Each replicate sample was analysed by macroinvertebrate taxonomists.

4.7 At each sample point one sediment sample was taken using a hand trowel (fourteen samples in total).

Core sample and sediment analysis

4.8 Following collection, the seventy cores to be analysed were sieved using a 1mm mesh size. Invertebrates retained in the sieve were then sorted and identified to species level where possible. The dry weight of organisms within each sample was also recorded for each sample.

4.9 For each replicate the following information was obtained:

Total number of species
Total number of individuals (0.01 m^{-2})

4.10 Particle size analysis was undertaken to identify the distribution of grain sizes at various locations along the foreshore.

5.0 RESULTS

5.1 The data derived from the inter-tidal sediment and invertebrate samples are provided in Appendices 1 & 2. A total of 42 taxa were recorded across all sites. Most of the species sampled were polychaetes (19 taxa), followed by crustaceans (15 taxa) and molluscs (4 taxa). Small numbers of other animal groups were recorded in some locations including Maldanidae (bamboo worms) at sampling location E on the lower shore of transect 2 and Gobiidae (a fish) at sampling location O on the mid-upper shore of transect 4 among others. Sessile fauna, such as hydroids, sponges, tunicates and barnacles, are almost completely absent from the study area.

5.2 Total abundance ranged from 380 individuals per m^2 at sampling location A (Transect 3 lower shore) up to 16,020 individuals per m^2 at sampling location D (Transect 3 upper shore). The average total abundance across all sampling locations was 3,930 individuals per m^2. This average total abundance is comparable with the findings of a similar study of invertebrate species richness on the Formby Bar, an important wader feeding and roosting area immediately north of the Alt Estuary in Merseyside, which was considered to be a valuable feeding resource for waders. Drawing G1430.01.014 illustrates the total abundance of invertebrate taxa at each sampling location across the shore. The survey results appear to indicate that total abundance was greatest at the sampling locations on the upper shore and total abundance gradually decreased moving along each transect towards the lower shore.

5.3 Species richness ranged from 9 species at sampling locations C (Transect 3 mid-upper shore) and O (Transect 4 mid shore) up to 18 species at sampling location F (Transect 2 mid-lower shore). The average species richness was 13 species. Drawing G1430.01.015 illustrates species richness at each sampling location across the survey area. The survey results appear to indicate that species richness is fairly uniform across the Pegwell Bay.

Sediment and biotope classification of Pegwell Bay

5.4 The shore at Pegwell Bay was dominated by well sorted medium to very fine sands which made up at least 75% of the sediment. There was a mixture of sediments from the stations on the middle shore ranging from predominantly medium sands to predominantly fine sand to very fine sand and silt. However, the midshore stations of B, C, D, G, L, J and O all had similar faunal compositions of moderate numbers of amphipod genus *Bathyporeia* (various species present) with cockles *Cerastoderma edule,* Baltic tellins *Macoma balthica* and spionid worms which led to the biotope classification of '*Cerastoderma edule* and polychaetes in littoral muddy sand' (LS.LSa.MuSa.CerPo) (see ***Figure*** overleaf).

5.5 On the upper shore there was a small proportion of silt with fine and medium sand probably due to deposition from ebb tide flows off the saltmarsh at the top of the shore. The highest abundance of infaunal organisms was found on the upper shore with 14,500 individuals/m^2 for the amphipod *Bathyporeia sarsi*. The dendogram (***Figure***) identified a slight difference in invertebrate community at stations H, M and N compared to the mid-shore stations with the addition of the amphipod *Corophium arenarium*, the isopod *Cyathura carinata* but with

fewer spionid polychaetes. This community on the upper shore was classified as '*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand' (part) (LS.LSa.MuSa.BatCare) (2). The classification does not contain all the typical species of the biotope partly due to the invertebrate community present on the upper shore and it contains some from LS.LSa.MuSa.CerPo. However it was felt that it was sufficiently different from the mid-shore to be classified as a separate biotope.

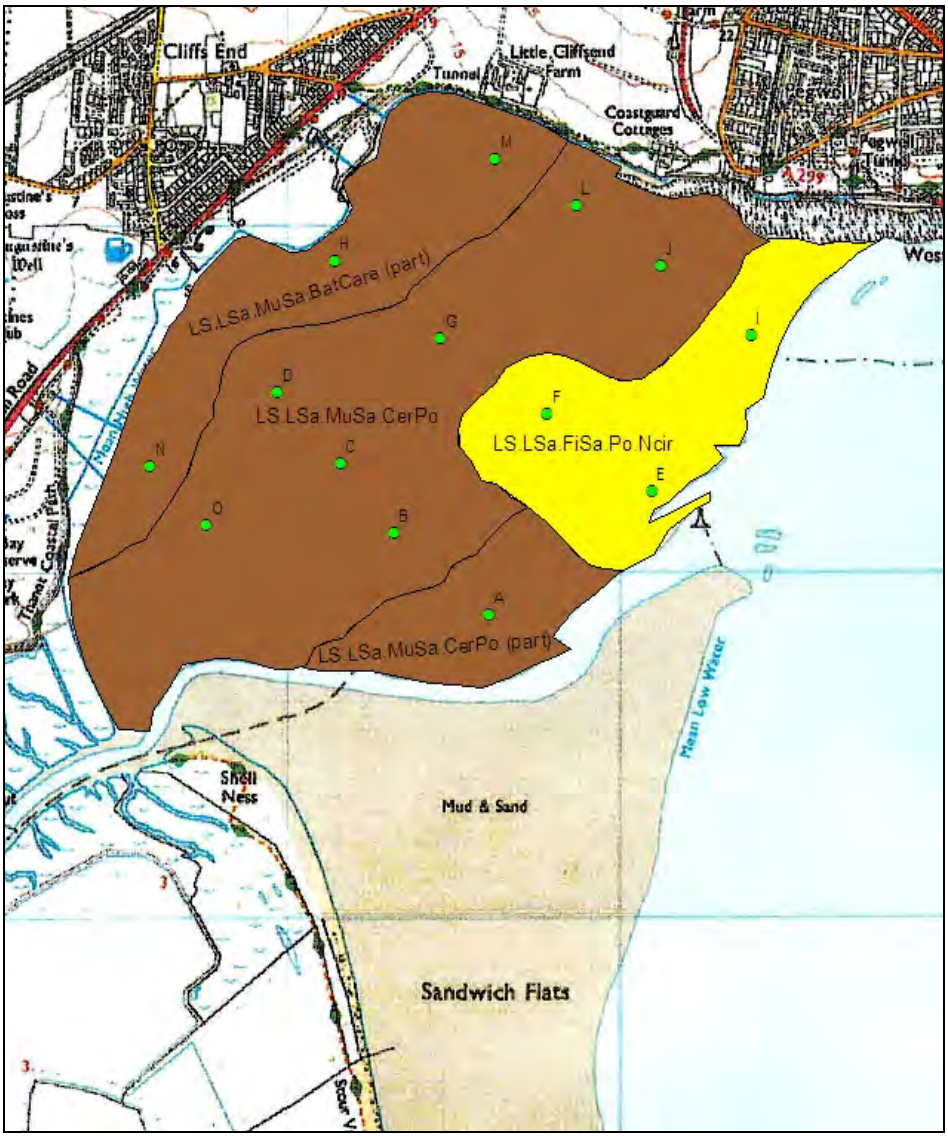


Figure 2. Biotope map and sampling locations (green circles) in Pegwell Bay

5.6 At the north-eastern end of the shore the sediments at stations E, F and I were a mixture of fine sand with some medium sand, a small proportion of very fine sand and less than one percent silt. The dendogram and MDS plot of similarity (***Figure***3 and 4) indicated that these three stations had a distinct community from the rest of the shore with the polychaetes *Nepthys cirrosa*, *Magelona johnstoni* and *Spiophanes bombyx* but with very low abundance of bivalve molluscs leading to a classification of '*Nephtys cirrosa* dominated littoral fine sand' (LS.LSa.FiSa.PoNcir).

5.7 The final area of biotope was centred around station A, adjacent to the river channel where there was a higher proportion of very fine sand and silt compared to other stations. The invertebrate community at Station A was similar to that of the upper and mid shore but with very low abundances of organisms and the addition of low numbers of the mud shrimp *Corophium volutator*. This area was classified as '*Cerastoderma edule* and polychaetes in littoral muddy sand' (part) LS.LSa.MuSa.CerPo, as it probably represents a mixture of muddy sand and sandy mud biotopes.

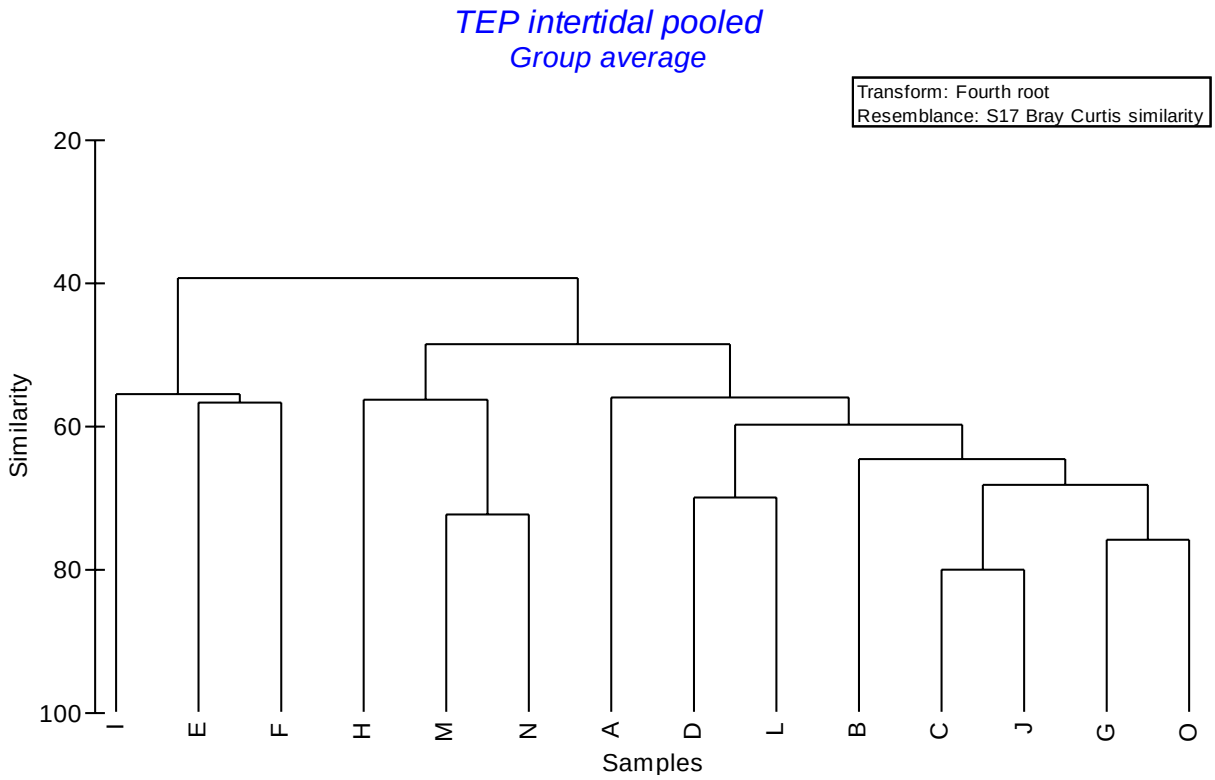


Figure 3. Dendogram showing percentage similarity between invertebrate communities from each sample station in Pegwell Bay using average values from 5 replicates.

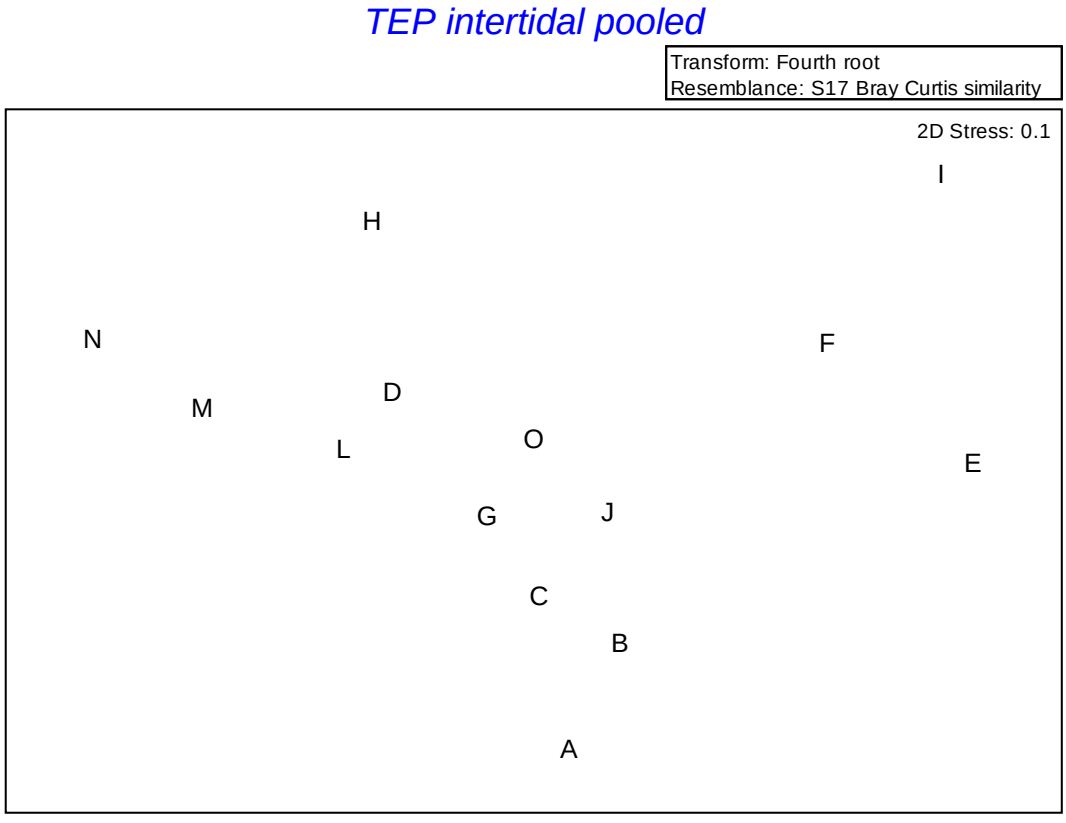


Figure 4. MDS plot of similarity of invertebrate communities from sample stations in Pegwell Bay using mean values from 5 replicates.

6.0 DISCUSSION

The value of the Pegwell Bay as a feeding area for waders

Wader invertebrate prey preferences

6.1 There are a number of scientific studies which have demonstrated the prey preferences for estuarine dwelling wader birds (Jones, E. and Newbery, 1977; West *et al*., unpublished). However, other research also suggests that waders are to some extent opportunistic in their feeding (www.Marlin.ac.uk). For example, bar-tailed godwit have been shown to feed on *Corophium* sp. on the surface of the shore if in sufficient abundance.

6.2 Invertebrate species which are especially important prey items for waders are identified by Prater 1981 and include the species ragworms *Hediste* sp., lugworms *Arenicola marina*, layer spire shell *Hydrobia ulvae*, edible mussel *Mytilus edulius*, cockles *Cerastoderma* sp., Baltic tellin *Macoma balthica*, peppery furrow shell *Scrobicularia plana* and mud shrimp *Corophium* sp.

6.3 Different prey are not equally important to all waders and generally the prey size and burrowing depth are correlated with the bill size of the wader. Plovers with the shortest bills tend to surface peck concentrating on *Hydrobia*. Dunlin and other birds with moderate length bills probe up to 4cm taking various worms and bi-valves as well as *Corophium*. Only long-billed birds are able to take deep burrowing prey such as lugworms *Arenicola* and ragworms *Hediste* (Prater, 1981).

6.4 There is a growing body of evidence to indicate that different wader species feed on different size ranges of each invertebrate prey species (Goss-Custard, in prep.). Therefore in some cases two different wader species will feed on the same invertebrate prey species but of different sizes. For example, the knot will take *Hediste* sp. and various other worms between the size range 10 to 59mm, however bar-tailed godwits will only tend to take worms at least 25mm or more in length. In one specific study Goss-Custard *et al*. (2006b) clearly demonstrated a predictable relationship between intake rate and prey size in shorebirds (*Charadriiformes*) eating macro-invertebrates.

The influence of sediment on invertebrate species richness and abundance

6.5 The inter-tidal invertebrate interest of the Pegwell Bay shore may to some extent be explained by its characteristic sandy sediment. Sandy or muddy sand shores tend to be less interesting compared to muddier shores, particularly on mobile sand shores which are relatively impoverished (Connor *et al*., 2004).

6.6 In all 42 invertebrate species were recorded indicating that the invertebrate communities associated with the Pegwell Bay shore are not impoverished. This finding indicates that there is sufficient invertebrate abundance and biomass to support the current numbers of regularly wintering bird species.

6.7 The significant differences in the number of species and individuals sampled among transects suggests that invertebrates are not evenly distributed along this stretch of shoreline. The varied invertebrate species richness and abundance will therefore influence the distribution of waders feeding on Pegwell Bay.

Pegwell Bay as a feeding resource for waders

6.8 A range of prey species associated with various wader birds were recorded during the 2009 invertebrate survey including catworms *Nephtys* sp., amphipods *Corophium* sp., common cockles *C. edule,* sandworms *Hediste* sp., laver spire shell *H. ulvae,* sand mason worm *Lanice conchilega,* Baltic tellin *M. balthica* and the polychaete *Scoloplos armiger*.

6.9 The distribution of these species was found to be patchy with some of these species being absent from many of the sampling locations. Invertebrate species abundances were also very variable with both high and low numbers of some species being recorded in different sampling locations.

Annelids

6.10 The polychaete *P. armiger* was probably the most important wader prey item annelid species within Pegwell Bay, and was recorded at abundances of up to 420 individuals per m^2 at sampling location B (Transect 3 mid-lower shore) indicating that this location provides good feeding for most of the waders which use Pegwell Bay. However *S. armiger* was fairly widespread in distribution. Catworms *Nephtys* sp. were less abundant with between 0 and 100 individuals per m^2 being recorded, although catworms were absent from most upper shore sampling locations. The important wader prey species *Hediste* sp. was only recorded at sampling location N (Transect 4, upper shore) and at a very low abundance.

6.11 The majority of wader species present at Pegwell Bay will take annelids although the largest annelids will only be taken by bar-tailed godwit, curlew and grey plover. Medium-sized annelids will be taken by oystercatchers and redshank and the smallest annelids will be taken by dunlin, ringed plover and knot.

Molluscs

6.12 The common cockle *C. edule* was present at the majority of sampling locations being recorded at an abundance of 0 to 420 individuals per m^2. This species was recorded at its greatest abundance at sampling location B, the same location where the polychaete *P. armiger* was particularly abundant.

6.13 The common cockle is an important prey item for knot, curlew and oystercatcher.

6.14 The Baltic tellin was also widespread across the survey area occurring at abundances of between 0 and 100 individuals per m^2. However, this species is usually present at higher abundances on the biotopes to which it is normally associated. For example, the '*Cerastoderma edule* and polychaetes in littoral muddy sand' biotope is described by Connor *et al*. (2004) as having a *M. balthica* abundance of 574/m^2.

6.15 The Baltic tellin is taken by a wide range of wader species although the abundances at which this species occurs at Pegwell Bay indicate that the Baltic tellin does not contribute significantly to the diet of waders using the Bay.

6.16 The laver spire shell *H. ulvae* appeared to have a limited distribution across Pegwell Bay being present at some sampling locations on the upper shore as

well as sampling location A (Transect 4 upper shore). This species was generally recorded in very low numbers not exceeding 80 individuals per m^2 at any sampling location. Typical densities for *H. ulvae* in UK estuaries are between 5,000-9,000/m^2 according to Prater (1981), however, the abundance of this species can vary considerably.

6.17 *H. ulvae* are a prey item favoured by knot, ringed plover, dunlin, grey plover and redshank.

Crustaceans

6.18 The amphipod *Corophium* sp. also appeared to have a limited distribution across Pegwell Bay being present at sampling locations on the upper shore in the north half of the Bay as well as sampling location A (Transect 3 lower shore). This species was generally recorded in very low numbers although a maximum count of 700 individuals per m^2 was recorded at sampling location N (Transect 4 upper shore).

6.19 *Corophium* sp. are an important prey item for dunlin, ringed plover and redshank.

6.20 The amphipod *Bathyporeia sarsi* is particularly abundant at Pegwell Bay being recorded at every sampling location at an abundance ranging from 100 to 14,500 individuals per m^2. This species is particularly abundant at the upper shore sampling locations for Transects 1, 2 and 3.

6.21 It is not clear how important *B. sarsi* is as a prey item for waders on the Pegwell Bay although it is known that this species is favoured by some species of fish such as flounder. It is possible that some of the smaller waders take *B. sarsi* however, this species is not considered to be as important a wader prey item as *Corophium* sp.

7.0 IMPLICATIONS AND RECOMMENDATIONS

7.1 In general research into the relationship between wader and prey distribution has shown that waders select areas with sediment types that favour the presence of their preferred prey. A recent study by Pedro *et al.* (2005) on the importance of drainage channels for waders foraging on tidal flat demonstrated that prey abundance corresponded closely with wader abundance, suggesting that the small scale distribution of birds on the tidal flats may be related to the presence of their prey.

7.2 Overall it is likely that the patchy distribution of inter-tidal invertebrate prey species within the Pegwell Bay is likely to be influencing the distribution of the principal feeding wader flocks to some extent. There is some evidence to indicate that the inter-tidal habitat associated with sampling location B (Transect 3 mid-lower shore) provides a valuable feeding area for most wader species, due to the presence of good numbers of the polychaete *P. armiger* and the common cockle *C. edule*. However, invertebrate prey items were found to be present in all sampling locations across the Pegwell Bay, indicating that the waders are generally not dependent on a specific location within the Pegwell Bay for feeding. The single possible exception to this was sampling location A (Transect 3 lower shore), which only supported low abundances of a limited number of wader prey items.

7.3 A recent research study concluded that shorebird survival is strongly influenced by the biomass densities of annelid worms and the bivalve molluscs *C. edule* and *M. balthica* (Stillman *et al*., 2005).

7.4 The widespread distribution of various annelid species and the common cockle *C. edule* will help to ensure that waders displaced from parts of the Pegwell Bay affected by the proposed cable development will be able to feed elsewhere within the Bay during the period of cable laying activities. However, it is recommended that the proposed cable laying activities avoid the mudflats near to sampling location B which represents an important feeding area for waders within the Pegwell Bay.

8.0 REFERENCES

CONNORS P.G, MYERS J.P., CONNORS C.S.W. and PITELKA F.A. January 1981. Interhabitat Movements by Sanderlings in Relation to Foraging Profitability and the Tidal Cycle. The Auk 98: 49 - 64

GOSS-CUSTARD, J.D. AND OTHERS (2006) *Intake rates and the functional response in shorebirds (Charadriiformes) eating macro-invertebrates,* Biological Review, Vol. 81, pp501-529.

PRATER, J. (1981) *Estuary birds of Britain and Ireland,* T & AD Poyser.

STILLMAN, A.R.; WEST, A.D.; GOSS-CUSTARD, J.D.; MCGORTY, S.; FROST, N.J; MORRISEY, D.J.; KENNY, A.J.; AND DREWITT, A.L. (2005) *Predicting site quality for shorebird communities: A case study on the Humber Estuary UK,* Marine Ecology Progress Series, Vol. 305, pp203-217.

SUFFOLK COAST AND HEATHS UNIT, *Disturbance of waders and wildfowl on the Stour – Orwell SPA.*

UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

APPENDIX 1
PSA results

TRANSECT 1 - Higher to Lower Shore

		M	L	J	I
	SAMPLE TYPE:	Trimodal, Moderately Sorted	Bimodal, Moderately Well Sorted	Bimodal, Moderately Well Sorted	Bimodal, Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Sl. Medium Gravelly Very Fine Sand	Sl. Very Fine Gravelly Medium Sand	Sl. Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	180.1	255.8	177.7	181.3
	SORTING (σ_a):	309.7	88.03	75.60	85.51
	SKEWNESS (Sk_a):	26.35	-0.584	4.849	10.51
	KURTOSIS (K_a):	789.6	12.69	123.7	246.9
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	127.9	220.0	158.6	164.7
	SORTING (σ_g):	1.837	1.583	1.446	1.376
	SKEWNESS (Sk_g):	1.051	-1.159	0.442	1.299
	KURTOSIS (K_g):	4.101	3.410	3.755	7.004
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.693	2.065	2.590	2.551
	SORTING (σ_ϕ):	0.859	0.656	0.530	0.459
	SKEWNESS (Sk_ϕ):	-0.157	1.742	-0.070	-0.973
	KURTOSIS (K_ϕ):	3.658	4.612	3.681	6.576
FOLK AND WARD METHOD (μm)	MEAN (M_G):	145.6	235.3	176.4	177.1
	SORTING (σ_G):	1.839	1.571	1.505	1.378
	SKEWNESS (Sk_G):	0.031	-0.679	0.271	0.544
	KURTOSIS (K_G):	0.544	1.141	2.285	1.635
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.780	2.088	2.503	2.497
	SORTING (σ_I):	0.879	0.652	0.590	0.462
	SKEWNESS (Sk_I):	-0.031	0.679	-0.271	-0.544
	KURTOSIS (K_G):	0.544	1.141	2.285	1.635
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Fine Sand	Fine Sand	Fine Sand
	SORTING:	Moderately Sorted	Moderately Well Sorted	Moderately Well Sorted	Well Sorted
	SKEWNESS:	Symmetrical	Very Fine Skewed	Coarse Skewed	Very Coarse Skewed
	KURTOSIS:	Very Platykurtic	Leptokurtic	Very Leptokurtic	Very Leptokurtic

TRANSECT 2 - Higher to Lower Shore

		H	G	F	E
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Unimodal, Very Poorly Sorted	Bimodal, Well Sorted	Bimodal, Moderately Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Muddy Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Fine Gravelly Medium Sand	Clayey Fine Sand	Slightly Medium Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	390.1	125.0	196.9	238.9
	SORTING (σ_a):	1234.4	90.37	241.7	473.2
	SKEWNESS (Sk_a):	14.20	1.255	32.23	13.87
	KURTOSIS (K_a):	213.8	16.20	1213.1	241.9
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	263.0	43.70	170.9	179.5
	SORTING (σ_g):	1.786	3.109	1.452	1.672
	SKEWNESS (Sk_g):	2.279	1.244	1.706	2.748
	KURTOSIS (K_g):	15.62	1.641	12.42	16.02
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	1.906	1.989	2.484	2.445
	SORTING (σ_ϕ):	0.837	0.679	0.536	0.742
	SKEWNESS (Sk_ϕ):	-2.204	1.359	-1.360	-2.617
	KURTOSIS (K_ϕ):	15.41	2.438	11.86	15.57
FOLK AND WARD METHOD (μm)	MEAN (M_G):	243.2	34.11	182.3	183.2
	SORTING (σ_G):	1.587	6.418	1.407	1.496
	SKEWNESS (Sk_G):	-0.190	-0.801	0.532	0.350
	KURTOSIS (K_G):	0.905	0.368	0.675	0.913
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.040	4.873	2.455	2.449
	SORTING (σ_I):	0.666	2.682	0.492	0.581
	SKEWNESS (Sk_I):	0.190	0.801	-0.532	-0.350
	KURTOSIS (K_G):	0.905	0.368	0.675	0.913
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Very Coarse Silt	Fine Sand	Fine Sand
	SORTING:	Moderately Well Sorted	Very Poorly Sorted	Well Sorted	Moderately Well Sorted
	SKEWNESS:	Fine Skewed	Very Fine Skewed	Very Coarse Skewed	Very Coarse Skewed
	KURTOSIS:	Mesokurtic	Very Platykurtic	Platykurtic	Mesokurtic

TRANSECT 3 - Higher to Lower Shore

		D	C	B	A
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Unimodal, Very Well Sorted	Unimodal, Well Sorted	Bimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Sl. Medium Gravelly Fine Sand	Slightly Medium Gravelly Fine Sand	Slightly Medium Gravelly Fine Sand	Sl. Medium Gravelly Clayey Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	197.1	223.0	238.0	121.9
	SORTING (σ_a):	525.0	803.6	814.6	374.9
	SKEWNESS (Sk_a):	17.07	11.14	11.13	21.59
	KURTOSIS (K_a):	301.6	127.9	127.1	531.2
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	149.7	142.5	149.3	38.75
	SORTING (σ_g):	1.546	1.569	1.641	2.964
	SKEWNESS (Sk_g):	3.064	6.416	4.968	1.594
	KURTOSIS (K_g):	28.40	59.44	39.69	3.432
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.648	2.721	2.607	2.338
	SORTING (σ_ϕ):	0.625	0.647	0.708	0.909
	SKEWNESS (Sk_ϕ):	-2.669	-6.084	-4.516	0.634
	KURTOSIS (K_ϕ):	27.27	56.98	37.36	4.545
FOLK AND WARD METHOD (μm)	MEAN (M_G):	169.1	148.0	151.0	27.50
	SORTING (σ_G):	1.488	1.228	1.348	6.332
	SKEWNESS (Sk_G):	0.244	-0.285	0.010	-0.609
	KURTOSIS (K_G):	2.408	1.714	2.560	2.168
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	2.564	2.756	2.727	5.184
	SORTING (σ_I):	0.573	0.296	0.431	2.663
	SKEWNESS (Sk_I):	-0.244	0.285	-0.010	0.609
	KURTOSIS (K_G):	2.408	1.714	2.560	2.168
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Fine Sand	Fine Sand	Coarse Silt
	SORTING:	Moderately Well Sorted	Very Well Sorted	Well Sorted	Very Poorly Sorted
	SKEWNESS:	Coarse Skewed	Fine Skewed	Symmetrical	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic

TRANSECT 4 - Higher to Lower Shore

		N	O
	SAMPLE TYPE:	Trimodal, Moderately Well Sorted	Bimodal, Moderately Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Medium Gravelly Fine Sand	Slightly Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	419.0	193.4
	SORTING (σ_a):	1659.9	327.0
	SKEWNESS (Sk_a):	6.913	20.73
	KURTOSIS (K_a):	56.99	523.0
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	131.3	153.8
	SORTING (σ_g):	2.352	1.547
	SKEWNESS (Sk_g):	3.669	2.306
	KURTOSIS (K_g):	18.09	16.58
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.664	2.572
	SORTING (σ_ϕ):	1.221	0.624
	SKEWNESS (Sk_ϕ):	-3.131	-1.754
	KURTOSIS (K_ϕ):	15.85	15.54
FOLK AND WARD METHOD (μm)	MEAN (M_G):	122.7	174.6
	SORTING (σ_G):	1.604	1.514
	SKEWNESS (Sk_G):	-0.200	0.263
	KURTOSIS (K_G):	0.956	2.364
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	3.027	2.518
	SORTING (σ_I):	0.681	0.598
	SKEWNESS (Sk_I):	0.200	-0.263
	KURTOSIS (K_G):	0.956	2.364
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand	Fine Sand
	SORTING:	Moderately Well Sorted	Moderately Well Sorted
	SKEWNESS:	Fine Skewed	Coarse Skewed
	KURTOSIS:	Mesokurtic	Very Leptokurtic

APPENDIX 2
Inter-tidal invertebrate results

APPENDIX 2 - Abundance of individual invertebrate species.

Individuals per m^2 in **bold**. SD is given below in each case.

SPECIES	Transect 3				Transect 2				Transect 1				Trans. 4	
	A	B	C	D	E	F	G	H	I	J	L	M	N	O
Anaitides maculata a bristleworm						**20** 44.7				**20** 44.7				
Bathyporeia elegans an amphipod				**80** 130.4							**20** 44.7	**20** 44.7	**20** 44.7	
Bathyporeia guilliamsoniana an amphipod					**180** 83.7				**40** 54.8					
Bathyporeia pilosa an amphipod				**20** 44.72			**20** 44.7	**20** 44.72				**420** 554	**240** 152	
Bathyporeia sarsi an amphipod	**60** 89.4	**100** 173	**580** 455	**7660** 4893	**200** 187	**380** 593	**1860** 1511	**14500** 4806	**100** 141	**640** 329	**2660** 1422	**3700** 4131	**1040** 896	**1920** 1862
Bathyporeia sp. an amphipod	**20** 44.7			**200** 158.1		**80** 130	**100** 141	**1180** 846.8	**20** 44.7	**60** 134	**520** 327	**220** 192	**100** 122	
Bodotriidae a crustacean					**20** 44.7									
Carcinus maenas a crustacean								**20** 44.72					**20** 44.7	
Capitellidae sp. a bristleworm		**20** 44.7				**40** 89.4						**20** 44.7		
Cerastoderma edule common cockle	**40** 89.4	**420** 130	**140** 114	**60** 54.77		**20** 44.7	**160** 114	**20** 44.72		**60** 89.4	**40** 54.8	**20** 44.7		**40** 54.7
Corophium arenarium an amphipod								**20** 44.72				**120** 164	**660** 483	
Corophium volutator an amphipod	**60** 89.4													
Corophium sp. an amphipod	**20** 44.7												**40** 54.8	
Crangon crangon brown shrimp		**40** 54.8		**20** 44.72	**20** 44.7	**20** 44.7		**20** 44.72	**40** 54.8			**20** 44.7	**20** 44.7	**60** 54.7
Cyathura carinata an isopod												**80** 44.7	**400** 346	
Donax vittatus banded wdge snail									**20** 44.7					
Eteone flava/longa a bristleworm	**20** 44.7	**40** 54.8	**120** 130	**80** 83.67	**40** 89.4	**20** 44.7				**60** 89.4		**20** 44.7		
Gobiidae sp. a fish														**20** 44.7
Hediste diversicolor sandworm													**20** 44.7	
Hydrobia ulvae laver spire shell				**20** 44.72							**80** 179		**60** 89.4	
Lanice conchilega sand mason worm				**20** 44.72		**40** 54.8			**40** 54.8					
Philoscia muscorum common striped woodlouse								**20** 44.72						
Macoma balthica Baltic macoma	**20** 44.7	**40** 54.8	**20** 44.7	**40** 54.77			**20** 44.7	**20** 44.72			**20** 44.7	**60** 134	**100** 100	**40** 54.7
Magelona johnstoni a bristleworm				**20** 44.72	**140** 134	**60** 89.4								

SPECIES	Transect 3				Transect 2				Transect 1				Trans. 4	
	A	B	C	D	E	F	G	H	I	J	L	M	N	O
Magelona sp. a bristleworm						**20** 44.7								
Malacoceros sp. a polychaete									**20** 44.7					
Maldanidae bamboo worm - a polyc.					**20** 44.7									
Nematoda a nemotode												**20** 44.7		
Nemertea ribbon worms											**20** 44.7	**40** 54.8	**20** 44.7	
Nephtys cirrosa a catworm					**40** 54.8	**60** 54.8		**20** 44.72	**60** 54.8					**20** 44.7
Nepthys hombergi a catworm	**40** 54.8	**20** 44.7	**20** 44.7		**20** 44.7	**20** 44.7	**20** 44.7			**20** 44.7				
Nephtys sp (damaged) a catworm						**20** 44.7			**20** 44.7					
Pectiniidae sp. juv. cgalice corals										**20** 44.7				
Phyllodocidae sp a bristleworm					**20** 44.7									
Pygospio elegans a bristleworm	**60** 89.4	**260** 152	**1500** 784	**1240** 669.3	**180** 192		**100** 122	**60** 89.44	**40** 89.4	**980** 622	**120** 83.7	**540** 428	**140** 219	**780** 487
Scoloplos armiger a polychaete	**20** 44.7	**420** 239	**200** 141	**60** 54.77	**80** 83.7	**60** 54.8	**140** 54.8		**80** 44.7	**140** 207	**40** 89.4			
Spiophanes bombyx a polychaete					**20** 44.7	**80** 130			**20** 44.7	**20** 44.7				
Spio martinensis a bristleworm				**20** 44.72							**20** 44.7			
Spio sp. a bristleworm		**20** 44.7			**20** 44.7			**20** 44.72						
Spionidae sp. (damaged) a bristleworm	**20** 44.7	**240** 114	**920** 396	**680** 622.1		**20** 44.7	**100** 141	**40** 54.77		**620** 531	**140** 167	**220** 110	**180** 164	
Tanaissus liljeborgi a crustacean			**40** 54.8		**20** 44.7	**20** 44.7	**40** 89.4	**60** 134.2		**80** 110	**80** 130			**20** 44.7
Urothoe poseidonis an amphipod		**40** 54.8			**20** 44.7	**20** 44.7	**60** 89.4		**40** 54.8					**40** 54.7
TOTAL ABUNDANCE	**380**	**1660**	**3540**	**10220**	**1040**	**1000**	**2620**	**16020**	**540**	**2720**	**3760**	**5520**	**3060**	**2940**
SPECIES RICHNESS	**11**	**12**	**9**	**15**	**16**	**18**	**11**	**14**	**13**	**12**	**12**	**15**	**15**	**9**

AVERAGE TOTAL ABUNDANCE =	**3930**
AVERAGE SPECIES RICHNESS =	**13**

DRAWINGS



KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

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Rev	Description	Dwn	Appvd	Date

TEP
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Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Sediment and Invertebrate Surveys:
Sampling Locations A-O

Map No.
G.1430.01.012

Scale: 1:10,000 @ A3

Date: 13/09/2010

Drawn: DH

Checked: TR

Approved: TR



KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

Total Abundance Chart

10000 *Abundance value*

Bar charts show total values for each sampling location as a percentage of the total value for all locations.

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Rev	Description	Dwn	Appvd	Date

TEP
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Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Invertebrate
Total Abundance Distribution

Map No.
G.1430.01.014

Scale: 1:10,000 @ A3

Date: 14/09/2010

Drawn: CB

Checked: TR

Approved: TR



KEY

- Sampling Locations A-O
- Transect 1
- Transect 2
- Transect 3
- Transect 4

Species Richness Chart

10 *Species Richness value*

Bar charts show total values for each sampling location as a percentage of the total value for all locations.

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Rev	Description	Dwn	Appvd	Date

TEP
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Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Inter-tidal Invertebrate Species Richness Distribution

Map No.
G.1430.01.015

Scale:	Date:
1:10,000 @ A3	14/09/2010

Drawn:	Checked:	Approved:
CB	TR	TR

Appendix 10: Breeding Bird and Redshank Nesting Survey

UK – BELGIUM INTERCONNECTOR
PROJECT NEMO

BREEDING BIRD SURVEY AND RESHANK NESTING SURVEY

(Doc Ref: TEP 1430.01.025 r1)

July 2010

Prepared by TEP for:

National Grid International Limited
National Grid House
Warwick Technology Park
Gallows Hill
Warwick

Written:	Checked:	Approved:
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CONTENTS PAGE

1.0 EXECUTIVE SUMMARY 1
Introduction 1
Methods 1
Redshank Nesting Survey 1
Results 1

2.0 INTRODUCTION 3

3.0 SITE DESCRIPTION 4
Sandwich Bay and Hacklinge Marshes SSSI 5
Thanet Coast and Sandwich Bay SPA 5

4.0 METHODS 5
Breeding Bird Survey 5
Redshank Nesting Survey 5

5.0 RESULTS 6
Breeding Bird Survey – Pegwell Bay Country Park and Stonelees 6
Redshank Nesting Survey 6

6.0 IMPLICATIONS AND RECOMMENDATIONS 8
The Ornithological Importance of the Pegwell Bay during the breeding season .. 8
2009 Breeding Bird Survey of Pegwell Bay Country Park, Stonelees and adjacent habitats 8
Recommendations 9

7.0 REFERENCES 10

APPENDICES

Appendix 1: Breeding bird survey form – Pegwell Bay Country Park, Stonelees and peripheral areas of the Pegwell Bay.

FIGURES

Figure 1: Aerial photograph illustrating site context

DRAWINGS

G1430.01.008A Breeding bird survey visit 1 – May 2009
G1430.01.009A Breeding bird survey visit 2 – June 2009
G1430.01.0010A Redshank survey visits 1– May 2009
G1430.01.0011A Redshank survey visits 2 – June 2009

1.0 EXECUTIVE SUMMARY

Introduction

1.1 TEP was commissioned by National Grid International Limited to undertake breeding bird and redshank nesting surveys to investigate the ornithological interest of part of the onshore environment of Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay.

1.2 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods.

1.3 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years

Methods

1.4 The breeding bird survey entailed two surveyors walking a series of line transects during two survey visits on 8th May and 22nd June 2009. The breeding bird survey focussed on the Pegwell Bay Country Park and the area to the south known as Stonelees as well as some peripheral habitats adjacent to the saltmarsh in the north half of the Bay.

Redshank Nesting Survey

1.5 The redshank nesting survey entailed two surveys walking a series of line transects during two survey visits on 29th May and 22nd June 2009. The redshank nesting bird survey focussed on all saltmarsh habitat within the Pegwell Bay.

1.6 Ecology surveys undertaken within the Pegwell Bay have been undertaken with the assistance of the Kent Wildlife Trust who issued a survey works permit to TEP and provided valuable support during the redshank survey.

Results

1.7 34 bird species were observed during the 2009 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit (some species were recorded on both visits).

1.8 No Schedule 1 species were observed during the 2009 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Dunnock and song thrush have been classified as probable breeders on site. Eight amber list species were also recorded.

1.9 The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds. The site supports good numbers of breeding whitethroat.

1.10 The redshank nesting survey undertaken in 2009 has confirmed that up to 10 pairs of redshank and two oystercatcher pairs bred on saltmarsh habitat within the Pegwell Bay to the north of the River Stour. Nesting takes place within three areas of saltmarsh habitat (Areas A to C).

Implications and Recommendations

1.11 All wild birds and their nests and eggs are protected under the *Wildlife and Countryside Act 1981 (as amended)*. Any removal of vegetation required for the cable installation should be undertaken outside of the nesting bird season (March – August inclusive).

1.12 If it is not possible to avoid habitat clearance works during the breeding season it will be necessary for an ecologist to undertake a pre-clearance check no more than 48 hours prior to the day the clearance works are undertaken. If breeding birds are discovered works will be subject to delay.

1.13 Survey findings contained within the previous TEP report '1430.01.024 Winter Bird Survey', strongly indicated that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May and that construction related activities on the mudflats of the Pegwell Bay avoid these periods.

1.14 Redshank and oystercatcher are sensitive to disturbance during the breeding season. It is also recommended, as a matter of best practice, that no construction related activities are undertaken in areas of saltmarsh used by redshank during the redshank nesting season which begins in mid-April and finishes in mid-July (Area A - including 100 metre buffer, Area B and Area C).

1.15 The practice of clearing vegetation within areas of saltmarsh to discourage nesting is NOT recommended since this could encourage redshank nesting.

2.0 INTRODUCTION

2.1 TEP was commissioned by National Grid International Limited to undertake a winter bird survey to investigate the ornithological interest of part of the onshore environment of Pegwell Bay. Surveys have been undertaken to inform a feasibility study into the constraints, risks and opportunities for installing an electricity interconnector cable within the Bay.

2.2 The proposed development is a UK – Belgium Interconnector being developed by a partnership involving National Grid and its counterpart in Belgium.

2.3 The interconnector will allow the transmission of electricity between the UK and Belgium in either direction, depending on the market in each country from time to time. Due to the length of cables required, transmission would be by high voltage direct current (HVDC) whereas the onshore transmission grids in each country operate with high voltage alternating current (HVAC). A converter station is required at each end of the link to convert between HVAC and HVDC and vice-versa.

2.4 The potential converter station site is at the former Richborough Power Station site in Kent as it has good prospects of an appropriate connection to the national grid transmission system (capable of import and export of power); is able to connect to submarine cables from the east coast; and can accommodate the converter station. The converter station would comprise around 4 hectares of electrical plant and buildings. The two tallest buildings would be approximately 25m high.

2.5 The scope of the breeding bird survey involves undertaking two visits during the period April to June inclusive focussing on the Pegwell Bay Country Park and the area of scrub and grassland habitat to the south known as Stonelees. The redshank nesting survey focussed on saltmarsh habitat within the Pegwell Bay.

3.0 SITE DESCRIPTION

3.1 Pegwell Bay is an area of mudflats and saltmarsh immediately to the south of Ramsgate in east Kent. An aerial photograph of Pegwell Bay and adjacent features is provided in Figure 1 below.

3.2 Pegwell Bay Country Park, managed by Kent Wildlife Trust, is immediately to the west of Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay.

3.3 The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees. The saltmarsh here contains a number of gulleys. There is a shingle/sandy area on the south side of the River Stour, known as Shellness, which was also included as a part of the Pegwell Bay winter bird survey.

Figure 1: Aerial photograph illustrating site context



Sandwich Bay and Hacklinge Marshes SSSI

3.4 Pegwell Bay is a part of the Sandwich Bay and Hacklinge Marshes Site of Special Scientific Interest (SSSI). The site is partly designated for its sand dunes which are outside Pegwell Bay, between the River Stour and Deal to the south.

3.5 The ornithological interest of Sandwich Bay and Hacklinge Marshes SSSI is centred on large numbers of waders and wildfowl which use the area in the winter as well as the spring and autumn migration periods (further details including site citations are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.6 Breeding birds associated with the Sandwich Bay and Hacklinge Marshes SSSI include redshank, oystercatcher and possibly ringed plover. Little tern has historically bred on the shingle just to the south of the River Stour although this species has not been a confirmed breeder for around ten years (Mitchell, 2009).

Thanet Coast and Sandwich Bay SPA

3.7 Pegwell Bay also forms a part of the Thanet Coast and Sandwich Bay Special Protection Area (SPA), which is a long stretch of rocky shore, adjoining areas of estuary, sand dune, maritime grassland, saltmarsh and grazing marsh (further details are provided in the TEP report 1430.01.024 Winter Bird Survey).

3.8 Citation sheets for all designated sites described are included in Appendix 2 of TEP report '1430.01,024 Winter Bird Survey'.

4.0 METHODS

Breeding Bird Survey

4.1 The breeding bird survey was undertaken by TEP Ornithology Manager [redacted] MIEEM CEnv and experienced ornithologist [redacted] MIEEM.

4.2 The breeding bird survey entailed two surveyors walking a series of line transects during two survey visits on 8th May and 22nd June 2009. The breeding bird survey focussed on the Pegwell Bay Country Park and the area to the south known as Stonelees as well as some peripheral habitats adjacent to the saltmarsh in the north half of the Bay.

Redshank Nesting Survey

4.3 The redshank nesting survey was undertaken by TEP Ornithology Manager [redacted] MIEEM CEnv and Kent Wildlife Reserves Manager [redacted]

4.4 The redshank nesting survey entailed walking a series of line transects during two survey visits on 29th May and 22nd June 2009. The redshank nesting bird survey focussed on all saltmarsh habitat within the Pegwell Bay.

4.5 Ecology surveys undertaken within the Pegwell Bay have been undertaken with the assistance of the Kent Wildlife Trust who issued a survey works permit to TEP.

5.0 RESULTS

Breeding Bird Survey – Pegwell Bay Country Park and Stonelees

5.1 The observations made during the breeding bird survey visits are illustrated in drawings G1430.01.008A and G1430.01.009A.

5.2 The results of the desktop survey undertaken revealed that a range of Birds of Conservation Concern (BoCC) have been recorded within the wider locality around Pegwell Bay since 2008 including 14 UK Biodiversity Action Plan (BAP) species and 26 BoCC amber-listed species.

5.3 A total of 34 bird species were observed during the 2009 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit (some species were recorded on both visits).

5.4 No Schedule 1 species were observed during the 2009 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Dunnock and song thrush have been classified as probable breeders on site.

5.5 Species covered by the Kent BAP recorded during the survey include lapwing, reed bunting and turtle dove.

5.6 Eight amber list species which are not UKBAP species (lapwing, kestrel, housemartin, meadow pipit, mistle thrush, swallow, whitethroat and wheatear), were also recorded during the survey.

5.7 The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds since these sites support a range of bird species including a number of declining BoCC bird species although some species may not be breeding within the survey area. The site supports good numbers of breeding whitethroat.

Redshank Nesting Survey

5.8 The locations of redshank sightings recorded during the survey visits in May and June 2009 are illustrated in Drawings G1430.01.010A and G1430.01.011A.

May 2009

5.9 Three distinct areas of saltmarsh within Pegwell Bay which appear to be used by nesting redshank were identified during the May 2009 visit. Area A is centred on a small brackish pool located on saltmarsh immediately to the north of the Pegwell Bay Country Park.

5.10 Area A was being used by up to 9 individual redshank birds however the majority of birds did not appear to be nesting at the time of this survey visit. One redshank was flushed indicating that it may have been on a nest at the time. Overall it is estimated that 1 or 2 nesting pairs were using Area A in June 2009.

5.11 Area B is centred on an area of saltmarsh which had been subject to mowing in the previous 2 years to reduce the dominance of cord-grass *Spartina* sp. in this location.

5.12 Area B was being used by up to 7 individual redshank birds and 2 oystercatchers. Overall it is estimated that 2 or 3 redshank nesting pairs and 1 oystercatcher nesting pair were using Area B in May 2009.

5.13 Area C constitutes the large area of saltmarsh located immediately east of Stonelees and north of the River Stour.

5.14 Area C was being used by up to 10 individual redshank birds and 2 oystercatchers. Overall it is estimated that up to 3 redshank nesting pairs and possibly 1 oystercatcher nesting pair were using Area C in June 2009.

5.15 Therefore in June 2009 it is estimated that **between 6 and 10 pairs of nesting redshank and 1 or 2 pairs of oystercatcher** were using the saltmarsh habitat within the Pegwell Bay to the north of the River Stour. It is possible that additional redshank pairs were nesting within saltmarsh on the south bank of the River Stour.

June 2009

5.16 Area A was being used by up to 12 individual redshank birds however the majority of birds did not appear to be nesting at the time of this survey visit. Observations of bird behaviour indicated that there were 2 nesting pairs of redshank in Area A.

5.17 Area B was being used by up to 5 individual redshank birds, all of which were displaying strong territorial behaviour, and 2 oystercatchers. Overall it is estimated that 2 or 3 nesting pairs of redshank were using Area B in June 2009.

5.18 Area C was being used by up to 10 individual redshank birds and 2 oystercatchers. Overall it is estimated that 1 or 2 redshank nesting pairs and possibly 1 oystercatcher nesting pair were using Area C in June 2009.

5.19 Therefore in June 2009 it is estimated that **between 5 and 7 pairs of nesting redshank and between 1 and 2 pairs of oystercatcher** were using the saltmarsh habitat within the Pegwell Bay to the north of the River Stour. It is possible that additional redshank pairs were nesting within saltmarsh on the south bank of the River Stour.

6.0 IMPLICATIONS AND RECOMMENDATIONS

The Ornithological Importance of the Pegwell Bay during the breeding season

6.1 The Sandwich Bay and Hacklinge Marshes SSSI is primarily designated because it supports nationally important wader populations during the winter and migration periods. However Pegwell Bay is also important for its breeding redshank, oystercatcher and possibly ringed plover.

2009 Breeding Bird Survey of Pegwell Bay Country Park, Stonelees and adjacent habitats

Breeding bird survey 2009

6.2 Many of the habitats present within Pegwell Bay Country Park, Stonelees and other areas on the periphery of Pegwell Bay have the potential to support breeding birds. These habitats include rough grassland, scrub trees, reedbed and hedgerows.

6.3 None of the birds observed within the Pegwell Bay survey area are Schedule 1 species which require additional protection during the bird breeding season. Neither was any evidence found to indicate that ringed plover bred within the Pegwell Bay north of the River Stour in 2009.

6.4 All wild birds and their nests and eggs are protected under the *Wildlife and Countryside Act 1981 (as amended)*. Any removal of vegetation should be undertaken outside of the nesting bird season (March – August inclusive).

6.5 If it is not possible to avoid trench digging works during the breeding season it will be necessary for an ecologist to undertake a pre-clearance check no more than 48 hours prior to the day the clearance works are undertaken. Delays to the commencement of works may arise if nesting birds are discovered.

Redshank nesting survey 2009

6.6 The redshank nesting survey undertaken in 2009 has confirmed that up to 10 pairs of redshank bred on saltmarsh habitat within the Pegwell Bay to the north of the River Stour. Nesting takes place within three areas of saltmarsh habitat (Areas A to C).

Area A – Pool immediately to the north of Pegwell Bay Country Park and adjacent saltmarsh habitat

6.7 Although this area only supported up to 2 pairs of breeding redshank during 2009 the pool appears to be an important feeding area for redshank breeding in other parts of the bay, as well as non-breeding birds.

Area B – Mown strip of saltmarsh habitat located immediately east of the hide in the Pegwell Bay Country Park

6.8 Area B supported 2 or 3 pairs of breeding redshank in 2009 as well as 1 pair of oystercatcher. The actual nest sites within this area appeared to be on the edge of the mown saltmarsh area where the vegetation could provide some protection for the nest.

Area C – Large area of saltmarsh habitat located to the south of Pegwell Bay Country Park

6.9 Area C supported up to 3 pairs of breeding redshank in 2009 as well as 1 pair of oystercatcher. The nest sites within this area appeared to be well spread across this large area of saltmarsh to the north of the River Stour.

6.10 Under the *Wildlife and Countryside Act 1981, as amended*, redshank and oystercatcher nest sites are protected from destruction however the nesting birds themselves are not protected from disturbance.

6.11 Redshank and oystercatcher are sensitive to disturbance during the breeding season. It is therefore recommended, as a matter of best practice, that no development activities are undertaken within saltmarsh habitat to the south of the Pegwell Bay Country Park (Area C) and east of the hide within Pegwell Bay Country Park (Area B) during the breeding season. The breeding season for redshank and oystercatcher typically starts in mid-April and finishes at the end of July.

6.12 Area A is already subject to some disturbance from the nearby footpath. Since this area provides an important high tide feeding area for redshank during the breeding season it is recommended that a buffer zone of 100 metres is provided around the edge of the pool. This will ensure that redshank are able to nest and feed in this location without being regularly disturbed.

Recommendations

6.13 Survey findings contained within the previous TEP report '1430.01.024 Winter Bird Survey', strongly indicated that the Pegwell Bay bird populations will be most sensitive to disturbance during the period October to February and also in May and that construction related activities on the mudflats of the Pegwell Bay avoid these periods.

6.14 It is also recommended that no construction related activities are undertaken in areas of saltmarsh used by redshank and oystercatcher during the nesting season for these species which begins in mid-April and finishes in mid-July (Area A - including 100 metre buffer, Area B and Area C).

6.15 The practice of clearing vegetation within areas of saltmarsh to discourage redshank nesting is NOT recommended. Undertaking vegetation clearance works across an extended area, i.e. wider than the cable trench footprint, would be likely to encourage redshank nesting rather than discourage nesting.

7.0 REFERENCES

EUROPEAN COMMISSION, (2009) *European Union Management Plan 2009 – 2011 Redshank (Tringa totanus)*.

HARRISON, C.; AND CASTELL, P. (2002) *Collins Field guide bird nests, eggs and nestlings of Britain and Europe.* Harper Collins Publishers.

MILTON, P., (2008) Pegwell *Bay Report 2007 and 2008.*

MILTON, P., (2008) Pegwell *Bay Report 2009.*

SUFFOLK COAST AND HEATHS UNIT, *Disturbance of waders and wildfowl on the Stour – Orwell SPA.*

STILLMAN, R. A. AND GOSS-CUSTARD, J. D. 2002. *Seasonal changes in the response of oystercatchers Haematopus ostralegus to human disturbance*. – J. Avian. Biol. 33: 358–365.

UK BIODIVERSITY PARTNERSHIP *(revised 2007) UK Biodiversity Action Plan HMSO, London.*

APPENDIX 1
Breeding bird survey form – Pegwell Bay Country Park, Stonelees and peripheral areas of the Pegwell Bay

BREEDING BIRD SURVEY RECORD

General Details:

Site Name	UK- Belgium Interconnector Project Nemo		
Job Number	1430.01	Doc. Ref	1430.01.026
Central NGR	TR340630		
Site Location	Pegwell Bay Country Park and Stonelees		
Date(s)	08.05.09 and 22.06.09		
Surveyor(s)	[redacted] MIEEM CEnv and [redacted] MIEEM		
Weather	1st visit – Cool with light breezes. 2nd visit – Hot and sunny.		
Seasonal Constraints	None. Timing of survey visits was in line with BTO guidelines for Breeding Bird Survey methodology (BBS).		
Methods	Two morning visits to site using transect method based on BTO Breeding Bird Survey.		
Drawing Ref(s):	See Drawings G1430.01.008 (visit one) G1430.01.009 (visit two)		

Existing Data:

Desktop Records were last updated 2010			
Source			
BTO website (Birdtrack)	The following species were recorded within 1km of km square TR3463 during the breeding season in 2008-2010: Brent goose, lapwing, curlew, herring gull, turtle dove, cuckoo, skylark, dunnock, song thrush, starling, house sparrow, tree sparrow, linnet, reed bunting (all UKBAP species). Shelduck, mallard, eider, fulmar, oystercatcher, ringed plover, grey plover, knot, curlew, common sandpiper, redshank, common gull, great black-backed gull, black-headed gull, lesser black-backed gull, sandwich tern, common tern, swift, swallow, meadow pipit, kestrel, stonechat, mistle thrush, whitethroat, wheatear, willow warbler (all amber-listed Birds of Conservation Concern).		

Habitat Description:

Pegwell Bay Country Park, managed by Kent Wildlife Trust, is located immediately to the west of the Pegwell Bay. The country park is comprised predominately of grazed pasture with some scrub. A public footpath follows the coastline between the country park and the saltmarsh which fringes the edge of the Pegwell Bay. The Kent Wildlife Trust also manages the saltmarsh within parts of Pegwell Bay itself.

The mouth of the River Stour forms the south boundary of Pegwell Bay. There is a larger area of saltmarsh just to the north of the River Stour, which is immediately east of the area known as Stonelees, an area of rough grassland and scattered scrub trees.

Survey Results:

Visit 1	**Date**	**08.05.09**	**Start time**	**0700hrs**	**End time**	**1100hrs**
Visit 2	**Date**	**22.06.09**	**Start time**	**0700hrs**	**End time**	**1100hrs**

Species	Visit 1 -number recorded	Visit 2 -number recorded	Breeding on site?	Conservation status
B - Blackbird	4	6	Pr (3)	
BC - Blackcap	8	6	Pr (3)	
BT - Blue tit	2	3	Pr (2)	
BF - Bullfinch	0	1	Ps	UK A
CA - Cormorant	1	0	-	
C - Carrion Crow	2	0	Ps	
CC - Chiffchaff	2	3	Pr (2)	
CD - Collared dove	1	2	-	
D - Dunnock	5	4	Pr (3)	UK A
GO - Goldfinch	2	2	Pr (1)	
GR - Greenfinch	0	1	Ps	
GT - Great tit	1	0	Ps	
HG - Herring gull	1	0	-	UK R
JD - Jackdaw	4	0	Ps	
K - Kestrel	0	3	Ps	A
L - Lapwing	0	1	-	A LBAP
LT - Long-tailed tit	0	3	Ps	
LW – Lesser whitethroat	1	1	Pr (1)	
MP – Meadow pipit	1	0	Ps	A
MG - Magpie	5	2	Pr (2)	
M - Mistle thrush	1	0	Ps	A
PW - Pied wagtail	0	1	Ps	
RW – Reed warbler	3	3	Pr (2)	
R - Robin	5	4	Pr (2)	
RB – Reed bunting	1	0	Ps	UK R LBAP
ST - Song thrush	2	1	Pr (1)	UK R
SG - Starling	1	0	Ps	UK R
SW – Sedge warbler	1	0	Ps	
SL - Swallow	1	0	-	A
TD – Turtle dove	1	0	Ps	UK R LBAP
W - Wheatear	0	4	Ps	A
WH - Whitethroat	23	11	Pr (10)	A
WP - Woodpigeon	7	0	Ps	
WR - Wren	20	5	Pr (5)	
TOTAL SPECIES	**27**	**21**		

Key: *C = Confirmed; Pr = Probable; Po = Possible; N = Not;*
LBAP = Local BAP; UK = UK BAP; R = Red List; A = Amber List; Sch 1 = Schedule 1.

Additional Notes:

Drawings

- The locations of all birds recorded during the breeding bird survey are illustrated on Drawings G1430.01.008 (visit one) and G1430.01.009 (visit two).

Summary:

The results of the desktop survey undertaken revealed that a range of BoCC have been recorded within the wider locality around Pegwell Bay since 2008. Important birds of conservation concern included 14 UK BAP species and 26 BoCC amber-listed species.

A total of 34 bird species were observed during the 2010 breeding bird survey at Pegwell Bay Country Park and Stonelees; 27 species in the early visit and 21 species in the late visit.

No Schedule 1 species were observed during the 2010 survey. Seven UKBAP species (bullfinch, dunnock, herring gull, reed bunting, song thrush, starling and turtle dove) were recorded on site during the survey. Of these species dunnock and song thrush have been classified as probable breeders on site.

Species covered by the Kent BAP recorded during the survey include lapwing, reed bunting and turtle dove.

Eight amber list species which are not UKBAP species (lapwing, kestrel, housemartin, meadow pipit, mistle thrush, swallow, whitethroat and wheatear), were also recorded during the survey.

The Pegwell Bay Country Park and Stonelees are considered to have local importance for breeding birds since these sites support a range of bird species including a number of declining BoCC bird species although some species may not be breeding within the survey area.

The site supports good numbers of breeding whitethroat. Whitethroats breed in tall herbage or low shrubby growth in open habitats, hedgerows and scrubland. The nest is located in low shrub or tall plants, usually about 30cm above the ground, but rarely on the ground or in thickets up to 5 metres high.

DRAWINGS

B	Blackbird
BC	Blackcap
BT	Blue tit
BF	Bullfinch
CA	Cormorant
C	Carrion Crow
CC	Chiffchaff
CD	Collared dove
D	Dunnock
GO	Goldfinch
GR	Greenfinch
GT	Great tit
HG	Herring gull
JD	Jackdaw
K	Kestrel
L	Lapwing
LT	Long-tailed tit
LW	Lesser whitethroat
MP	Meadow pipit
MG	Magpie
M	Mistle thrush
PW	Pied wagtail
RW	Reed warbler
R	Robin
RB	Reed bunting
ST	Song thrush
SG	Starling
SW	Sedge warbler
SL	Swallow
TD	Turtle dove
W	Wheatear
WH	Whitethroat
WP	Woodpigeon
WR	Wren

KEY

- Breeding birds survey area
- B⟶ Blackbird seen only in flight
- B⟶ Blackbird perched then flying away
- B̲ A calling blackbird
- B̲̲ A blackbird giving alarm calls
- (B) A blackbird in song
- B ---- (B) An aggressive encounter between two blackbirds
- (B B) Two blackbirds in song at the same time
- B_{juv} Juvenile blackbird
- B_{fam} Blackbird family
- B_{food} Blackbird carrying food
- B_{mat} Blackbird carrying nesting material
- *B Blackbird nest
- $B_{♀}$ Female blackbird
- $B_{♂}$ Male blackbird

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Rev	Description	Dwn	Appvd	Date
A	Inserted key & formatting	DH	TR	29/09/2010

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Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Breeding Bird Survey
Visit 1

Map No.
G.1430.01.008A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR

B	Blackbird
BC	Blackcap
BT	Blue tit
BF	Bullfinch
CA	Cormorant
C	Carrion Crow
CC	Chiffchaff
CD	Collared dove
D	Dunnock
GO	Goldfinch
GR	Greenfinch
GT	Great tit
HG	Herring gull
JD	Jackdaw
K	Kestrel
L	Lapwing
LT	Long-tailed tit
LW	Lesser whitethroat
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MG	Magpie
M	Mistle thrush
PW	Pied wagtail
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R	Robin
RB	Reed bunting
ST	Song thrush
SG	Starling
SW	Sedge warbler
SL	Swallow
TD	Turtle dove
W	Wheatear
WH	Whitethroat
WP	Woodpigeon
WR	Wren

KEY

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- B⟶ Blackbird seen only in flight
- B⟶ Blackbird perched then flying away
- B A calling blackbird
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- $B_{♀}$ Female blackbird
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Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Breeding Bird Survey
Visit 2

Map No.
G.1430.01.009A

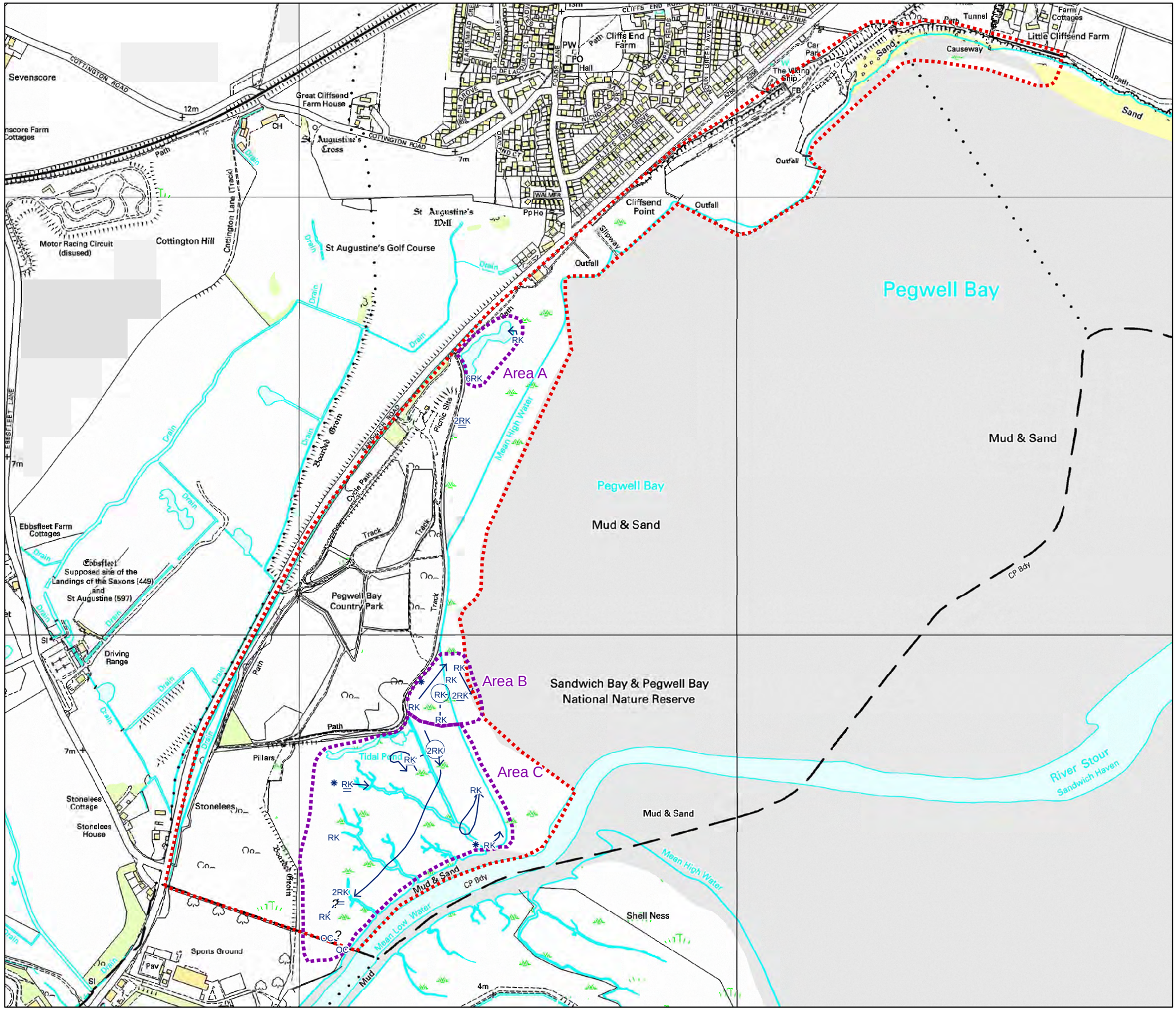
Scale: 1:8000 @ A3

Date: 08/09/10

Drawn: VG

Checked: TR

Approved: TR



KEY

- Breeding birds survey area
- Redshank nesting areas (A - C)
- RK⟶ Redshank seen only in flight
- RK⟶ Redshank perched then flying away
- RK A calling redshank
- RK A redshank giving alarm calls
- (RK) A redshank in song
- RK-- (RK) An aggressive encounter between two redshanks
- RK RK Two redshanks in song at the same time
- RK_{juv} Juvenile redshank
- RK_{fam} Redshank family
- RK_{food} Redshank carrying food
- RK_{mat} Redshank carrying nesting material
- *RK Redshank nest
- $RK_{♀}$ Female redshank
- $RK_{♂}$ Male redshank

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Rev	Description	Dwn	Appvd	Date
A	Amended key, added RS areas	DH	TR	29/09/2010

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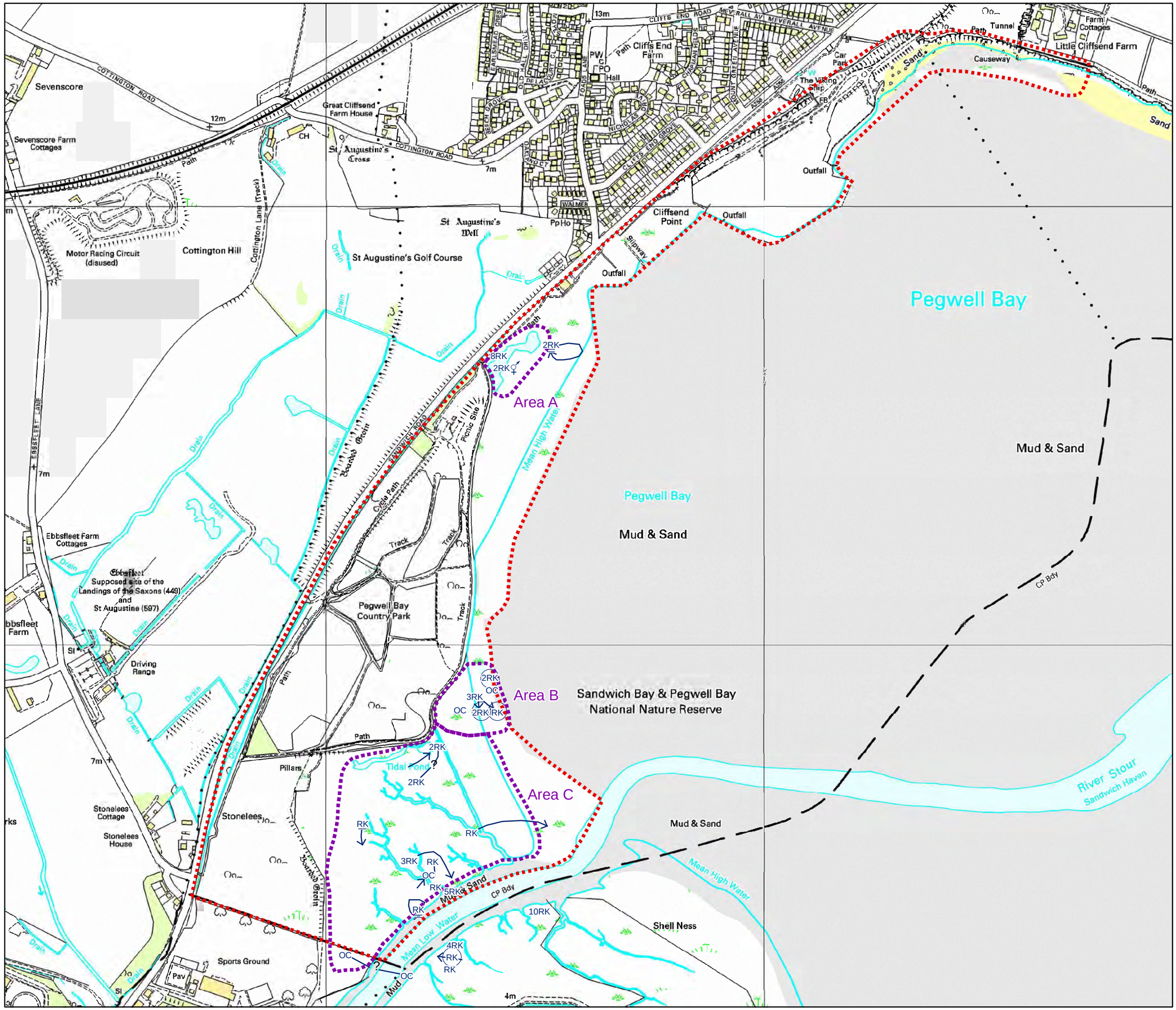
Project:
UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Redshank Survey
Visit 1

Map No.
G.1430.01.010A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR



KEY

- Breeding birds survey area
- Redshank nesting areas (A - C)
- —RK⟶ Redshank seen only in flight
- RK⟶ Redshank perched then flying away
- RK Redshank calling
- RK Redshank giving alarm calls
- (RK) Redshank in song
- RK- - (RK) An aggressive encounter between two redshanks
- RK RK Two redshanks in song at the same time
- RK_{juv} Juvenile redshank
- RK_{fam} Redshank family
- RK_{food} Redshank carrying food
- RK_{mat} Redshank carrying nesting material
- *RK Redshank nest
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- $RK_{♂}$ Male redshank

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Rev	Description	Dwn	Appvd	Date
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UK-Belgium Interconnector
Project Nemo

Title:
Pegwell Bay Redshank Survey
Visit 2

Map No.
G.1430.01.011A

Scale:	Date:
1:8000 @ A3	08/09/10

Drawn:	Checked:	Approved:
VG	TR	TR

Appendix 11: Benthic Survey Report

Marine Survey Report
Project NEMO

elia nationalgrid

Environmental Survey
2010

HVDC subsea cable link route between

Ramsgate, UK and

Zeebrügge, Belgium



Final Revision

March 2011

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Marine Survey Report

Project NEMO

Clients

Environmental Survey 2010

Final Report 2011

May 2011

HVDC subsea cable link route between
Ramsgate, UK and
Zeebrügge, Belgium

Document control

Answerable for	Position	Name
Content	Marine Biologist	[redacted]
	Marine Biologist	
	Marine Biologist	
	Marine Biologist	
Check	Senior Biologist	
Approval	Project Manager	

Revision history

Revision	Date	Comment	Signature
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02	2010-12-21	For client review	HS
A	2011-03-30	Issued for use	SP
B	2011-05-13	Issued for use	SP

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CONTENTS

1. Executive Summary 9
2. Introduction 12
2.1. General Project Information 12
2.2. General Background Information 12
2.3. Scope of Work - Project 12
2.4. Scope Of Work - Environmental Survey 13
2.5. Project Execution 14
3. Project parameters 15
3.1. Time & Date 15
3.2. Geodetic Parameters 15
3.3. Documentation and QA / QC 16
3.4. Daily Progress Report 16
4. Materials and Methods 17
4.1. Video/Photo Camera 17
4.2. Sampling and Sieving 18
4.3. Beam Trawling 18
4.4. Station Selection and Sample Preservation 19
4.5. PSA Methodology 21
4.6. Habitat Classification 21
5. Results 24
5.1. Benthic Fauna 24
5.2. Habitat Description 27
5.3. Biogenic Reefs 31
5.4. Trawl 36
5.5. UK BAP Species 37
5.6. Statistics Habitat Stations/Species 37
5.7. Multivariate Analysis 38
5.8. Particle Size Analysis 41
6. Conclusions 42
7. References 44

APPENDICES

Appendix A	Benthic grab sample position list
Appendix B	Trawl position list
Appendix C	Vessel Specifications
Appendix D	Equipment list
Appendix E	Personnel
Appendix F	Survey log
Appendix G	Grab station photo identification table
Appendix H	Grab station identification table
Appendix I	Transect photo identification table
Appendix J	Total species list
Appendix K	Grab station field information
Appendix L	Raw data abundance table for each grab station
Appendix M	Transect position list
Appendix N	Annex 1 habitat overview
Appendix O	Trawl identification table
Appendix P	PSA results

SURVEY CHARTS

The survey route habitat charts provide the results within the entire surveyed route. The charts are presented at a scale of 1:5 000.

Block	Chart	KP Start	KP End	Horizontal Scale
1	100702-MMT-EN2-SUR-DWG-ENV00001	0.000	14.776	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00002	14.714	29.393	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00003	29.211	44.212	1:5000
1	100702-MMT-EN2-SUR-DWG-ENV00004	42.547	56.814	1:5000
2	100702-MMT-EN2-SUR-DWG-ENV00005	56.721	71.663	1:5000
2	100702-MMT-EN2-SUR-DWG-ENV00006	78.579	86.437	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00007	86.361	101.166	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00008	101.080	115.903	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00009	115.819	129.209	1:5000
3	100702-MMT-EN2-SUR-DWG-ENV00010	123.369	128.256	1:5000

LIST OF ILLUSTRATIONS

Figure 1. Environmental sampling sites....11
Figure 2. Drop Down Video Camera....17
Figure 3. Scale....17
Figure 4. Day Grab....18
Figure 5 Beam Trawl....18
Figure 6. Index Map with Kilometre Posts (KP)....23
Figure 7 Individual abundance at each station referring to raw data....25
Figure 8. B01_007 tubes of O.fusiformis....28
Figure 9. B01_007_GS tubes of O.fusiformis....28
Figure 10. Habitat overview according to the EUNIS classification codes....30
Figure 11. B03_039 S. spinulosa reef....32
Figure 12. B03_040 S. spinulosa reef....32
Figure 13. Habitats A5.611 Sabellaria spinulosa reefs in Block 3....33
Figure 14. Sabellaria reef from Side Scan Sonar....34
Figure 15. Sabellaria reef overview from Side Scan Sonar....35
Figure 16. Sabellaria reef from AGDS....35
Figure 17. Bray-Curtis resemblance dendrogram....39
Figure 18. Macrofaunal Station Bray-Curtis resemblance MDS....40
Figure 19. Fractional composition of sediments from England to Belgium....41

LIST OF TABLES

Table 1. Horizontal Datum....15
Table 2. SACFOR Scale....20
Table 3 Intervals for each Survey Block....21
Table 4. Overview of higher taxonomic groups....24
Table 5. Habitat classes identified in the entire survey area. EUNIS classification code....26

ABBREVIATIONS

Annex	Annex 1 in EC habitat directive (COUNCIL DIRECTIVE 92/43/EEC)
AGDS	Acoustic Ground Discrimination System
ATR	Acceptance Test Report
BAP	Biodiversity Action Plan
DC	Direct Current
DDV	Drop Down Video
DPR	Daily Progress Report
Elia	Elia Asset S.A.
ETA	Estimated Time of Arrival
EIA	Environmental Impact Assessment
GPS	Global Positioning System
HSE	Health Safety Environment
HVDC	High Voltage Direct Current
Ins. Samp. Vol.	Insufficient Sample Volume
KP	Kilometre Post
kn	Knot
M/S	Metre(s) per Second
MAG	Magnetometer
MBES	Multibeam Echo Sonar
MMT	Marin Mätteknik
NGIL	National Grid International Ltd.
PDF	Portable Document Format
PMSS	Project Management Support Services Ltd.
QA	Quality Assurance
QC	Quality Control
RPL	Route Position List
SAC	Special Areas of Conservation
SACFOR	SACFOR Abundance Scale
SBP	Sub-Bottom Profiler
SSS	Side Scan Sonar
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
WGS84	World Geodetic Spheroid 1984

1. EXECUTIVE SUMMARY

This report presents results obtained from the marine environmental survey along the suggested cable corridor, for a planned HVDC electrical interconnector cable between Ramsgate, UK and West Zeebrügge, Belgium planned in collaboration between Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL). The objectives were to identify and classify habitats, biotopes and species diversity for further environmental evaluation.

A geophysical, geotechnical and environmental survey was conducted to map the conditions along the suggested cable corridor, to support the selection of a route for installation of the cable. The environmental sampling stations were selected using information from the geophysical survey. Sampling stations were chosen with emphasis on the variations of the seabed characteristics and areas of interest, such as stations including possible Annex 1 habitats. For detailed information of sample positions see Appendix A and Figure 1.

The surveyed interconnector cable corridor is 500 metres wide and includes offshore, nearshore and onshore operations. The environmental survey included the nearshore and offshore part of the survey. The purpose of the benthic survey is to provide details of the different benthic habitats along the cable route. The habitat classification was performed according to the EUNIS biodiversity database.

The water movement in the survey area is mostly driven by tides that are semi diurnal, in the shallow waters the winds are also influential. The seabed sediment is mainly a composition of sand and gravel. The eastern end of the cable route is dominated by fine sand and some silt whereas in the western area there is mostly medium sand with patches of gravel. Bedrock (Chalk) is present at or near the surface in the western part.

Grab sampling for macrofauna and photographic identification was performed as well as sediment sampling for Particle Size Analysis (PSA). A Day grab was used for the benthic sampling at a total of 50 stations. Each station was sampled with three grabs and photo documentation was executed prior to sampling.

To complement the benthic grab sampling, a beam trawl was used to sample fish and epibenthic mega fauna at four stations. For trawl positions see Appendix B.

Across two of the selected stations, in addition to the still photo and sampling, the drop down photo and video camera was used for recording transects. These were considered to be possible Annex 1 habitat containing *Sabellaria* reefs structures. Transects were recorded to estimate the size of the possible reef structures.

In total almost 281 species were identified from grab sampling together with grab photos along the whole cable corridor. The most diverse animal groups were polychaetes and crustaceans with, 80 and 83 species found in each group respectively. The polychaete *Owenia fusiformis* was the dominating species amongst the polychaetes, forming large habitats followed by *Sabellaria spinulosa* forming reef structures at two stations.

The diversity and species composition varies with the sediment as the main factor but also factors such as currents and depth have an impact on the biological composition. The stations with the most diverse infauna were found in fine sediment mixed with coarser sediment such as shell fragments. The similarities of species composition between sample stations were investigated using statistical methods.

The results of this survey are in line with what can be expected along such a long route and large area, containing both nearshore and offshore habitats.

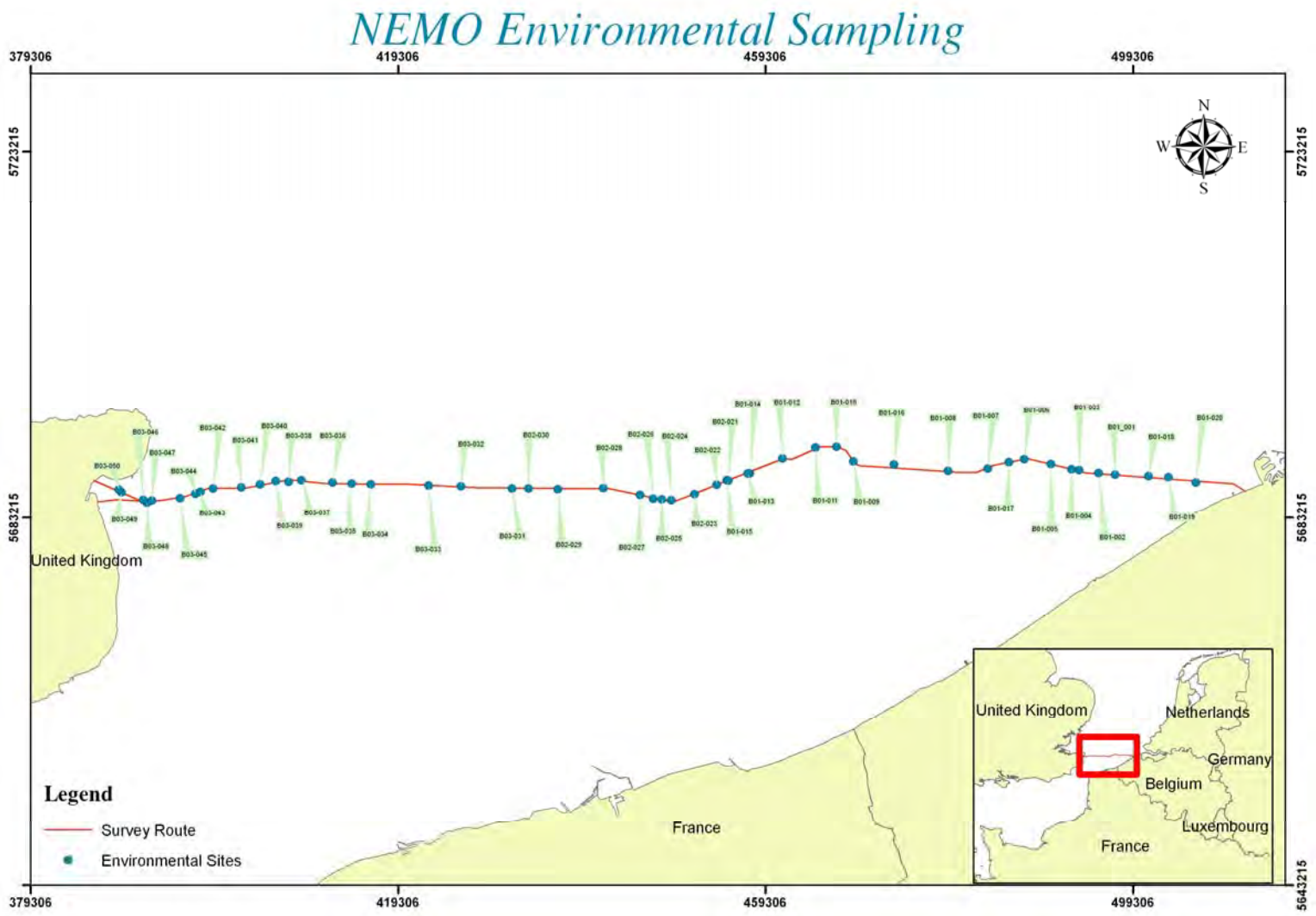


Figure 1. Environmental sampling sites

2. INTRODUCTION

2.1. General Project Information

MMT was contracted by Elia Asset S.A. and National Grid International Ltd, for their jointly planned HVDC electrical interconnector cable between UK (Ramsgate) and Belgium (Zeebrügge). The marine consultant Project Management Support Services Ltd. (PMSS) was appointed by the client as a representative. The geophysical survey covered a 500 m wide corridor. The total route length was approximately 130 km. The corridor between the jointing pit locations was surveyed with geophysical, geotechnical and environmental methods. Due to water depth range along the planned route (2-55m) the survey was divided into offshore, nearshore and inshore/land operations.

The aim of the environmental survey was to ground-truth the geophysical data to identified species and biotopes along the route and to identify sensitive habitats for further habitat mapping and environmental evaluations. The methods for sampling were performed in accordance with guidelines of Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook (Davies J. et al. 2001) and the biotope classification followed European Union Nature Identification System (EUNIS) developed and maintained by the European Topic Centre on Biological Diversity for the European Environment Agency and the European Environmental Information Observation Network.

2.2. General Background Information

The English Channel connects water from the North Sea and water from the Atlantic. The North Sea stretches mainly over the European continental shelf. The coast and nearshore seabed have been shaped by deep geological structures, rises or subsidence depending on location. Atlantic waters with salinities exceeding 35 parts per thousand enter the North Sea through the English Channel, while large quantities of fresh water are coming from rivers e.g. Rhine and Thames. Seabed structures, affecting the benthic community, are shaped by hydrographical factors, such as influence of tidal currents, water temperature and wave exposure.

In this environmental survey a drop camera equipped with a combined video and photo camera was used together with a grab sampler (Day grab). Camera and video recording techniques have been used in a variety of applications and are appropriate for the identification of seabed habitats/biotopes as well as epibenthic fauna. Photo images were used to ground-truth the epibenthic fauna whereas the video was used to assess locations for areas that were of special interest (e.g. Annex 1 areas). This technique has also become quite useful in hard bottom substrates where grab sampling is of limited use, due to possible damage to equipment. At each sampling station three grab samples were collected for further analyses of infauna.

2.3. Scope of Work - Project

The objective for the project was to perform a marine survey campaign for the NEMO HVDC interconnector cable between West Zeebrügge, Belgium and Ramsgate, UK.

The survey campaign included:

- Geophysical route survey (offshore as well as nearshore)
- Geotechnical sampling programme
- Benthic sampling programme
- Onshore survey

The scope of work included, the acquisition, processing, interpretation and reporting of appropriate hydrographical geological and biological data as required to:

- Facilitate installation of a marine high voltage (400 kV) DC power cable
- Establish through Geophysical Survey the nature of the corridor to support the Environmental survey and inform the Geotechnical Campaign
- Establish geotechnical properties of the soil as basis for a conceptual design of the cable, installation methodologies and landfall execution.
- Establish the ecological nature of the corridor to support the Environmental Impact assessment.

The main instruments used during the geophysical survey were multibeam echo sounder (MBES) collecting bathymetrical and Acoustic Ground Discrimination System (AGDS) data, side scan sonar (SSS), magnetometer (MAG) and sub bottom profiler, sparker (SBP). The marine Geophysical survey was performed between August and September 2010 while the Environmental survey was performed between September and October 2010. For detailed information of vessel specification and equipment list see Appendices C and D. For information of personnel attending during the present survey see Appendix E and the survey log in Appendix F.

2.4. Scope Of Work - Environmental Survey

The scope of work for the environmental survey includes identification of habitats along the entire route spanning from Zeebrügge, Belgium to Ramsgate, UK. The survey corridor was 500 m and the length of the route approximately 130 km.

The main aim was to identify and classify habitats, biotopes and species diversity for further evaluation of the area according to Annex I habitat of EC Habitats Directive 92/43 SAC as well as the UK BAP. Habitat classification was performed according to EUNIS classification system.

Prior to the environmental survey, bathymetric and side scan data were collected in the area and used for stratified random selection of stations for further biological sampling.

2.5. Project Execution

Apart from MMT's quality system this report also refers to the following documents:

- Project Nemo Technical Specification Part 1 to 4
- Method_Statement_NEMO_100305A-1.pdf (statement by MMT)
- 2_2_NEMO_Questionnaire_Seabed_Survey-MMT-comment.pdf
- Actions and Confirmations_20100412.pdf
- Actions and Confirmations_Part2.docx
- NEMO-Seabed_Survey-QA.pdf
- Project manual

3. PROJECT PARAMETERS

3.1. Time & Date

All raw data was recorded in UTC.

All display overlays and log books were annotated in UTC.

- Date format: dd mmm yyyy (e.g. 12 Sep 2010)
- Time stamps in: UTC
- Time stamps for time series: apply to the end of the averaging period.

The DPR refers to UTC.

3.2. Geodetic Parameters

Horizontal Datum

All coordinates are based on the following parameters (see Table 1):
Geodetic Datum and Grid Coordinate system
Datum: WGS 84

Projection: Universal Transverse Mercator
UTM zone: 31 North

Table 1. Horizontal Datum

Horizontal Datum	
Projection	UTM 31 North
Ellipsoid	GRS 80
Geodetic Datum	WGS84
Flattening	1/298.25722
Semi major Axis	6378137
Eccentricity Squared	0.00669437999
Central Scale Factor	0.9996
False Easting	500 000 m
False Northing	0 m
Latitude Origin	0°
Central Meridian	03° 00' 00"E

3.3. Documentation and QA / QC

General survey information (including line plan, production, data quality, breakdown, sea level recordings, sound-velocity profiles, etc) is documented according to MMT Quality Plan.

A Project Manual was produced and forwarded to the client during the preparation phase of the survey. Daily and Weekly reports were forwarded by e-mail to the client and the client's consultants offices.

Before commencement of the survey calibrations and acceptance test was performed. The methodologies, procedures and results from this is presented in the Acceptance Test Report document 100702-EN2-MMT-ATR-PRO-ICEBEAM1.

Quality system used during the project consists of the following documents:

- Project Manual
- HSE Plan
- Quality Plan / Plan of Work
- Procedures
- Job descriptions and responsibilities
- Control documents
- Data inventory routines
- Technical Specifications

During the project the QA system was used to:

- Ensure correct logging of data according to the agreed contractual method
- Ensure correct processing of data (e.g. photos)
- Ensure that charts and reports correspond to the Contractor's requirements
- Ensure correct storage of collected data
- Maintain efficient work procedures and make daily work routines as smooth as possible
- Track and improve HSE performance
- Improve the working environment

3.4. Daily Progress Report

The progress of the survey operations is documented in the DPR (Daily Progress Report). The DPRs were produced onboard the vessels for all operating days. The DPR was approved by the Client representative on-board and sent by e-mail to the client as a daily routine.

The offshore environmental survey was performed between the 22nd September and 2nd October 2010 and the nearshore between 14th and 18th of October. The weather was mostly favourable with some exceptions of hard heavy winds which lead to a few days of weather standby, spent in West Zeebrügge harbour.

4. MATERIALS AND METHODS

The environmental survey was carried out by grab sampling and photographic documentation. The stations sampled were selected from reviewing the geophysical data and in agreement with the client. The client also required a habitat map of the cable route corridor with sensitive areas in details (e.g. Annex 1 areas). The stations were selected in a stratified random way in accordance with the requirements of the client and the selection was approved by the client representative before commencement of sampling. Prior to sampling the seabed of all sampling stations was photo documented using the drop down video and still camera system. The areas characterised by a hard bottom or coarse substrate could not be sampled with grab samplers, partly due to difficulty to receive a sufficient sample volume and the risk of damaging the equipment. In this type of area photo documentation is an efficient way of identifying epifauna.

4.1. Video/Photo Camera

The video and still camera system was mounted on a Box Deployment Frame with transponder mounted for positioning (Figure 2). The camera was a Canon EOS 5D Digital Still Camera System, 22 megapixels with inbuilt HD-Video system. The photos were stored in the camera and a low definition video was streamed through the coax cable for live viewing. One LED light Newtsun NS600-S 5600 was used for illumination.



Figure 2. Drop Down Video Camera

The scale is always the same in each still image, as the camera cage is landed on the seafloor.

The scale of the photo was initially tested with two rulers mounted on a board under the camera cage feet (Figure 3). At each station 5 UV photographs were taken. After each recovery the stills were uploaded to the server.



Figure 3. Scale

During the photo transect survey the drop frame was towed in the water column just off the sea bed. At intervals of 20 m the camera was landed on the seabed and two photos were taken. The still image size is 0.97 m x 0.64 m with an area of 0.62 m².

4.2. Sampling and Sieving

The sampling equipment used in the environmental seabed sampling included a 0.1 m² Day grab with sample inspection flaps (Figure 4). The samples were sieved using a 5 mm over 1 mm sieve. Remaining sediment (usually gravel, clays or larger shell fragments) were sorted, using stereo microscopes for the fine fractions. A 0.5 litre sediment sample was stored from each sampling location for further particle size analysis (PSA). The PSA analyses were performed by ALS Environmental (Analytical Chemistry and Testing Services). Fractions > 2 mm-0.063 mm were determined by wet sieving method and fractions < 0.063 mm were determined by laser particle size analyzer using liquid dispersion mode.

A log of sample positions, time, type, water depth together with other field notes was made for later reference. Each grab sample was documented with still photos on landing.

Three grab replicates were collected at each station. Samples with a minimum volume of 5 litres were accepted. If the first attempt was below acceptable volume, another attempt at the station was made with a maximum of five attempts at each station. If none of the five samples had an accepted volume, the sample with the largest volume was saved with a note highlighting the volume. These samples are not included in any statistical analyses.



Figure 4. Day Grab

4.3. Beam Trawling

A beam trawl was used at the UK side at four trawl locations investigating the mega fauna (> 1cm) composition. The trawl is constructed as a net bag mounted between two "runners" which are pulled across the sediment like a sledge (**Fel! Hittar inte referenskälla.**). A metal beam connects the runners. The width of the beam trawl used in this survey was 2 m. The trawling speed was about 1.5 knots and each drag lasted in total 30 minutes with launch and recovery. The distance covered was approximately 600 m for three of the four trawl drags, while the fourth was 1200 m long.

The catch was photographed with sample station identifier and the volume measured, in whole litres and documented. When the catch volume was less than 3 litres, the tow was repeated to ensure that the low volume did not result from the net not fishing properly.



Figure 5 Beam Trawl

Sufficient catches were sorted in order to ensure that rarer species were properly accounted for. The aim was to obtain abundance data for each taxonomic order in the catch. Successive sub-samples of the catch were washed over a large 5 mm sieve to remove any sediment, and then transferred to a sorting bench. Individual taxa were sorted into separate jars and identified while on the vessel. A reference collection was later identified in the laboratory. Larger fauna such as fish were measured, photographed and released, identified if possible.

4.4. Station Selection and Sample Preservation

With the setup of the geophysical survey providing an accurate base-map of the topography, Side Scan Sonar and AGDS data, stratified random sampling is considered the most beneficial method. Stratified random sampling involves dividing the survey area into discrete sections which are allocated a proportional or weighted number of randomly selected stations within the selected areas.

The stratification is selected on the basis of environmental conditions, such as known geophysical and geological data or other variables, including known biotopes, water depth and distance from shore. This method has proven to provide greater precision than a simple random method and allows the use of different sampling techniques (Tucker H.D. 1998). It furthermore provides stabilization in statistical estimates of differences between strata, by sampling equal numbers from strata that can vary in size and enables sufficient sample points to support a separate analysis of any subgroup.

The number of samples and replicates required is subject to the necessity for achieving an accurate description of the fauna, while taking into account natural variation, which is dependent on the sediment type and environmental conditions. With the stratified random method the sample station locations were determined after the geophysical and geological field work, prior to commencement of the environmental survey.

Selection of locations for trawling was based on analyses of geophysical data (SSS, MBES and AGDS). The objective was to sample different types of habitat along the route in UK waters and to make sure that trawling was not performed in any sensitive Annex 1 habitat areas. The trawl lines were also planned never to cross a border between different habitats identified from the geophysical data. Because the proposed cable route is situated in an area where sand dominates the seabed, the trawls were somewhat longer than originally suggested, in order to collect a sufficient amount of epibenthos. The intention was to keep all lines of the same length for the results to be comparable; however this was proved to be impossible due to poor epifauna acquisition.

Samples, from both grab sampling and beam trawling, were preserved in ethanol directly without the use of formalin. This method is considered reliable and has great health and safety benefits compared to using formalin. Biomass loss in the samples (significant in the first three weeks) has been concluded not to differ significantly between the two preservation methods (Rumohr et al. 1987, Wetzel et al. 2005).

The classification codes presented in the habitat maps are based on the European Union Nature Identification System (EUNIS). PSA results, surface sediment interpretation and characteristic species identified from grab sampling formed base for the classification. In addition to this, the photographic documentation was used for verifying habitat changes during final classification.

Quantitative methods were used for the identification of biota in grab samples and still photographs. The results are presented in individuals per m^2 and for colonial species in percentage cover. The semi quantitative SACFOR abundance scale (Table 2) was used for the video analyses. According to the SACFOR scale the abundances are expressed as S - superabundant; A - abundant; C - common; F - frequent; O - occasional; R - rare; P - present. The result of the EUNIS habitat classification is presented in separate charts covering the entire route.

PRIMER 6 (Plymouth Routines in Multivariate Ecological Research) was used for the statistical analyses. This software consists primarily of a wide range of univariate, graphical and multivariate routines for analysing arrays of species-by-samples data from community ecology.

The descriptions of the habitats along the route are divided into three blocks. The block limits coincide with each country border, Belgium represents Block 1, France Block 2 and UK Block 3. Two landfall options were investigated at the UK coast, the northern and the southern landfall (Figure 6). The trawling was only performed in Block 3 (for detailed information see habitat charts).

Kilometre Posts (KP) are commonly used for reference in pipeline and cable route surveys. The numerical value represents the distance in kilometres from the Belgian landfall end of the cable (

Block	KP-Interval
Block 1	0 – 59.02
Block 2	59.02 – 82.27
Block 3	82.27 – 129.21

).

Table 2. SACFOR Scale

Growth form	Size of individuals/ colonies							
% cover	Crust/ meadow	Massive /Turf	<1 cm	1-3 cm	3-15 cm	>15 cm	Density	
>80%	S		S				>1 / 0.001 m^2 (1x1 cm)	>10,000 / m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2	1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10 x 10 cm)	100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2	10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2	
1-5% or density	R	O	R	O	F	C	1-9 / 10m^2 (3.16 x 3.16 m)	
<1% or density		R		R	O	F	1-9 / 100 m^2 (10 x 10 m)	

					R	O	1-9 / 1000 m^2 (31.6 x 31.6 m)	
						R	<1 / 1000 m^2	

Table 3 Intervals for each Survey Block

Block	KP-Interval
Block 1	0 – 59.02
Block 2	59.02 – 82.27
Block 3	82.27 – 129.21

4.5. PSA Methodology

The Particle Size Analysis groups particles into separate sizes and calculates the relative proportion by weight of each size range.

For this survey the different fractions for grain size analysis were, > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50mm, 0.125-0.25 mm and 0.063-0.125 mm which were determined by wet sieving method: Other fractions were determined from "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Wet sieving involves the sediment particles, within a sieve using water to facilitate the mechanical separation of smaller from larger particles. With a mechanical shaker the sieve and sample were placed on the top of it in addition to a water-spray nozzle that controlled the flow of water. The rinsing with water continued until the liquid which was discharged through the receiver was clear. Sample residues on the sieve were dried and weighed.

The method of liquid dispersion is such as that it uses diffracted light that is produced when a laser beam passes through a dispersion of particles in a liquid. As particle size increases so does the angle of diffraction. A mathematical model is then applied to generate a particle size from the angel diffracted and computer software is then used to process the information and to draw appropriate graphs.

4.6. Habitat Classification

The Marine Habitat Classification of the communities of the different habitat types is based on physical characteristics such as benthic geology, wave exposure, tidal current, temperature and salinity together with key species for the area.

The classification is divided into six hierarchical levels. At the first level the Marine habitats are divided from the coastal and terrestrial habitats. At Level 2, the biological zone and presence/absence of rock is a classification criterion and at Level 3 the softer substrata is divided into different sediment types. On these levels the classification is based on physical characters.

Level 4 references to specific taxa, fro rocky substrates major epifauna is used and for softer substrates the classification relies on both zonation and physical attributes. Further at Level 5 the classification is based on both the physical and biological characters of the habitats. Classes are defined with both infauna and epifauna on

different substrates. At the highest level, 6, the different characterizing taxa are associated with differing environmental characteristics of the habitat.

The intention of this report is to give a comprehensive view of the biota along the surveyed area and list the habitats found, as well as identifying habitats included in the definition for UK Biodiversity Action Plan, BAP, or Special Areas of Conservation, SAC, habitats.

The UK Biodiversity Steering Group was created 1995 to develop the UK Biodiversity Action Plan (BAP) in response to the Convention of Biological Diversity signed in Rio de Janeiro in 1992. The BAP was first published in 1995, which identified a list of priority species together with priority habitats within the UK. A revised list of priority species and habitats was approved in June 2007.

Special Areas of Conservation (SACs) is a network of areas identified to conserve biodiversity across the European Union. These areas are identified according to the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, also called the Habitat Directive that came into force on 21 May 1992. The central aim of the Habitat Directive is, through a coherent network of areas, to conserve the biodiversity in the European Union. In Annex 1 of the Directive seven marine habitat types are listed and Annex II specifies animals and plants whose conservation requires special areas of conservation.

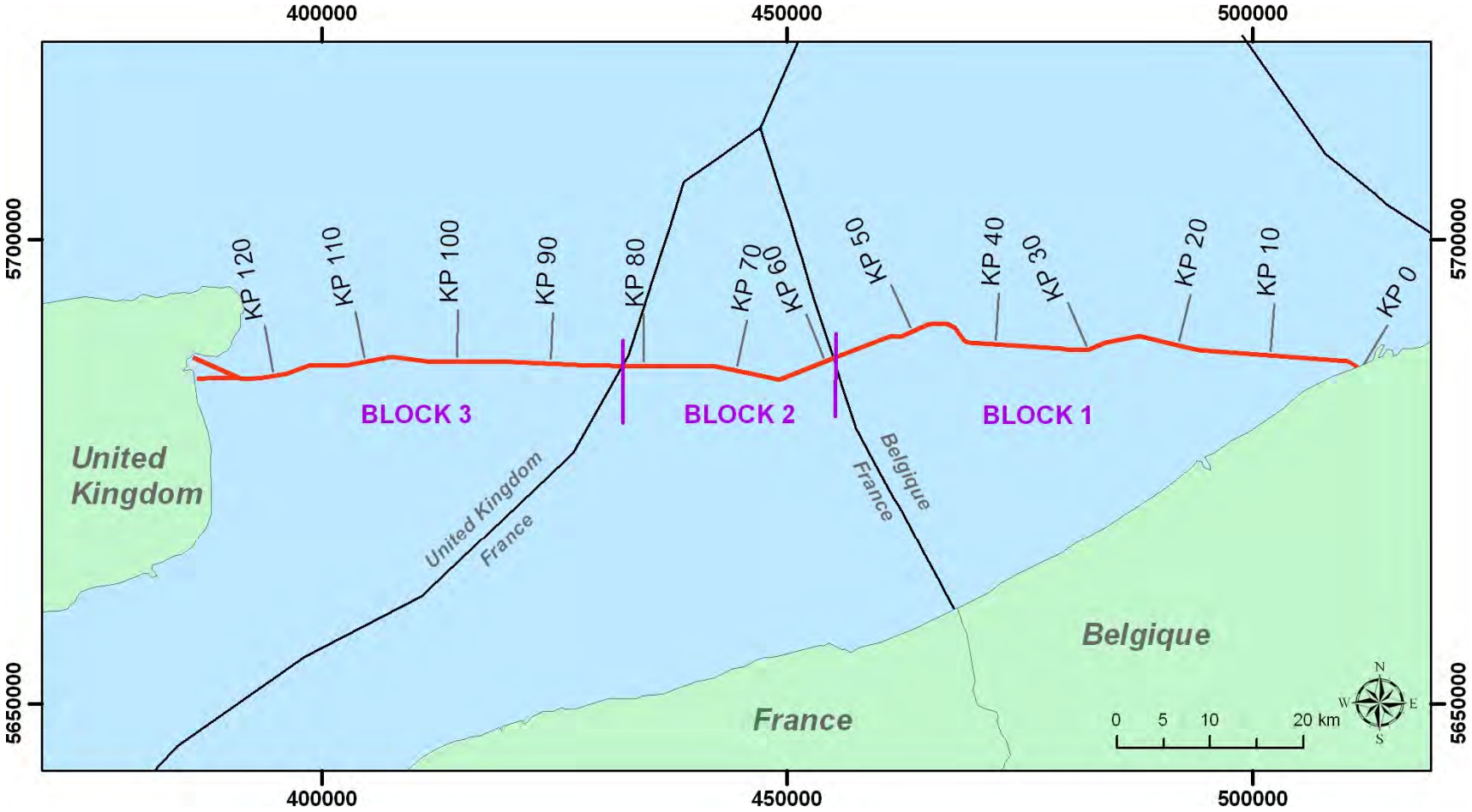


Figure 6. Index Map with Kilometre Posts (KP)

5. RESULTS

5.1. Benthic Fauna

A total of 281 species were identified from grab samples and photo identification along the whole cable corridor (see Appendix G, H, I and J). For detailed information of each sample station see Appendix K. The most dominant taxonomic groups were the polychaetes and crustaceans with 80 and 83 species respectively. The polychaete *Owenia fusiformis* was the dominant species followed by *Sabellaria spinulosa,* which can form large biogenic reef habitats suitable for other epifauna. An overview of the abundance of different higher taxonomic groups is presented in Table 4 and information of the different habitat classes which were identified along the surveyed route can be found in Table 5. The abundance of individuals is also presented for each grab station in Figure 7. For more detailed information of the abundance see Appendix L.

Table 4. Overview of higher taxonomic groups

Higher Taxonomic Groups	Number of taxa	% of total taxa
Cnidaria	18	6.4
Polychaeta	81	28.8
Mollusca – Bivalvia	28	10.0
Mollusca – Gastropoda	11	3.9
Mollusca – Nudibranchia	3	1.1
Mollusca – Cephalopoda	1	0.4
Arthropoda	83	29.5
Arthropoda - Pycnogonida	3	1.1
Bryozoa	7	2.5
Echinodermata	20	7.1
Chordata – Actinopterygii	16	5.7
Chordata – Cephalochordata spp	1	0.4
Chordata – Ascidiacea spp	1	0.4
Cephalorhyncha spp	1	0.4
Ctenophora spp	1	0.4
Echiura spp	1	0.4
Nemertea spp	1	0.4
Nematoda spp	1	0.4
Porifera spp	1	0.4
Sipuncula spp	2	0.7
Total	**281**	100 %

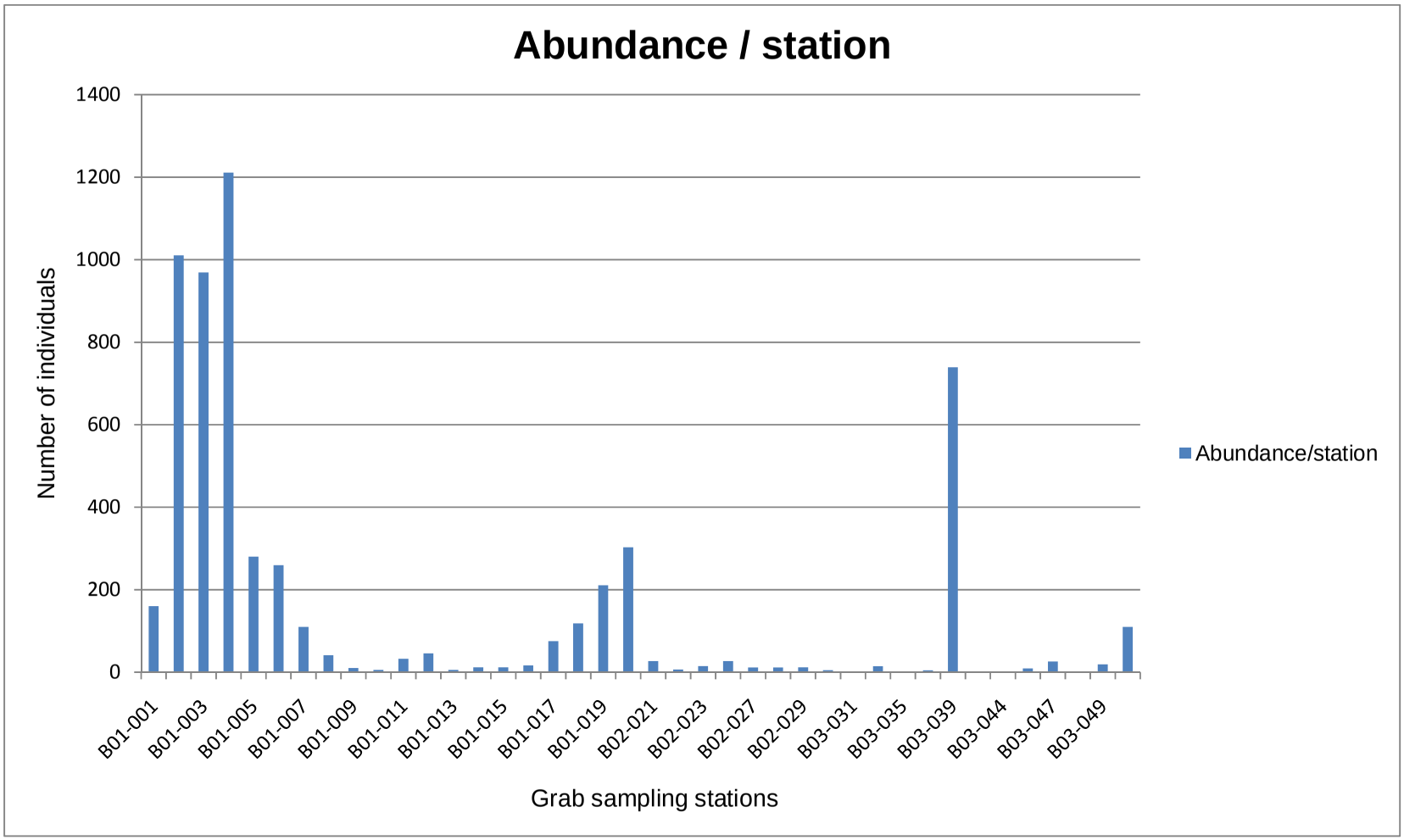
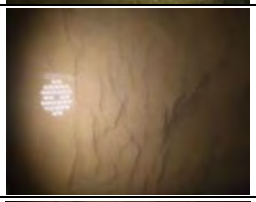


Figure 7 Individual abundance at each station referring to raw data.
(e.g. not extrapolated to square meters).

Table 5. Habitat classes identified in the entire survey area. EUNIS classification code

Example image	Habitat Class	Description
	A5.141	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
	A5.145	*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel
	A5.23	Infralittoral fine sand
	A5.231	Infralittoral mobile clean sand with sparse fauna
	A5.233	*Nephtys cirrosa* and *Bathyporeia spp*. in infralittoral sand
	A5.24	Infralittoral muddy sand
	A5.25	Circalittoral fine sand
image n/a, too shallow and/or turbid waters.	A5.33	Infralittoral sandy mud

Example image	Habitat Class	Description
image n/a, too shallow for survey	A5.34	Infralittoral fine mud
image n/a, too shallow for survey	A5.43	Infralittoral mixed sediments
	A5.611	*Sabellaria spinulosa* on stable circalittoral mixed sediment

5.2. Habitat Description

On the Belgian side and in French waters the habitats are large and more uniform compared to variable and smaller habitats in the west of the survey route (Figure 10). Sand, sand waves and ripples dominate the geological surface over the entire corridor, with occasional patches of cobbles, gravel and sand. Bedrock (Chalk) covered with sand is only present close to the UK coast. (see Transect position list in Appendix M)

Following the survey corridor in Block 1 from the coast of Zeebrügge westwards at depths from 1-16 metres, the dominant habitat is A5.33 described as 'Infralittoral sandy mud'. In this habitat the prevailing species were the polychaetes *Owenia fusiformis* and *Caulleriella killariensis* and the bivalves *Macoma balthica* and *Ensis magnus*. Also a variety of crustaceans and anemones were present. Further westwards at depths between 10-20 m, smaller areas of three other habitats were present. In habitat A5.34 (Infralittoral fine mud) the mussels *M. balthica* and *Abra tenuis*, and polychaetes *Notomastus latericeus* and *C. killariensis* were common. Typical species found in A5.24 (Infralittoral muddy sand) were *O. fusiformis*, *E. magnus and C. killariensis*. Polychaetes were the dominant fauna in habitat A5.23 (Infralittoral fine sand) with *Hesionura elongata*, *Sphaerosyllis bulbosa*, *O. fusiformis*, *Lanice conchilega*, *Spiophanes bombyx* being the most abundant species. The brittle star *Ophiura albida* was also frequent.

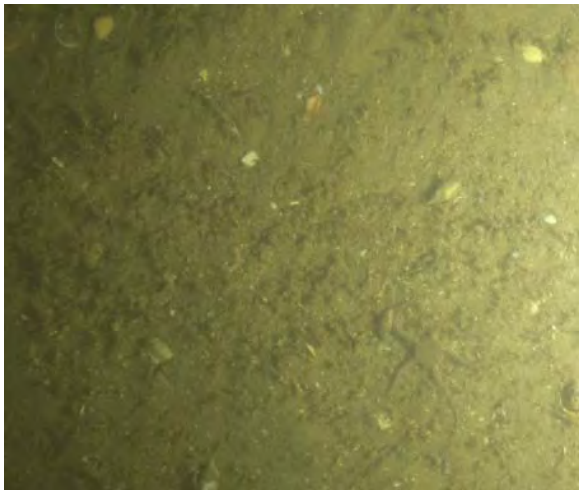


Figure 8. B01_007 tubes of O.fusiformis

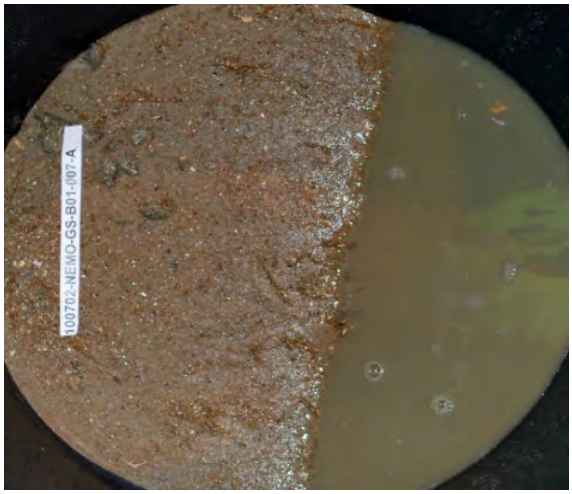


Figure 9. B01_007_GS tubes of O.fusiformis.

The habitat A5.25 (Circalittoral fine sand) stretched over a 65 km section of the route with increasing depth from 19-43 m towards the west, starting at KP 22 in Block 1 continuing through Block 2 until Block 3 at KP 82. Besides sand, the sea bed comprised some shell fragments, gravel and cobbles. This stable environment supports a more diverse community. Samples were dominated by crustaceans and polychaetes, with *L. conchilega*, *O. fusiformis*, *S. bombyx* and *Nephtys cirrosa* being the most frequent species. In Figure 8 and Figure 9 images of *O. fusiformis* tubes are shown from photosample respectively grabsample at station B01_007. Crustaceans were mostly represented by Gammaridae, *Gastrosaccus spinifer*, *Urothoe spp.* and Euphausiacea, and the sea urchin *Echinocyamus pusillus*, peanut worms Sipunculidea and anemones *Actiniaria spp.* were common as well. However, the infaunal abundance within this habitat decreased westwards. Within habitat A5.25, a small patch of A5.23 (Infralittoral fine sand) in Block 1 at KP 33, and two smaller patches of habitat A5.233 (*N. cirrosa* and *Bathyporeia spp.* in infralittoral sand) in Block 2 were identified. In A5.23 the polychaetes *H. elongata* and *Sphaerosyllis bulbosa* dominated the sampled fauna. In A5.233 the most abundant taxa were polychaetes *N. cirrosa* and *O. borealis* and crustaceans Paguridae, *Urothoe spp.* and *Bathyporeia spp.*

Further westwards in Block 3, the habitats were more variable and there were eight different habitats classified from KP 82-128 in the UK waters. In habitat A5.141 (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles) cobbles with tubes of Serpularidae, the sea urchin *P. miliaris* and anemones Actiniaria were common. In A5.145 (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel) mostly polychaetes like *Polycirrus medusa* and *N. latericeus* were present, as well as Nematoda and the lancelet *B. lanceolatum.* Not many species occurred in A5.231 (Infralittoral mobile clean sand with sparse fauna). Among them were the crustacean *Urothoe spp.* and the polychaete *N. cirrosa*. Further segments of A5.25 (Circalittoral fine sand) appear in Block 3 between KP 102.5-118 and this habitat has been described above. Fewer species were found to be in A5.25 in the west of the route. Two areas of reef aggregations of the Ross worm

Sabellaria spinulosa were present in Block 3 classified as habitat A5.611 (*Sabellaria spinulosa* on stable circalittoral mixed sediment). Compared to their surroundings, the *Sabellaria* reefs are inhabited by a higher diversity of species. Some of the associated species are the Long-clawed porcelain crab *Pisidia longicornis* and brittle stars Ophiuroidea and *A. squamata* to mention a few. Habitat A5.23 (Infralittoral fine sand) is situated between KP 115.5-117.5 and closer to UK coast at KP 112.5-127. In these parts the polychaete *Ophelia borealis* and the crustacean *Urothoe brevicornis* were the most abundant species. Unlike the adjacent habitats A5.23 (Infralittoral fine sand) and A5.25 (Circalittoral fine sand), the sea bed in A5.43 (Infralittoral mixed sediments) consisted mainly of gravel where the bivalve Mytilidae was abundant. In habitat A5.24 (Infralittoral muddy sand) the polychaete *N. latericeus*, the bivalves *Nucula nitidosa* and *Abra spp.*, the crustacean Gammaridae spp. and the brittle star *Amphipholis squamata* were abundant. The sea spider *Anoplodactylus petiolatus* was also common in this area.

Along the route the most diverse infauna habitat was A5.24 (Infralittoral muddy sand) at the UK coast with 74 species in one grab sample followed by the *S. spinulosa* reef A5.611 with 46 species. Also habitats A5.23 and A5.25 between KP 21.5-29 in Block 1 were characterised by high species abundance.

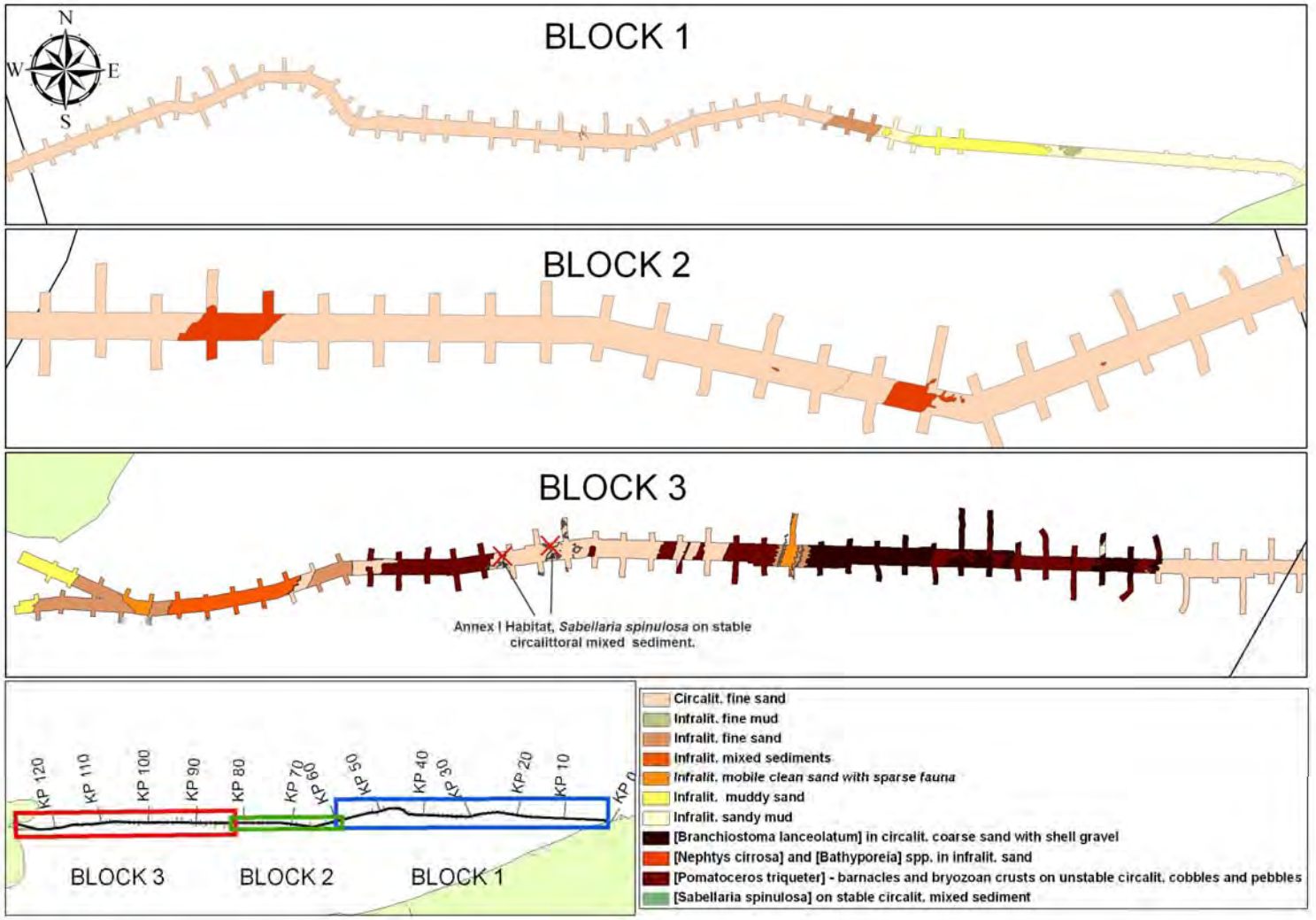


Figure 10. Habitat overview according to the EUNIS classification codes.
Annex I Habitats are marked with red crosses.

5.3. Biogenic Reefs

Biogenic reefs are elevated structures on the seabed created by the species community. One of the most important biogenic reef forming species in UK waters is *S. spinulosa*.

This marine polychaete is often visible/ recorded as individual tubes or in small groups but can also form dense aggregations with elevation above the surrounding seabed in a reef structure which may persist for many years. Such a subtidal reef stabilises otherwise mobile sediment, and thus provides hard substrata and crevices for species which would not otherwise colonize the area. Therefore, biogenic reefs usually have a richer and more diverse associated fauna and flora than its surroundings (Holt et al. 1998, Lancaster and Savage 2008). The formation of extensive reefs by *S. spinulosa* is thought to be relatively scarce around the British Isles (JNCC 2010).

At grab sites B03-036 (A through C) and B03-036 (A and B) some small fractions of old and empty *S. spinulosa* tubes were retrieved. From the still photographs taken prior to grab sampling at the stations B03_039 and B03_040, possible reef structures of the polychaete *S. spinulosa* were observed (Figure 11). In agreement with the client representative, grab samples were collected. The sample taken at station B03_040 contained only few *Sabellaria sp.* tubes attached to stones (Figure 12). However, at station B03_039 over 900 individuals of *S. spinulosa* were present. This biotope also showed a considerable species richness. Dominant species included, among others, 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 Actiniaria. The elevation of *S. spinulosa* tubes measured in the day grab was 7 cm.

Accordingly, two cross transects were conducted in Block 3 in order to estimate the extent of *S. spinulosa* reef. Because of poor visibility, instead of video recording the seabed, photographs were taken every 20 m along each transect. For detailed information about these transects, see transect table in Appendix M.

Transects B03_039_001 (E 406212, N 5687069 to E 405865, N 5687311) and B03_039_002 (E 406045, N 5687269 to E 405931, N 5687099) stretch over an area of sand and gravel and lie approximately 20 km off the coast of England (Figure 13). Parts of a *S. spinulosa* reef and some epifauna e.g. starfish *A. rubens*, crustaceans *P. longicornis*, Paguridae, Galatheidae, Caridea, Portunidae spp., anemones Actiniaria and sea urchins *Psammechinus miliaris* were identified. The tubes height varies along the transects and elevation from seabed is between 5-15 cm. This elongated and narrow habitat A5.611 extends from northwest to southeast between KP 108.4 and KP 108.7 at a depth of 23-28 m and is approximately 424 m long and 59 m broad.



Figure 11. B03_039 S. spinulosa reef

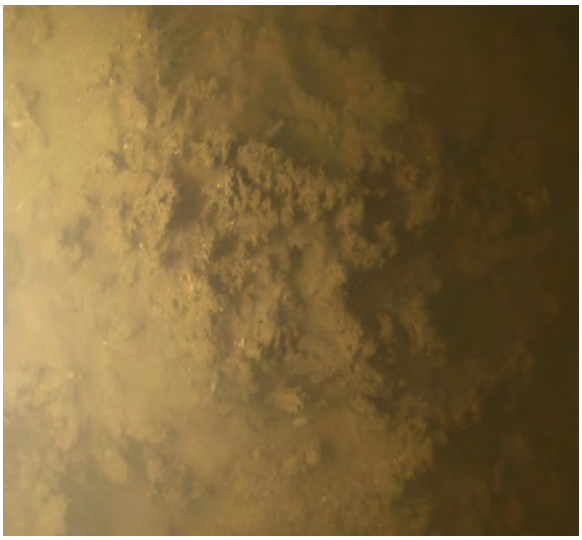


Figure 12. B03_040 S. spinulosa reef

The seabed in transects B03_040_001 (E 404311, N 5686855 to E 404117, N 5686847) and B03_040_002 (E 404296, N 5686929 to E 404305, N 5686811) consisted of mainly sand with some gravel and cobbles (Figure 13). Due to the poor visibility it is difficult to make a reliable statement, but there are probably *Sabellaria sp.* reef structures. Within this area, the reef structure seems to be patchy and scattered. This circular region is situated between KP 110.3 and KP 110.4 at a depth of 26.8 m and is about 31 m in diameter. The *Sabellaria sp*. reef is visible in the side scan sonar data (Figure 14 and Figure 15) and the extent was confirmed from the photo transect survey (the presence of Annex 1 habitats are listed in Appendix N). AGDS data on its own was not sufficient for determining the presence of the *Sabellaria* reef (Figure 16).

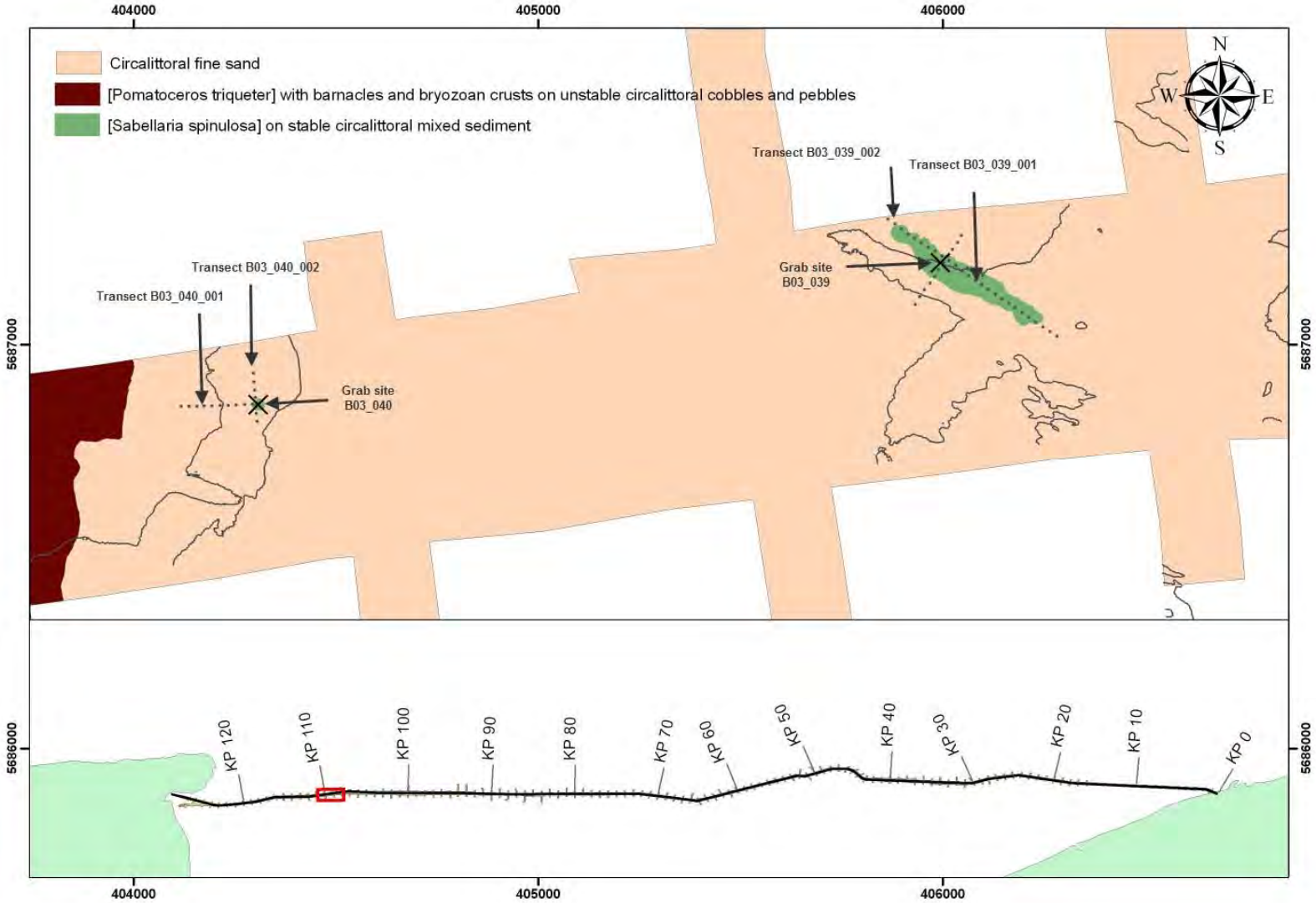


Figure 13. Habitats A5.611 Sabellaria spinulosa reefs in Block 3.
(according to the EUNIS classification codes)

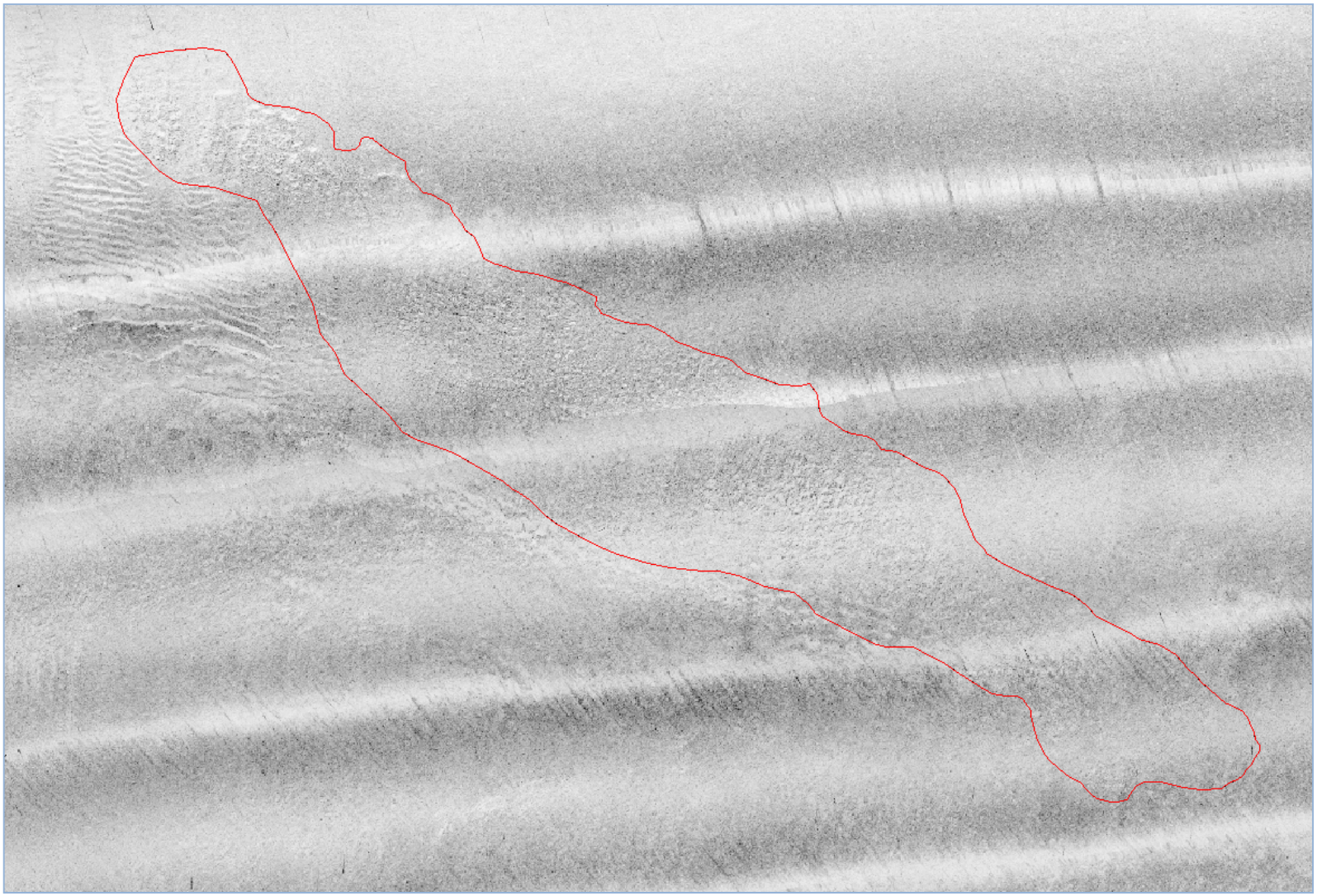


Figure 14. Sabellaria reef from Side Scan Sonar

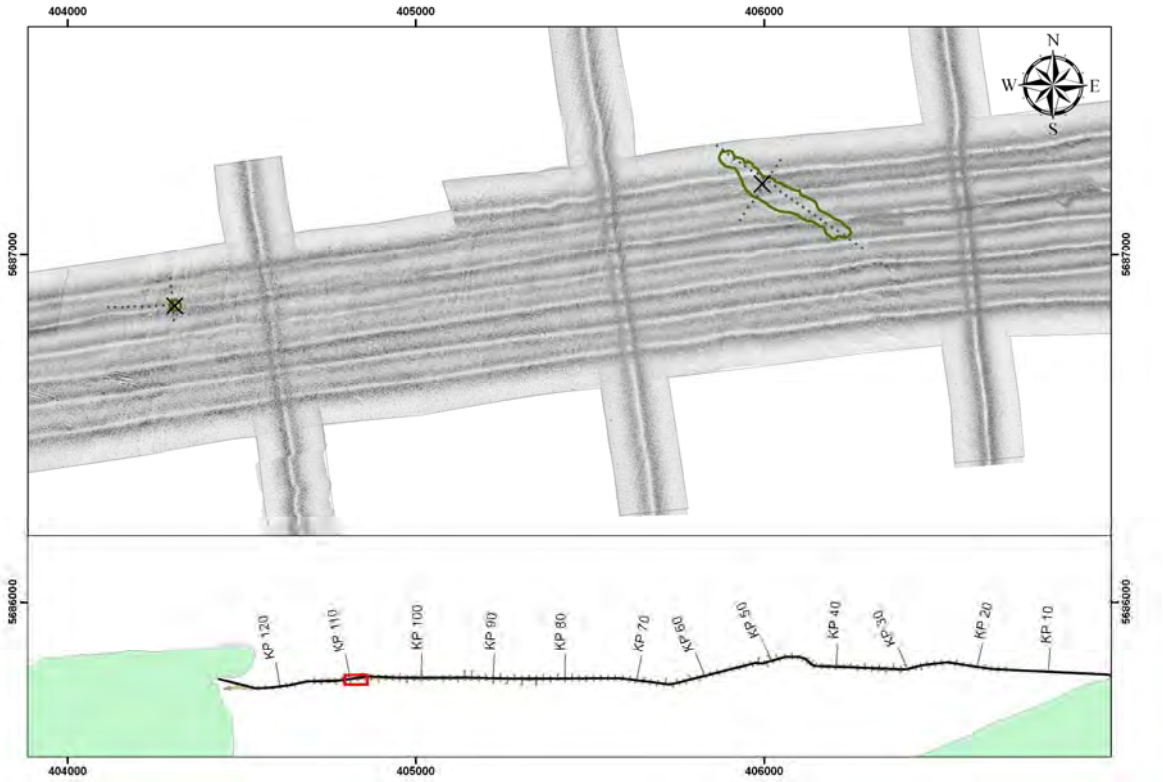


Figure 15. Sabellaria reef overview from Side Scan Sonar

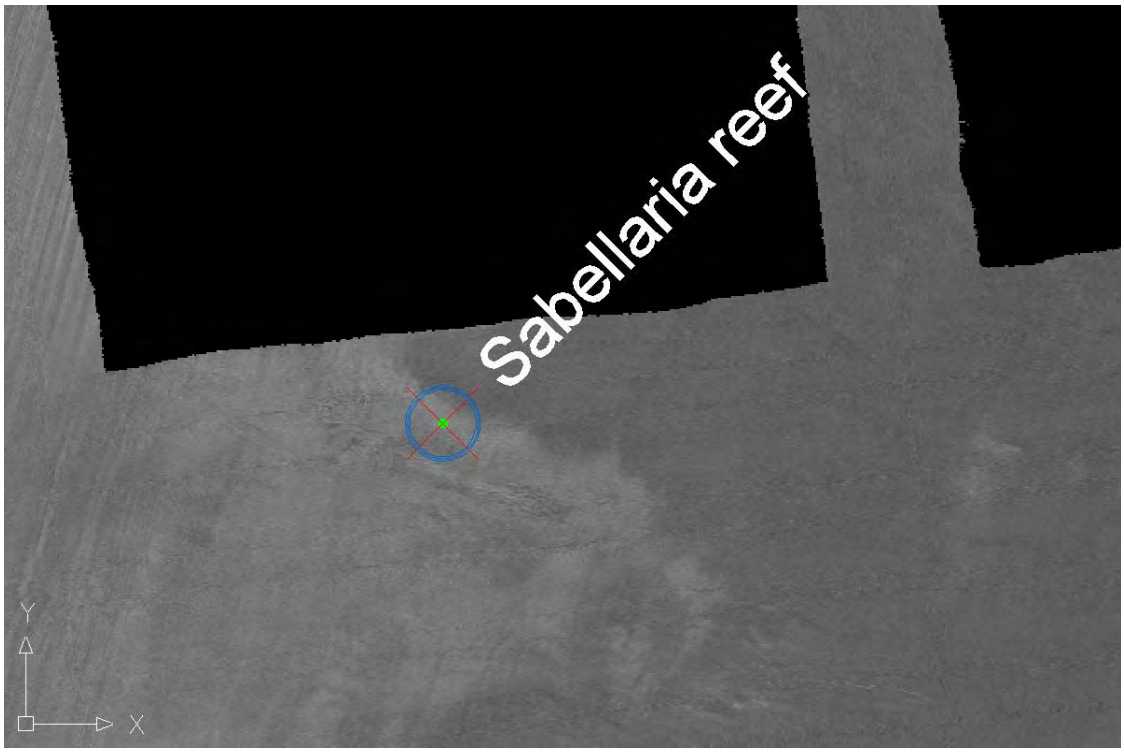


Figure 16. Sabellaria reef from AGDS

5.4. Trawl

Trawling was performed with a Beam trawl at four different stations in Block 3 (UK waters) to register fish and epibenthic megafauna (>1 cm). A total of 65 species were identified from the trawling (see appendix O).

At trawl location 001 (E 431618.45, N 5686686 to E 431195, N 5686686) the trawl passed over sandwaves at depths between 34-40 m covering a distance of 600 m. A sample of 10 litres was retrieved containing 15 species. Plaice *Pleuronectes platessa*, goby *Pomatoschistus spp*., Greater weever *Trachinus draco*, common hermit crab *Pagurus bernhardus*, marbled swimming crab *Liocarcinus marmoreus* and common shrimp *Crangon crangon* were the most abundant species.

At trawl location 002 (E 426267.39, N 5686965 to E 426207, N 5686362) the trawl went 600 m over a seabed with sand and gravel at a depth of 40-42 m, and a sample of 4 litres with 23 species recovered. Dominant species were goby *Pomatoschistus spp*., common dragonet *Callionymus lyra*, common shrimp *C. crangon*, common hermit crab *P. bernhardus* and marbled swimming crab *L. marmoreus*.

The seabed in the area of the trawl location 003 (E 416314, N 5686883 to E 416909, N 5686778) was composed of sand and gravel. The trawl was pulled 600 m at a depth of 40 m over the bottom. During sampling the trawl broke and only 1 litre of sample could be saved. This was however concluded acceptable by the client representative onboard. A total of 47 species were detected of which there were mostly crustaceans, especially the shrimp *Pandalina spp*., and echinoderms like the sea urchin *P. miliaris*.

At trawl location 004 (E 413827, N 5686470 to E 413933, N 5687099) sand and some sand ripples represented the seabed surface at a depth of 34 m. All three trawling trials resulted in trawls containing very small sample volumes. Nevertheless, the third trial was accepted by the client representative. The transect length was 640 m and a sample volume of 2 litres with 13 species was recovered. Crustaceans were the most abundant in this trawl sample like the common hermit crab *P. bernhardus*, shrimp *Crangon spp*. and barnacle *Balanus balanus*. Also the greater weever *T. draco* was abundant.

5.5. UK BAP Species

UK BAP species were found in trawl, grab photo and grab. The plaice, *P. platessa*, was found when trawling in B03_001 and B03_002 and in grab photo B01_011. The sole *Solea solea* was found in trawl stations B03_001, B03_002 and B03_003 and in grab station B01_002. The horse mackerel *T. trachurus* was found in trawl station B03_003.

These species are listed as “Grouped plan species”; they are treated as one species in a group of species for which an action plan is stated. According to the UK BAP homepage very few of the UK commercially exploited fish species are in immediate danger of extinction. However, there are local stocks of fish subject to excessive exploitation even though the species itself may not be in immediate danger.

The overruling threat for these groups are the extensive fishing pressure, as quoted from the UKBAP homepage: “The principal factor causing the decline in spawning stock biomass is summarised simply, but effectively, as `too many boats chasing too few fish`, i.e. the collective fishing power of the EU nations` fishing fleets is much greater than the productivity that the stocks can support”.

5.6. Statistics Habitat Stations/Species

The statistical analysis is based on macrofaunal data derived from the taxonomic analysis of the samples at each station. At some stations, one or two samples had too low sample volume or no sediment recovery on retrieval, mostly due to hard substrates. Samples with a volume of less than 5 litres were not included in the statistical analyses. A total of 50 (at 9 stations sediment recovery failed) stations were sampled and 39 of these stations contained three (A, B, C) samples. In total, 103 samples were used in the statistical analyses from 39 stations. The abundances were expressed as abundance per station (0.1 m^2). The full macrobenthic dataset is presented in Appendix H (Grab station identification table).

5.7. Multivariate Analysis

Multivariate analysis was undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v6.0 statistical package (Clarke and Gorley, 2006). A statistical Bray-Curtis resemblance calculation (Primer 6) was performed. Based on the Bray-Curtis similarity a cluster analysis is performed, which displays a dendrogram with the relationships between data. Multi dimensional scaling (MDS) is also performed with a two-dimensional image of the relationship between the stations.

The factor 'station' was used to visualize the similarities and dissimilarities between grab samples within each station as well as between stations. The data was transformed with square root. The transformation is performed on the data to give dominant and superabundant species a lower weight in order to make rarer species to contribute in the resemblance analyses. SIMPROF, the similarity profiling algorithm was used to identify statistically significant ($P < 0.05$) differences between stations. In Figure 17 the black lines indicate a significant split and the red lines are non-significant splits. The SIMPROF analysis showed eleven statistically different groups where one of the groups includes 64 of the 103 samples (Figure 18).

The low stress value (0.13) for the MDS ordination shows that the data probably has a reliable representation of the area. A resemblance level of 25% was overlaid from the cluster to identify groups with relative similarities. The cluster groups were poorly defined within the plot, with overlap between the groups. However, the statistical significant (SIMPROF) large group was at the resemblance level 25% divided into two groups that are fairly different from the fourth group while the third group is overlapping.

Most of the differences between the first and the fourth group considering species composition (Figure 18 from left to right 2, 1, 3, 4) can be explained by the sediment structure. The sediment at the stations in Block 3 (UK), where most of the samples of group 1 are situated, consists of medium sand forming sand waves. Group 4 sample stations are found in Block 1 (Belgium), apart from sample B03-050 in Block 3, and the seabed comprises fine sand with a silt fraction. Group 2 is similar to group 1, but the seabed was dominated by sand ripples and some patches of sand and gravel. The sediment at the locations from group 3 is made up of medium sand and a mixture of sand, gravel, ripples and waves. This shows that the composition of species and abundance are correlated with the sediment structure. The species are often environment specific. Some species are only found in fine soft sediments with low water motion while others are found in strongly current swept coarse sediment areas. The species niche is dependent on feeding behaviour such as deposit feeders, suspension feeders, predators etc. or shelter from predators or other rough conditions as well as food availability for the specific species in the area. Temperature and salinity can also be a determining factor for a species niche. All together, this determines the species richness and abundance in the different seabed habitats and shows the correlation between sediment structure and species composition.

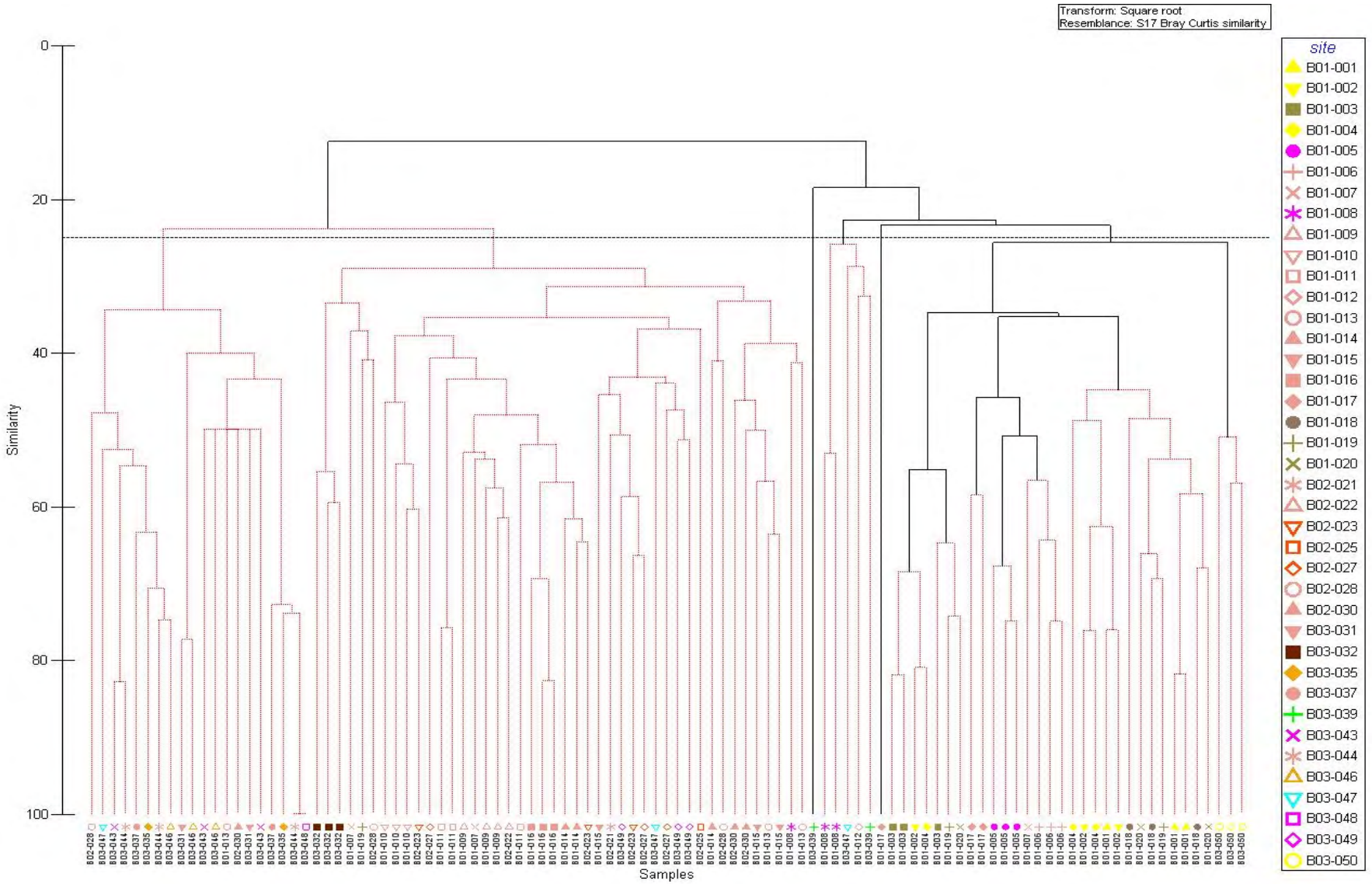


Figure 17. Bray-Curtis resemblance dendrogram.
Comparison of site similarities with square root transformed sample data

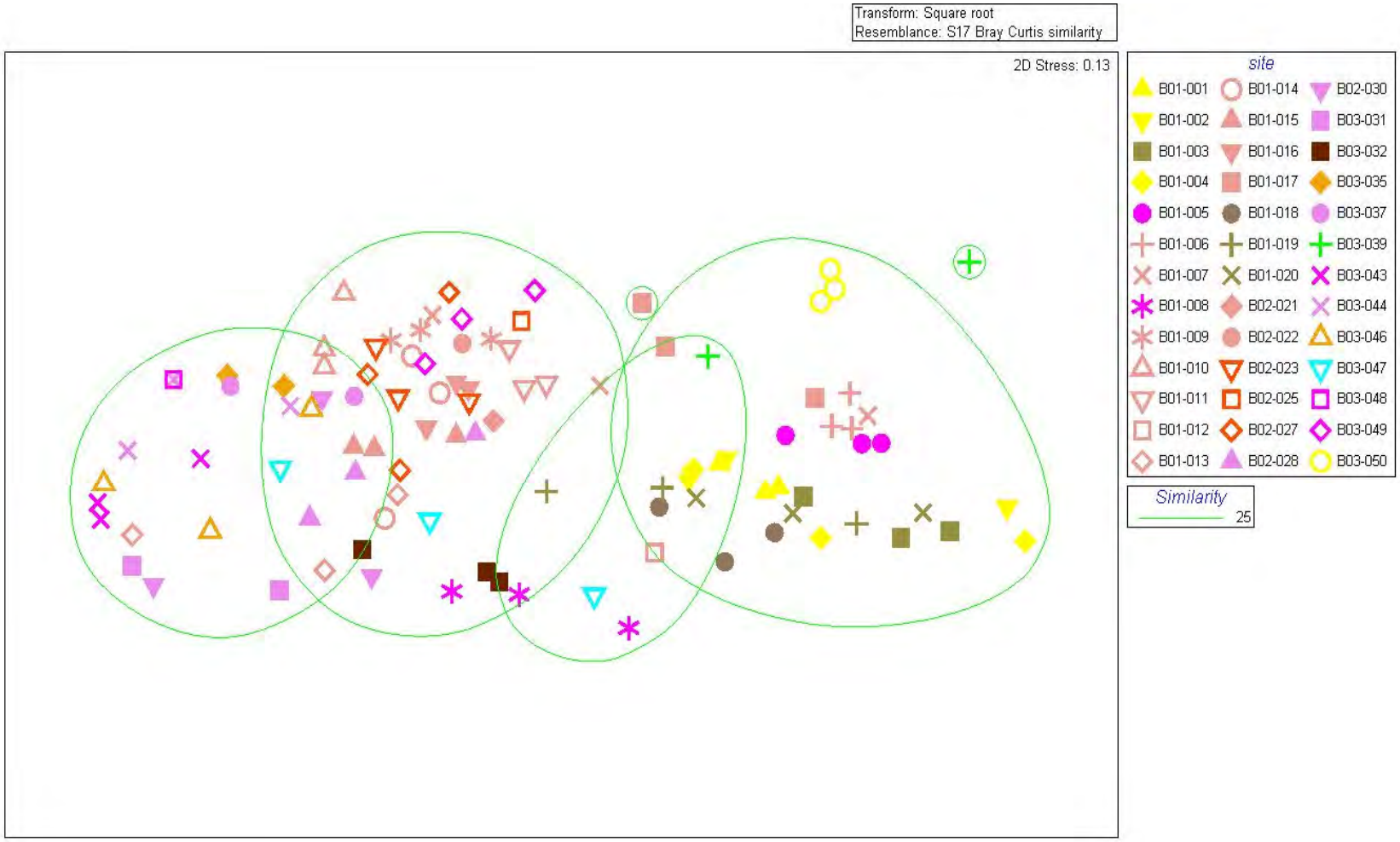


Figure 18. Macrofaunal Station Bray-Curtis resemblance MDS.
Comparison of site similarities with square root transformed grab sample data.

5.8. Particle Size Analysis

At all sample stations particle size analysis (PSA) was conducted. Fractions > 2 mm-0.063 mm were determined by wet sieving method and fractions < 0.063 mm were determined by laser particle size analyzer using liquid dispersion mode. Detailed results for each sample station containing sample weight, fraction weight, fraction percentage part, fraction cumulative part and a graphic depiction of the particle size composition are presented in Appendix P.

The sampled sediments across the surveyed corridor were quite similar; all consisting of mainly sand (Figure 19). Merely the grain composition of sand meaning fine, medium and coarse granules differed between sample stations. Across the route, the proportions of fine sand ranged from 0.48% to 81.73%, and the proportions of medium sand were between 1.7% and 93.84%. Depending on the station, there was either a higher proportion of fine sands or a higher proportion of medium sands. The samples obtained in Block 1 (Belgium) from the KP 5.5 to about KP 19.5 were mainly composed of fine sand. Only close to the Belgian shoreline in KP 5.5-6.0, and at KP18.5, the fine sand was mixed with silt and clay. Some silt may derive from sediment deposition from Zeebrügge Channel. From KP19.5 in Block 1 to the coast of the UK in Block 3, samples essentially consisted of medium sand. A single sample (B01_008) derived from an area with sand waves was found to also contain a comparably high fraction of coarse sand namely 32.44%. At KP 73.0, KP 115.5 and close to Ramsgate at KP 126.5 samples with high fractions of fine sand (60.13-81.73%) were recovered. Only in Block 3 between KP 82.27-88.42 and close to Ramsgate (B03_050) were samples with higher amounts of coarse fractions between 18.24-29.03%.

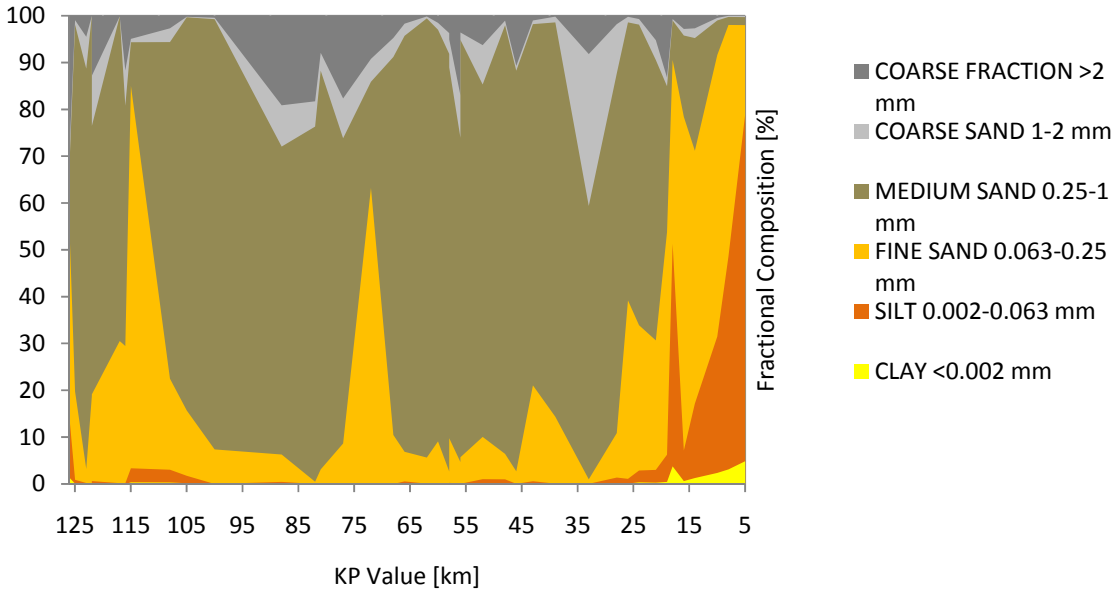


Figure 19. Fractional composition of sediments from England to Belgium

6. CONCLUSIONS

The aim of this survey was to investigate the habitats along the proposed HVDC Subsea cable link route between Zeebrügge, Belgium, and Ramsgate, UK, with emphasis on classifying habitats and species diversity, and on identifying Annex 1 habitats and UK Biodiversity Action Plan (UK BAP) areas. The bottom substrates were investigated with a drop camera and with sediment sampling.

In total 80 close-up photo images were analysed, one at each sample station, together with additional stills along the cross transects. The photo resolution makes it possible to identify biota to lowest taxonomic level practicable at all stations were visibility was acceptable. The fauna at 50 stations with sub samples, where it was possible, was identified to lowest taxonomic level and the abundances were registered in each grab sample. The benthic sediment substrates contain primarily infauna which is preferably sampled using a grab sampler. As a complement to grab sampling, trawling was performed in UK waters only. Benthic species and abundances were noted.

The North Atlantic currents, wind patterns and river runoffs from rivers such as the Rhine and Thames aid in concentrating nutrients near the coasts. These nearshore areas are more diverse than the offshore areas, but they also experience eutrophication with land based nutrients and contaminants. This occurs especially in the southern North Sea due to shallow waters that are surrounded by densely populated countries.

The base for the interpretation and classification of habitats of the entire route are the result from the analyses of photo transects and grab samples together with information from bathymetry and side scan sonar. The findings of this survey are in line with what can be expected in such an area. In the nearshore area habitats are patchier and more species rich than in offshore areas, where long parts of the surveyed route are similar. Along the planned HVDC Subsea cable link route, eleven habitats were identified. The seabed comprises predominantly sand and on occasion cobbles, gravel and silt. The diversity and species composition varies with sediment, but also current and depth have an impact on the biological assemblages.

Two reefs of the Ross worm *S. spinulosa* were found in the surveyed area approximately 20 km off the coast of the UK. The reefs were found at depths between 23 m and 28 m with varying size and density. The larger *Sabellaria* reef is 424 m long and 59 m wide, whereas the smaller is relatively circular, 31 m in diameter. Elevation of tubes was estimated to be between 5-15 cm. Due to strong currents, the visibility in these areas was very poor and the reef and colonies may be patchy.

S. spinulosa reefs have been recorded at several places off the east coast of England, but reefs also exist in the English Channel (Hastings), Dorset and Severn Estuary (OSPAR Commission 2010). *S. spinulosa* is found from the low intertidal to offshore, inhabiting a variety of depths ranging from a few metres to over 40 m depth or even deeper (Holt et al. 1998). The Ross worm is a suspension feeder, and reef communities are often found in areas with weak or moderately strong tidal flows (Jones et al. 2001). Favoured reef locations are areas in proximity to sandwaves (Hendrick and Foster-Smith 2006). These characteristics apply to the reef stations found in this survey.

S. spinulosa reefs are listed under Annex 1 of the Habitats Directive as a marine habitat to be protected by the designation of Special Areas of Conservation. *S. spinulosa* larvae are strongly stimulated to metamorphose and settle on the tubes of both living and dead worms. Nevertheless, the Ross worm is often the first to settle on newly

exposed surfaces and enables the establishment of many other species (OSPAR Commission 2010). Hence, such a biogenic reef contributes to biodiversity and ecosystem function (Limpenny et al. 2010).

Typical of this Annex 1 habitat is that the biodiversity within the reef is higher compared to adjacent areas. Species listed (OSPAR Commission 2010) as often associated with *Sabellaria* reefs such as polychaetes *Harmothoe spp.*, *L. conchilega* and cirratulids, tube-building amphipods e.g. *Ampelisca spp.*, hermit crabs, amphipods and hydroids were also found in the reef at sample station B03_039. Associations between *S. spinulosa* aggregations with high numbers of crustaceans have been observed at other locations including a strong connection with the porcelain crab *P. longicornis* at Hastings Shingle Bank in the English Channel. With regard to the food web, this association is important as *P. longicornis* is likely to become a relevant food source for fish and possibly larger invertebrates (Pearce et al. 2007). Crustaceans, and especially *P. longicornis*, were abundant in the reef at sample station B03_039.

The temporal stability of *S. spinulosa* reefs is still uncertain and only few studies have been conducted on the persistence of colonies. There are indications that suggest that *Sabellaria* reefs generate and degenerate over a time span ranging from months to a few years. Unfortunately, no firm explanation can be offered (OSPAR Commission 2010). Natural variability and storms, changes in circulation patterns caused by tidal currents or ice winters likely also play part in changes in the extent of the *Sabellaria* reefs (Vorberg 2000). *S. spinulosa* does not appear to be particularly sensitive to changes in water quality (Holt et al. 1998), but physical damage deriving from trawling, dredging and net fishing is regarded to have the greatest detrimental effect on the *Sabellaria* reefs (Riesen and Reise 1982). Reports of reef damage caused by benthic trawling are widespread, probably because of the association between *Sabellaria* reefs and the commercially valuable pink shrimp *Pandalus montagui* (Holt et al. 1998).

7. REFERENCES

The identification literature used is not specified in this list.

ALS Environmental (Analytical Chemistry and Testing Services), website, December 2010, http://www.alsglobal.se/

Clarke, K.R. and Gorley, R.N. (2006) *PRIMER v6: User Manual/ Tutorial*. PRIMER-E: Plymouth.

Council Directive 92/43/EEC website, December 2010, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:html

Davis J., Baxter J., Bradley M., Connor D., Khan J., Murray E., Sanderson W., Turnbull C. and Vincent M. (2001) Marine Monitoring Handbook, 405pp, ISBN 1 86107 5243

European Nature Information System (EUNIS) website, December 2010, http://eunis.eea.europa.eu/habitats

Hendrick V. J. and Foster-Smith R. L. (2006) *Sabellaria spinulosa* reef: a scoring system for evaluating "reefiness" in the context of the Habitats Directive, Journal of the Marine Biological Association of the United Kingdom, 86: 665-677

Holt T.J, Rees E.J, Hawkins S.J. and Seed R. (1998) Biogenic Reefs (Volume IX) An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association of Marine Science (UK Marine SACs Project), 170pp

Jones L. A., Hiscock K. and Connor D. W. (2001) Marine Habitat Reviews, A summary of ecological requirements and sensitivity characteristics for the conservation and management of SACs, Joint Nature Conservation Committee, Peterborough, UK Marine SACs Project report, website December 2010, http://www.ukmarinesac.org.uk/pdfs/marine-habitats-review.pdf

Joint Nature Conservation Commitee (JNCC) website, December 2010, http://www.jncc.gov.uk/default.aspx?page=1451

http://www.lavallab.com/particle-size-analysis-guide.htm

Lancaster J. and Savage A. (2008) How Do You Solve a Problem Like Sabellaria?, website, December 2010, http://www.entecuk.com/news07_44_f.html

Limpenny D.S., Foster-Smith R.L., Edwards T.M., Hendrick V.J., Diesing M., Eggleton J.D., Meadows W.J., Crutchfield Z., Pfeifer S. and Reach I.S. (2010) Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef, Aggregate Levy Sustainability Fund Project MAL0008, Joint Nature Conservation Committee, Peterborough, 134 pp., ISBN - 978 0 907545 33 0

Mathematical Methods in Sample Surveys, Tucker H.E.,

Mulitvariate Analys Vol 3. World Scientific Publishing Co Pte. Ltd. 1998.

MMT's Geophysical Report ; 100702-MMT-EN2-SUR-REP-NEMOGTS-Outline_01

Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual
Office of Science & Technology Office of Water. U.S Environmental Protection Agency Washington, DC 20460
U.S.EPA 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA 823-B-01-002. U.S. Environmental Protection Agency, Office of Water, Wahingto, DC.

OSPAR Comission (2010) *Sabellaria spinulosa* reefs, Quality status report, Case reports for the OSPAR list of threatened and/or declining species and habitats – Update, website December 2010,

http://qsr2010.ospar.org/media/assessments/Species/p0010_supplements/CH10_04_Sabellaria_spinulosa.pdf

Pearce B., Taylor J. and Seiderer L. J. (2007) Recoverability of *Sabellaria spinulosa* following aggregate extraction, Aggregate Levy Sustainability Fund MAL0027, Marine Ecological Surveys Limited, Bath, 87 pp. ISBN 978-0-9506920-1-2

Riesen W. and Reise K. (1982) Macrobenthos of the subtidal Wadden Sea: Revisited after 55 years, Helgolander Meeresuntersuchungen, 35:409-423

Rumohr H., Brey T. and Ankar S. (1987) A complication of biometric conversion factors for benthic invertebrates of the Baltic Sea. Baltic Mar Biol Publ No. 9:1-56

Stat Trek Teach yourself statistics Statistics Tutorial: Stratified Random Sampling
http://stattrek.com/Lesson6/STR.aspx

Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates Designation: C 136 – 01

http://www.scribd.com/doc/31193705/ASTM-C136-Sieve-Analysis-of-Fine-and-Coarse-Aggregates
ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.20 on Normal Weight Aggregates.

Vorberg R. (2000) Effects of the shrimp fisheries on reefs of *Sabellaria spinulosa* (Polychaeta), ICES Journal of Marine Science, 57: 1416-1420

Wetzel M. A., Leuchs H. and Koop J. H. E. (2005) Preservation effects on wet weight, dry weight, and ash-free dry weight biomass estimates of four common estuarine macro-invertebrates: no difference between ethanol and formalin, Helgoland Marine Research, 59: 206-213

UK Biodiversity Action Plan (BAP) website December2010,
http://www.ukbap.org.uk/

ID	Easting	Northing	Depth (m)	Attempt (of 5 possible)	Type of Sampling	Comment
100702-NEMO-GS-B01-001	497417	5687890	11.8	3	Photo/Grab	
100702-NEMO-GS-B01-002	495583	5688054	12.8	3	Photo/Grab	
100702-NEMO-GS-B01-003	493466	5688414	16.4	3	Photo/Grab	
100702-NEMO-GS-B01-004	492663	5688496	16.5	4	Photo/Grab	
100702-NEMO-GS-B01-005	490394	5689065	18.9	5	Photo/Grab	
100702-NEMO-GS-B01-006	487526	5689606	21.5	4	Photo/Grab	
100702-NEMO-GS-B01-007	483541	5688555	26.0	3	Photo/Grab	
100702-NEMO-GS-B01-008	479218	5688336	17.0	3	Photo/Grab	
100702-NEMO-GS-B01-009	468907	5689330	29.0	3	Photo/Grab	
100702-NEMO-GS-B01-010	467066	5690950	29.0	3	Photo/Grab	
100702-NEMO-GS-B01-011	464768	5690840	27.0	4	Photo/Grab	
100702-NEMO-GS-B01-012	461179	5689687	34.5	5	Photo/Grab	Two grabs accepted
100702-NEMO-GS-B01-013	457427	5688051	28.0	3	Photo/Grab	
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100702-NEMO-GS-B01-018	501049	5687734	10.0	3	Photo/Grab	
100702-NEMO-GS-B01-019	503201	5687622	8.6	4	Photo/Grab	
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100702-NEMO-GS-B03-048	391993	5684853	9.0	5	Photo/Grab	
100702-NEMO-GS-B03-049	389215	5685981	2.0	3	Photo/Grab	
100702-NEMO-GS-B03-050	388933	5686257	3.0	3	Photo/Grab	Old sabellaria tube fragments

ID	Start Easting	Start Northing	Stop Easting	Stop Northing	Depth (m)	Distance (m)	Type of Sampling	comments
100702-NEMO-TRAWL-B03-001	431618	5686686	431195	5686248	34-40	1200	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-002	426267	5686965	426207	5686362	40-42	610	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-003	416314	5686883	416909	5686778	40	600	Trawl	Trawl damaged due to rough seafloor. No more attempts.
100702-NEMO-TRAWL-B03-004_A	413910	5687172	414005	5686780	34	600	Trawl	Low volume.
100702-NEMO-TRAWL-B03-004_B	413827	5686420	413933	5687099	34	600	Trawl	No sample, low volym.
100702-NEMO-TRAWL-B03-004_C	413827	5686420	413933	5687099	34	640	Trawl	Successful trawling
100702-NEMO-TRAWL-B03-005							Trawl	Sea floor was to rocky to trawl
100702-NEMO-TRAWL-B03-006							Trawl	Too shallow to trawl for Icebeam
100702-NEMO-TRAWL-B03-007							Trawl	Too shallow to trawl for Icebeam

Survey Vessel – Icebeam



Flag Swedish

Weight Br.Tonnage 473, Net.Tonnage 141

Length 40 m

Draft 3.5 m

Speed 10 kts

Navigation and Positioning

Primary Positioning System	— Applanix PosMV 320 with C-NAV correction — Fugro Differential GPS utilizing Starfix-XP and Starfix-HP Differential system.
Primary INS system	— Applanix PosMV 320
Secondary INS system	— IXSEA GAPS III
Primary Gyro system	— Applanix PosMV 320
Secondary Gyro system	— IXSEA GAPS III
Aron 2000 navigation survey system	
Underwater positioning	— USBL IXSEA GAPS III

Bathymetry and Geophysics

Echo sounder	— Kongsberg Multibeam EM 3002D
Moving Sound Velocity Profiler	— Valeport Mini SVS
Hull mounted Sound Velocity Profiler	— Valeport Mini SVS
MBES Software SIS v. 3.7	
Side Scan Sonar system	— Edgetech 4200, 300 / 600 kHz
Geophysical acquisition software	— Triton SS-logger (Side Scan Sonar)
Sub-bottom Profiler	— Chirp Edgetech DW-106, 1-6 kHz
Geophysical acquisition software	— Triton ISIS / Edgetech Discover
Sub-bottom profiler Geosparker200	

Sampling Equipment

Day Grab sampler and a beam trawl.

Drop Camera Equipment

MMT made freshwater lens housing with a Canon EOS 5D MK II

Offline Software

Triton Suite digital hydro acoustic interpretation software
Triton map mosaic software
IVS Fledermaus editing software
Caris bathymetrical software
Applanix PosPac
TerraPos
AutoCad 2009 Map presentation software
AutoChart
ArcGIS software package
3 PC work stations
Visual Soft package

Survey Vessel – M.P.R. 1



IMO 9586409

Flag Netherlands

Weight Br. Tonnage 254, Net. Tonnage 76

Length 27 m

Draft 2.63 m

Speed 10 kts

Navigation and Positioning

Positioning System — Fugro starfix

Sampling Equipment

Day Grab sampler

Equipment	Type
Primary Positioning System	Applanix POS/MV 320 with RTG corrections from CNAV
Secondary Positioning System	Fugro HP Starpack with IALA and SBAS.
Heading	Applanix POS/MV 320 (Primary)
Motion Sensor	Applanix POS/MV 320 (Primary)
Heading	GAPS III (Secondary)
Motion Sensor	GAPS III (Secondary)
USBL	GAPS III
Transponder Camera cage	GAPS MT8
Drop camera frame	Box Deployment Frame
Camera	Canon EOS 5D MK II
Illumination POD	NUYTCO NEWTSUN NS 600-PS2-300V
Illumination FLOODLIGHT	NUYTCO NEWTSUN NS 600-S-5600
Freshwater lens	MMT
Biological grab sampler	Day grab 0.1 m^2 sampling area
Sieve	5 mm stainless, 1 mm stainless
Trawl	2 m Lowestoft Beam Trawl, 5 mm mesh
Transponder trawl	MIPS
Stereo Microscope	Zeiss Stemi 2000- C/ Wild M3C/ Olympus
Microscope	Zeiss Axiostar plus Binocular microscope
Statistical software package	PRIMER 6, and STATISTICA

Icebeam Name	Position
[redacted]	Chief Officer
	Marine Biologist
	Marine Biologist
	Surveyor
	Chief Engineer
	Second Officer
	Marine Biologist
	Surveyor
	Surveyor
	Captain
	Marine Biologist
	Motorman
	Cook
	Offshore Manager
	Surveyor
	Second Officer
	Client Representative

MPR1 Name	Position
[redacted]	Engineer
	Engineer
	Client Representative
	Marine Biologist
	Marine Biologist
	Survey
	Offshore Manager
	VC tech
	Technical Manager
	Captain
	CPT and Vibrocore Operator
	AB
	Marine Geologist

SURVEY ONLINE PROTOCOL 100702-NEMO							
Date	**Time UTC**	**Operator**	**Event**	**Result**	**Site-name**	**Comments**	**DL/QC**
2010-09-23	00:00		Mobilisation Zebrugge				
2010-09-23	12:50	TW	Transit to Test				
2010-09-23	15:20	TS	on location B01-002				
2010-09-23	15:20	TS	Breakdown equipment				
2010-09-23	17:12	TW	Launch Camera Cage				
2010-09-23	17:16	TW	Bio sampling Day grab		100702-NEMO-GS-B01-002		
2010-09-23	17:33	TW	Recover Camera cage				
2010-09-23	17:44	TS	Trassit to B01-006, because of low visibility on B01-002				
2010-09-23	18:49	TW	on location B01-006		100702-NEMO-GS-B01-006		
2010-09-23	18:57	TW	Launch Camera Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:10	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:14	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:18	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:20	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:21	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:24	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:26	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:28	TW	Lift Cage		100702-NEMO-GS-B01-006		
2010-09-23	19:31	TW	Photo taken		100702-NEMO-GS-B01-006		
2010-09-23	19:40	TW	Recover Camera cage		100702-NEMO-GS-B01-006		TW
2010-09-23	19:55	TW	Breakdown equipment				
2010-09-23	20:44	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_A		
2010-09-23	21:03	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_B		
2010-09-23	21:23	TW	Bio sampling Day grab		100702-NEMO-GS-B01-006_C		
2010-09-23	21:32	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-006_C2		TW
2010-09-23	21:44	TW	Transit to B01-017				
2010-09-23	22:11	TW	On Location B01-017		100702-NEMO-GS-B01-017		
2010-09-23	22:20	TW	Launch Camera Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:23	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:25	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:30	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:31	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:36	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:37	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:42	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:43	TW	Lift Cage		100702-NEMO-GS-B01-017		
2010-09-23	22:48	TW	Photo taken		100702-NEMO-GS-B01-017		
2010-09-23	22:56	TW	Recover Camera cage				TW
2010-09-23	23:12	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_A		

2010-09-23	23:20	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_B		
2010-09-23	23:29	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-017_C		TW
2010-09-23	23:37	TW	Transit to B01-07				
2010-09-24			New Day				
2010-09-24	00:32	TW	on location B01-0067				
2010-09-24	00:37	TW	Launch Camera Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:40	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:41	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:44	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:45	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:49	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:51	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:53	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	00:55	TW	Lift Cage		100702-NEMO-GS-B01-007		
2010-09-24	00:58	TW	Photo taken		100702-NEMO-GS-B01-007		
2010-09-24	01:04	TW	Recover Camera cage				TW
2010-09-24	01:14	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_A		
2010-09-24	01:19	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_B		
2010-09-24	01:24	TW	Bio sampling Day grab	X	100702-NEMO-GS-B01-007_C		TW
2010-09-24	01:25	TW	Transit to B01-008		100702-NEMO-GS-B01-007		
2010-09-24	02:45	KR	On Location B01-008				
2010-09-24	02:46	KR	Launch Camera Cage		100702-NEMO-GS-B01-008		
2010-09-24	05:52	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-008		
2010-09-24	05:54	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	02:59	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:00	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:05	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:08	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:11	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:13	KR	Lift Cage		100702-NEMO-GS-B01-008		
2010-09-24	03:20	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-008		
2010-09-24	03:23	KR	Recover Camera cage		100702-NEMO-GS-B01-008		KR
2010-09-24	03:35	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		
2010-09-24	03:42	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		
2010-09-24	03:47	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-008		KR
2010-09-24	03:50	KR	Transit to B01-009		100702-NEMO-GS-B01-008		
2010-09-24	05:14	KR	On Location B01-009		100702-NEMO-GS-B01-009		
2010-09-24	05:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:26	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:28	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:35	KR	Lift Cage		100702-NEMO-GS-B01-009		

2010-09-24	05:39	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:40	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:45	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:46	KR	Lift Cage		100702-NEMO-GS-B01-009		
2010-09-24	05:49	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-009		
2010-09-24	05:50	KR	Recover Camera cage		100702-NEMO-GS-B01-009		KR
2010-09-24	06:07	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		
2010-09-24	06:15	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		
2010-09-24	06:22	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-009		KR
2010-09-24	06:23	KR	Transit to B01-010		100702-NEMO-GS-B01-009		
2010-09-24	07:15	KR	On Location B01-010		100702-NEMO-GS-B01-010		
2010-09-24	07:17	KR	Launch Camera Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:22	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:24	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:30	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:31	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:43	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:44	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:49	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-010		
2010-09-24	07:50	KR	Lift Cage		100702-NEMO-GS-B01-010		
2010-09-24	07:58	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-010		
2010-09-24	08:00	KR	Recover Camera cage		100702-NEMO-GS-B01-010		KR
2010-09-24	08:15	KR	Pic 20104457 in Folder B01-010 - Drawing Failed, download directly from memory card!				
2010-09-24	08:20	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		
2010-09-24	08:27	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		
2010-09-24	08:35	KR	Bio sampling Day grab	X	100702-NEMO-GS-B01-010		KR
2010-09-24	08:36	KR	Transit to B01-011		100702-NEMO-GS-B01-010		
2010-09-24	09:13	KR	On Location B01-011		100702-NEMO-GS-B01-011		
2010-09-24	09:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:18	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:19	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:24	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:25	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:28	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:29	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:32	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:33	KR	Lift Cage		100702-NEMO-GS-B01-011		
2010-09-24	09:38	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-011		
2010-09-24	09:40	KR	Recover Camera cage		100702-NEMO-GS-B01-011		KR
2010-09-24	10:00	KR	Bio sampling Day grab_A		100702-NEMO-GS-B01-011		
2010-09-24	10:05	KR	Bio sampling Day grab_A2	X	100702-NEMO-GS-B01-011		

2010-09-24	10:10	KR	GAPS UP				
2010-09-24	10:15	KR	Breaking off due to weather		100702-NEMO-GS-B01-011		
2010-09-24	14:55	TS	along side key411, zeebrugge. Waiting on weather.				
2010-09-25			New Day				
2010-09-25		TW	along side key411, zeebrugge. Waiting on weather.				
2010-09-26			New Day				
2010-09-26	12:20	TW	Transit to B01-011				
2010-09-26	18:10	TW	On Location B01-011		100702-NEMO-GS-B01-011		
2010-09-26	18:15	TW	GAPS DOWN				
2010-09-26	18:46	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-011		
2010-09-26	18:57	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-011		TW
2010-09-26	19:03	TW	Transit to B01-012				
2010-09-26	19:37	TW	On Location B01-012		100702-NEMO-GS-B01-012		
2010-09-26	19:48	TW	Launch Camera Cage		100702-NEMO-GS-B01-012		
2010-09-26	19:53	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-012		
2010-09-26	19:57	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:02	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:03	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:08	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:09	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:13	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:15	TW	Lift Cage		100702-NEMO-GS-B01-012		
2010-09-26	20:18	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-012		
2010-09-26	20:28	TW	Recover Camera cage				TW
2010-09-26	20:42	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-012		
2010-09-26	20:54	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-012		
2010-09-26	21:02	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B01-012		
2010-09-26	21:13	TW	Bio sampling Day grab_A4	X	100702-NEMO-GS-B01-012		
2010-09-26	21:25	TW	Bio sampling Day grab_B		100702-NEMO-GS-B01-012		TW
2010-09-26	21:30	TW	Transit to B01-014				
2010-09-26	21:55	TW	On Location B01-014		100702-NEMO-GS-B01-014		
2010-09-26	22:11	TW	Launch Camera Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:14	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:15	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:19	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:20	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:25	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:26	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:31	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:32	TW	Lift Cage		100702-NEMO-GS-B01-014		
2010-09-26	22:36	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-014		
2010-09-26	22:43	TW	Recover Camera cage				TW

2010-09-26	22:55	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-014		
2010-09-26	23:02	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-014		
2010-09-26	23:11	TW	Bio sampling Day grab_A3	X	100702-NEMO-GS-B01-014		
2010-09-26	23:18	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-014		
2010-09-26	23:27	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-014		TW
2010-09-26	23:30	TW	Transit to B01-013				
2010-09-26	23:37	TW	On Location B01-013		100702-NEMO-GS-B01-013		
2010-09-26	23:42	TW	Launch Camera Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:46	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:48	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:54	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:55	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-26	23:59	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-013		
2010-09-26	23:59	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-27			New Day				
2010-09-27	00:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-013		
2010-09-27	00:04	TW	Lift Cage		100702-NEMO-GS-B01-013		
2010-09-27	00:07	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-013		
2010-09-27	00:15	TW	Recover Camera cage				TW
2010-09-27	00:24	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-013		
2010-09-27	00:30	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-013		
2010-09-27	00:39	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-013		TW
2010-09-27	00:41	TW	Transit to B02-021				
2010-09-27	01:14	TW	On Location B02-21		100702-NEMO-GS-B02-021		
2010-09-27	01:18	TW	Launch Camera Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:23	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:24	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:29	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-021	Moved due to not enough slack so took 2 more in new location	
2010-09-27	01:30	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:33	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:33	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:38	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-021		
2010-09-27	01:39	TW	Lift Cage		100702-NEMO-GS-B02-021		
2010-09-27	01:43	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-021		KR
2010-09-27	01:51	TW	Recover Camera cage		100702-NEMO-GS-B02-021		
2010-09-27	02:14	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-021		
2010-09-27	02:23	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-021		
2010-09-27	02:39	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-021		
2010-09-27	02:47	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-021		
2010-09-27	02:58	KR	Bio sampling Day grab_A_5	X	100702-NEMO-GS-B02-021		KR

2010-09-27	03:03	KR	Transit to B01-015		100702-NEMO-GS-B01-015		
2010-09-27	03:10	KR	On Location B01-015		100702-NEMO-GS-B01-015		
2010-09-27	03:15	KR	Launch Camera Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:24	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:25	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:35	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:41	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:42	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:47	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-015		
2010-09-27	03:48	KR	Lift Cage		100702-NEMO-GS-B01-015		
2010-09-27	03:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-015		KR
2010-09-27	03:55	KR	Recover Camera cage		100702-NEMO-GS-B01-015		
2010-09-27	04:11	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-015		
2010-09-27	04:24	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-015		
2010-09-27	04:32	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-015		KR
2010-09-27	04:44	KR	Transit to B01-016		100702-NEMO-GS-B01-015		
2010-09-27	06:40	KR	On Location B01-016		100702-NEMO-GS-B01-016		
2010-09-27	06:41	KR	Launch Camera Cage		100702-NEMO-GS-B01-016		
2010-09-27	06:50	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-016		
2010-09-27	06:51	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	06:57	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-016		
2010-09-27	06:58	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:01	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-016		
2010-09-27	07:02	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:07	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-016		
2010-09-27	07:08	KR	Lift Cage		100702-NEMO-GS-B01-016		
2010-09-27	07:12	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-016		KR
2010-09-27	07:13	KR	Recover Camera cage		100702-NEMO-GS-B01-016		
2010-09-27	07:31	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-016		
2010-09-27	07:39	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-016		
2010-09-27	07:46	KR	Bio sampling Day grab_C		100702-NEMO-GS-B01-016		
2010-09-27	07:52	KR	Bio sampling Day grab_C_2	X	100702-NEMO-GS-B01-016		KR
2010-09-27	07:55	KR	Transit to B01-005		100702-NEMO-GS-B01-016		
2010-09-27	09:40	KR	On Location B01-005		100702-NEMO-GS-B01-005		
2010-09-27	09:45	KR	Launch Camera Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:00	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:08	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:13	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:15	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:24	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:25	TW	Lift Cage		100702-NEMO-GS-B01-005		

2010-09-27	10:31	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:33	TW	Lift Cage		100702-NEMO-GS-B01-005		
2010-09-27	10:37	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-005		
2010-09-27	10:45	TW	Recover Camera cage				TW
2010-09-27	10:58	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-005		
2010-09-27	11:05	TW	Bio sampling Day grab_A2	X	100702-NEMO-GS-B01-005		
2010-09-27	11:11	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-005		
2010-09-27	11:19	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-005		
2010-09-27	11:25	TW	Bio sampling Day grab_C2	X	100702-NEMO-GS-B01-005	Extra ask for by Biologists	TW
2010-09-27	11:30	TW	Transit to B01-004				
2010-09-27	11:50	TW	On Location B01-004		100702-NEMO-GS-B01-004		
2010-09-27	12:08	TW	Launch Camera Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:17	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:17	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:22	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:23	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:30	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:31	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:36	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:37	TW	Lift Cage		100702-NEMO-GS-B01-004		
2010-09-27	12:42	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-004		
2010-09-27	12:47	TW	Recover Camera cage				TW
2010-09-27	12:55	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-004		
2010-09-27	13:02	TW	Bio sampling Day grab_B		100702-NEMO-GS-B01-004		
2010-09-27	13:09	TW	Bio sampling Day grab_B2		100702-NEMO-GS-B01-004		
2010-09-27	13:16	TW	Bio sampling Day grab_B3	X	100702-NEMO-GS-B01-004		
2010-09-27	13:22	TW	Bio sampling Day grab_C		100702-NEMO-GS-B01-004		TW
2010-09-27	13:24	TW	Transit to B01-003				
2010-09-27	13:40	TW	On Location B01-003		100702-NEMO-GS-B01-003		
2010-09-27	13:47	TW	Launch Camera Cage		100702-NEMO-GS-B01-003		
2010-09-27	13:51	TW	Photo 1 and 2 taken		100702-NEMO-GS-B01-003		
2010-09-27	13:51	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	13:59	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:02	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:05	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:06	TW	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:14	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:15	KR	Lift Cage		100702-NEMO-GS-B01-003		
2010-09-27	14:20	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-003		
2010-09-27	14:21	KR	Recover Camera cage				TW
2010-09-27	14:41	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-003		
2010-09-27	14:48	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-003		

2010-09-27	14:55	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-003		TW
2010-09-27	14:56	KR	Transit to B01-002				
2010-09-27	15:30	KR	On Location B01-002		100702-NEMO-GS-B01-003		
2010-09-27	15:31	KR	Launch Camera Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:35	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-002	4 Photos taken	
2010-09-27	15:36	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:44	KR	Photo 3 and 4 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:45	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:48	KR	Photo 5 and 6 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:49	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	15:53	KR	Photo 7 and 8 taken		100702-NEMO-GS-B01-002		
2010-09-27	15:54	KR	Lift Cage		100702-NEMO-GS-B01-002		
2010-09-27	16:00	KR	Photo 9 and 10 taken		100702-NEMO-GS-B01-002		
2010-09-27	16:01	KR	Recover Camera cage				TW
2010-09-27	16:41	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B01-002		
2010-09-27	17:02	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B01-002		
2010-09-27	17:08	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B01-002		TW
2010-09-27							
2010-09-27	17:15	KR	Transit to B01-001		100702-NEMO-GS-B01-002		
2010-09-27	17:40	KR	On Location B01-001		100702-NEMO-GS-B01-001		
2010-09-27	17:45	KR	Launch Camera Cage		100702-NEMO-GS-B01-001		
2010-09-27	17:54	KR	Photo 1 and 2 taken		100702-NEMO-GS-B01-001		
2010-09-27	17:56	KR	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:00	TW	Photo 3 and 4 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:02	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:04	TW	Photo 5 and 6 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:06	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:09	TW	Photo 7 and 8 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:11	TW	Lift Cage		100702-NEMO-GS-B01-001		
2010-09-27	18:13	TW	Photo 9 and 10 taken		100702-NEMO-GS-B01-001		
2010-09-27	18:21	TW	Recover Camera cage				TW
2010-09-27	18:32	TW	Bio sampling Day grab_A		100702-NEMO-GS-B01-001		
2010-09-27	18:39	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B01-001		
2010-09-27	18:49	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B01-001	Biologists decided unable to get good samples so called off.	TW
2010-09-27	18:52	TW	GAPS UP				
2010-09-27	18:55	TW	Transit to B02-022				
2010-09-27	22:13	TW	GAPS DOWN				
2010-09-27	22:16	TW	On Location B02-022		100702-NEMO-GS-B02-022		
2010-09-27	22:22	TW	Launch Camera Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:35	TW	Recover Camera cage			Problem with transponder	

2010-09-27	22:46	TW	Launch Camera Cage				
2010-09-27	22:50	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:50	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:54	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:54	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	22:58	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-022		
2010-09-27	22:59	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	23:05	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-022		
2010-09-27	23:08	TW	Lift Cage		100702-NEMO-GS-B02-022		
2010-09-27	23:10	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-022		
2010-09-27	23:16	TW	Recover Camera cage				TW
2010-09-27	23:33	TW	Bio sampling Day grab_A		100702-NEMO-GS-B02-022		
2010-09-27	23:41	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B02-022		
2010-09-27	23:48	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B02-022		
2010-09-27	23:56	TW	Bio sampling Day grab_A4	X	100702-NEMO-GS-B02-022		
2010-09-28			New Day				
2010-09-28	00:04	TW	Bio sampling Day grab_B		100702-NEMO-GS-B02-022		TW
2010-09-28	00:06	TW	Transit to B02-023				
2010-09-28	00:31	TW	On Location B02-023		100702-NEMO-GS-B02-023		
2010-09-28	00:35	TW	Launch Camera Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:39	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:40	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:45	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:46	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:50	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:50	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	00:54	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-023		
2010-09-28	00:54	TW	Lift Cage		100702-NEMO-GS-B02-023		
2010-09-28	01:05	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-023		
2010-09-28	01:10	TW	Recover Camera cage				KR
2010-09-28	01:26	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-023		
2010-09-28	01:33	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-023		
2010-09-28	01:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-023		KR
2010-09-28	01:40	TW	Transit to B02-024				
2010-09-28	02:23	KR	On Location B02-024		100702-NEMO-GS-B02-024		
2010-09-28	02:24	KR	Launch Camera Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:33	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:24	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:39	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:40	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:43	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:44	KR	Lift Cage		100702-NEMO-GS-B02-024		

2010-09-28	02:48	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:49	KR	Lift Cage		100702-NEMO-GS-B02-024		
2010-09-28	02:53	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-024		
2010-09-28	02:55	KR	Recover Camera cage				KR
2010-09-28	03:13	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-024		
2010-09-28	03:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-024		
2010-09-28	03:30	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-024		
2010-09-28	03:45	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-024		
2010-09-28	04:00	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B02-024		KR
2010-09-28	04:01	KR	Transit to B02-025				
2010-09-28	04:20	KR	On Location B02-025		100702-NEMO-GS-B02-025		
2010-09-28	04:25	KR	Launch Camera Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:29	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:30	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:34	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:35	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:39	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:40	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:45	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:46	KR	Lift Cage		100702-NEMO-GS-B02-025		
2010-09-28	04:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-025		
2010-09-28	04:52	KR	Recover Camera cage				KR
2010-09-28	05:10	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-025		
2010-09-28	05:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-025		
2010-09-28	05:30	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-025		
2010-09-28	05:41	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-025		
2010-09-28	05:54	KR	Bio sampling Day grab_A_5	X	100702-NEMO-GS-B02-025		KR
2010-09-28	06:00	KR	Transit to B02-026				
2010-09-28	06:20	KR	On Location B02-026		100702-NEMO-GS-B02-026		
2010-09-28	06:30	KR	Launch Camera Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:02	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:03	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:08	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:09	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:11	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:12	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:16	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:17	KR	Lift Cage		100702-NEMO-GS-B02-026		
2010-09-28	07:22	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-026		
2010-09-28	07:23	KR	Recover Camera cage				TW
2010-09-28	07:54	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-026		
2010-09-28	08:12	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-026		

2010-09-28	08:18	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-026		
2010-09-28	08:25	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B02-026		
2010-09-28	08:32	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B02-026		TW
2010-09-28	08:41	KR	Transit to B02-027				
2010-09-28	08:55	KR	On Location B02-027		100702-NEMO-GS-B02-027		
2010-09-28	09:15	KR	Launch Camera Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:25	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:26	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:30	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:31	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:35	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:36	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:42	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:43	KR	Lift Cage		100702-NEMO-GS-B02-027		
2010-09-28	09:50	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-027		
2010-09-28	09:51	KR	Recover Camera cage				TW
2010-09-28	10:20	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-027		
2010-09-28	10:29	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-027		
2010-09-28	10:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-027		TW
2010-09-28	10:40	TW	Transit to B02-028				
2010-09-28	11:18	TW	On Location B02-028		100702-NEMO-GS-B02-028		
2010-09-28	11:22	TW	Launch Camera Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:49	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-028		
2010-09-28	11:50	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:53	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-028		
2010-09-28	11:53	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	11:59	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:00	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	12:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:03	TW	Lift Cage		100702-NEMO-GS-B02-028		
2010-09-28	12:07	TW	Photo 9 and 10 taken		100702-NEMO-GS-B02-028		
2010-09-28	12:17	TW	Recover Camera cage				TW
2010-09-28	12:25	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-028		
2010-09-28	12:32	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-028		
2010-09-28	12:37	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B02-028		TW
2010-09-28	12:39	TW	Transit to B02-029				
2010-09-28	12:46	TW	GAPS UP				
2010-09-28	13:23	TW	GAPS DOWN				
2010-09-28	13:26	TW	On Location B02-029		100702-NEMO-GS-B02-029		
2010-09-28	13:30	TW	Launch Camera Cage		100702-NEMO-GS-B02-029		
2010-09-28	13:46	TW	Photo 1 and 2 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:47	TW	Lift Cage		100702-NEMO-GS-B02-029		

2010-09-28	13:52	TW	Photo 3 and 4 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:52	TW	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	13:57	TW	Photo 5 and 6 taken		100702-NEMO-GS-B02-029		
2010-09-28	13:57	TW	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	14:03	TW	Photo 7 and 8 taken		100702-NEMO-GS-B02-029		
2010-09-28	14:05	KR	Lift Cage		100702-NEMO-GS-B02-029		
2010-09-28	14:10	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-029		
2010-09-28	14:13	KR	Recover Camera cage		100702-NEMO-GS-B02-029		KR
2010-09-28	14:24	KR	Bio sampling Day grab_A		100702-NEMO-GS-B02-029		
2010-09-28	14:35	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B02-029		
2010-09-28	14:41	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B02-029		
2010-09-28	14:48	KR	Bio sampling Day grab_A_4				
2010-09-28	14:59	KR	Bio sampling Day grab_A_5				
2010-09-28	15:03	KR	Transit to B02-030		100702-NEMO-GS-B02-030		
2010-09-28	15:40	KR	On Location B02-030		100702-NEMO-GS-B02-030		
2010-09-28	15:45	KR	Launch Camera Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:02	KR	Photo 1 and 2 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:05	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:11	KR	Photo 3 and 4 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:12	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:16	KR	Photo 5 and 6 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:17	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:21	KR	Photo 7 and 8 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:22	KR	Lift Cage		100702-NEMO-GS-B02-030		
2010-09-28	16:28	KR	Photo 9 and 10 taken		100702-NEMO-GS-B02-030		
2010-09-28	16:30	KR	Recover Camera cage		100702-NEMO-GS-B02-030		KR
2010-09-28	16:45	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B02-030		
2010-09-28	16:51	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B02-030		
2010-09-28	16:56	KR	Bio sampling Day grab_C		100702-NEMO-GS-B02-030		
2010-09-28	17:03	KR	Bio sampling Day grab_C_1	X	100702-NEMO-GS-B02-030		
2010-09-28	17:10	KR	Transit to B03-031				
2010-09-28	17:35	KR	On Location B03-031		100702-NEMO-GS-B03-031		
2010-09-28	17:40	KR	Launch Camera Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:48	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-031		
2010-09-28	17:49	KR	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:55	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-031		
2010-09-28	17:56	KR	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	17:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-031		
2010-09-28	18:00	TW	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	18:04	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-031		
2010-09-28	18:05	TW	Lift Cage		100702-NEMO-GS-B03-031		
2010-09-28	18:09	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-031		

2010-09-28	18:16	TW	Recover Camera cage				TW
2010-09-28	18:25	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-031		
2010-09-28	18:30	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-031		
2010-09-28	18:35	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-031		TW
2010-09-28	18:40	TW	Transit to B03-032				
2010-09-28	19:18	TW	On Location B03-032		100702-NEMO-GS-B03-032		
2010-09-28	19:20	TW	Launch Camera Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:25	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:26	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:30	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:30	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:34	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:34	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:38	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:38	TW	Lift Cage		100702-NEMO-GS-B03-032		
2010-09-28	19:42	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-032		
2010-09-28	19:46	TW	Recover Camera cage				TW
2010-09-28	19:54	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-032		
2010-09-28	19:59	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-032		
2010-09-28	20:07	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-032		TW
2010-09-28	20:08	TW	Transit to B03-033				
2010-09-28	20:32	TW	On Location B03-033		100702-NEMO-GS-B03-033		
2010-09-28	20:36	TW	Launch Camera Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:39	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:40	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:44	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:44	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:48	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:48	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:52	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-033		
2010-09-28	20:52	TW	Lift Cage		100702-NEMO-GS-B03-033		
2010-09-28	20:56	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-033		
2010-09-28	21:00	TW	Recover Camera cage				TW
2010-09-28	21:08	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-033		
2010-09-28	21:14	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-033		
2010-09-28	21:18	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-033		
2010-09-28	21:23	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-033		
2010-09-28	21:29	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-033		TW
2010-09-28	21:31	TW	Transit to B03-034				
2010-09-29	22:03	TW	On Location B03-034		100702-NEMO-GS-B03-034		
2010-09-29	22:09	TW	Launch Camera Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:14	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-034		

2010-09-29	22:15	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:20	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:20	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:27	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:27	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:34	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-034		
2010-09-29	22:34	TW	Lift Cage		100702-NEMO-GS-B03-034		
2010-09-29	22:41	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-034		
2010-09-29	20:45	TW	Recover Camera cage				TW
2010-09-29	23:05	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-034		
2010-09-29	23:11	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-034		
2010-09-29	23:18	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-034		
2010-09-29	23:25	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-034		
2010-09-29	23:30	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-034		TW
2010-09-29	23:31	TW	Transit to B03-035				
2010-09-29	23:32	TW	GAPS UP				
2010-09-29	23:49	TW	GAPS DOWN				
2010-09-29	23:49	TW	On Location B03-035		100702-NEMO-GS-B03-035		
2010-09-29	23:55	TW	Launch Camera Cage		100702-NEMO-GS-B03-035		
2010-09-29	23:58	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-035		
2010-09-29	23:58	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29			New Day				
2010-09-29	00:02	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:02	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:06	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:06	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:11	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:11	TW	Lift Cage		100702-NEMO-GS-B03-035		
2010-09-29	00:16	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-035		
2010-09-29	00:20	TW	Recover Camera cage				TW
2010-09-29	00:28	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-035		
2010-09-29	00:32	TW	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-035		
2010-09-29	00:36	TW	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-035		TW
2010-09-29	00:37	TW	Transit to B03-036				
2010-09-29	00:57	TW	On Location B03-036		100702-NEMO-GS-B03-036		
2010-09-29	01:00	TW	Launch Camera Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:05	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:05	TW	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:10	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:10	TW	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	01:14	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-036		
2010-09-29	01:18	TW	Lift Cage		100702-NEMO-GS-B03-036		

2010-09-29	01:32	TW	Recover Camera cage				
2010-09-29	01:32	TW	Breakdown Equipment			Object obstructing camer lens	
2010-09-29	02:35	KR	Launch Camera Cage				
2010-09-29	02:49	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-036		
2010-09-29	02:50	KR	Lift Cage		100702-NEMO-GS-B03-036		
2010-09-29	02:56	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-036		
2010-09-29	02:57	KR	Lift Cage				
2010-09-29	03:01	KR	Photo 11 and 12 taken		100702-NEMO-GS-B03-036	12 Photos taken	
2010-09-29	03:05	KR	Recover Camera cage		100702-NEMO-GS-B03-036		KR
2010-09-29	03:15	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-036		
2010-09-29	03:22	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-036		
2010-09-29	03:28	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-036		
2010-09-29	03:36	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-036		
2010-09-29	03:43	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-036		
2010-09-29	03:48	KR	Transit to B03-038				
2010-09-29	04:39	KR	On Location B03-038		100702-NEMO-GS-B03-037		
2010-09-29	04:40	KR	Launch Camera Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:45	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-037		
2010-09-29	04:46	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:53	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-037		
2010-09-29	04:54	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	04:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:00	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	05:03	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:04	KR	Lift Cage		100702-NEMO-GS-B03-037		
2010-09-29	05:09	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-037		
2010-09-29	05:12	KR	Recover Camera cage				KR
2010-09-29	05:27	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-037		
2010-09-29	05:31	KR	Bio sampling Day grab_B		100702-NEMO-GS-B03-037		
2010-09-29	05:37	KR	Bio sampling Day grab_B_2		100702-NEMO-GS-B03-037		
2010-09-29	05:45	KR	Bio sampling Day grab_B_3	X	100702-NEMO-GS-B03-037		
2010-09-29	05:48	KR	Bio sampling Day grab_C		100702-NEMO-GS-B03-037		
2010-09-29	05:50	KR	Transit to B03-038				
2010-09-29	06:20	KR	On Location B03-038		100702-NEMO-GS-B03-038		
2010-09-29	06:21	KR	Launch Camera Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:29	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:30	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:33	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:34	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:38	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:39	KR	Lift Cage		100702-NEMO-GS-B03-038		

2010-09-29	06:44	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:45	KR	Lift Cage		100702-NEMO-GS-B03-038		
2010-09-29	06:52	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-038		
2010-09-29	06:55	KR	Recover Camera cage				KR
2010-09-29	06:59	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-038		
2010-09-29	07:11	KR	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-038		
2010-09-29	07:19	KR	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-038		
2010-09-29	07:26	KR	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-038		
2010-09-29	07:30	KR	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-038		
2010-09-29	07:35	KR	Transit to B03-039				
2010-09-29	07:50	KR	On Location B03-039		100702-NEMO-GS-B03-039		
2010-09-29	07:51	KR	Launch Camera Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:00	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:01	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:06	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:07	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:13	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:14	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:20	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:22	KR	Lift Cage		100702-NEMO-GS-B03-039		
2010-09-29	08:28	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-039		
2010-09-29	08:30	KR	Recover Camera cage		100702-NEMO-GS-B03-039		KR
2010-09-29	08:31	KR	No samples, Sabellaria reef found		100702-NEMO-GS-B03-039		
2010-09-29	08:55	KR	Launch Camera Cage		100702-NEMO-GS-B03-039		
2010-09-29	09:10	KR	Starting Transect-001 lines to inspect the reef		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:25	KR	Photo 1 and 2 taken, B03-039_001		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:32	KR	Photo 1 and 2 taken, B03-039_002		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:40	KR	Photo 1 and 2 taken, B03-039_003		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:47	KR	Photo 1 and 2 taken, B03-039_004		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	09:55	KR	Photo 1 and 2 taken, B03-039_005		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:14	TW	Photo 1 and 2 taken, B03-039_006		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:23	TW	Photo 1 and 2 taken, B03-039_007		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:30	TW	Photo 1 and 2 taken, B03-039_008		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:37	TW	Photo 1 and 2 taken, B03-039_009		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:43	TW	Photo 1 and 2 taken, B03-039_010		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:49	TW	Photo 1 and 2 taken, B03-039_011		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	10:56	TW	Photo 1 and 2 taken, B03-039_012		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:02	TW	Photo 1 and 2 taken, B03-039_013		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:09	TW	Photo 1 and 2 taken, B03-039_014		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:16	TW	Photo 1 and 2 taken, B03-039_015		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:24	TW	Photo 1 and 2 taken, B03-039_016		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:30	TW	Photo 1 and 2 taken, B03-039_017		100702-NEMO-GS-B03-039_Transect-001		

2010-09-29	11:37	TW	Photo 1 and 2 taken, B03-039_018		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:43	TW	Photo 1 and 2 taken, B03-039_019		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:49	TW	Photo 1 and 2 taken, B03-039_020		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	11:55	TW	Photo 1 and 2 taken, B03-039_021		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:04	TW	Photo 1 and 2 taken, B03-039_022		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:10	TW	Photo 1 and 2 taken, B03-039_023		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:16	TW	Photo 1 and 2 taken, B03-039_024		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:22	TW	Photo 1 and 2 taken, B03-039_025		100702-NEMO-GS-B03-039_Transect-001		
2010-09-29	12:29	TW	Photo 1 and 2 taken, B03-039_026		100702-NEMO-GS-B03-039_Transect-001		TW
2010-09-29	12:36	TW	Recover Camera cage				
2010-09-29	12:53	TW	Launch Camera Cage				
2010-09-29	12:54	TW	Starting Transect-002 lines to inspect the reef		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:04	TW	Photo 1 and 2 taken, B03-039-2_001		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:14	TW	Photo 3 and 4 taken, B03-039-2_002		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:21	TW	Photo 5 and 6 taken, B03-039-2_003		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:30	TW	Photo 7 and 8 taken, B03-039-2_004		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:35	TW	Photo 8 and 9 taken, B03-039-2_005		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:42	TW	Photo 9 and 10 taken, B03-039-2_006		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	13:52	TW	Photo 11 and 12 taken, B03-039_007		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:01	TW	Photo 13 and 14 taken, B03-039_008		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:09	TW	Photo 15 and 16 taken, B03-039_009		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:15	KR	Photo 17 and 18 taken, B03-039_010		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:23	KR	Photo 19 and 20 taken, B03-039_011		100702-NEMO-GS-B03-039_Transect-002		
2010-09-29	14:25	KR	Recover Camera Cage				KR
2010-09-29	14:30	KR	Transit to B03-040		100702-NEMO-GS-B03-040		
2010-09-29	15:10	KR	On Location B03-040		100702-NEMO-GS-B03-040		
2010-09-29	15:15	KR	Launch Camera Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:24	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-040	4 photos taken	
2010-09-29	15:25	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:28	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-040	3 photos taken	
2010-09-29	15:29	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:37	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-040	Possible reef found	
2010-09-29	15:38	KR	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:41	FA	Photo 7 and 8 taken		100702-NEMO-GS-B03-040		
2010-09-29	15:42	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	15:48	FA	Photo 9 and 10 taken		100702-NEMO-GS-B03-040		
2010-09-29	15:49	FA	Lift cage		100702-NEMO-GS-B03-040		
2010-09-29	16:16	FA	Photo 11 and 12 taken		100702-NEMO-GS-B03-040		
2010-09-29	16:20	FA	Lift cage		100702-NEMO-GS-B03-040		
2010-09-29	16:29	FA	Photo 13 and 14 taken		100702-NEMO-GS-B03-040		
2010-09-29	16:31	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	16:38	FA	Photo 15 and 16 taken, B03-039_009		100702-NEMO-GS-B03-040		

2010-09-29	16:39	FA	Lift Cage		100702-NEMO-GS-B03-040		
2010-09-29	16:50	KR	Recover Camera cage				KR
2010-09-29	16:55	KR	No Samples, Reef found		100702-NEMO-GS-B03-040		
2010-09-29	17:08	KR	Transit to B03-041		100702-NEMO-GS-B03-040		
2010-09-29	17:55	KR	On Location B03-041		100702-NEMO-GS-B03-041		
2010-09-29	17:56	KR	Launch Camera Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:06	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:07	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:12	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:13	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:16	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:17	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:20	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:21	TW	Lift Cage		100702-NEMO-GS-B03-041		
2010-09-29	18:25	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-041		
2010-09-29	18:33	TW	Recover Camera cage				TW
2010-09-29	18:39	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-041		
2010-09-29	18:43	TW	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-041		
2010-09-29	18:47	TW	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-041		
2010-09-29	18:50	TW	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-041		
2010-09-29	18:54	TW	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-041		TW
2010-09-29	18:58	TW	Transit to B03-042				
2010-09-29	19:35	TW	On Location B03-042		100702-NEMO-GS-B03-042	Freshwater lens contaminated	
2010-09-29	19:38	TW	Launch Camera Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:47	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:48	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:50	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:51	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:54	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:54	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	19:58	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-042		
2010-09-29	19:58	TW	Lift Cage		100702-NEMO-GS-B03-042		
2010-09-29	20:03	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-042		
2010-09-29	20:08	TW	Recover Camera cage				TW
2010-09-29	20:15	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-042		
2010-09-29	20:18	TW	Bio sampling Day grab_A_2		100702-NEMO-GS-B03-042		
2010-09-29	20:21	TW	Bio sampling Day grab_A_3		100702-NEMO-GS-B03-042		
2010-09-29	20:26	TW	Bio sampling Day grab_A_4		100702-NEMO-GS-B03-042		
2010-09-29	20:29	TW	Bio sampling Day grab_A_5		100702-NEMO-GS-B03-042		TW
2010-09-29	20:31	TW	GAPS UP				
2010-09-29	20:35	TW	Transit to B03-043				

2010-09-29	21:03	TW	GAPS DOWN				
2010-09-29	21:05	TW	On Location B03-043				
2010-09-29	21:11	TW	Launch Camera Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:16	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:17	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:20	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:20	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:25	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:27	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:30	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:31	TW	Lift Cage		100702-NEMO-GS-B03-043		
2010-09-29	21:35	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-043		
2010-09-29	21:45	TW	Recover Camera cage				TW
2010-09-29	21:55	TW	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-043		
2010-09-29	21:58	TW	Bio sampling Day grab_B		100702-NEMO-GS-B03-043		
2010-09-30			New Day				
2010-09-30	22:01	TW	Bio sampling Day grab_C		100702-NEMO-GS-B03-043		TW
2010-09-30	22:06	TW	Transit to B03-044				
2010-09-30	22:20	TW	On Location B03-044				
2010-09-30	22:45	TW	**Equipment breakdown**			**Freshwater lens broke when refilling**	
2010-09-30	23:15	TW	Launch Camera Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:24	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:24	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:30	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:31	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:36	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:36	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:42	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:43	TW	Lift Cage		100702-NEMO-GS-B03-044		
2010-09-30	23:48	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-044		
2010-09-30	23:55	TW	Recover Camera cage				KR
2010-09-30	00:04	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-044		
2010-09-30	00:07	TW	Bio sampling Day grab_B		100702-NEMO-GS-B03-044		
2010-09-30	00:11	TW	Bio sampling Day grab_C		100702-NEMO-GS-B03-044		KR
2010-09-30	00:13	TW	Transit to B03-045				
2010-09-30	00:32	TW	On Location B03-045		100702-NEMO-GS-B03-045		
2010-09-30	00:37	TW	Launch Camera Cage		100702-NEMO-GS-B03-045		
2010-09-30	00:42	TW	Photo 1 and 2 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:43	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	00:47	TW	Photo 3 and 4 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:47	TW	Lift Cage		100702-NEMO-GS-B03-045		

2010-09-30	00:53	TW	Photo 5 and 6 taken		100702-NEMO-GS-B03-045		
2010-09-30	00:54	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	01:00	TW	Photo 7 and 8 taken		100702-NEMO-GS-B03-045		
2010-09-30	01:01	TW	Lift Cage		100702-NEMO-GS-B03-045		
2010-09-30	01:09	TW	Photo 9 and 10 taken		100702-NEMO-GS-B03-045		
2010-09-30	01:17	TW	Recover Camera cage				KR
2010-09-30	01:19	TW	GAPS UP				
2010-09-30	01:22	TW	Bio sampling Day grab_A		100702-NEMO-GS-B03-045		
2010-09-30	01:26	TW	Bio sampling Day grab_A2		100702-NEMO-GS-B03-045		
2010-09-30	01:29	TW	Bio sampling Day grab_A3		100702-NEMO-GS-B03-045		
2010-09-30	01:32	TW	Bio sampling Day grab_A4		100702-NEMO-GS-B03-045		
2010-09-30	01:35	TW	Bio sampling Day grab_A5		100702-NEMO-GS-B03-045		KR
2010-09-30	01:38	TW	Transit to B03-047				
2010-09-30	02:40	KR	On Location B03-047		100702-NEMO-GS-B03-047		
2010-09-30	02:43	KR	Launch Camera Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:48	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-047		
2010-09-30	02:49	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:54	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-047		
2010-09-30	02:55	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	02:59	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:00	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	03:05	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:06	KR	Lift Cage		100702-NEMO-GS-B03-047		
2010-09-30	03:10	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-047		
2010-09-30	03:12	KR	Recover Camera cage				KR
2010-09-30	03:21	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-047		
2010-09-30	03:23	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-047		
2010-09-30	03:30	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-047		KR
2010-09-30							
2010-09-30	03:31	KR	Transit to B03-047		100702-NEMO-GS-B03-048		
2010-09-30	03:40	KR	On Location B03-047		100702-NEMO-GS-B03-048		
2010-09-30	03:45	KR	Launch Camera Cage		100702-NEMO-GS-B03-048		
2010-09-30	03:53	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-048		
2010-09-30	03:54	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	03:58	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-048		
2010-09-30	03:59	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:03	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:04	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:08	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:09	KR	Lift Cage		100702-NEMO-GS-B03-048		
2010-09-30	04:15	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-048		
2010-09-30	04:16	KR	Recover Camera cage				KR

2010-09-30	04:20	KR	Bio sampling Day grab_A		100702-NEMO-GS-B03-048		
2010-09-30	04:24	KR	Bio sampling Day grab_A_2	X	100702-NEMO-GS-B03-048		
2010-09-30	04:28	KR	Bio sampling Day grab_B		100702-NEMO-GS-B03-048		
2010-09-30	04:34	KR	Bio sampling Day grab_B_2		100702-NEMO-GS-B03-048		
2010-09-30	04:37	KR	Bio sampling Day grab_B_3		100702-NEMO-GS-B03-048		KR
2010-09-30							
2010-09-30	04:45	KR	Transit to B03-046				
2010-09-30	05:00	KR	On Location B03-046		100702-NEMO-GS-B03-046		
2010-09-30	05:02	KR	Launch Camera Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:07	KR	Photo 1 and 2 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:08	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:09	KR	Photo 3 and 4 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:10	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:15	KR	Photo 5 and 6 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:16	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:19	KR	Photo 7 and 8 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:20	KR	Lift Cage		100702-NEMO-GS-B03-046		
2010-09-30	05:23	KR	Photo 9 and 10 taken		100702-NEMO-GS-B03-046		
2010-09-30	05:25	KR	Recover Camera cage				KR
2010-09-30	05:35	KR	Bio sampling Day grab_A	X	100702-NEMO-GS-B03-046		
2010-09-30	05:40	KR	Bio sampling Day grab_B	X	100702-NEMO-GS-B03-046		
2010-09-30	05:45	KR	Bio sampling Day grab_C	X	100702-NEMO-GS-B03-046		KR
2010-09-30	05:45	TS	Transit to trawlsite 005				
2010-09-30	07:00	TS	at location trawlsite 005		100702-NEMO-TRAWL-B03-005	Could not trawl due to rocky seafloor	
2010-09-30	07:25	TS	Transit to trawlsite 004				
2010-09-30	08:35	TS	at location trawlsite 004				
2010-09-30	08:48	KR	Trawl_Start_300m		100702-NEMO-TRAWL-B03-004		
2010-09-30	08:57	KR	Trawl_Stop_300m		100702-NEMO-TRAWL-B03-004		
2010-09-30	09:29	KR	Trawl_Start_600m		100702-NEMO-TRAWL-B03-004		
2010-09-30	09:43	KR	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:17	TW	Trawl_Start_600m_2		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:31	TW	Trawl_Stop_600m_2		100702-NEMO-TRAWL-B03-004		
2010-09-30	10:36	TW	Transit to trawlsite 003				
2010-09-30	11:05	TW	at location trawlsite 003		100702-NEMO-TRAWL-B03-003		
2010-09-30	11:08	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-003	Not returning as destroyed trawling net	
2010-09-30	11:22	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-003		
2010-09-30	11:25	TS	Trawl on deck				
2010-09-30	11:25	TS	Transit to B03-40 for Grab and photo transect.				
2010-09-30	12:30	TW	On Location B03-040_Transect		100702-NEMO-GS-B03-040_Transect		
2010-09-30	12:59	TW	GAPS DOWN		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:06	TW	Launch Camera Cage		100702-NEMO-GS-B03-040_Transect		

2010-09-30	13:09	TW	Photo 1 and 2 taken B03-040_001		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:10	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:15	TW	Photo 3 and 4 taken B03-040_002		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:16	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:21	TW	Photo 5 and 6 taken B03-040_003		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:22	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:27	TW	Photo 7 and 8 taken B03-040_004		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:28	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:33	TW	Photo 9 and 10 taken B03-040_005		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:34	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:38	TW	Photo 11 and 12 taken B03-040_006		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:39	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:45	TW	Photo 13 and 14 taken B03-040_007		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:46	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:51	TW	Photo 15 and 16 taken B03-040_008		100702-NEMO-GS-B03-040_Transect		
2010-09-30	13:53	TW	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:01	KR	Photo 17 and 18 taken B03-040_009		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:02	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:08	KR	Photo 19 and 20 taken B03-040_010		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:09	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:16	KR	Photo 21 and 22 taken B03-040_011		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:17	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		KR
2010-09-30	14:18	KR	Transectline 1 done		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:30	KR	Start of Transectline 2		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:36	KR	Photo 1 and 2 taken B03-040_001		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:37	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:54	KR	Photo 3 and 4 taken B03-040_002		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:55	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:57	KR	Photo 5 and 6 taken B03-040_003		100702-NEMO-GS-B03-040_Transect		
2010-09-30	14:58	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:05	KR	Photo 7 and 8 taken B03-040_004		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:06	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:12	KR	Photo 9 and 10 taken B03-040_005		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:13	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:17	KR	Photo 11 and 12 taken B03-040_006		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:18	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:24	KR	Photo 13 and 14 taken B03-040_007		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:25	KR	Lift Cage		100702-NEMO-GS-B03-040_Transect		
2010-09-30	15:26	KR	Recover Camera cage		100702-NEMO-GS-B03-040_Transect		KR
2010-09-30	16:05	KR	Grabsampler_A		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:12	KR	Grabsampler_B		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:14	KR	Grabsampler_C		100702-NEMO-GS-B03-040_Transect		

2010-09-30	16:17	KR	Grabsampler_D		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:20	KR	Grabsampler_E		100702-NEMO-GS-B03-040_Transect		
2010-09-30	16:25	KR	Transit to B03_039		100702-NEMO-GS-B03-040_Transect		
2010-09-30	17:10	KR	Grabsampler_A		100702-NEMO-GS-B03-039		
2010-09-30	17:12	KR	Grabsampler_B		100702-NEMO-GS-B03-039		
2010-09-30	17:15	KR	Grabsampler_C		100702-NEMO-GS-B03-039	Sabellaria reef in the graber	
2010-09-30	17:26	KR	Transit to Trawl_002				
2010-09-30	18:48	TW	On location Trawl_002		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:01	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:14	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-002		
2010-09-30	19:23	TW	Transit to Trawl_001				
2010-09-30	19:55	TW	On location Trawl_001		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:03	TW	Trawl_Start_600m		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:18	TW	Trawl_Stop_600m		100702-NEMO-TRAWL-B03-001		
2010-09-30	20:27	TW	Transit to Zeebruggen				

100702-NEMO-GS-B01																				
Photo ID	B01-001	B01-002	B01-003	B01-004	B01-005	B01-006	B01-007	B01-008	B01-009	B01-010	B01-011	B01-012	B01-013	B01-014	B01-015	B01-016	B01-017	B01-018	B01-019	B01-020
Clay	x?		x?	x?	x?															
Sand	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Gravel										x			x		x					
Pebbles and Cobbles											x	x		x	x					
Large Shell fragments						<5%	<5%	<5%			<5%			<5%						
Small Shell fragments						<5%	<5%	<5%	<5%	<5%			35%	<5%						
Comments	Zero visibility.	Poor visibility. Sand bottom.	Zero visibility.	Zero visibility.	Zero visibility.	Holes in the bottom, maybe from *Ensis spp.*	Fine sand with shell fragments.	Coarse sand and shell gravel.	Fine sand with shell fragments.	Fine sand, some smal cobbles and shell fragments.	Fine sand, some smal cobbles and shell fragments.	Sand with a few cobbles.	Fine sand with shell fragments.		Sand, gravel and two bigger cobbles.	Fine sand.	Poor visibility. Fine sand.	No photos taken.	No photos taken	No photos taken
EUNIS habitat classification	A5.24	A5.24	A5.33	A5.24	A5.23	A5.25	A5.25	A5.23	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.25	A5.34	A5.33	A5.33
Comments EUNIS code																				

SPECIES /m²

CNIDARIA																				
Hydrozoa											P		P		P					
CRUSTACEA																				
Paguridae						3.2	16.1	1.6	1.6				1.6							
Caridea							4.8													
MOLLUSCA-BIVALVIA																				
Ensis spp.							6.5													
ECHINODERMATA																				
Asteroidea							3.2					1.6			1.6					
Asterias rubens		3.2				3.2	3.2										1.6			
Ophiura spp.						6.5	8.1													
Ophiura albida						9.7					1.6									
Ophiura ophiura							1.6		1.6											
VARIA																				
Pleuronectes platessa											1.6									
Callionymus sp.												4.8	1.6	180.6		1.6				

100702-NEMO-GS-B02										
Photo ID	B02-021	B02-022	B02-023	B02-024	B02-025	B02-026	B02-027	B02-028	B02-029	B02-030
Clay										
Sand	x	x	x	x	x	x	x	x	x	x
Gravel								x		x
Pebbles and Cobbles	x	x			x	x				
Boulders										
Bedrock										
Large Shell fragments								<5%	<5%	5%
Small Shell fragments	<5%						<5%	<5%	<5%	5%
Comments		Occasional cobbles.			Occasional cobbles.	Occasional cobbles.				
EUNIS habitat classification	A5.25	A5.25	A5.233	A5.233	A5.233	A5.25	A5.233	A5.25	A5.25	A5.25
Comments EUNIS code			Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233	Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233	Eunis code indicates infralittoral although it's deeper than 20m. This is because the fauna resembles that of code A5.233					

SPECIES /m²

CNIDARIA										
Hydrozoa		P				P			P	
Actiniaria						6.5			4.8	
CRUSTACEA										
Paguridae	1.6	1.6		4.8	1.6	4.8		1.6		
Portunidae										1.6
ECHINODERMATA										
Asterias rubens	1.6				1.6	1.6				
Ophiura albida					1.6					
Ophiura spp.		1.6								
Psammechinus miliaris						1.6				
VARIA										
Alcyonidium diaphanum						P				
Callionymus spp.					9.7					
Flustra foliacea						P				

100702-NEMO-GS-B03																				
Photo ID	B03-031	B03-032	B03-033	B03-034	B03-035	B03-036	B03-037	B03-038	B03-039	B03-040	B03-041	B03-042	B03-043	B03-044	B03-045	B03-046	B03-047	B03-048	B03-049	B03-050
Clay							x													
Sand	x	x	x	x	x	x	x	x	x	x	x?	x	x	x?	x?	x?	x?	x?		
Gravel	x	x						x	x	x	x		x							
Pebbles and Cobbles			x	x		x		x			x									
Large Shell fragments	15%							20%												
Small Shell fragments	15%							10%					30%							
Comments		Shell gravel. No animalia visible.	Cobbles with serpularidae tubes.	Poor visibility. Cobbles with Serpulariadae tubes.	No animalia visible.	Burried cobbles. No animalia visible.	Poor visibility.	Poor visibility.	Poor visibility, tubes of possible Sabellaria is visible. Shell gravel.	Poor visibility, tubes of possible Sabellaria is visible. Shell gravel.	Poor visibility. Cobbles with Serpulidae worms.	No animalia visible.	Shell gravel. No animalia visible.	Zero visibility.	Zero visibility.	Zero visibility.	Zero visibility.	Zero visibility.	No photos taken.	No photos taken.
EUNIS habitat classification	A5.25	A5.145	A5.141	A5.141	A5.231	A5.25	A5.25	A5.25	A5.611	A5.611	A5.141	A5.25	A5.25	A5.23	A5.43	A5.231	A5.43	A5.23	A5.23	A5.24
Comments EUNIS code									Annex 1 area- Sabellaria	Annex 1 area- Sabellaria										

SPECIES /m²

CNIDARIA																				
Actiniaria			4.8					1.6												
Hydrozoa								P												
CRUSTACEA																				
Caridea									1.6											
Ebalia spp.			1.6																	
Porcellinidae									1.6											
Portunidae							1.6		1.6											
ECHINODERMATA																				
Asterias rubens			1.6						1.6											
Asteroidea											1.6									
Ophiura albida			1.6																	
Psammechinus miliaris			8.1																	
MOLLUSCA-BIVALVIA																				
Aequipecten opercularis			1.6																	
MOLLUSCA - GASTROPODA																				
Buccinum undatum			1.6																	
ANNELIDA-POLYCHAETA																				
Tubes of *Sabellaria spp.* (SACFOR)									S	A										
VARIA																				
Bryozoa								P												

100702-NEMO-GS-B01-001			
Easting:	497417	Depth:	11.8
Northing:	5687890		
SPECIES /m²	A	B	C
CRUSTACEA			
Crangon crangon		30	
Diastylis rugosa		10	10
Liocarcinus holsatus	20		
weight (g/m²):	63.9840	43.9450	0.2860
ECHINODERMATA			
Asterias rubens	10		
Ophiura ophiura		10	
weight (g/m²):	47.1240	8.6530	
MOLLUSCA-BIVALVIA			
Abra alba			10
Ensis magnus	710		1190
Ensis spp.		700	
weight (g/m²):	45.9650	42.5250	75.4800
POLYCHAETA			
Caulleriella killariensis	80	10	200
Heteromastus filiformis	10	10	
Nephtys hombergii	30	20	10
Owenia fusiformis	1070	240	400
Spiophanes bombyx	10	10	10
weight (g/m²):	12.9890	4.2530	2.3960

100702-NEMO-GS-B01-003			
Easting:	493466	Depth:	16.4
Northing:	5688414		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria		160	
weight (g/m²):		0.6960	
CRUSTACEA			
Diastylis spp.	20	10	
weight (g/m²):	0.2750	0.2250	
ECHINODERMATA			
Ophiura ophiura	20	20	
Ophiura sarsii			20
weight (g/m²):	15.5380	19.1930	13.7970
MOLLUSCA-BIVALVIA			
Abra alba			10
Abra nitida		20	
Ensis magnus	160	280	210
Ensis spp.		10	
Kurtiella bidentata		10	
Tellimya ferruginosa			10
weight (g/m²):	40.6380	69.1740	32.5760
POLYCHAETA			
Heteromastus filiformis	140		
Nephtys hombergii	20	50	10
Notomastus latericeus	10		
Owenia fusiformis	2560	15200	10120
weight (g/m²):	2.9574	28.7190	44.7210
VARIA			
Porifera spp.			P
weight (g/m²):			0.0500

100702-NEMO-GS-B01-002			
Easting:	495583	Depth:	12.8
Northing:	5688054		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	10		
weight (g/m²):	19.1300		
CRUSTACEA			
Crangon crangon			10
Liocarcinus holsatus	10		
weight (g/m²):	60.9620		9.4860
ECHINODERMATA			
Asterias rubens	30		
Ophiura spp.	50		10
Ophiura ophiura	10	60	20
Ophiura sarsii	10		
weight (g/m²):	92.6650	47.1500	20.3670
MOLLUSCA-BIVALVIA			
Abra alba	80		
Abra spp.	10		10
Ensis magnus	160	30	0
Ensis spp.	110		190
Tellinidae		20	
weight (g/m²):	37.1610	6.9340	22.1390
POLYCHAETA			
Capitellidae			10
Caulleriella killariensis			20
Eunereis longissima	20		
Heteromastus filiformis		10	30
Lanice conchilega	50		
Nephtys hombergii	10		
Owenia fusiformis	27850	750	720
Spiophanes bombyx			10
weight (g/m²):	27.4620	4.9320	4.9040
VARIA			
Solea solea	10		
weight (g/m²):	78.7220		

100702-NEMO-GS-B01-004			
Easting:	492663	Depth:	16.5
Northing:	5688496		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	10		
Anthozoa		230	940
weight (g/m²):	18.4520	0.6680	6.2980
CRUSTACEA			
Liocarcinus holsatus			10
weight (g/m²):			0.7910
ECHINODERMATA			
Ophiura ophiura	20	20	
weight (g/m²):	19.133	21.155	
MOLLUSCA-BIVALVIA			
Bivalvia	10		
Kurtiella bidentata		40	
Mya spp.		60	
Tellimya ferruginosa	10	930	
weight (g/m²):	-	0.1410	2.8480
POLYCHAETA			
Alitta succinea			10
Capitella capitata-complex	80	20	
Caulleriella killariensis		20	
Eunereis longissima			60
Glycera convoluta		10	10
Heteromastus filiformis	20		
Lagis koreni		10	10
Notomastus latericeus			50
Owenia fusiformis	610	1200	31850
Pholoe spp.			20
Sthenelais boa			10
weight (g/m²):	2.519	5.264	106.569
VARIA			
Priapulida			60
weight (g/m²):			175.9000

100702-NEMO-GS-B01-005			
Easting:	490394	Depth:	18.9
Northing:	5689065		
SPECIES /m²	A	B	C
CNIDARIA			
Campanulinidae spp.		P	
Hydrozoa		P	
weight (g/m²):		0.4590	
CRUSTACEA			
Crangon crangon	10	0	10
Pariambus typicus	0	10	0
weight (g/m²):	4.6520	0.0040	4.5440
ECHINODERMATA			
Echinocardium cordatum		20	50
Ophiura albida	180	30	10
Ophiura ophiura	10		10
Ophiura spp.	10	10	
weight (g/m²):	56.2870	161.6630	444.8600
MOLLUSCA-BIVALVIA			
Abra spp.		30	
Bivalvia	20	10	
Ensis spp.	10		
Kurtiella bidentata		20	10
weight (g/m²):	6.1700	0.4000	0.2000
MOLLUSCA-GASTROPODA			
Buccinum undatum			10
Gastropoda		20	
weight (g/m²):		0.1000	0.0500
POLYCHAETA			
Capitella capitata-complex		10	
Cauleriella alata	50		
Caulleriella killariensis			10
Chaetozone setosa	10	10	10
Cirratulidae spp.	30	40	30
Eumida bahusiensis	20		
Eunereis longissima	40	20	20
Glycera convoluta		10	
Heteromastus filiformis	40	20	50
Lagis koreni	20	40	10
Lanice conchilega	210	150	40
Mediomastus fragilis	10	10	10
Notomastus latericeus	10	60	30
Owenia fusiformis	2130	3200	940
Pholoe baltica		10	10
Phyllodoce citrina		10	
Phyllodoce mucosa	60	20	20
Scoloplos armiger	20	10	20
Spio filicornis	0	10	10
Spiophanes bombyx	110	170	20
Sthenelais boa	20		
weight (g/m²):	22.6580	17.8030	5.7240
VARIA			
Nemertea	20	20	10
weight (g/m²):	0.1780	0.1450	0.0280

100702-NEMO-GS-B01-006			
Easting:	487526	Depth:	21.5
Northing:	5689606		
SPECIES /m²	A	B	C
CNIDARIA			
Hydrozoa	P		
weight (g/m²):	-		
CRUSTACEA			
Abludomelita obtusata		10	
Aora gracilis	10		
Brachyura	10		
Gammaridae	40	40	
Leucothoe incisa			10
Liocarcinus pusillus	10		
Pariambus typicus		20	
weight (g/m²):	0.0870	21.9970	0.1480
ECHINODERMATA			
Asterias rubens	10	20	
Echinocardium cordatum	10		
Ophiocten affinis	10		
Ophiura albida	20	40	
Ophiura ophiura	10	20	20
Ophiuroidea spp.	10		
weight (g/m²):	479.3360	444.3000	24.6090
MOLLUSCA-BIVALVIA			
Bivalvia	10	10	
Ensis magnus	380		10
Ensis spp.		680	550
Spisula elliptica			10
weight (g/m²):	720.9170	580.2400	446.2870
MOLLUSCA-GASTROPODA			
Euspira pulchella	10		
Gastropoda		10	
weight (g/m²):	0.0430	0.0090	
POLYCHAETA			
Capitella capitata-complex	10	50	40
Chaetozone setosa	10		
Eteone spp.		10	10
Eumida bahusiensis	10	40	
Eumida sanguinea		20	
Eumida spp.	10		
Eunereis longissima		20	
Heteromastus filiformis			10
Lagis koreni			30
Lanice conchilega	1060	920	900
Nephtys cirrosa		10	
Notomastus latericeus	10	10	
Owenia fusiformis	170	250	130
Phyllodoce groenlandica		10	
Phyllodoce mucosa	70		40
Phyllodoce spp.	20	10	
Pseudopolydora pulchra	30	30	20
Scoloplos armiger			20
Spio filicornis		20	10
Spiophanes bombyx	410	620	630
weight (g/m²):	26.3240	28.3340	24.0750
VARIA			
Bryozoa	P		
Nemertea		10	60
Sipuncula		10	
weight (g/m²):	0.0240	0.2170	1.4660

100702-NEMO-GS-B01-007			
Easting:	483541	Depth:	26.0
Northing:	5688555		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	180		
weight (g/m²):	3.2910		
CRUSTACEA			
Liocarcinus holsatus		10	
Pagurus bernhardus		10	10
Pisidia longicornis		20	
Processa spp.			10
Thia scutellata		10	10
weight (g/m²):		71.8620	6.3930
ECHINODERMATA			
Echinocardium cordatum	40	30	10
Echinocyamus pusillus		10	
Ophiocten affinis	10		
Ophiura albida	40		
Ophiura ophiura	30		
Ophiura sarsii	10		
weight (g/m²):	51.0630	191.3240	124.0000
MOLLUSCA-BIVALVIA			
Abra prismatica	30		
Bivalvia		10	
Mactridae		10	
weight (g/m²):	2.5800	0.4040	
MOLLUSCA-GASTROPODA			
Chauvetia brunnea		10	
Nassarius reticulatus	30		
weight (g/m²):	78.2000	0.0950	
POLYCHAETA			
Aonides paucibranchiata			10
Capitella capitata-complex		10	
Cauleriella alata	10		
Eumida bahusiensis	80		
Eumida spp.	10		
Eunereis longissima	10		
Heteromastus filiformis		10	
Lagis koreni	80	10	
Lanice conchilega	1160		
Nephtys cirrosa		20	20
Notomastus latericeus		30	
Owenia fusiformis	760	20	
Pseudopolydora pulchra	10		
Scoloplos armiger	10		10
Spio decoratus		10	
Spiophanes bombyx	100		10
weight (g/m²):	3.7171	0.6276	0.4397
VARIA			
Ascidiacea	P		10
Electra pilosa		P	
Nematoda		20	
Sipuncula		10	
Sipunculidea	260		
weight (g/m²):	1.1600	0.1980	-

100702-NEMO-GS-B01-008			
Easting:	479218	Depth:	17.0
Northing:	5688336		
SPECIES /m²	A	B	C
CRUSTACEA			
Copepoda		30	
Crustacea	10	20	
Urothoe spp.		40	
weight (g/m²):	0.0060	0.3420	
ECHINODERMATA			
Echinocyamus pusillus		10	20
weight (g/m²):		0.0500	0.1200
MOLLUSCA-BIVALVIA			
Glycymeris glycymeris			20
Mytilidae			30
Tellina pygmaea			20
Tellinidae	30		
weight (g/m²):	1.0420		0.1800
POLYCHAETA			
Eumida bahusiensis	10		
Glycera lapidum	20	10	
Hesionura elongata	10	180	40
Nephtys spp.		10	
Pisione remota	10	10	
Polygordius appendiculatus	10	20	10
Saccocirrus papillocercus		20	
Sphaerosyllis bulbosa		110	20
weight (g/m²):	0.0920	0.3160	0.0020
VARIA			
Nematoda	150	360	
Nemertea	10		
weight (g/m²):	0.0540	0.0180	

100702-NEMO-GS-B01-009			
Easting:	468907	Depth:	29.0
Northing:	5689330		
SPECIES /m²	A	B	C
CNIDARIA			
Diphasia		P	P
weight (g/m²):		0.0080	0.0780
CRUSTACEA			
Bathyporeia elegans	10		
Bathyporeia guilliamsoniana		10	
Diastylis rugosa	10		
Diastylis spp.			10
Oedicerotidae spp.			10
Thia scutellata	10		20
weight (g/m²):	0.3130	0.0360	0.9860
ECHINODERMATA			
Asterias rubens			
Echinocardium cordatum		10	10
Ophiura spp.	10		
weight (g/m²):	87.7850	81.7130	49.3240
POLYCHAETA			
Nephtys cirrosa	20	20	40
Nephtys spp.	10	10	
Spiophanes bombyx	20	10	40
weight (g/m²):	1.3910	0.6210	2.7760
VARIA			
Echiura			10
Nemertea			20
weight (g/m²):			0.2570

100702-NEMO-GS-B01-010			
Easting:	467066	Depth:	29.0
Northing:	5690950		
SPECIES /m²	A	B	C
CNIDARIA			
Tubularia spp.	P		
weight (g/m²):	0.3250		
CRUSTACEA			
Bathyporeia spp.	10		10
Crustacea			10
Leucothoe spp.		10	
Mysidae		10	
Oedicerotidae	10	10	10
Processa spp.	20		
weight (g/m²):	1.3580	0.1760	0.0430
ECHINODERMATA			
Ophiurae			10
Spatangoida			10
weight (g/m²):			0.2340
POLYCHAETA			
Nephtys cirrosa	10	30	
Nephtys spp.			10
Spio armata			10
weight (g/m²):	1.8650	3.4720	0.5190

100702-NEMO-GS-B01-011			
Easting:	464768	Depth:	27.0
Northing:	5690840		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia guilliamsoniana			10
Bathyporeia spp.	20		
Diastylis spp.			10
Processa spp.			10
Urothoe brevicornis			50
Urothoe spp.	190	210	
weight (g/m²):	3.0260	1.2130	2.0560
ECHINODERMATA			
Echinocardium cordatum	50	70	
Echinocardium flavescens			60
Ophiocten affinis	60		
Ophiura albida		30	
Ophiura spp.			10
weight (g/m²):	10.5700	34.2320	23.5050
POLYCHAETA			
Nephtys cirrosa	20	70	90
Spiophanes bombyx		10	10
weight (g/m²):	0.7440	5.5420	5.7650

100702-NEMO-GS-B01-012			
Easting:	461179	Depth:	34.5
Northing:	5689687		
SPECIES /m²	A	B	C Ins. Samp. Vol.
ECHINODERMATA			
Echinocyamus pusillus	780		
Ophiuroidea	30		
Psammechinus miliaris	10		
weight (g/m²):	4.0390		
MOLLUSCA-BIVALVIA			
Arca tetragona	20		
weight (g/m²):	0.3140		
POLYCHAETA			
Aonides paucibranchiata	20		
Glycera lapidum	10		
Glycera spp.	20		
Lagis koreni	10		
Owenia fusiformis	10		
Spio filicornis	10		
weight (g/m²):	0.8970		

100702-NEMO-GS-B01-013			
Easting:	457427	Depth:	28.0
Northing:	5688051		
SPECIES /m²	A	B	C
CRUSTACEA			
Thia scutellata			10
weight (g/m²):			0.1770
ECHINODERMATA			
Echinocyamus pusillus	10		20
weight (g/m²):	0.0070		0.0430
MOLLUSCA-BIVALVIA			
Mytilus spp.		10	
Spisula elliptica			10
weight (g/m²):		0.0160	0.3280
POLYCHAETA			
Glycera lapidum		30	10
Hesionura elongata		10	10
Nephtys cirrosa			10
Phyllodoce citrina			10
Pisione remota			20
Polygordius appendiculatus		10	
weight (g/m²):		0.0150	2.0590
VARIA			
Echiura			10
weight (g/m²):			0.0060

100702-NEMO-GS-B01-014			
Easting:	457609	Depth:	33.0
Northing:	5688048		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia guilliamsoniana		10	
Liocarcinus pusillus		10	
Thia scutellata			10
Urothoe brevicornis		10	
Urothoe spp.	40		
weight (g/m²):	0.4090	0.5860	1.9330
ECHINODERMATA			
Echinocardium spp.	30		
Ophiocten affinis		10	
Ophiura spp.	10		
weight (g/m²):	3.4440	0.0750	
MOLLUSCA-BIVALVIA			
Spisula elliptica			10
weight (g/m²):			0.1780
POLYCHAETA			
Nephtys cirrosa	70	70	
Spio armata	10	10	10
Spio filicornis			10
Spiophanes bombyx			10
weight (g/m²):	4.3390	3.0410	2.4600
VARIA			
Echiichthys vipera			10
Gobiidae			10
Pomatoschistus spp.		10	
weight (g/m²):		2.4060	135.6140

100702-NEMO-GS-B01-015			
Easting:	454992	Depth:	38.5
Northing:	5687268		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea			20
Gastrosaccus spinifer		50	
Processa spp.		20	
Urothoe brevicornis	10		10
Urothoe spp.	10		10
weight (g/m²):	0.0860	2.0710	0.5340
ECHINODERMATA			
Echinocyamus pusillus	20	10	60
weight (g/m²):	0.1140	0.0660	0.0840
MOLLUSCA-BIVALVIA			
Spisula elliptica	10	10	
Tellina pygmaea			10
Tellinidae			
weight (g/m²):	0.1970	0.0120	0.1180
POLYCHAETA			
Glycera lapidum			10
Hesionura elongata	10		
Nephtys cirrosa	10	10	30
Nephtys spp.			10
Spio armata			30
weight (g/m²):	0.1970	0.5010	2.0630

100702-NEMO-GS-B01-016			
Easting:	473336	Depth:	23.4
Northing:	5688994		
SPECIES /m²	A	B	C
CRUSTACEA			
Paguridae			10
Thia scutellata	10		
weight (g/m²):	0.1730		0.0990
ECHINODERMATA			
Echinocardium cordatum		10	
Ophiura albida	10		10
weight (g/m²):	0.4280	61.8420	0.2140
MOLLUSCA-BIVALVIA			
Spisula elliptica		10	
weight (g/m²):		12.8800	
MOLLUSCA-GASTROPODA			
Nassarius reticulatus	10		
weight (g/m²):	28.2920		
POLYCHAETA			
Nephtys cirrosa	100	130	140
Spiophanes bombyx	20		20
weight (g/m²):	4.5870	7.3800	5.6840

100702-NEMO-GS-B01-017			
Easting:	485843	Depth:	22.4
Northing:	5689248		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	20		
Rhizorhagium roseum			
weight (g/m²):	12.9130	1.2320	
CRUSTACEA			
Ampelisca spp.			10
Autonoe longipes			20
Bodotria scorpioides			10
Dendrobranchiata spp.	10		
Gammaridea			20
Gammarus spp.		10	
Haustoriidae			10
Leucothoe incisa			10
Liocarcinus marmoreus		10	
Paguridae		10	
Pagurus bernhardus		10	20
Processa canaliculata			10
Semibalanus balanoides		20	
Stenothoe monoculoides		10	
Thia scutellata	10		
weight (g/m²):	1.9880	64.2500	0.9400
ECHINODERMATA			
Echinocardium cordatum	30	10	30
Ophiura albida	10		10
Ophiuroidea			10
weight (g/m²):	445.2840	54.8000	373.7600
MOLLUSCA-BIVALVIA			
Abra spp.			10
Bivalvia	10	10	
Ensis magnus		10	
Spisula elliptica	10		
Tellina fabula		10	
Tellina pygmaea			10
weight (g/m²):	0.6330	6.6500	0.4680
MOLLUSCA-GASTROPODA			
Nassarius reticulatus	10		
weight (g/m²):	14.1530		
POLYCHAETA			
Chaetozone setosa	30	10	30
Dipolydora flava		10	
Eteone spp.	10		20
Eumida bahusiensis	10		60
Eunereis longissima	0		10
Lanice conchilega	210	70	190
Magelona johnstoni	40	10	60
Nephtys assimilis			10
Nephtys cirrosa	30		
Nephtys hombergii	10		
Nephtys spp.	10		10
Owenia fusiformis	10	10	600
Pseudopolydora pulchra			10
Scoloplos armiger	20	10	10
Spio filicornis	30		20
Spiophanes bombyx	100	20	160
weight (g/m²):	8.4480	5.1584	32.1260
VARIA			
Pomatoschistus minutus			10
weight (g/m²):			1.2280

100702-NEMO-GS-B01-018			
Easting:	501049	Depth:	10.0
Northing:	5687734		
SPECIES /m²	A	B	C
CNIDARIA			
Diphasia spp.	P		
Nemertesia sp.	P		
Sertulariidae			P
weight (g/m²):	0.0180		0.0500
CRUSTACEA			
Crangon allmanni		10	
Diastylis glabra		10	
weight (g/m²):		0.3860	
ECHINODERMATA			
Holothuroidea	10		
Ophiura ophiura		10	
weight (g/m²):	0.6830	0.4100	
MOLLUSCA-BIVALVIA			
Abra tenuis	310		
Ensis magnus		10	10
Macoma balthica		600	370
weight (g/m²):	4.5090	10.9500	8.9260
POLYCHAETA			
Caulleriella killariensis	610	480	180
Heteromastus filiformis			10
Nephtys hombergii		10	
Notomastus latericeus	290	320	
Owenia fusiformis	30	230	40
weight (g/m²):	1.2260	8.0630	0.5810
VARIA			
Nematoda	10		
weight (g/m²):	-		

100702-NEMO-GS-B01-019			
Easting:	503201	Depth:	8.6
Northing:	5687622		
SPECIES /m²	A	B	C
CNIDARIA			
Anthozoa		20	
Hydrozoa	P		
weight (g/m²):	0.1200	0.3040	
CRUSTACEA			
Crangon crangon		20	
Diastylis spp.			30
Pisidia longicornis	10		
weight (g/m²):	0.6920	0.1970	0.2000
MOLLUSCA-BIVALVIA			
Ensis magnus		10	
Macoma balthica	20	110	60
weight (g/m²):	12.5250	6.5960	55.9780
POLYCHAETA			
Caulleriella killariensis		150	230
Cirratulidae		10	
Lagis koreni		10	
Nephtys hombergii		30	
Nephtys spp.			10
Notomastus latericeus			20
Owenia fusiformis	140	5230	220
weight (g/m²):	3.4580	90.1210	5.0410

100702-NEMO-GS-B01-020			
Easting:	506189	Depth:	8.0
Northing:	5687053		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria		10	
Anthozoa	20		
Hydrozoa			P
Obelia spp.	P		
Tubularia indivisa	P		
weight (g/m²):	15.6200	29.8160	1.9600
CRUSTACEA			
Autonoe longipes			10
Carcinus maenas	10		
Crangon crangon	10		
Diastylis spp.	10		
Gammaridae			10
Gammarus spp.	10		
Idotea linearis	10		
Pisidia longicornis			40
weight (g/m²):	9.8500		10.6730
ECHINODERMATA			
Asterias rubens	80		
Ophiura ophiura	10		10
weight (g/m²):	13.3980		7.6940
MOLLUSCA-BIVALVIA			
Abra nitida	20		
Abra prismatica	0		660
Ensis magnus	180	150	
Macoma balthica	770	270	
weight (g/m²):	46.7800	29.9810	80.9830
POLYCHAETA			
Alitta succinea	10		
Caulleriella killariensis	30	10	40
Cirratulidae spp.	30		30
Eunereis longissima	20	10	20
Heteromastus filiformis	80		
Nephtys hombergii		10	
Notomastus latericeus	10	40	260
Owenia fusiformis	5260	140	50
Polydora cornuta	170		
Spiophanes bombyx			10
weight (g/m²):	50.5070	9.8080	10.7130

100702-NEMO-GS-B02-021			
Easting:	455282	Depth:	42.0
Northing:	5687273		
SPECIES /m²	A	B	C
		Ins. Samp. Vol.	Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia guilliamsoniana	70		
Bathyporeia spp.	10		
Bathyporeia tenuipes			
Crangon allmanni	10		
Pinnotheres pisum	10		
Thia scutellata	30		
weight (g/m²):	3.9780		
ECHINODERMATA			
Echinocardium spp.	20		
Echinocyamus pusillus	70		
Ophiura spp.	10		
weight (g/m²):	10.2390		
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		
weight (g/m²):	6.7670		
POLYCHAETA			
Nephtys cirrosa	10		
Ophelia borealis	10		
Spio armata	10		
weight (g/m²):	2.2750		

100702-NEMO-GS-B02-022			
Easting:	454014.11	Depth:	36.4
Northing:	5686798.88		
SPECIES /m²	A	B	C
			Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia elegans	20		
Urothoe brevicornis	40		
weight (g/m²):	0.867		
ECHINODERMATA			
Echinocardium cordatum	10		
Ophiura spp.	20		
weight (g/m²):	4.788		
MOLLUSCA-BIVALVIA			
Ensis spp.			
weight (g/m²):	0.208		
POLYCHAETA			
Nephtys cirrosa	30		
Spiophanes bombyx	10		
weight (g/m²):	0.656		

100702-NEMO-GS-B02-023			
Easting:	451605	Depth:	38.0
Northing:	5685778		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia elegans			
Bathyporeia guilliamsoniana	30		
Bathyporeia spp.	120	10	10
Mysidae	10	10	
Pontoporeiidae		10	
Urothoe spp.	50		
weight (g/m²):	0.6880	0.2890	0.0320
POLYCHAETA			
Nephtys cirrosa	10	40	60
Nephtys spp.		10	
Ophelia borealis	10		
Scolelepis bonnieri		10	
Spio armata	10		50
weight (g/m²):	1.4650	4.2010	2.8820

100702-NEMO-GS-B02-024			
Easting:	449052	Depth:	35.8
Northing:	5685125		
SPECIES /m²	A	B	C
	Ins. Samp. Vol.	Ins. Samp. Vol.	Ins. Samp. Vol.

100702-NEMO-GS-B02-025			
Easting:	448045	Depth:	35.9
Northing:	5685205		
SPECIES /m²	A	B	C
	Ins. Samp. Vol.		Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia guilliamsoniana	40	20	
Bathyporeia sarsi		40	
Crangon spp.		10	
Gastrosaccus spinifer		20	
Processa spp.		40	
Urothoe brevicornis	40		
weight (g/m²):	0.5020	9.0630	
ECHINODERMATA			
Echinocyamus pusillus	80	140	
Ophiocten affinis		20	
weight (g/m²):	0.4000	1.7810	
MOLLUSCA-BIVALVIA			
Tapes spp.		10	
weight (g/m²):		0.1410	
MOLLUSCA-GASTROPODA		0	
Euspira montagui		10	
weight (g/m²):		0.1980	
POLYCHAETA			
Nephtys cirrosa	10	20	
Ophelia borealis		20	
weight (g/m²):	0.5540	1.1860	

100702-NEMO-GS-B02-026			
Easting:	447097	Depth:	37.1
Northing::	5685290		
SPECIES /m²	A	B	C
	Ins. Samp. Vol.	Ins. Samp. Vol.	Ins. Samp. Vol.

100702-NEMO-GS-B02-027			
Easting:	445688	Depth:	36.1
Northing:	5685690		
SPECIES /m²	A	B	C
CRUSTACEA			
Bathyporeia elegans	20		
Bathyporeia guilliamsoniana	10	10	
Bathyporeia nana	20		
Bathyporeia spp.		10	10
Bathyporeia tenuipes	40		
Crustacea			10
Gammaridae	10		0
Gastrosaccus spinifer			10
Liocarcinus pusillus		10	
Urothoe elegans	10		
Urothoe marina	10		
Urothoe spp.		40	10
weight (g/m²):	0.3550	0.1650	0.1580
MOLLUSCA-BIVALVIA			
Spisula elliptica		20	
weight (g/m²):		0.3370	
POLYCHAETA			
Glycera oxycephala			10
Nephtys cirrosa	10		10
Ophelia borealis		10	30
Spio armata		10	
Spiophanes bombyx	10		
Terebellidae spp.			10
weight (g/m²):	0.8770	0.5450	3.5240

100702-NEMO-GS-B02-028			
Easting:	441671	Depth:	31.0
Northing:	5686433		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea	70		
Gammaridae	10		
Gastrosaccus spinifer		30	
Isopoda		10	
Leucothoe incisa			
Pisidia longicornis			40
Thia scutellata		10	
weight (g/m²):	0.9430	0.4130	0.0490
MOLLUSCA-BIVALVIA			
Abra nitida			10
weight (g/m²):			0.2700
POLYCHAETA			
Heteromastus filiformis			10
Nephtys cirrosa			20
Ophelia borealis	10		10
Polycirrus medusa		10	110
weight (g/m²):	0.3260	0.0120	1.3650

100702-NEMO-GS-B02-029			
Easting:	436734	Depth:	38.5
Northing:	5686299		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.
CRUSTACEA			
Bathyporeia spp.		10	
Liocarcinus pusillus	10		
weight (g/m²):	0.1710	0.0280	
ECHINODERMATA			
Echinocyamus pusillus	60	70	
Ophiuroidea		10	
weight (g/m²):	0.2090	0.1810	
MOLLUSCA-GASTROPODA			
Euspira pulchella	10		
weight (g/m²):	0.4420		
POLYCHAETA			
Glycera lapidum		20	
Ophelia borealis	20		
Polycirrus spp.		10	
weight (g/m²):	0.0740	0.0410	

100702-NEMO-GS-B02-030			
Easting:	433539	Depth:	40.0
Northing:	5686382		
SPECIES /m²	A	B	C
ECHINODERMATA			
Echinocyamus pusillus	10	10	
Ophiocten affinis		20	
Ophiura ophiura			10
weight (g/m²):	0.3880	0.5330	7.2140
MOLLUSCA-BIVALVIA			
Glycymeris glycymeris		10	
Glycymeris spp.	10		
Goodallia triangularis	20		
Spisula elliptica	20		
Tellina pygmaea	10		
weight (g/m²):	0.3870	0.2000	
POLYCHAETA			
Glycera lapidum	10		
Nephtys cirrosa		10	
weight (g/m²):	0.0040	2.1340	
VARIA			
Ammodytes tobianus		10	
weight (g/m²):		75.3900	

100702-NEMO-GS-B03-031			
Easting:	431715	Depth:	32.0
Northing:	5686388		
SPECIES /m²	A	B	C
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		
weight (g/m²):	0.1210		
POLYCHAETA			
Glycera lapidum		10	
Owenia fusiformis	10		
weight (g/m²):	0.1090	0.0670	

100702-NEMO-GS-B03-32			
Easting:	426153	Depth:	42.2
Northing:	5686634		
SPECIES /m²	A	B	C
CNIDARIA			
Hydrozoa			P
weight (g/m²):			0.0700
CRUSTACEA			
Liocarcinus marmoreus			10
Monoculodes carinatus			20
weight (g/m²):			3.7700
ECHINODERMATA			
Echinocyamus pusillus			10
weight (g/m²):			0.1620
MOLLUSCA-BIVALVIA			
Spisula elliptica	10		10
Tellina pygmaea	10		
Tellinidae			
weight (g/m²):	0.4770		0.5170
POLYCHAETA	0		
Aonides paucibranchiata	20		
Glycera lapidum			30
Lumbrineris latreilli	10		
Notomastus latericeus	30		30
Polycirrus medusa	50	10	
weight (g/m²):	5.7530	0.1310	0.6450
VARIA			
Branchiostoma lanceolatum	20	20	20
Nematoda	20	50	60
weight (g/m²):	0.4260	1.6330	1.5280

100702-NEMO-GS-B03-033			
Easting:	422672	Depth:	40.8
Northing:	5686733		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-034			
Easting:	416374	Depth:	40.8
Northing:	5686854		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-035			
Easting:	414266	Depth:	18.9
Northing:	5686938		
SPECIES /m²	A	B	C
CRUSTACEA			
Euphausiacea		10	
Hippomedon denticulatus		10	
weight (g/m²):		0.5040	
POLYCHAETA			
Glycera oxycephala	10		
Nephtys cirrosa	10	10	
Ophelia borealis		10	
weight (g/m²):	0.5230	1.2240	

100702-NEMO-GS-B03-036			
Easting:	412197	Depth:	46.0
Northing:	5687033		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-037			
Easting:	408771	Depth:	53.7
Northing:	5687304		
SPECIES /m²	A	B Ins. Samp. Vol.	C
CNIDARIA			
Diphasia spp.		P	
weight (g/m²):		0.0690	
ECHINODERMATA			
Ophiuroidea	10		
weight (g/m²):	0.0070		
MOLLUSCA-GASTROPODA			
Nassarius nitidus			10
weight (g/m²):			14.7450
POLYCHAETA			
Lagis koreni		10	30
Nephtys cirrosa	10		10
Nephtys spp.		10	
Ophelia borealis			20
weight (g/m²):	0.0130	1.1620	2.9300
VARIA			
Ctenophora		10	
weight (g/m²):		0.0220	

100702-NEMO-GS-B03-038			
Easting:	407401	Depth:	41.1
Northing:	5687145		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-039			
Easting:	405926	Depth:	22.5
Northing:	5687038		
SPECIES /m²	A	B	C Ins. Samp. Vol.
CNIDARIA			
Actiniaria		30	
Anthozoa	10		
Diphasia		P	
Hydrallmania falcata		P	
weight (g/m²):	70.9260	4.2810	
CRUSTACEA			
Abludomelita obtusata		10	
Ampelisca spinipes		10	
Galathea intermedia		20	
Galathea spp.		10	
Gammaridae		10	
Gammaropsis maculata		40	
Liocarcinus spp.		10	
Mysidae	10		
Pilumnus spp.		10	
Pisidia longicornis		1600	
Upogebia stellata		10	
weight (g/m²):	0.2640	11.8600	
ECHINODERMATA			
Amphipholis squamata		110	
Asterias rubens		30	
Leptasterias muelleri		10	
Ophiura spp.	10		
Ophiuroidea		340	
weight (g/m²):	0.0030	257.3080	
MOLLUSCA-BIVALVIA			
Abra nitida	30		
Abra prismatica		170	
weight (g/m²):	0.1980	0.9010	
MOLLUSCA-GASTROPODA			
Odostomia unidentata		20	
weight (g/m²):		10.0990	
POLYCHAETA			
Cauleriella alata		10	
Cirratulidae	10		
Eulalia viridis		10	
Eunereis longissima		10	
Glycera alba		10	
Harmothoe aspera		30	
Harmothoe clavigera		50	
Harmothoe extenuata		30	
Harmothoe spp.	10	110	
Heteromastus filiformis		30	
Lanice conchilega	10		
Mysta picta		10	
Nephtys cirrosa		10	
Notomastus latericeus		10	
Ophelia borealis	30	10	
Pherusa plumosa		10	
Sabellaria spinulosa	1080	10630	
Scalibregma inflatum	10		
Spio filicornis	10		
Spiophanes bombyx	60	10	
Sthenelais boa		30	
weight (g/m²):	6.9190	155.1690	
VARIA			
Gaidropsarus spp.		10	
Sipuncula spp.		10	
weight (g/m²):		67.3580	

100702-NEMO-GS-B03-040			
Easting:	404309	Depth:	26.5
Northing:	5686851		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-041			
Easting:	402231	Depth:	19.7
Northing:	5686507		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-042			
Easting:	399159	Depth:	17.8
Northing:	5686401		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-043			
Easting:	397792	Depth:	37.0
Northing:	5686013		
SPECIES /m²	A	B	C
CRUSTACEA			
Porcellanidae			10
weight (g/m²):			0.0210
POLYCHAETA			
Ophelia borealis		20	
Pholoe inornata	10		
weight (g/m²):	0.0060	0.9910	

100702-NEMO-GS-B03-044			
Easting:	397257	Depth:	16.0
Northing:	5685815		
SPECIES /m²	A	B	C
POLYCHAETA			
Nephtys cirrosa	10		10
Ophelia borealis	30	10	
weight (g/m²):	7.7710	1.2360	0.1370

100702-NEMO-GS-B03-045			
Easting:	395600	Depth:	12.0
Northing:	5685354		
SPECIES /m²	A Ins. Samp. Vol.	B Ins. Samp. Vol.	C Ins. Samp. Vol.

100702-NEMO-GS-B03-046			
Easting:	391595	Depth:	10.0
Northing:	5685158		
SPECIES /m²	A	B	C
CRUSTACEA			
Gastrosaccus spinifer		10	
Urothoe spp.	30		
weight (g/m²):	0.4400	0.2500	
MOLLUSCA-BIVALVIA			
Mytilidae			20
Spisula elliptica			20
weight (g/m²):			0.1800
POLYCHAETA			
Nephtys cirrosa	10		
Ophelia borealis	10		
weight (g/m²):	0.0660		

100702-NEMO-GS-B03-047			
Easting:	392526	Depth:	12.0
Northing:	5685110		
SPECIES /m²	A	B	C
CRUSTACEA			
Balanus spp.			200
Bathyporeia spp.	20		
Lysianassidae			10
Pagurus spp.			10
Podoceridae			10
weight (g/m²):	0.0170		20.1830
ECHINODERMATA			
Amphiuridae		10	
Ophiuroidea			10
weight (g/m²):		0.0400	0.0090
MOLLUSCA-BIVALVIA			
Corbula gibba		10	
Goodallia triangularis			10
Mytilidae	70		300
Spisula elliptica	10		30
weight (g/m²):	0.3900	0.1290	0.3430
POLYCHAETA			
Glycera lapidum	10		
Macrochaeta helgolandica	20		
Ophelia borealis	20	20	
Terebellidae spp.		10	
weight (g/m²):	2.3980	0.5180	

100702-NEMO-GS-B03-048			
Easting:	391993	Depth:	9.0
Northing:	5684853		
SPECIES /m²	A	B Ins. Samp. Vol.	C Ins. Samp. Vol.
Nephtys cirrosa	10		10
Ophelia borealis		20	10
weight (g/m²):	0.2050	1.9040	0.3079

100702-NEMO-GS-B03-049			
Easting:	389215	Depth:	2.0
Northing:	5685982		
SPECIES /m²	A	B	C
CNIDARIA			
Tubularia spp.			P
weight (g/m²):			0.0110
CRUSTACEA			
Bathyporeia guilliamsoniana		20	
Bathyporeia nana		10	
Bathyporeia spp.			20
Dexaminidae			10
Urothoe brevicornis		60	70
Urothoe spp.	20	10	
weight (g/m²):	0.1360	0.7630	0.4070
MOLLUSCA-BIVALVIA			
Abra nitida		10	
Mytilidae	20		10
weight (g/m²):	0.0130	0.1150	0.0170
POLYCHAETA			
Ampharete spp.	10		
Glycera capitata	20		
Glycera oxycephala	20		10
Lagis koreni	10		10
Lumbrineris aniara	10		
Nephtys cirrosa	10	20	10
Notomastus latericeus	10	0	
Ophelia borealis	30	10	20
Phyllodoce mucosa	10		
Spio armata	20	10	10
Spiophanes kroyeri	10		
Travisia forbesii			10
weight (g/m²):	2.4570	2.6820	1.6430
VARIA			
Pycnogonida	50		
Vesicularia spinosa	P	P	
weight (g/m²):	30.8190	0.2370	

100702-NEMO-GS-B03-050			
Easting:	387873	Depth:	3.0
Northing:	5685179		
SPECIES /m²	A	B	C
CNIDARIA			
Actiniaria	40	20	
Anthozoa			70
weight (g/m²):	15.1210	13.4680	42.8030
CRUSTACEA			
Ampelisca brevicornis	10		30
Ampelisca spp.		30	
Aoridae	30	20	
Balanus balanus			10
Campylaspis spp.	10		
Carcinus maenas	10		
Corophium spp.		20	
Diastylis glabra	20		
Diastylis spp.			10
Gammaridae	100		120
Pagurus bernhardus		10	
Pisidia longicornis	30	20	
Portunidae spp.	10		
weight (g/m²):	1.9680	6.6040	1.5660
ECHINODERMATA			
Amphipholis squamata	80	70	
Ophiura albida		10	
Ophiura spp.	20	40	10
Psammechinus miliaris			10
weight (g/m²):	0.1400	1.4210	0.5100
MOLLUSCA-BIVALVIA			
Abra alba	50		50
Abra spp.		100	
Bivalvia			10
Corbula gibba	20	10	
Ensis magnus		20	40
Macoma balthica	10		
Nucula nitidosa	40	100	140
Nucula sulcata		10	
Spisula elliptica		20	
Tellimya ferruginosa	10		
weight (g/m²):	17.7710	11.1840	36.7340
MOLLUSCA-GASTROPODA			
Buccinum undatum		10	10
Gibbula spp.		10	10
Nassarius nitidus			10
weight (g/m²):		5.3120	25.1480
MOLLUSCA-NUDIBRANCHIA			
Nudibranchia	10		
weight (g/m²):	0.0960		

100702-NEMO-GS-B03-050			
POLYCHAETA			
Ampharete spp.	10		10
Ampharete finmarchica	20	10	
Aphrodita aculeata		20	10
Cauleriella alata	10	10	
Caulleriella killariensis	10		
Cirratulidae		50	10
Eteone spp.			10
Eumida sanguinea	10		
Eunereis longissima	10	10	20
Gattyana cirrhosa	10		
Glycera alba		20	
Glycera spp.			10
Harmothoe clavigera		10	
Harmothoe extenuata	10		
Heteromastus filiformis	70	50	20
Lagis koreni	50	20	40
Lanice conchilega	10	70	
Lepidonotus squamatus			10
Lumbrineris aniara		20	10
Mysta picta		10	
Neoamphitrite spp.	10		
Nephtys hombergii			10
Nephtys kersivalensis	10		
Nephtys spp.	20	10	80
Notomastus latericeus	100	160	100
Pholoe baltica			10
Phyllodoce mucosa		10	20
Polycirrus medusa	20	20	
Pygospio elegans			10
Scalibregma inflatum	40	10	
Scolelepis bonnieri			
Scoloplos armiger	10	30	30
Spiophanes bombyx			20
Sthenelais boa		10	
weight (g/m²):	8.8990	14.7350	5.6910
VARIA			
Achelia echinata	10		
Alcyonidium diaphanum	P		P
Ammothella longipes		10	
Anoplodactylus petiolatus	50	70	70
Flustra foliacea			P
Nemertea	10		
Pycnogonida	10		
weight (g/m²):	8.3850	0.0010	5.4420

100702-NEMO-DDV-B03-039_001									
Photo ID	039-001_001	039-001_002	039-001_003	039-001_004	039-001_005	039-001_006	039-001_007	039-001_008	039-001_009
X	406212	406229	406247	406265	406281	406195	406178	406162	406146
Y	5687069	5687056	5687044	5687032	5687020	5687080	5687092	5687103	5687114
Sand	x			x	x	x	x	x	x
Gravel				x	x				
Large Shell fragments				<20%	<10%				
Small Shell fragments							X		
Comments	Poor visibility. *Sabellaria* reef.	Zero visibility due to strong current.	Poor visibility. Maybe cobbles covered with *Serpulidae*.	Poor visibility due to strong current.	Poor visibility due to strong current.	*Sabellaria* reef	*Sabellaria* reef with leftovers of fishing gear.	*Sabellaria* reef with fishing net	*Sabellaria* reef.
EUNIS habitat classification	A5.611					A5.611	A5.611	A5.611	A5.611
Comments EUNIS code	Annex 1 area-Sabellaria					Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria

SPECIES /m²

CNIDARIA									
Actiniaria									
CRUSTACEA									
Crustacea									
Paguridae								1.6	
Galatheidae									
Caridea									
Brachyura									
Liocarcinus spp.									
Portunidae									
Pisidia longicornis								4.8	
ECHINODERMATA									
Asterias rubens	1.6					1.6			
Psammechinus miliaris									
POLYCHAETA									
Tubes of *Sabellaria spp.* (SACFOR)	A					S	S	A	A

100702-NEMO-DDV-B03-039_001									
Photo ID	039-001_010	039-001_011	039-001_012	039-001_013	039-001_014	039-001_015	039-001_016	039-001_017	039-001_018
X	406129	406112	406096	406080	406064	406048	406032	406015	405998
Y	5687125	5687137	5687149	5687159	5687171	5687181	5687196	5687208	5687219
Sand	x		x			x	x	x	x
Gravel			x						
Large Shell fragments									
Small Shell fragments			x			x	x	x	
Comments	*Sabellaria* reef.	Zero visibility.	*Sabellaria* reef with shell gravel.	Zero visibility.	Zero visibility.	*Sabellaria* reef.	*Sabellaria* reef.	*Sabellaria* reef.	Poor visibility. *Sabellaria* reef.
EUNIS habitat classification	A5.611		A5.611			A5.611	A5.611	A5.611	A5.611
Comments EUNIS code	Annex 1 area-Sabellaria		Annex 1 area-Sabellaria			Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria	Annex 1 area-Sabellaria

SPECIES /m²

CNIDARIA									
Actiniaria			1.6				3.2	6.5	
CRUSTACEA									
Crustacea			1.6			1.6		6.5	
Paguridae									
Galatheidae						1.6			
Caridea							3.2	1.6	
Brachyura						1.6		4.8	
Liocarcinus spp.								1.6	
Portunidae								1.6	
Pisidia longicornis						1.6		8.1	
ECHINODERMATA									
Asterias rubens	3.2		3.2			3.2	1.6	3.2	
Psammechinus miliaris								16.1	
POLYCHAETA									
Tubes of *Sabellaria spp.* (SACFOR)	S		S			S	S	S	A

100702-NEMO-DDV-B03-039_001								
Photo ID	039-001_019	039-001_020	039-001_021	039-001_022	039-001_023	039-001_024	039-001_025	039-001_026
X	405981	405963	405946	405930	405914	405897	405881	405865
Y	5687232	5687240	5687252	5687263	5687273	5687286	5687299	5687311
Sand		x		x	x	x	x	x
Gravel								
Large Shell fragments								
Small Shell fragments								
Comments	Zero visibility.	Poor visibility. *Sabellaria* reef.	Zero visibility.	A few *Sabellaria* tubes.	Poor visibility. *Sabellaria* reef.	Poor visibility. *Sabellaria* reef.	Very poor visibility. Probably sandy bottom .	Very poor visibility. Probably sandy bottom .
EUNIS habitat classification		A5.611		A5.611	A5.611	A5.611		
Comments EUNIS code		Annex 1 area-Sabellaria		Annex 1 area-Sabellaria		Annex 1 area-Sabellaria		

SPECIES /m²

CNIDARIA								
Actiniaria								
CRUSTACEA								
Crustacea								
Paguridae								
Galatheidae								
Caridea					1.6			
Brachyura								
Liocarcinus spp.								
Portunidae								
Pisidia longicornis								
ECHINODERMATA								
Asterias rubens								
Psammechinus miliaris								
POLYCHAETA								
Tubes of *Sabellaria spp.* (SACFOR)		C		F	S	C		

100702-NEMO-DDV-B03-039_002											
Photo ID	039-002_001	039-002_002	039-002_003	039-002_004	039-002_005	039-002_006	039-002_007	039-002_008	039-002_009	039-002_010	039-002_011
X	406046	406036	406023	406012	406000	405989	405980	405968	405955	405943	405932
Y	5687270	5687253	5687236	5687219	5687203	5687186	5687169	5687152	5687137	5687118	5687100
Clay										x?	x?
Sand	x	x	x	x	x	x	x?	x?	x?	x	x
Gravel											
Pebbles and Cobbles	x	x	x	x						x	x
Small Shell fragments											
Comments	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. Cobbles covered with *Serpulidae.*	Poor visibility. *Sabellaria* reef.	Poor visibility. *Sabellaria* reef.	Zero visibility. Probably sand bottom.	Zero visibility. Probably sand bottom.	Zero visibility. Probably sand bottom.	Poor visibility. Cobbles on sand bottom.	Poor visibility. Cobbles on sand bottom.
EUNIS habitat classification					A5.611	A5.611					
Comments EUNIS code					Annex 1 area-Sabellaria	Annex 1 area-Sabellaria					

SPECIES /m²

CRUSTACEA											
Paguridae	1.6										
MOLLUSCA											
Gastropoda					1.6						
ECHINODERMATA											
Echinidea	1.6										
POLYCHAETA											
Tubes of *Sabellaria spp.* (SACFOR)					A	A					

100702-NEMO-DDV-B03-040_001											
Photo ID	040-001_001	040-001_002	040-001_003	040-001_004	040-001_005	040-001_006	040-001_007	040-001_008	040-001_009	040-001_010	040-001_011
X	404311	404294	404275	404254	404234	404214	404194	404174	404157	404137	404117
Y	5686856	5686853	5686853	5686851	5686850	5686850	5686849	5686849	5686848	5686848	5686848
Clay			x?								
Sand	x	x	x	x	x	x	x	x	x	x	x
Gravel	x		x	x			x				
Pebbles and Cobbles						x					
Small Shell fragments				<1%							
Comments	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility.	Poor visibility. A few cobbles.	Poor visibility. Maby old *sabellaria* tubes with epifauna.	Poor visibility. Maby old *sabellaria* tubes with epifauna.	Poor visibility. Maby old *sabellaria* reef.	Zero visibility.	Poor visibility. Maby old *sabellaria* reef.
EUNIS habitat classification									A5.611		
Comments EUNIS code									Annex 1 area-Sabellaria		

SPECIES /m²

CNIDARIA											
Hydrozoa								P			
ECHINODERMATA											
Asterias rubens			1.6				1.6				1.6
POLYCHAETA											
Tubes of *Sabellaria spp.* (SACFOR)									A		

100702-NEMO-DDV-B03-040_002							
Photo ID	040-002_001	040-002_002	040-002_003	040-002_004	040-002_005	040-002_006	040-002_007
X	404296	404297	404299	404301	404302	404304	404305
Y	5686930	5686908	5686888	5686870	5686849	5686831	5686811
Clay							
Sand	x	x?	x?	x?	x?	x	x
Gravel							
Boulders							
Small Shell fragments							
Comments	Poor visibility. No visible reef structures	Zero visibility	Zero visibility	Zero visibility	Zero visibility	Poor visibility. No visible reef structures, sand and shell fragments.	Poor visibility. No visible reef structures
EUNIS habitat classification							

Group	Phylum	Species	Group	Phylum	Species
CNIDARIA	CNIDARIA	*Abietinaria abietina*	CRUSTACEA	ARTHROPODA	Gammaridae
CNIDARIA	CNIDARIA	Actiniaria	CRUSTACEA	ARTHROPODA	Gammaridea
CNIDARIA	CNIDARIA	*Alcyonium spp.*	CRUSTACEA	ARTHROPODA	*Gammaropsis maculata*
CNIDARIA	CNIDARIA	Anthozoa	CRUSTACEA	ARTHROPODA	*Gammarus spp.*
CNIDARIA	CNIDARIA	Campanulariidae	CRUSTACEA	ARTHROPODA	*Gastrosaccus spinifer*
CNIDARIA	CNIDARIA	*Clytia hemisphaerica*	CRUSTACEA	ARTHROPODA	Haustoriidae
CNIDARIA	CNIDARIA	*Diphasia spp.*	CRUSTACEA	ARTHROPODA	*Hippolyte varians*
CNIDARIA	CNIDARIA	*Hydrallmania falcata*	CRUSTACEA	ARTHROPODA	*Hippomedon denticulatus*
CNIDARIA	CNIDARIA	Hydrozoa	CRUSTACEA	ARTHROPODA	*Idotea linearis*
CNIDARIA	CNIDARIA	*Nemertesia spp.*	CRUSTACEA	ARTHROPODA	*Iphimedia spp.*
CNIDARIA	CNIDARIA	*Obelia spp.*	CRUSTACEA	ARTHROPODA	Isopoda
CNIDARIA	CNIDARIA	Plumulariidae	CRUSTACEA	ARTHROPODA	Ischyroceridae
CNIDARIA	CNIDARIA	*Rhizorhagium roseum*	CRUSTACEA	ARTHROPODA	*Leucothoe incisa*
CNIDARIA	CNIDARIA	*Sertularia cupressina*	CRUSTACEA	ARTHROPODA	*Leucothoe spp.*
CNIDARIA	CNIDARIA	Sertulariidae	CRUSTACEA	ARTHROPODA	*Liocarcinus holsatus*
CNIDARIA	CNIDARIA	*Tubularia indivisa*	CRUSTACEA	ARTHROPODA	*Liocarcinus marmoreus*
CNIDARIA	CNIDARIA	*Tubularia spp.*	CRUSTACEA	ARTHROPODA	*Liocarcinus pusillus*
CRUSTACEA	ARTHROPODA	*Abludomelita obtusata*	CRUSTACEA	ARTHROPODA	*Liocarcinus spp.*
CRUSTACEA	ARTHROPODA	*Ampelisca brevicornis*	CRUSTACEA	ARTHROPODA	Lysianassidae
CRUSTACEA	ARTHROPODA	*Ampelisca spinipes*	CRUSTACEA	ARTHROPODA	*Macropodia tenuirostris*
CRUSTACEA	ARTHROPODA	*Ampelisca spp.*	CRUSTACEA	ARTHROPODA	*Monoculodes carinatus*
CRUSTACEA	ARTHROPODA	*Anopladactylus petiolatus*	CRUSTACEA	ARTHROPODA	Mysidae
CRUSTACEA	ARTHROPODA	*Aora gracilis*	CRUSTACEA	ARTHROPODA	Oedicerotidae
CRUSTACEA	ARTHROPODA	Aoridae	CRUSTACEA	ARTHROPODA	Paguridae
CRUSTACEA	ARTHROPODA	*Autonoe longipes*	CRUSTACEA	ARTHROPODA	*Pagurus bernhardus*
CRUSTACEA	ARTHROPODA	*Balanus balanus*	CRUSTACEA	ARTHROPODA	*Pagurus spp.*
CRUSTACEA	ARTHROPODA	*Balanus crenatus*	CRUSTACEA	ARTHROPODA	*Pandalina spp.*
CRUSTACEA	ARTHROPODA	*Balanus spp.*	CRUSTACEA	ARTHROPODA	*Pariambus typicus*
CRUSTACEA	ARTHROPODA	*Bathyporeia elegans*	CRUSTACEA	ARTHROPODA	*Pilumnus spp.*
CRUSTACEA	ARTHROPODA	*Bathyporeia guilliamsoniana*	CRUSTACEA	ARTHROPODA	*Pinnotheres pisum*
CRUSTACEA	ARTHROPODA	*Bathyporeia nana*	CRUSTACEA	ARTHROPODA	*Pisidia longicornis*
CRUSTACEA	ARTHROPODA	*Bathyporeia sarsi*	CRUSTACEA	ARTHROPODA	Podoceridae
CRUSTACEA	ARTHROPODA	*Bathyporeia spp.*	CRUSTACEA	ARTHROPODA	Pontoporeiidae
CRUSTACEA	ARTHROPODA	*Bathyporeia tenuipes*	CRUSTACEA	ARTHROPODA	Porcellanidae
CRUSTACEA	ARTHROPODA	*Bodotria scorpioides*	CRUSTACEA	ARTHROPODA	Portunidae
CRUSTACEA	ARTHROPODA	*Brachyura spp.*	CRUSTACEA	ARTHROPODA	*Processa canaliculata*
CRUSTACEA	ARTHROPODA	*Campylaspis spp.*	CRUSTACEA	ARTHROPODA	*Processa spp.*
CRUSTACEA	ARTHROPODA	*Carcinus maenas*	CRUSTACEA	ARTHROPODA	*Semibalanus balanoides*
CRUSTACEA	ARTHROPODA	Caridea	CRUSTACEA	ARTHROPODA	*Stenothoe monoculoides*
CRUSTACEA	ARTHROPODA	Copepoda	CRUSTACEA	ARTHROPODA	*Thia scutellata*
CRUSTACEA	ARTHROPODA	*Corophium spp.*	CRUSTACEA	ARTHROPODA	*Upogebia stellata*
CRUSTACEA	ARTHROPODA	*Crangon allmanni*	CRUSTACEA	ARTHROPODA	*Urothoe brevicornis*
CRUSTACEA	ARTHROPODA	*Crangon crangon*	CRUSTACEA	ARTHROPODA	*Urothoe elegans*
CRUSTACEA	ARTHROPODA	*Crangon spp.*	CRUSTACEA	ARTHROPODA	*Urothoe marina*
CRUSTACEA	ARTHROPODA	Crustacea	CRUSTACEA	ARTHROPODA	*Urothoe spp.*
CRUSTACEA	ARTHROPODA	Dendrobranchiata	ECHINODERMATA	ECHINODERMATA	*Amphipholis squamata*
CRUSTACEA	ARTHROPODA	Dexaminidae	ECHINODERMATA	ECHINODERMATA	Amphiuridae
CRUSTACEA	ARTHROPODA	*Diastylis glabra*	ECHINODERMATA	ECHINODERMATA	*Asterias rubens*
CRUSTACEA	ARTHROPODA	*Diastylis rugosa*	ECHINODERMATA	ECHINODERMATA	*Echinocardium cordatum*
CRUSTACEA	ARTHROPODA	*Diastylis spp.*	ECHINODERMATA	ECHINODERMATA	*Echinocardium flavescens*
CRUSTACEA	ARTHROPODA	Euphausiacea	ECHINODERMATA	ECHINODERMATA	*Echinocardium spp.*
CRUSTACEA	ARTHROPODA	*Galathea intermedia*	ECHINODERMATA	ECHINODERMATA	*Echinocyamus pusillus*
CRUSTACEA	ARTHROPODA	*Galathea spp.*	ECHINODERMATA	ECHINODERMATA	Echinidea
CRUSTACEA	ARTHROPODA	Galatheidae	ECHINODERMATA	ECHINODERMATA	Holothurioidea

Group	Phylum	Species	Group	Phylum	Species
ECHINODERMATA	ECHINODERMATA	*Leptasterias muelleri*	MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	Nudibranchia
ECHINODERMATA	ECHINODERMATA	*Ophiocten affinis*	POLYCHAETA	ANNELIDA	*Alitta succinea*
ECHINODERMATA	ECHINODERMATA	*Ophiothrix fragilis*	POLYCHAETA	ANNELIDA	*Ampharete spp.*
ECHINODERMATA	ECHINODERMATA	*Ophiura albida*	POLYCHAETA	ANNELIDA	*Ampharete finmarchica*
ECHINODERMATA	ECHINODERMATA	*Ophiura ophiura*	POLYCHAETA	ANNELIDA	*Aonides paucibranchiata*
ECHINODERMATA	ECHINODERMATA	*Ophiura sarsii*	POLYCHAETA	ANNELIDA	*Aphrodita aculeata*
ECHINODERMATA	ECHINODERMATA	*Ophiura spp.*	POLYCHAETA	ANNELIDA	*Capitella capitata-complex*
ECHINODERMATA	ECHINODERMATA	Ophiurida	POLYCHAETA	ANNELIDA	*Capitellidae spp.*
ECHINODERMATA	ECHINODERMATA	Ophiuroidea	POLYCHAETA	ANNELIDA	*Cauleriella alata*
ECHINODERMATA	ECHINODERMATA	*Psammechinus miliaris*	POLYCHAETA	ANNELIDA	*Caulleriella killariensis*
ECHINODERMATA	ECHINODERMATA	Spatangoida	POLYCHAETA	ANNELIDA	*Chaetozone setosa*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra alba*	POLYCHAETA	ANNELIDA	Cirratulidae
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra nitida*	POLYCHAETA	ANNELIDA	*Dipolydora flava*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra prismatica*	POLYCHAETA	ANNELIDA	*Eteone spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra spp.*	POLYCHAETA	ANNELIDA	*Eulalia viridis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Abra tenuis*	POLYCHAETA	ANNELIDA	*Eumida bahusiensis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Aequipecten opercularis*	POLYCHAETA	ANNELIDA	*Eumida sanguinea*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Arca tetragona*	POLYCHAETA	ANNELIDA	*Eumida spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	Bivalvia	POLYCHAETA	ANNELIDA	*Eunereis longissima*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Corbula gibba*	POLYCHAETA	ANNELIDA	*Eusyllis blomstrandi*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Ensis magnus*	POLYCHAETA	ANNELIDA	*Gattyana cirrhosa*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Ensis spp.*	POLYCHAETA	ANNELIDA	*Glycera alba*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Glycymeris glycymeris*	POLYCHAETA	ANNELIDA	*Glycera capitata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Glycymeris spp.*	POLYCHAETA	ANNELIDA	*Glycera convoluta*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Goodallia triangularis*	POLYCHAETA	ANNELIDA	*Glycera lapidum*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Kurtiella bidentata*	POLYCHAETA	ANNELIDA	*Glycera oxycephala*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Macoma balthica*	POLYCHAETA	ANNELIDA	*Glycera spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	Mactridae	POLYCHAETA	ANNELIDA	*Harmothoe aspera*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Mya spp.*	POLYCHAETA	ANNELIDA	*Harmothoe clavigera*
MOLLUSCA-BIVALVIA	MOLLUSCA	Mytilidae	POLYCHAETA	ANNELIDA	*Harmothoe extenuata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Mytilus spp.*	POLYCHAETA	ANNELIDA	*Harmothoe spp.*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Nucula nitidosa*	POLYCHAETA	ANNELIDA	*Hesionura elongata*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Nucula sulcata*	POLYCHAETA	ANNELIDA	*Heteromastus filiformis*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Spisula elliptica*	POLYCHAETA	ANNELIDA	*Lagis koreni*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tapes spp.*	POLYCHAETA	ANNELIDA	*Lanice conchilega*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellimya ferruginosa*	POLYCHAETA	ANNELIDA	*Lepidonotus squamatus*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellina fabula*	POLYCHAETA	ANNELIDA	*Lumbrineris aniara*
MOLLUSCA-BIVALVIA	MOLLUSCA	*Tellina pygmaea*	POLYCHAETA	ANNELIDA	*Lumbrineris latreilli*
MOLLUSCA-BIVALVIA	MOLLUSCA	Tellinidae	POLYCHAETA	ANNELIDA	*Macrochaeta helgolandica*
MOLLUSCA-CEPHALOPODA	MOLLUSCA	*Sepiola atlantica*	POLYCHAETA	ANNELIDA	*Magelona johnstoni*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Buccinum undatum*	POLYCHAETA	ANNELIDA	*Mediomastus fragilis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Chauvetia brunnea*	POLYCHAETA	ANNELIDA	*Mysta picta*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Crepidula fornicata*	POLYCHAETA	ANNELIDA	*Neoamphitrite spp.*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Cryptonatica affinis*	POLYCHAETA	ANNELIDA	*Nephtys assimilis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Euspira montagui*	POLYCHAETA	ANNELIDA	*Nephtys cirrosa*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Euspira pulchella*	POLYCHAETA	ANNELIDA	*Nephtys hombergii*
MOLLUSCA-GASTROPODA	MOLLUSCA	Gastropoda	POLYCHAETA	ANNELIDA	*Nephtys kersivalensis*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Gibbula spp.*	POLYCHAETA	ANNELIDA	*Nephtys longosetosa*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Nassarius nitidus*	POLYCHAETA	ANNELIDA	*Nephtys spp.*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Nassarius reticulatus*	POLYCHAETA	ANNELIDA	*Notomastus latericeus*
MOLLUSCA-GASTROPODA	MOLLUSCA	*Odostomia unidentata*	POLYCHAETA	ANNELIDA	*Ophelia borealis*
MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	*Adalaria proxima*	POLYCHAETA	ANNELIDA	*Owenia fusiformis*
MOLLUSCA-NUDIBRANCHIA	MOLLUSCA	*Aeolidiella spp.*	POLYCHAETA	ANNELIDA	*Pherusa plumosa*

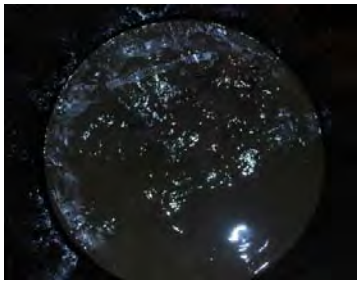
Group	Phylum	Species	Group	Phylum	Species
POLYCHAETA	ANNELIDA	*Pholoe baltica*	VARIA	BRYOZOA	Calloporidae
POLYCHAETA	ANNELIDA	*Pholoe inornata*	VARIA	BRYOZOA	*Electra pilosa*
POLYCHAETA	ANNELIDA	*Pholoe spp.*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce citrina*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce groenlandica*	VARIA	BRYOZOA	*Flustra foliacea*
POLYCHAETA	ANNELIDA	*Phyllodoce mucosa*	VARIA	BRYOZOA	*Vesicularia spinosa*
POLYCHAETA	ANNELIDA	*Phyllodoce spp.*	VARIA	CEPHALORYNCHA	Priapulida
POLYCHAETA	ANNELIDA	*Pisione remota*	VARIA	CHORDATA	Actinopterygii
POLYCHAETA	ANNELIDA	*Polycirrus medusa*	VARIA	CHORDATA	*Ammodytes tobianus*
POLYCHAETA	ANNELIDA	*Polycirrus spp.*	VARIA	CHORDATA	*Arnoglossus laterna*
POLYCHAETA	ANNELIDA	*Polydora cornuta*	VARIA	CHORDATA	Ascidiacea
POLYCHAETA	ANNELIDA	*Polygordius appendiculatus*	VARIA	CHORDATA	*Branchiostoma lanceolatum*
POLYCHAETA	ANNELIDA	*Pseudopolydora pulchra*	VARIA	CHORDATA	*Callionymus lyra*
POLYCHAETA	ANNELIDA	*Pygospio elegans*	VARIA	CHORDATA	*Echiichthys vipera*
POLYCHAETA	ANNELIDA	*Sabellaria spinulosa*	VARIA	CHORDATA	*Gaidropsarus spp.*
POLYCHAETA	ANNELIDA	*Saccocirrus papillocercus*	VARIA	CHORDATA	Gobiidae
POLYCHAETA	ANNELIDA	*Scalibregma inflatum*	VARIA	CHORDATA	*Hyperoplus lanceolatus*
POLYCHAETA	ANNELIDA	*Scolelepis bonnieri*	VARIA	CHORDATA	*Pleuronectes platessa*
POLYCHAETA	ANNELIDA	*Scoloplos armiger*	VARIA	CHORDATA	*Pomatoschistus minutus*
POLYCHAETA	ANNELIDA	*Sphaerosyllis bulbosa*	VARIA	CHORDATA	*Pomatoschistus spp.*
POLYCHAETA	ANNELIDA	*Spio armata*	VARIA	CHORDATA	*Solea solea*
POLYCHAETA	ANNELIDA	*Spio decoratus*	VARIA	CHORDATA	*Trachinus draco*
POLYCHAETA	ANNELIDA	*Spio filicornis*	VARIA	CHORDATA	*Trachurus trachurus*
POLYCHAETA	ANNELIDA	*Spiophanes bombyx*	VARIA	CHORDATA	*Trisopterus minutus*
POLYCHAETA	ANNELIDA	*Spiophanes kroyeri*	VARIA	CTENOPHORA	Ctenophora spp.
POLYCHAETA	ANNELIDA	*Sthenelais boa*	VARIA	ECHIURA	Echiura spp.
POLYCHAETA	ANNELIDA	Terebellidae	VARIA	NEMATODA	Nematoda
POLYCHAETA	ANNELIDA	*Travisia forbesii*	VARIA	NEMERTEA	Nemertea
VARIA	ARTHROPODA	*Achelia echinata*	VARIA	PORIFERA	Porifera
VARIA	ARTHROPODA	*Ammothella longipes*	VARIA	SIPUNCULA	Sipuncula
VARIA	ARTHROPODA	Pycnogonida	VARIA	SIPUNCULA	Sipunculidea
VARIA	BRYOZOA	*Alcyonidium diaphanum*			

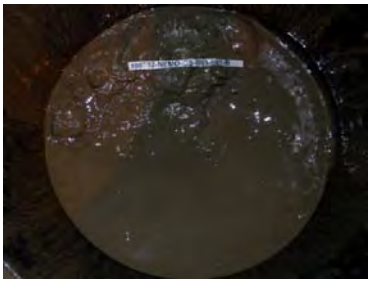
100702-NEMO-GS-B01-001

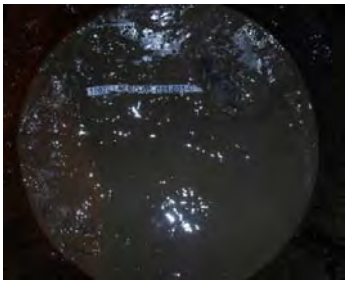


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 12m

Sampled by: [redacted]







Grab id. B01-001A	**Grab id.** B01-001B	**Grab id.** B01-001C
Easting 497417	**Easting** 497417	**Easting** 497417
Northing 5687890	**Northing** 5687890	**Northing** 5687890
Sample volume 6,5L	**Sample volume** 6L	**Sample volume** 7L

EUNIS Code: A5.24

Geo observation: Sand and silt dominating.

Habitat description:
Poor visibility, mostly sand and silt. Laminated composition, top layer covered with coarser silt/sand and shell fragments.

Additional note:

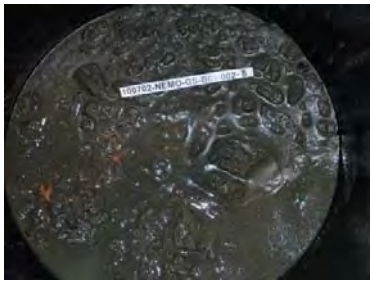
100702-NEMO-GS-B01-002

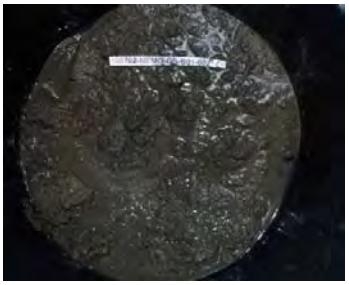


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 19m

Sampled by: [redacted]







Grab id. B01-002A	**Grab id.** B01-002B	**Grab id.** B01-002C
Easting 4955582	**Easting** 4955582	**Easting** 4955583
Northing 5688054	**Northing** 5688055	**Northing** 5688055
Sample volume 6L	**Sample volume** 6L	**Sample volume** 7L

EUNIS Code: A5.24

Geo observation: Fine sand, rather stiff and unsorted.

Habitat description:
Poor visibility, mostly fine sand and silt.

Additional note:

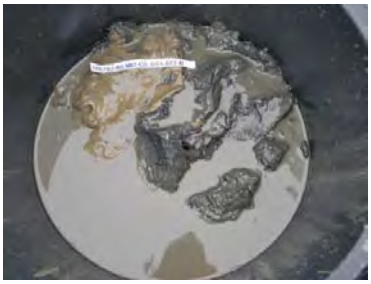
100702-NEMO-GS-B01-003

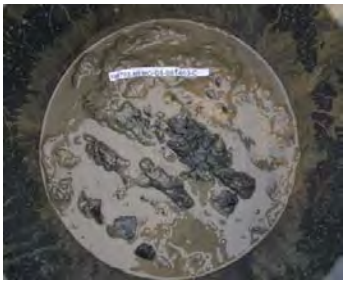


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 19m

Sampled by: [redacted]







Grab id. B01-003A	**Grab id.** B01-003B	**Grab id.** B01-003C
Easting 493466	**Easting** 493466	**Easting** 493466
Northing 5688414	**Northing** 5688413	**Northing** 5688491
Sample volume 11L	**Sample volume** 11L	**Sample volume** 11L

EUNIS Code: A5.24

Geo observation: Fine sand, rather stiff and unsorted.

Habitat description:
Poor visibility, mostly fine sand and silt.

Additional note:

100702-NEMO-GS-B01-004



Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 17m

Sampled by: [redacted]

Grab id. B01-004A	**Grab id.** B01-004B	**Grab id.** B01-004C
Easting 492662	**Easting** 492662	**Easting** 492662
Northing 5688496	**Northing** 5688495	**Northing** 5688495
Sample volume 5L	**Sample volume** 6L	**Sample volume** 9L

EUNIS Code: A5.24

Geo observation: Very soft silt and fine sand. Presence of hydrosulphide.

Habitat description:
Poor visibility, probably fine sand and silt. Samples quite anoxic.

Additional note: Five attempts were necessary to acquire sufficient samples. Attempt 2 and 3 were insufficient in sample size and were therefore discarded.

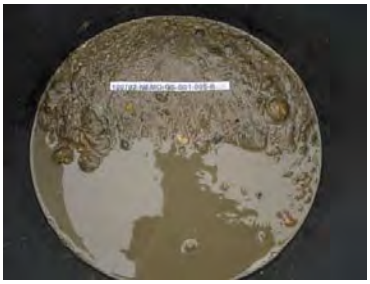
100702-NEMO-GS-B01-005



Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 18m

Sampled by: [redacted]







Grab id. B01-005A	**Grab id.** B01-005B	**Grab id.** B01-005C
Easting 490393	**Easting** 490391	**Easting** 490391
Northing 5689065	**Northing** 5689065	**Northing** 5689065
Sample volume 5L	**Sample volume** 5L	**Sample volume** 4,5L

EUNIS Code: A5.23

Geo observation: Fine sand and silt, medium sorted.

Habitat description:
Poor visibility, probably fine sand and silt. Currents at 1,7 kn.

Additional note: Five attempts were necessary to acquire sufficient samples, these due to strong currents.

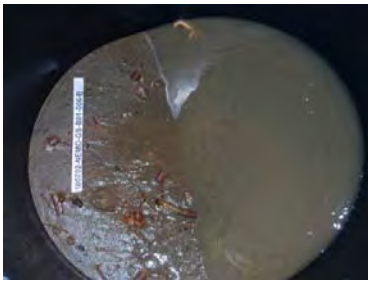
100702-NEMO-GS-B01-006

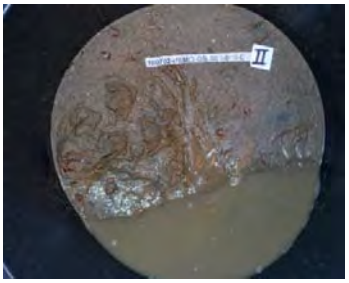


Date: 2010 - 09 - 23 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 21m

Sampled by: [redacted]







Grab id. B01-006A	**Grab id.** B01-006B	**Grab id.** B01-006C
Easting 487525	**Easting** 487526	**Easting** 487526
Northing 5689606	**Northing** 5689607	**Northing** 5689606
Sample volume 8,5L	**Sample volume** 8L	**Sample volume** 8L

EUNIS Code: A5.25

Geo observation: Fine sand appears to be well sorted.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish.

Additional note: For grab C the first sample was not sufficient and was discarded.
A second sample was of sufficient volume.

100702-NEMO-GS-B01-007



Date: 2010 - 09 - 24 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 26m

Sampled by: [redacted]







Grab id. B01-007A
Easting 483541
Northing 5688555
Sample volume 10L

Grab id. B01-007B
Easting 483539
Northing 5688555
Sample volume 12L

Grab id. B01-007C
Easting 483541
Northing 5688554
Sample volume 11L

EUNIS Code: A5.25

Geo observation: Well sorted, coarser sand.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish. Strong currents.

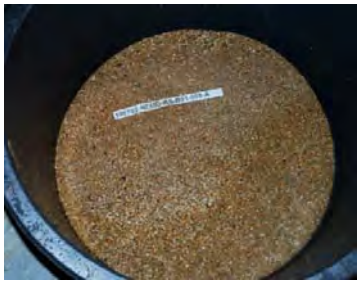
Additional note:

100702-NEMO-GS-B01-008



Date: 2010 - 09 - 24 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 17m

Sampled by: [redacted]







Grab id. B01-008A
Easting 479217
Northing 5688335
Sample volume 12,5L

Grab id. B01-008B
Easting 479218
Northing 5688335
Sample volume 12,5L

Grab id. B01-008C
Easting 479217
Northing 5688334
Sample volume 11L

EUNIS Code: A5.23

Geo observation: Sand, silt. Sediment stirs up when DC is moved.

Habitat description:
Visibility sufficient, fine sand and larger shell fragments from *Ensis* sp and some starfish. Strong currents.

Additional note:

100702-NEMO-GS-B01-009



Date: 2010 - 09 - 24 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 29m

Sampled by: [redacted]







Grab id. B01-009A	**Grab id.** B01-009B	**Grab id.** B01-009C
Easting 468906	**Easting** 468906	**Easting** 468906
Northing 5689329	**Northing** 5689329	**Northing** 5689330
Sample volume 5L	**Sample volume** 5L	**Sample volume** 6L

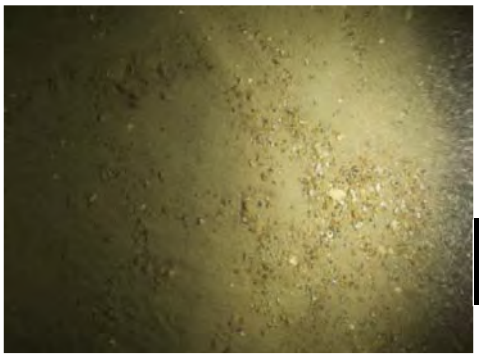
EUNIS Code: A5.25

Geo observation: Sand and silt.

Habitat description:
Visibility sufficient, fine sand and silt, medium sorted with occasional pebbles.
Strong currents.

Additional note:

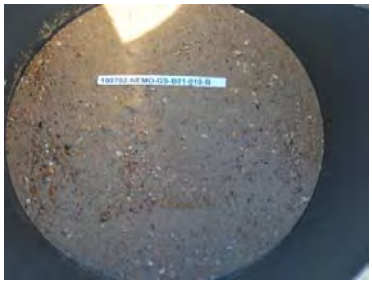
100702-NEMO-GS-B01-010



Date: 2010 - 09 - 24 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 29m

Sampled by: [redacted]







Grab id. B01-010A
Easting 467065
Northing 5690950
Sample volume 7L

Grab id. B01-010B
Easting 467067
Northing 5690951
Sample volume 6L

Grab id. B01-010C
Easting 467065
Northing 5690949
Sample volume 6L

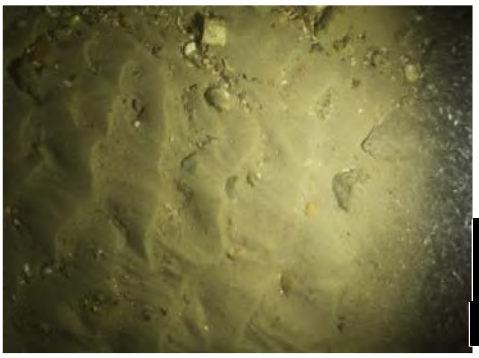
EUNIS Code: A5.25

Geo observation: Fine sand and some gravel.

Habitat description:
Visibility sufficient, fine sand and not much visible epifauna, well sorted.
Strong currents.

Additional note:

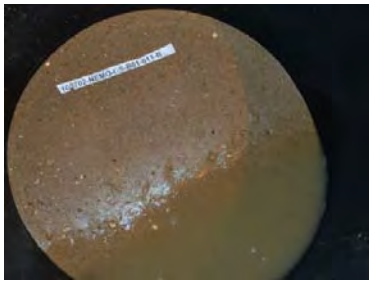
100702-NEMO-GS-B01-011



Date: 2010 - 09 - 24 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 29m

Sampled by: [redacted]







Grab id. B01-011A	**Grab id.** B01-011B	**Grab id.** B01-011C
Easting 464767	**Easting** 464765	**Easting** 464765
Northing 5690839	**Northing** 5690840	**Northing** 5690839
Sample volume 10L	**Sample volume** 10L	**Sample volume** 9L

EUNIS Code: A5.25

Geo observation: Fine sand and some gravel.

Habitat description:
First attempt of sampling was aborted due to poor weather conditions. Second sampling had sufficient visibility, moderate currents. Some pebbles, fine sand and soft composition.

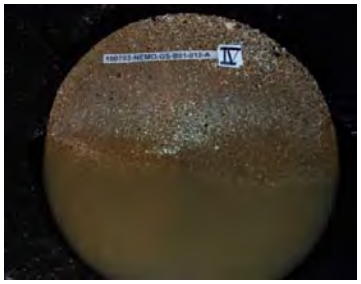
Additional note:

100702-NEMO-GS-B01-012



Date: 2010 - 09 - 26 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 38m

Sampled by: [redacted]





No sample photo was possible

Grab id. B01-012A	**Grab id.** B01-012B	**Grab id.** B01-012C
Easting 461178	**Easting** 461177	**Easting**
Northing 5689687	**Northing** 5689687	**Northing**
Sample volume 8L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Sand with ripples, shell fragments with a couple of stones

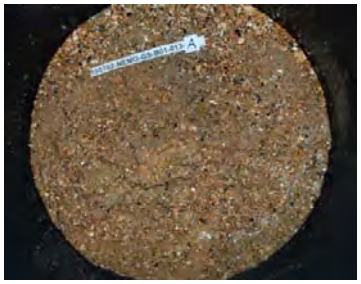
Additional note:
Sampling was difficult and five attempts were made. Only one sufficient sample was retrieved. 012B contained a stone, one attempt contained only water due to top lock being open. The other two attempts recovered insufficient sample volume due to stones being trapped in the opening when the Day grabber shut closed.

100702-NEMO-GS-B01-013

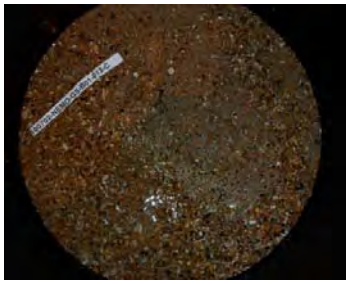


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 28m

Sampled by: [redacted]







Grab id. B01-013A	**Grab id.** B01-013B	**Grab id.** B01-013C
Easting 457427	**Easting** 457427	**Easting** 457426
Northing 5688051	**Northing** 5688051	**Northing** 5688051
Sample volume 12L	**Sample volume** 11L	**Sample volume** 11L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Sand with few shell fragments with a couple of stones, slight ripples.

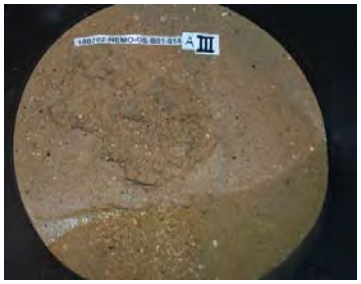
Additional note:

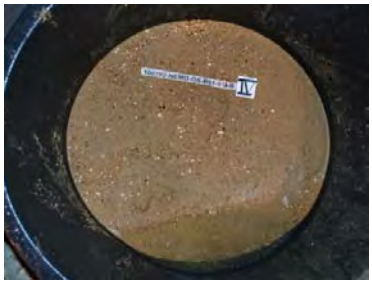
100702-NEMO-GS-B01-014

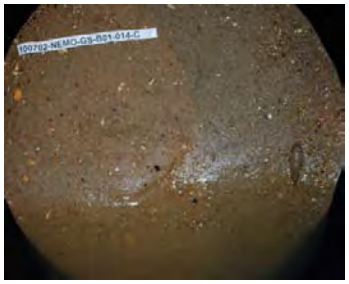


Date: 2010 - 09 - 26 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 33m

Sampled by: [redacted]







Grab id. B01-014A	**Grab id.** B01-014B	**Grab id.** B01-014C
Easting 457608	**Easting** 457609	**Easting** 457609
Northing 5688048	**Northing** 5688047	**Northing** 5688047
Sample volume 9L	**Sample volume** 12L	**Sample volume** 9L

EUNIS Code: A5.24

Geo observation: Fine sand and soft.

Habitat description:
Sand with ripples, shell fragments with a couple of stones.

Additional note: Sampling was difficult and five attempts were made to attain three samples.

100702-NEMO-GS-B01-015



Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 40m

Sampled by: [redacted]







Grab id. B01-015A
Easting 454992
Northing 5687268
Sample volume 9L

Grab id. B01-015B
Easting 454991
Northing 5687268
Sample volume 9,5L

Grab id. B01-015C
Easting 454992
Northing 5687268
Sample volume 10L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Fine sand with occasional stones, very strong currents.

Additional note:

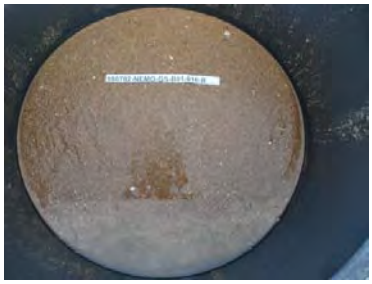
100702-NEMO-GS-B01-016

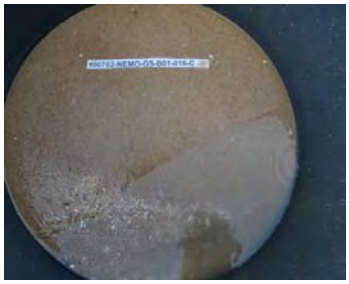


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 22m

Sampled by: [redacted]







Grab id. B01-016A	**Grab id.** B01-016B	**Grab id.** B01-016C
Easting 473336	**Easting** 473336	**Easting** 473337
Northing 5688993	**Northing** 5688993	**Northing** 5688993
Sample volume 5L	**Sample volume** 7L	**Sample volume** 6L

EUNIS Code: A5.25

Geo observation: Fine sand and soft.

Habitat description:
Very fine sand but low visibility appears to be well sorted.

Additional note: Sampling was difficult, success after four trials.

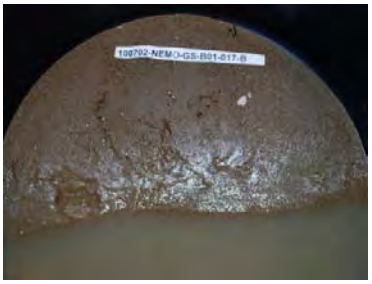
100702-NEMO-GS-B01-017



Date: 2010 - 09 - 23 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 24m

Sampled by: [redacted]







Grab id. B01-017A
Easting 485842
Northing 5689248
Sample volume 8L

Grab id. B01-017B
Easting 485843
Northing 5689248
Sample volume 5L

Grab id. B01-017C
Easting 485842
Northing 5689248
Sample volume 9L

EUNIS Code: A5.25

Geo observation: Fine sand and well sorted.

Habitat description:
Sand with irregular ripples, brittle stars. No sign of shell fragments.
Low visibility due to high particular content in the water column.

Additional note:

100702-NEMO-GS-B01-018

No photo was possible

Date: 2010 - 10 - 14 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 10m

Sampled by: [redacted]





Grab id. B01-018A
Easting 501049
Northing 5687734
Sample volume 10L

Grab id. B01-018B
Easting 501049
Northing 5687734
Sample volume 9L

Grab id. B01-018C
Easting 501049
Northing 5687734
Sample volume 11L

EUNIS Code: A5.34

Geo observation: Fine sand and clay, very soft.

Habitat description:
No ability to describe site from sea floor photos due to murky water.

Additional note: No photo identification was possible.

100702-NEMO-GS-B01-019

No photo was possible

Date: 2010 - 10 - 14 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 8.6m

Sampled by: [redacted]





Grab id. B01-019A	**Grab id.** B01-019B	**Grab id.** B01-019C
Easting 503201	**Easting** 503201	**Easting** 503201
Northing 5687622	**Northing** 5687622	**Northing** 5687622
Sample volume 14L	**Sample volume** 7L	**Sample volume** 7L

EUNIS Code: A5.33

Geo observation: Sandy clay and silt, very soft.

Habitat description:
No photos were taken due to zero visibility on the previous station B01_018.
This station is situated in the same area and the same depth.

Additional note: Several attempts were necessary to retrieve samples.
No photo identification was possible.

100702-NEMO-GS-B01-020

No photo was possible

Date: 2010 - 10 - 14 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 8m

Sampled by: [redacted]







Grab id. B01-020A	**Grab id.** B01-020B	**Grab id.** B01-020C
Easting 503201	**Easting** 503201	**Easting** 503201
Northing 5687622	**Northing** 5687622	**Northing** 5687622
Sample volume 8L	**Sample volume** 10L	**Sample volume** 11L

EUNIS Code: A5.33

Geo observation: Sandy clay and silt, very soft.

Habitat description:
No photos were taken due to zero visibility on the previous station B01-018.
This station is situated in the same area and about the same depth.

Additional note: Several attempts were necessary to retrieve samples.
No photo identification was possible.

100702-NEMO-GS-B02-021



Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 42m

Sampled by: [redacted]



No sample for photo identification

Grab id. B02-021A	**Grab id.** B02-021B	**Grab id.** B02-021C
Easting 455282	**Easting**	**Easting**
Northing 5687273	**Northing**	**Northing**
Sample volume 8L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.25

Geo observation: Medium sorted, stones and sand.

Habitat description:
Sand with high ridges and stones.

Additional note: Several attempts were necessary to retrieve samples, only one sufficient sample was retrieved.

100702-NEMO-GS-B02-022

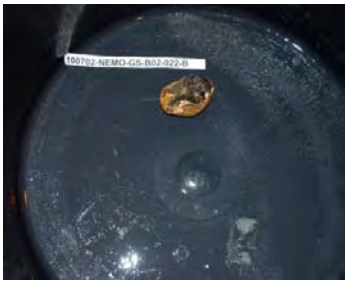


Date: 2010 - 09 - 27 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 37m

Sampled by: [redacted]







Grab id. B02-022A
Easting 454016
Northing 5686802
Sample volume 5L

Grab id. B02-022B
Easting 454016
Northing 5686804
Sample volume 6L

Grab id. B02-022C
Easting 454016
Northing 5686803
Sample volume 0L

EUNIS Code: A5.25

Geo observation: Fine sand

Habitat description:
Sand, stones and few shell fragments. Some hermit crabs.

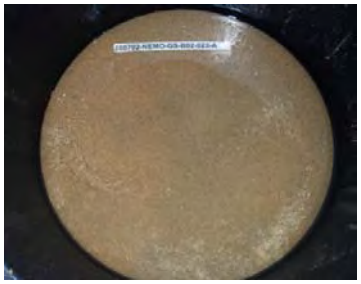
Additional note: Several attempts were necessary to retrieve samples, only two sufficient samples were retrieved.

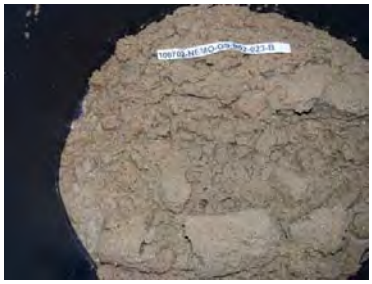
100702-NEMO-GS-B02-023

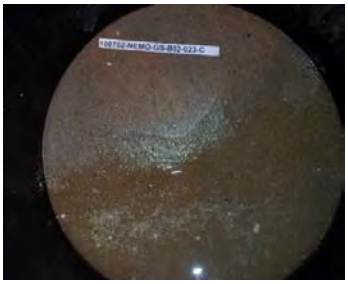


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 38m

Sampled by: [redacted]







Grab id. B02-023A	**Grab id.** B02-023B	**Grab id.** B02-023C
Easting 451605	**Easting** 451605	**Easting** 451605
Northing 5686778	**Northing** 5686777	**Northing** 5686777
Sample volume 10L	**Sample volume** 11L	**Sample volume** 9L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Soft and fine sand.

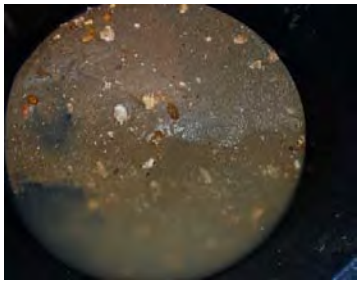
Additional note: Eunis code indicates infralittoral although its deeper then 20m this is because the fauna resembles that of code A5.233.

100702-NEMO-GS-B02-024

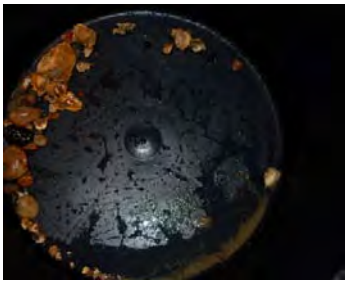


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 38m

Sampled by: [redacted]







Grab id. B02-024A	**Grab id.** B02-024B	**Grab id.** B02-024C
Easting 449052	**Easting** 449052	**Easting** 449053
Northing 5685125	**Northing** 5685125	**Northing** 5685127
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Fine sand and some cobble areas.

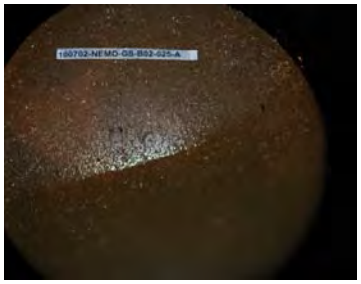
Additional note: Several attempts were necessary to retrieve samples, but no sufficient samples were possible. Eunis code indicates infralittoral although its deeper then 20m, this is because the fauna resembles that of code A5.233.

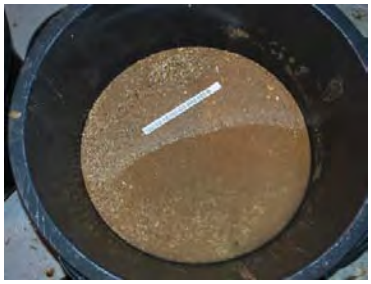
100702-NEMO-GS-B02-025



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 27m

Sampled by: [redacted]





Grab id. B02-025A	**Grab id.** B02-025B	**Grab id.** B02-025C
Easting 448045	**Easting** 448043	**Easting**
Northing 5685205	**Northing** 5685205	**Northing**
Sample volume 3L	**Sample volume** 6L	**Sample volume** 0L

EUNIS Code: A5.233

Geo observation: Fine sand

Habitat description:
Fine sand and some gravel and stones.

Additional note: Several attempts were necessary to retrieve samples, only two were possible. Eunis code indicates infralittoral although its deeper then 20m, this is because the fauna resembles that of code A5.233. Occasional stones.

100702-NEMO-GS-B02-026



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 36m

Sampled by: [redacted]



Grab id. B02-026A	**Grab id.** B02-026B	**Grab id.** B02-026C
Easting 4487096	**Easting**	**Easting**
Northing 5685290	**Northing**	**Northing**
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand and cobbles.

Habitat description:
Fine sand and some gravel with a lot of stones.

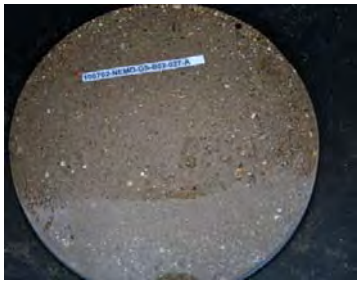
Additional note: Several attempts were necessary to retrieve samples, none were possible due to cobbles that got stuck in the grabber and prevented it from closing.

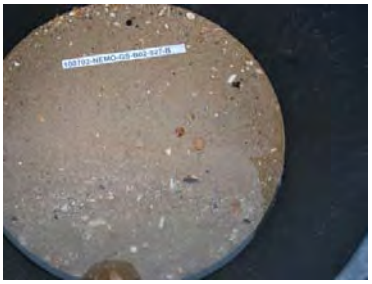
100702-NEMO-GS-B02-027



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 35m

Sampled by: [redacted]







Grab id. B02-027A
Easting 445688
Northing 5685690
Sample volume 7L

Grab id. B02-027B
Easting 445688
Northing 5685690
Sample volume 6L

Grab id. B02-027C
Easting 445687
Northing 5685690
Sample volume 9L

EUNIS Code: A5.233

Geo observation: Sand and gravel.

Habitat description:
Well sorted, soft fine sand with some gravel. Good visibility,

Additional note:

100702-NEMO-GS-B02-028



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 32m

Sampled by: [redacted]







Grab id. B02-028A
Easting 441671
Northing 5686432
Sample volume 9L

Grab id. B02-028B
Easting 441671
Northing 5686432
Sample volume 7L

Grab id. B02-028C
Easting 441671
Northing 5686432
Sample volume 7L

EUNIS Code: A5.25

Geo observation: Sand and gravel.

Habitat description:
Coarser sand, gravel and pebbles.

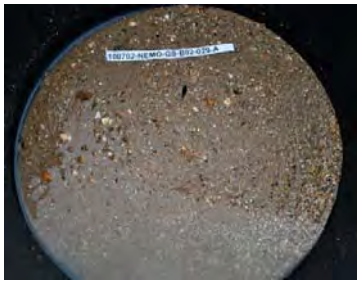
Additional note:

100702-NEMO-GS-B02-029



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 37m

Sampled by: [redacted]





Grab id. B02-029A	**Grab id.** B02-029B	**Grab id.** B02-029C
Easting 436734	**Easting** 436736	**Easting**
Northing 5686299	**Northing** 5686299	**Northing**
Sample volume 3L	**Sample volume** 2L	**Sample volume** 0L

EUNIS Code: A5.25

Geo observation: Sand and gravel.

Habitat description:
Fine sand and gravel, coarser substrate. Current at 1.7kn with good visibility.

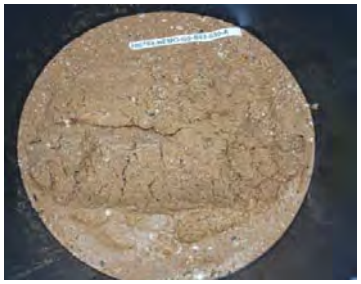
Additional note: Five attempts were performed and two sufficient samples were collected.

100702-NEMO-GS-B02-030



Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 40m

Sampled by: [redacted]







Grab id. B02-030A	**Grab id.** B02-030B	**Grab id.** B02-030C
Easting 433539	**Easting** 433538	**Easting** 433538
Northing 5686381	**Northing** 5686382	**Northing** 5686382
Sample volume 11L	**Sample volume** 9L	**Sample volume** 8L

EUNIS Code: A5.25

Geo observation: Fine sand.

Habitat description:
Fine sand and coarser sand with some shell fragments. Well sorted.

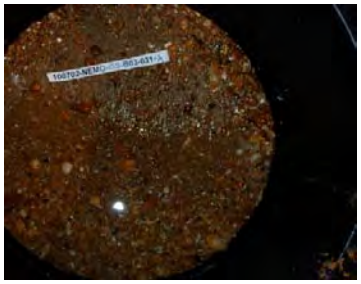
Additional note:

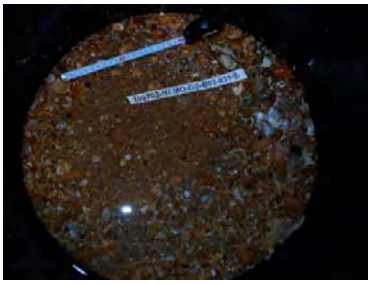
100702-NEMO-GS-B03-031

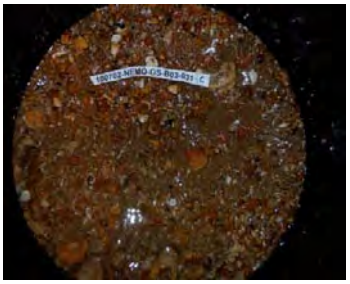


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 32m

Sampled by: [redacted]







Grab id. B03-031A
Easting 431714
Northing 5686388
Sample volume 8L

Grab id. B03-031B
Easting 431714
Northing 5686388
Sample volume 8L

Grab id. B03-031C
Easting 431714
Northing 5686387
Sample volume 8L

EUNIS Code: A5.25

Geo observation: Fine sand and gravel.

Habitat description:
Fine sand and coarser sand with some shell fragments, unsorted.

Additional note:

100702-NEMO-GS-B03-032

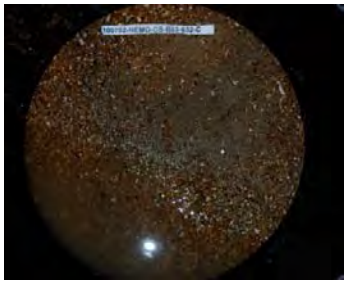


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 42m

Sampled by: [redacted]







Grab id. B03-032A	**Grab id.** B03-032B	**Grab id.** B03-032C
Easting 427106	**Easting** 427106	**Easting** 427106
Northing 5686538	**Northing** 5686538	**Northing** 5686538
Sample volume 6L	**Sample volume** 11L	**Sample volume** 6L

EUNIS Code: A5.145

Geo observation: Fine sand and coarse sand.

Habitat description:
Fine sand and coarser sand, soft.

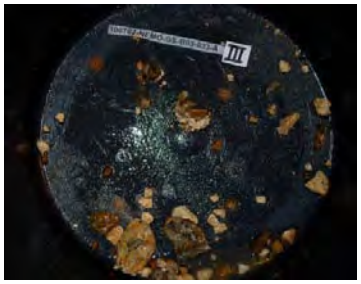
Additional note:

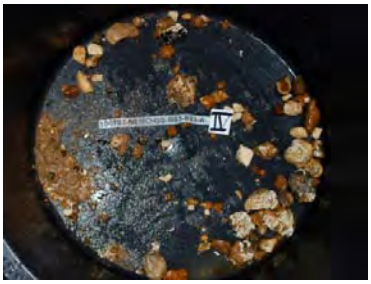
100702-NEMO-GS-B03-033

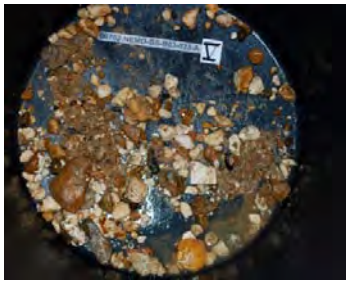


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 40m

Sampled by: [redacted]







Grab id. B03-033A	**Grab id.** B03-033B	**Grab id.** B03-033C
Easting 422672	**Easting** 422672	**Easting** 422672
Northing 5686733	**Northing** 5686733	**Northing** 5686733
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.141

Geo observation: Fine sand and silt.

Habitat description:
Fine sand, some silt and stones.

Additional note: No samples were possible due to the stones.

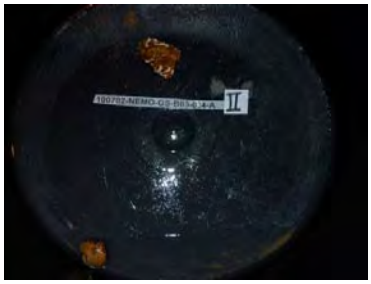
100702-NEMO-GS-B03-034

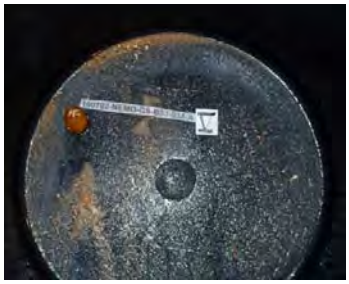


Date: 2010 - 09 - 28 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 40m

Sampled by: [redacted]







Grab id. B03-034A	**Grab id.** B03-034B	**Grab id.** B03-034C
Easting 416373	**Easting** 416374	**Easting** 416373
Northing 5686853	**Northing** 5686853	**Northing** 5686852
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.141

Geo observation: Fine sand and silt.

Habitat description:
Fine sand, some silt and stones.

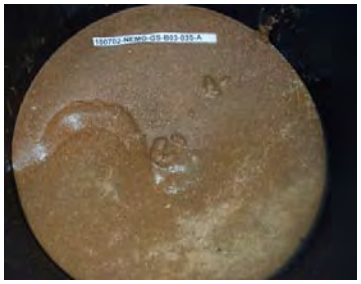
Additional note: No samples were possible due to the stones that got stuck in the grabber.

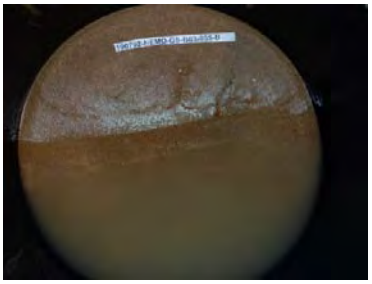
100702-NEMO-GS-B03-035



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 20m

Sampled by: [redacted]







Grab id. B03-035A	**Grab id.** B03-035B	**Grab id.** B03-035C
Easting 414266	**Easting** 414265	**Easting** 414265
Northing 5686937	**Northing** 5686937	**Northing** 5686936
Sample volume 8L	**Sample volume** 8L	**Sample volume** 8L

EUNIS Code: A5.231

Geo observation: Fine sand.

Habitat description:
Fine sand and ridges.

Additional note: No samples were possible due to the stones that got stuck in the grabber.

100702-NEMO-GS-B03-036

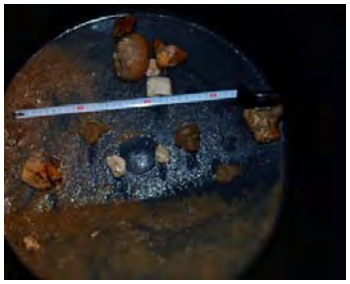


Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 48m

Sampled by: [redacted]







Grab id. B03-036A	**Grab id.** B03-036B	**Grab id.** B03-036C
Easting 412196	**Easting** 412198	**Easting** 412199
Northing 5687033	**Northing** 5687032	**Northing** 5687035
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.25

Geo observation: Fine sand.

Habitat description:
Sand bottom with stones and some silt, maybe some hydroids, poor visibility.
Currents at 2kn.

Additional note: Clumps of empty Sabellaria tubes. Difficult to retrieve any samples.

100702-NEMO-GS-B03-037



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 55m

Sampled by: [redacted]







Grab id. B03-037A
Easting 408770
Northing 5687304
Sample volume 8L

Grab id. B03-037B
Easting 408771
Northing 5687303
Sample volume 4L

Grab id. B03-037C
Easting 408770
Northing 5687304
Sample volume 7L

EUNIS Code: A5.25

Geo observation: Fine sand and silt.

Habitat description:
Poor visibility due to currents at 2kn. Sediments very soft with some stones buried under the loose upper layer.

Additional note: Clumps of empty Sabellaria tubes.

100702-NEMO-GS-B03-038



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 36m

Sampled by: [redacted]







Grab id. B03-038A
Easting 407401
Northing 5687145
Sample volume <1L

Grab id. B03-038B
Easting 407402
Northing 5687144
Sample volume <1L

Grab id. B03-038C
Easting 407405
Northing 5687141
Sample volume <1L

EUNIS Code: A5.25

Geo observation: Stones and sand.

Habitat description:
Possibly Sabellaria, currents at 0,5kn.

Additional note: Stones made it hard to retrieve a sufficient sample.

100702-NEMO-GS-B03-039_0



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 22m

Sampled by: [redacted]

Grab id. B03-039_0A	**Grab id.** B03-038_0B	**Grab id.** B03-038_0C
Easting 405998	**Easting**	**Easting**
Northing 5687204	**Northing**	**Northing**
Sample volume 0L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.611

Geo observation: Silt and fine sand.

Habitat description:
Currents at 1kn, low visibility. Possible reef structures of Sabellaria. In photos reef is dominating, appears to be 5-10 cm rise above sediment surface.

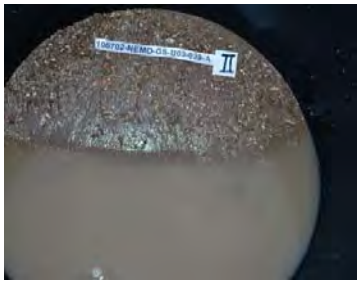
Additional note: No grab was retrieved due to Sabellaria reef but a transect was made. See transect DDV-B03-039_001, Appendix K.

100702-NEMO-GS-B03-039_2



Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 28m

Sampled by: [redacted]





Grab id. B03-039_2A	**Grab id.** B03-039_2B	**Grab id.** B03-039_2C
Easting 0405993	**Easting** 0405993	**Easting**
Northing 5687202	**Northing** 5687202	**Northing**
Sample volume 6L	**Sample volume** 9.5L	**Sample volume** <1L

EUNIS Code: A5.611

Geo observation: Fine sand, well sorted.

Habitat description:
Sabellaria reef, silt and sand. Reef structure approximately 7cm above sediment surface.

Additional note: Sabellaria reef was sampled, with only two successful samples.

100702-NEMO-GS-B03-040_0



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 28m

Sampled by: [redacted]

Grab id. B03-040-0A	**Grab id.** B03-040_0B	**Grab id.** B03-040_0C
Easting 404304	**Easting**	**Easting**
Northing 5686851	**Northing**	**Northing**
Sample volume 0L	**Sample volume** 0L	**Sample volume** 0L

EUNIS Code: A5.611

Geo observation: Fine sand and Sabellaria.

Habitat description:
Sand and silt.

Additional note: Sabellaria reef apparent, no samples were taken at this point.

100702-NEMO-GS-B03-040_2

Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 28m

Sampled by: [redacted]





Grab id. B03-040_2A	**Grab id.** B03-040_2B	**Grab id.** B03-040_2C
Easting 404309	**Easting** 404309	**Easting** 404309
Northing 5686851	**Northing** 5686851	**Northing** 5686851
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.611

Geo observation: Fine sand, well sorted.

Habitat description:
Stones, covered with Sabellaria tubes.

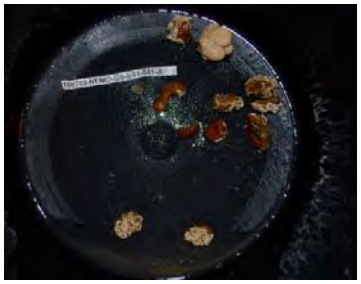
Additional note: Returned to position for B03_040 for attempted grab.

100702-NEMO-GS-B03-041



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 19m

Sampled by: [redacted]







Grab id. B03-041A	**Grab id.** B03-041B	**Grab id.** B03-041C
Easting 402231	**Easting** 402231	**Easting** 402231
Northing 5686507	**Northing** 5686507	**Northing** 5686508
Sample volume <1L	**Sample volume** <1L	**Sample volume** <1L

EUNIS Code: A5.141

Geo observation: Stones and coarse sand.

Habitat description:
Stones, covered with Serpulids. Visibility sufficient with currents at 1,3kn.

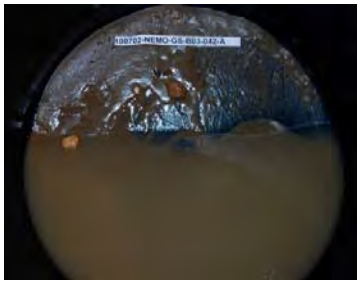
Additional note:

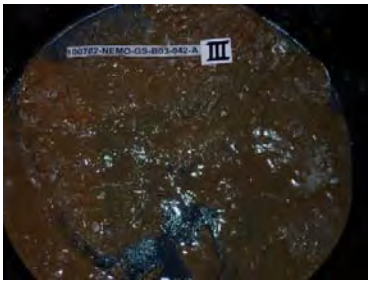
100702-NEMO-GS-B03-042



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 43m

Sampled by: [redacted]







Grab id. B03-042A	**Grab id.** B03-042B	**Grab id.** B03-042C
Easting 399159	**Easting** 399159	**Easting** 399159
Northing 5686401	**Northing** 5686401	**Northing** 5686400
Sample volume <1L	**Sample volume** <1L	**Sample volume <1**L

EUNIS Code: A5.25

Geo observation: Stones and fine sand.

Habitat description:
Poor to none visibility. Sand and stones, well sorted and soft sediment

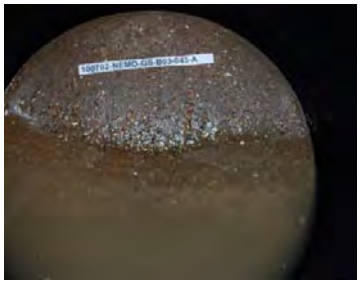
Additional note:

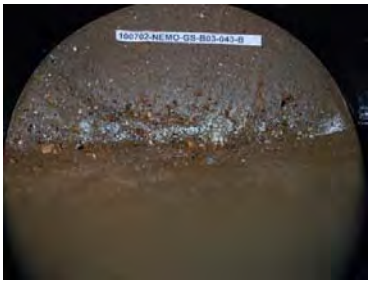
100702-NEMO-GS-B03-043



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 37m

Sampled by: [redacted]







Grab id. B03-043A
Easting 397791
Northing 5686013
Sample volume 7L

Grab id. B03-043B
Easting 397791
Northing 5686013
Sample volume 6L

Grab id. B03-043C
Easting 397791
Northing 5686013
Sample volume 8L

EUNIS Code: A5.25

Geo observation: Stones and fine sand.

Habitat description:
Sand, well sorted and soft sediment.

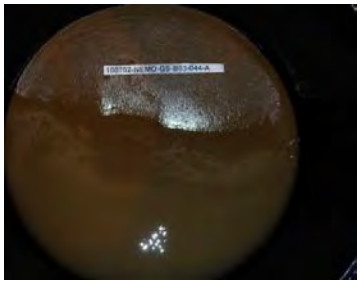
Additional note:

100702-NEMO-GS-B03-044

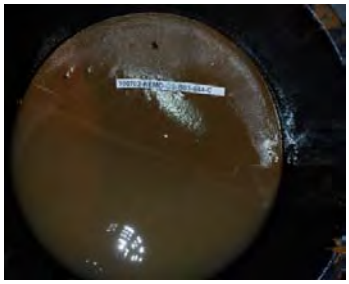


Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 16m

Sampled by: [redacted]







Grab id. B03-044A	**Grab id.** B03-044B	**Grab id.** B03-044C
Easting 397256	**Easting** 397256	**Easting** 397255
Northing 5685814	**Northing** 5685815	**Northing** 5685815
Sample volume 6,5L	**Sample volume** 6L	**Sample volume** 6,5L

EUNIS Code: A5.23

Geo observation: Fine sand and well sorted sand.

Habitat description:
No visibility at all.

Additional note:

100702-NEMO-GS-B03-045



Date: 2010 - 09 - 29 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 12m

Sampled by: [redacted]







Grab id. B03-045A
Easting 395600
Northing 5685353
Sample volume <1L

Grab id. B03-045B
Easting 395602
Northing 5685353
Sample volume <1L

Grab id. B03-045C
Easting 395602
Northing 5685356
Sample volume <1L

EUNIS Code: A5.43

Geo observation: Fine sand and stones.

Habitat description:
Currents at 1,2kn and 6,6m/s wind resulting in low visibility.

Additional note: Sampling was difficult and did not result in any samples of sufficient volume.

100702-NEMO-GS-B03-046



Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 10m

Sampled by: [redacted]







Grab id. B03-046A
Easting 391595
Northing 5685157
Sample volume 8L

Grab id. B03-046B
Easting 391595
Northing 5685159
Sample volume 11L

Grab id. B03-046C
Easting 391595
Northing 5685159
Sample volume 8L

EUNIS Code: A5.231

Geo observation: Fine sand and gravel.

Habitat description:
No visibility at all, expects soft sand and silt.

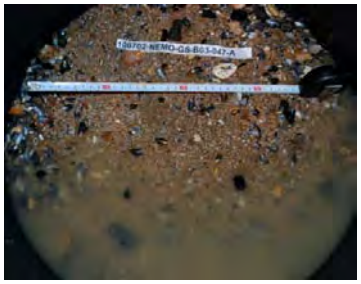
Additional note:

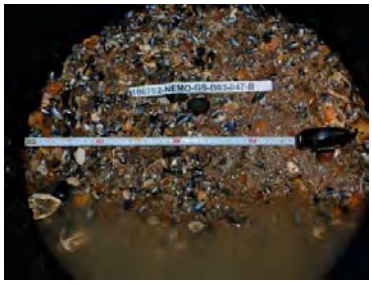
100702-NEMO-GS-B03-047



Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 12m

Sampled by: [redacted]







Grab id. B03-047A	**Grab id.** B03-047B	**Grab id.** B03-047C
Easting 392525	**Easting** 392524	**Easting** 392526
Northing 5685110	**Northing** 5685110	**Northing** 5685109
Sample volume 10L	**Sample volume** 6L	**Sample volume** 9L

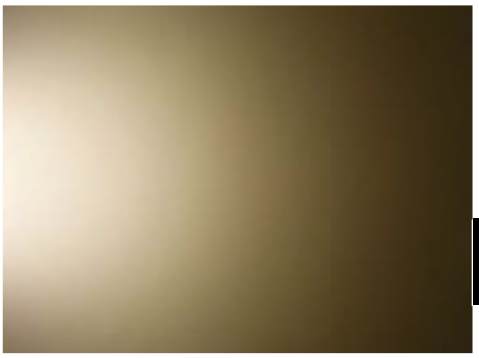
EUNIS Code: A5.43

Geo observation: Unsorted, sand and gravel.

Habitat description:
No visibility at all, expect soft sand and silt.

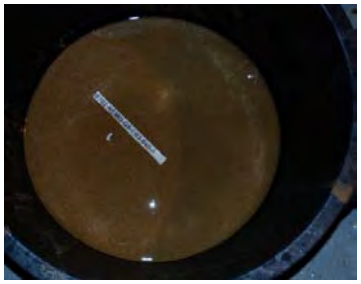
Additional note:

100702-NEMO-GS-B03-048



Date: 2010 - 09 - 30 **Vessel:** Ice Beam
Sampler: Day grab **Water depth:** 9m

Sampled by: [redacted]







Grab id. B03-048A
Easting 391993
Northing 5684854
Sample volume 5L

Grab id. B03-048B
Easting 391994
Northing 5684853
Sample volume 4L

Grab id. B03-048C
Easting 391995
Northing 5684853
Sample volume 4L

EUNIS Code: A5.23

Geo observation: Well sorted and soft fine sand.

Habitat description:
No visibility at all, expected soft sand and silt.
High currents and harsh wind.

Additional note:

100702-NEMO-GS-B03-049

No photo was possible

Date: 2010 - 10 - 18 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 2m

Sampled by: [redacted]







Grab id. B03-049A	**Grab id.** B03-049B	**Grab id.** B03-049C
Easting 389215	**Easting** 389215	**Easting** 389215
Northing 5685981	**Northing** 5685981	**Northing** 5685981
Sample volume 7L	**Sample volume** 8L	**Sample volume** 9L

EUNIS Code: A5.23

Geo observation: Mixed sediment.

Habitat description:

Not able to describe site from sea floor photos,
due to only 2m depth, which was to shallows for the camera.

Additional note:

100702-NEMO-GS-B03-050

Date: 2010 - 10 - 18 **Vessel:** MPR1
Sampler: Day grab **Water depth:** 3m

No photo was possible

Sampled by: [redacted]





Grab id. B03-050 A	**Grab id.** B03-050 B	**Grab id.** B03-050 C
Easting 388933	**Easting** 388933	**Easting** 388933
Northing 5686257	**Northing** 5686257	**Northing** 5686257
Sample volume 7L	**Sample volume** 6.5L	**Sample volume** 7L

EUNIS Code: A5.24

Geo observation: Mixed sediment.

Habitat description:
Not able to describe site from sea floor photos due to murky water.
Old Sabellaria reef fragments, no sign of living Sabellaria.

Additional note:

	Raw data Abundance Block 01				Comment							
	RED=Grab not approved **YELLOW=Grab low volume, but analysed** **BLUE=Grab approved** **P=Present**											
Phylum	**Species**	**B01-001-A**	**B01-001-B**	**B01-001-C**		**B01-002-A**	**B01-002-B**	**B01-002-C**		**B01-003-A**	**B01-003-B**	**B01-003-C**
Cnidaria	Actinaria spp.					1					16	
Cnidaria	Anthozoa spp.											
Cnidaria	Campanulinidae spp.											
Cnidaria	Diphasia spp.											
Cnidaria	Hydrallmania falcata											
Cnidaria	Hydrozoa spp.											
Cnidaria	Nemertesia sp.											
Cnidaria	Obelia spp.											
Cnidaria	Rhizorhagium roseum											
Cnidaria	Sertulariidae											
Cnidaria	Tubularia indivisa											
Cnidaria	Tubularia spp.											
	Individuals	0	0	0		1	0	0		0	16	0
	Taxa	**0**	**0**	**0**		**1**	**0**	**0**		**0**	**1**	**0**
Arthropoda	Abludomelita obtusata											
Arthropoda	Ampelisca brevicornis											
Arthropoda	Ampelisca spinipes											
Arthropoda	Ampelisca spp.											
Arthropoda	Aora gracilis											
Arthropoda	Aoridae spp.											
Arthropoda	Autonoe longipes											
Arthropoda	Balanus balanus											
Arthropoda	Balanus spp.											
Arthropoda	Bathyporeia elegans											
Arthropoda	Bathyporeia guilliamsoniana											
Arthropoda	Bathyporeia nana											
Arthropoda	Bathyporeia sarsi											
Arthropoda	Bathyporeia spp.											
Arthropoda	Bathyporeia tenuipes											
Arthropoda	Bodotria scorpioides											
Arthropoda	Brachyura spp.											
Arthropoda	Campylaspis spp.											
Arthropoda	Carcinus maenas											
Arthropoda	Copepoda spp.											

Phylum	Species	B01-001-A	B01-001-B	B01-001-C	B01-002-A	B01-002-B	B01-002-C	B01-003-A	B01-003-B	B01-003-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon		3				1			
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa		1	1						
Arthropoda	Diastylis spp.							2	1	
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus	2			1					
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	2	4	1		1	0	1		2	1	0	
	Taxa	**1**	**2**	**1**		**1**	**0**	**1**		**1**	**1**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens	1				3							
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura		1			1	6	2		2	2		
Echinodermata	Ophiura sarsii					1						2	
Echinodermata	Ophiura spp.					5		1					
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	1	1	0		10	6	3		2	2	2	
	Taxa	**1**	**1**	**0**		**4**	**1**	**2**		**1**	**1**	**1**	
Mollusca	Abra alba			1		8						1	
Mollusca	Abra nitida										2		
Mollusca	Abra prismatica												
Mollusca	Abra spp.					1		1					
Mollusca	Abra tenuis												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus	71		119		16	3			16	28	21	
Mollusca	Ensis spp.		70			11		19			1		
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata										1		
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa											1	
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.						2						
	Individuals	71	70	120		36	5	20		16	32	23	
	Taxa	**1**	**1**	**2**		**4**	**2**	**2**		**1**	**4**	**3**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.							1					
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis	8	1	20				2					
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima					2							
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis	1	1				1	3		14			
Annelida	Lagis koreni												
Annelida	Lanice conchilega					5							
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii	3	2	1		1				2	5	1	
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus									1			
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	107	24	40		2785	75	72		256	1520	1012	
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx	1	1	1				1					
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	120	29	62		2793	76	79		273	1525	1013	
	Taxa	**5**	**5**	**4**		**4**	**2**	**5**		**4**	**2**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B01-001-A	B01-001-B	B01-001-C		B01-002-A	B01-002-B	B01-002-C		B01-003-A	B01-003-B	B01-003-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.											P	
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea					1							
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		1	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**1**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Cnidaria	Actinaria spp.	1								
Cnidaria	Anthozoa spp.		23	94						
Cnidaria	Campanulinidae spp.					P				
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.					P		P		
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	1	23	94	0	0	0	0	0	0
	Taxa	**1**	**1**	**1**	**0**	**2**	**0**	**1**	**0**	**0**
Arthropoda	Abludomelita obtusata								1	
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis							1		
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.							1		
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon				1		1			
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.							4	4	
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									1
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus			1						
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus							1		
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus					1			2	
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.									
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis									
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.									
	Individuals	0	0	1	1	1	1	7	7	1
	Taxa	**0**	**0**	**1**	**1**	**1**	**1**	**4**	**3**	**1**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens							1	2	
Echinodermata	Echinocardium cordatum					2	5	1		
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus									
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis							1		
Echinodermata	Ophiura albida				18	3	1	2	4	
Echinodermata	Ophiura ophiura	2	2		1		1	1	2	2
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.				1	1				
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.							1		
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	2	2	0	20	6	7	7	8	2
	Taxa	**1**	**1**	**0**	**3**	**3**	**3**	**6**	**3**	**1**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.					3				
Mollusca	Abra tenuis									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C		B01-005-A	B01-005-B	B01-005-C		B01-006-A	B01-006-B	B01-006-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.	1				2	1			1	1		
Mollusca	Corbula gibba												
Mollusca	Ensis magnus									38		1	
Mollusca	Ensis spp.					1					68	55	
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata		4				2	1					
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.		6										
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica											1	
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa	1	93										
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	2	103	0		3	6	1		39	69	57	
	Taxa	**2**	**3**	**0**		**2**	**3**	**1**		**2**	**2**	**3**	
Mollusca	Buccinum undatum							1					
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella									1			
Mollusca	Gastropoda spp.						2				1		
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	2	1		1	1	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**1**		**1**	**1**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea			1									
Annelida	Ampharete												

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex	8	2			1		1	5	4
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata				5					
Annelida	Caulleriella killariensis		2				1			
Annelida	Chaetozone setosa				1	1	1	1		
Annelida	Cirratulidae spp.				3	4	3			
Annelida	Dipolydora flava									
Annelida	Eteone spp.								1	1
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis				2			1	4	
Annelida	Eumida sanguinea								2	
Annelida	Eumida spp.							1		
Annelida	Eunereis longissima			6	4	2	2		2	
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta		1	1		1				
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis	2			4	2	5			1
Annelida	Lagis koreni		1	1	2	4	1			3
Annelida	Lanice conchilega				21	15	4	106	92	90
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis				1	1	1			
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-004-A	B01-004-B	B01-004-C	B01-005-A	B01-005-B	B01-005-C	B01-006-A	B01-006-B	B01-006-C
Annelida	Nephtys cirrosa								1	
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									
Annelida	Notomastus latericeus			5	1	6	3	1	1	
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis	61	120	3185	213	320	94	17	25	13
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica					1	1			
Annelida	Pholoe inornata									
Annelida	Pholoe spp.			2						
Annelida	Phyllodoce citrina					1				
Annelida	Phyllodoce groenlandica								1	
Annelida	Phyllodoce mucosa				6	2	2	7		4
Annelida	Phyllodoce spp.							2	1	
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra							3	3	2
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger				2	1	2			2
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis					1	1		2	1
Annelida	Spiophanes bombyx				11	17	2	41	62	63
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa			1	2					
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	71	126	3202	278	385	126	184	205	184
	Taxa	**3**	**5**	**8**	**15**	**16**	**15**	**11**	**14**	**11**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum							P		

Phylum	Species	B01-004-A	B01-004-B	B01-004-C		B01-005-A	B01-005-B	B01-005-C		B01-006-A	B01-006-B	B01-006-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.					2	2	1			1	6	
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.			6									
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.										1		
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	6		2	2	1		0	2	6	
	Taxa	**0**	**0**	**1**		**1**	**1**	**1**		**1**	**2**	**1**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-007-A	B01-007-B	B01-007-C	B01-008-A	B01-008-B	B01-008-C	B01-009-A	B01-009-B	B01-009-C
Cnidaria	Actinaria spp.	18								
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.								P	P
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	18	0	0	0	0	0	0	0	0
	Taxa	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans							1		
Arthropoda	Bathyporeia guilliamsoniana								1	
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.					3				

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.					1	2						
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa									1			
Arthropoda	Diastylis spp.											1	
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus		1										
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.											1	
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus		1	1									
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis		2										
Arthropoda	Podoceridae spp.												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.			1									
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata		1	1						1		2	
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.						4						
	Individuals	0	5	3		1	9	0		3	1	4	
	Taxa	**0**	**4**	**3**		**1**	**3**	**0**		**3**	**1**	**3**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum	4	3	1							1	1	
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus		1				1	2					
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis	1											
Echinodermata	Ophiura albida	4											
Echinodermata	Ophiura ophiura	3											
Echinodermata	Ophiura sarsii	1											
Echinodermata	Ophiura spp.									1			
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	13	4	1		0	1	2		1	1	1	
	Taxa	**5**	**2**	**1**		**0**	**1**	**1**		**1**	**1**	**1**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica	3											
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.		1										
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris							2					
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.		1										
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.							3					
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea							2					
Mollusca	Tellinidae spp.					3							
	Individuals	3	2	0		3	0	7		0	0	0	
	Taxa	**1**	**2**	**0**		**1**	**0**	**3**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea		1										
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus	3											
Mollusca	Odostomia unidentata												
	Individuals	3	1	0		0	0	0		0	0	0	
	Taxa	**1**	**1**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata			1									
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex		1										
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata	1											
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis	8				1							
Annelida	Eumida sanguinea												
Annelida	Eumida spp.	1											
Annelida	Eunereis longissima	1											
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum					2	1						
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata					1	18	4					
Annelida	Heteromastus filiformis		1										
Annelida	Lagis koreni	8	1										
Annelida	Lanice conchilega	116											
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Annelida	Nephtys cirrosa		2	2						2	2	4	
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.						1			1	1		
Annelida	Notomastus latericeus		3										
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	76	2										
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota					1	1						
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus					1	2	1					
Annelida	Pseudopolydora pulchra	1											
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus						2						
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger	1		1									
Annelida	Sphaerosyllis bulbosa						11	2					
Annelida	Spio armata												
Annelida	Spio decoratus		1										
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx	10		1						2	1	4	
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	230	14	5		6	36	7		5	4	8	
	Taxa	**10**	**7**	**4**		**5**	**7**	**3**		**3**	**3**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B01-007-A	B01-007-B	B01-007-C		B01-008-A	B01-008-B	B01-008-C		B01-009-A	B01-009-B	B01-009-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.	P		1									
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.											1	
Bryozoa	Electra pilosa		P										
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.		2			15	36						
Nemertea	Nemertea spp.					1						2	
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.		1										
Sipuncula	Sipunculidea spp.	26											
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	26	3	1		16	36	0		0	0	3	
	Taxa	**2**	**3**	**1**		**2**	**1**	**0**		**0**	**0**	**2**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

B01-012 resulted in two approved grabs.

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.	P								
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana						1			
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.	1		1	2					
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.			1						
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.						1			
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.		1							
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.		1							
Arthropoda	Oedicerotidae spp.	1	1	1						
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.	2					1			
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis						5			
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.				19	21				
	Individuals	4	3	3	21	21	8	0	0	0
	Taxa	**3**	**3**	**3**	**2**	**1**	**4**	**0**	**0**	**0**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens									
Echinodermata	Echinocardium cordatum				5	7				
Echinodermata	Echinocardium flavescens						6			
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus							78		
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis				6					
Echinodermata	Ophiura albida					3				
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.						1			
Echinodermata	Ophiurae spp.			1						
Echinodermata	Ophiuroidea spp.							3		
Echinodermata	Psammechinus miliaris							1		
Echinodermata	Spatangoida spp.			1						
	Individuals	0	0	2	11	10	7	82	0	0
	Taxa	**0**	**0**	**2**	**2**	**2**	**2**	**3**	**0**	**0**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Mollusca	Arca tetragona							2		
Mollusca	Bivalvia spp.									
Mollusca	Corbula gibba									
Mollusca	Ensis magnus									
Mollusca	Ensis spp.									
Mollusca	Glycymeris glycymeris									
Mollusca	Glycymeris spp.									
Mollusca	Goodallia triangularis									
Mollusca	Kurtiella bidentata									
Mollusca	Macoma balthica									
Mollusca	Mactridae spp.									
Mollusca	Mya spp.									
Mollusca	Mytilus spp.									
Mollusca	Mytilidae spp.									
Mollusca	Nucula nitidosa									
Mollusca	Nucula sulcata									
Mollusca	Spisula elliptica									
Mollusca	Tapes spp.									
Mollusca	Tellimya ferruginosa									
Mollusca	Tellina fabula									
Mollusca	Tellina pygmaea									
Mollusca	Tellinidae spp.									
	Individuals	0	0	0	0	0	0	2	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
Mollusca	Buccinum undatum									
Mollusca	Chauvetia brunnea									
Mollusca	Euspira montagui									
Mollusca	Euspira pulchella									
Mollusca	Gastropoda spp.									
Mollusca	Gibbula spp.									
Mollusca	Nassarius nitidus									
Mollusca	Nassarius reticulatus									
Mollusca	Odostomia unidentata									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mollusca	Nudibranchia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annelida	Alitta succinea									
Annelida	Ampharete									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata							2		
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum							1		
Annelida	Glycera oxycephala									
Annelida	Glycera spp.							2		
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni							1		
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C	B01-011-A	B01-011-B	B01-011-C	B01-012-A	B01-012-B	B01-012-C
Annelida	Nephtys cirrosa	1	3		2	7	9			
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.			1						
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis							1		
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata			1						
Annelida	Spio decoratus									
Annelida	Spio filicornis							1		
Annelida	Spiophanes bombyx					1	1			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	1	3	2	2	8	10	8	0	0
	Taxa	**1**	**1**	**2**	**1**	**2**	**2**	**6**	**0**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-010-A	B01-010-B	B01-010-C		B01-011-A	B01-011-B	B01-011-C		B01-012-A	B01-012-B	B01-012-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana					1				
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									2
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer								5	
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus					1				
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.								2	
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata			1			1			
Arthropoda	Upogebia stellata									
Arthropoda	Urothoe brevicornis					1		1		1
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.				4			1		1
	Individuals	0	0	1	4	3	1	2	7	4
	Taxa	**0**	**0**	**1**	**1**	**3**	**2**	**2**	**2**	**3**
Echinodermata	Amphipholis squamata									
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens									
Echinodermata	Echinocardium cordatum									
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.				3					
Echinodermata	Echinocyamus pusillus	1		2				2	1	6
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri									
Echinodermata	Ophiocten affinis					1				
Echinodermata	Ophiura albida									
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.				1					
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.									
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	1	0	2	4	1	0	2	1	6
	Taxa	**1**	**0**	**1**	**2**	**1**	**0**	**1**	**1**	**1**
Mollusca	Abra alba									
Mollusca	Abra nitida									
Mollusca	Abra prismatica									
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C		B01-014-A	B01-014-B	B01-014-C		B01-015-A	B01-015-B	B01-015-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.		1										
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica			1				1		1	1		
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea											1	
Mollusca	Tellinidae spp.												
	Individuals	0	1	1		0	0	1		1	1	1	
	Taxa	**0**	**1**	**1**		**0**	**0**	**1**		**1**	**1**	**1**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum		3	1						1
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata		1	1				1		
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni									
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C	B01-014-A	B01-014-B	B01-014-C	B01-015-A	B01-015-B	B01-015-C
Annelida	Nephtys cirrosa			1	7	7		1	1	3
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									1
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina			1						
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota			2						
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus		1							
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata				1	1	1			3
Annelida	Spio decoratus									
Annelida	Spio filicornis						1			
Annelida	Spiophanes bombyx						1			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	0	5	6	8	8	3	2	1	8
	Taxa	**0**	**3**	**5**	**2**	**2**	**3**	**2**	**1**	**4**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-013-A	B01-013-B	B01-013-C		B01-014-A	B01-014-B	B01-014-C		B01-015-A	B01-015-B	B01-015-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera							1					
Echiura	Echiura spp.			1									
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.							1					
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.						1						
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	1		0	1	2		0	0	0	
	Taxa	**0**	**0**	**1**		**0**	**1**	**2**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Cnidaria	Actinaria spp.					2							
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.									P			
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.									P			
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum						P						
Cnidaria	Sertulariidae											p	
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		2	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**1**	**0**		**2**	**0**	**1**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.							1					
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes							2					
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides							1					
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni								1	
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.				1					
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra								1	
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.						2			
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.					1				
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.						1			
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa						1			
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus					1				
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.			1		1				
Arthropoda	Pagurus bernhardus					1	2			
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata							1					
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides						2						
Arthropoda	Stenothoe monoculoides						1						
Arthropoda	Thia scutellata	1				1							
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	1	0	1		2	7	11		0	2	0	
	Taxa	**1**	**0**	**1**		**2**	**6**	**8**		**0**	**2**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum		1			3	1	3					
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.									1			
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida	1		1		1		1					
Echinodermata	Ophiura ophiura										1		
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.							1					
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	1	1	1		4	1	5		1	1	0	
	Taxa	**1**	**1**	**1**		**2**	**1**	**3**		**1**	**1**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.							1					
Mollusca	Abra tenuis									31			

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.					1	1						
Mollusca	Corbula gibba												
Mollusca	Ensis magnus						1				1	1	
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica										60	37	
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica		1			1							
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula						1						
Mollusca	Tellina pygmaea							1					
Mollusca	Tellinidae spp.												
	Individuals	0	1	0		2	3	2		31	61	38	
	Taxa	**0**	**1**	**0**		**2**	**3**	**2**		**1**	**2**	**2**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus	1				1							
Mollusca	Odostomia unidentata												
	Individuals	1	0	0		1	0	0		0	0	0	
	Taxa	**1**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis							61	48	18
Annelida	Chaetozone setosa				3	1	3			
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava					1				
Annelida	Eteone spp.				1		2			
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis				1		6			
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima						1			
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									1
Annelida	Lagis koreni									
Annelida	Lanice conchilega				21	7	19			
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni				4	1	6			
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis						1			

Phylum	Species	B01-016-A	B01-016-B	B01-016-C	B01-017-A	B01-017-B	B01-017-C	B01-018-A	B01-018-B	B01-018-C
Annelida	Nephtys cirrosa	10	13	14	3					
Annelida	Nephtys hombergii				1				1	
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.				1		1			
Annelida	Notomastus latericeus							29	32	
Annelida	Ophelia borealis									
Annelida	Owenia fusiformis				1	1	60	3	23	4
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra						1			
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger				2	1	1			
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis				3		2			
Annelida	Spiophanes bombyx	2		2	10	2	16			
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	15	13	16	54	14	119	93	104	23
	Taxa	**2**	**1**	**2**	**12**	**7**	**13**	**3**	**4**	**3**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B01-016-A	B01-016-B	B01-016-C		B01-017-A	B01-017-B	B01-017-C		B01-018-A	B01-018-B	B01-018-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.									1			
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus							1					
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	1		1	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**1**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Cnidaria	Actinaria spp.						1	
Cnidaria	Anthozoa spp.		2			2		
Cnidaria	Campanulinidae spp.							
Cnidaria	Diphasia spp.							
Cnidaria	Hydrallmania falcata							
Cnidaria	Hydrozoa spp.	P						P
Cnidaria	Nemertesia sp.							
Cnidaria	Obelia spp.					P		
Cnidaria	Rhizorhagium roseum							
Cnidaria	Sertulariidae							
Cnidaria	Tubularia indivisa					P		
Cnidaria	Tubularia spp.							
	Individuals	0	2	0		2	1	0
	Taxa	**1**	**1**	**0**		**3**	**1**	**1**
Arthropoda	Abludomelita obtusata							
Arthropoda	Ampelisca brevicornis							
Arthropoda	Ampelisca spinipes							
Arthropoda	Ampelisca spp.							
Arthropoda	Aora gracilis							
Arthropoda	Aoridae spp.							
Arthropoda	Autonoe longipes							
Arthropoda	Balanus balanus							
Arthropoda	Balanus spp.							
Arthropoda	Bathyporeia elegans							
Arthropoda	Bathyporeia guilliamsoniana							
Arthropoda	Bathyporeia nana							
Arthropoda	Bathyporeia sarsi							
Arthropoda	Bathyporeia spp.							
Arthropoda	Bathyporeia tenuipes							
Arthropoda	Bodotria scorpioides							
Arthropoda	Brachyura spp.							
Arthropoda	Campylaspis spp.							
Arthropoda	Carcinus maenas					1		
Arthropoda	Copepoda spp.							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Arthropoda	Corophium spp.							
Arthropoda	Crangon allmanni							
Arthropoda	Crangon crangon		2			1		1
Arthropoda	Crangon spp.							
Arthropoda	Crustacea spp.							
Arthropoda	Dendrobranchiata spp.							
Arthropoda	Dexaminidae spp.							
Arthropoda	Diastylis glabra							
Arthropoda	Diastylis rugosa							
Arthropoda	Diastylis spp.			3		1		
Arthropoda	Euphausiacea spp.							
Arthropoda	Galathea intermedia							
Arthropoda	Galathea spp.							
Arthropoda	Gammaridae spp.							
Arthropoda	Gammaridea spp.							
Arthropoda	Gammaropsis maculata							
Arthropoda	Gammarus spp.					1		
Arthropoda	Gastrosaccus spinifer							
Arthropoda	Haustoriidae spp.							
Arthropoda	Hippomedon denticulatus							
Arthropoda	Idotea linearis					1		
Arthropoda	Isopoda spp.							
Arthropoda	Leucothoe incisa							
Arthropoda	Leucothoe spp.							
Arthropoda	Liocarcinus holsatus							
Arthropoda	Liocarcinus marmoreus							1
Arthropoda	Liocarcinus pusillus							
Arthropoda	Liocarcinus spp.							
Arthropoda	Lysianassidae spp.							
Arthropoda	Monoculodes carinatus							
Arthropoda	Mysidae spp.							
Arthropoda	Oedicerotidae spp.							
Arthropoda	Paguridae spp.							
Arthropoda	Pagurus bernhardus							
Arthropoda	Pagurus spp.							
Arthropoda	Pariambus typicus							
Arthropoda	Pilumnus spp.							
Arthropoda	Pinnotheres pisum							
Arthropoda	Pisidia longicornis	1						
Arthropoda	Podoceridae spp.							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Arthropoda	Pontoporeiidae spp.							
Arthropoda	Porcellanidae spp.							
Arthropoda	Portunidae spp.							
Arthropoda	Processa canaliculata							
Arthropoda	Processa spp.							
Arthropoda	Semibalanus balanoides							
Arthropoda	Stenothoe monoculoides							
Arthropoda	Thia scutellata							
Arthropoda	Upogebia stellata							
Arthropoda	Urothoe brevicornis							
Arthropoda	Urothoe elegans							
Arthropoda	Urothoe marina							
Arthropoda	Urothoe spp.							
	Individuals	1	2	3		5	0	2
	Taxa	**1**	**1**	**1**		**5**	**1**	**2**
Echinodermata	Amphipholis squamata							
Echinodermata	Amphiuridae spp.							
Echinodermata	Asterias rubens					8		4
Echinodermata	Echinocardium cordatum							
Echinodermata	Echinocardium flavescens							
Echinodermata	Echinocardium spp.							
Echinodermata	Echinocyamus pusillus							
Echinodermata	Holothurioidea spp.							
Echinodermata	Leptasterias muelleri							
Echinodermata	Ophiocten affinis							
Echinodermata	Ophiura albida							
Echinodermata	Ophiura ophiura					1		
Echinodermata	Ophiura sarsii							
Echinodermata	Ophiura spp.							
Echinodermata	Ophiurae spp.							
Echinodermata	Ophiuroidea spp.							
Echinodermata	Psammechinus miliaris							
Echinodermata	Spatangoida spp.							
	Individuals	0	0	0		9	0	4
	Taxa	**0**	**0**	**0**		**2**	**1**	**1**
Mollusca	Abra alba							1
Mollusca	Abra nitida					2		
Mollusca	Abra prismatica							
Mollusca	Abra spp.							
Mollusca	Abra tenuis							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Mollusca	Arca tetragona							
Mollusca	Bivalvia spp.							
Mollusca	Corbula gibba							
Mollusca	Ensis magnus		1			18	15	57
Mollusca	Ensis spp.							
Mollusca	Glycymeris glycymeris							
Mollusca	Glycymeris spp.							
Mollusca	Goodallia triangularis							
Mollusca	Kurtiella bidentata							
Mollusca	Macoma balthica	2	11	6		77	27	66
Mollusca	Mactridae spp.							
Mollusca	Mya spp.							
Mollusca	Mytilus spp.							
Mollusca	Mytilidae spp.							
Mollusca	Nucula nitidosa							
Mollusca	Nucula sulcata							
Mollusca	Spisula elliptica							
Mollusca	Tapes spp.							
Mollusca	Tellimya ferruginosa							
Mollusca	Tellina fabula							
Mollusca	Tellina pygmaea							
Mollusca	Tellinidae spp.							
	Individuals	2	12	6		97	42	124
	Taxa	**1**	**2**	**1**		**3**	**2**	**3**
Mollusca	Buccinum undatum							
Mollusca	Chauvetia brunnea							
Mollusca	Euspira montagui							
Mollusca	Euspira pulchella							
Mollusca	Gastropoda spp.							
Mollusca	Gibbula spp.							
Mollusca	Nassarius nitidus							
Mollusca	Nassarius reticulatus							
Mollusca	Odostomia unidentata							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Mollusca	Nudibranchia spp.							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Annelida	Alitta succinea					1		
Annelida	Ampharete							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Annelida	Ampharete finmarchica							
Annelida	Aonides paucibranchiata							
Annelida	Aphrodita aculeata							
Annelida	Capitella capitata-complex							
Annelida	Capitellidae spp.							
Annelida	Cauleriella alata							
Annelida	Caulleriella killariensis		15	23		3	1	4
Annelida	Chaetozone setosa							
Annelida	Cirratulidae spp.		1			3		3
Annelida	Dipolydora flava							
Annelida	Eteone spp.							
Annelida	Eulalia viridis							
Annelida	Eumida bahusiensis							
Annelida	Eumida sanguinea							
Annelida	Eumida spp.							
Annelida	Eunereis longissima					2	1	2
Annelida	Gattyana cirrhosa							
Annelida	Glycera alba							
Annelida	Glycera capitata							
Annelida	Glycera convoluta							
Annelida	Glycera lapidum							
Annelida	Glycera oxycephala							
Annelida	Glycera spp.							
Annelida	Harmothoe aspera							
Annelida	Harmothoe clavigera							
Annelida	Harmothoe extenuata							
Annelida	Harmothoe spp.							
Annelida	Hesionura elongata							
Annelida	Heteromastus filiformis					8		
Annelida	Lagis koreni		1					
Annelida	Lanice conchilega							
Annelida	Lepidonotus squamatus							
Annelida	Lumbrineris aniara							
Annelida	Lumbrineris latreilli							
Annelida	Macrochaeta helgolandica							
Annelida	Magelona johnstoni							
Annelida	Mediomastus fragilis							
Annelida	Mysta picta							
Annelida	Neoamphitrite spp.							
Annelida	Nephtys assimilis							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Annelida	Nephtys cirrosa							
Annelida	Nephtys hombergii		3				1	
Annelida	Nephtys kersivalensis							
Annelida	Nephtys spp.			1				
Annelida	Notomastus latericeus			2		1	4	26
Annelida	Ophelia borealis							
Annelida	Owenia fusiformis	14	523	22		526	14	5
Annelida	Pherusa plumosa							
Annelida	Pholoe baltica							
Annelida	Pholoe inornata							
Annelida	Pholoe spp.							
Annelida	Phyllodoce citrina							
Annelida	Phyllodoce groenlandica							
Annelida	Phyllodoce mucosa							
Annelida	Phyllodoce spp.							
Annelida	Pisione remota							
Annelida	Polycirrus medusa							
Annelida	Polycirrus spp.							
Annelida	Polydora cornuta					17		
Annelida	Polygordius appendiculatus							
Annelida	Pseudopolydora pulchra							
Annelida	Pygospio elegans							
Annelida	Sabellaria spinulosa							
Annelida	Saccocirrus papillocercus							
Annelida	Scalibregma inflatum							
Annelida	Scolelepis bonnieri							
Annelida	Scoloplos armiger							
Annelida	Sphaerosyllis bulbosa							
Annelida	Spio armata							
Annelida	Spio decoratus							
Annelida	Spio filicornis							
Annelida	Spiophanes bombyx							1
Annelida	Spiophanes kroyeri							
Annelida	Sthenelais boa							
Annelida	Terebellidae spp.							
Annelida	Travisia forbesii							
	Individuals	14	543	48		561	21	41
	Taxa	**1**	**5**	**4**		**8**	**5**	**6**
Arthropoda	Achelia echinata							
Bryozoa	Alcyonidium diaphanum							

Phylum	Species	B01-019-A	B01-019-B	B01-019-C		B01-020-A	B01-020-B	B01-020-C
Chordata	Ammodytes tobianus							
Arthropoda	Anoplodactylus petiolatus							
Arthropoda	Ammothella longipes							
Chordata	Ascidiacea spp.							
Chordata	Branchiostoma lanceolatum							
Ctenophora	Ctenophora spp.							
Chordata	Echiichthys vipera							
Echiura	Echiura spp.							
Bryozoa	Electra pilosa							
Bryozoa	Flustra foliacea							
Chordata	Gaidropsarus spp.							
Chordata	Gobiidae spp.							
Nematoda	Nematoda spp.							
Nemertea	Nemertea spp.							
Chordata	Pomatoschistus minutus							
Chordata	Pomatoschistus spp.							
Porifera	Porifera spp.							
Cephalorhyncha	Priapulida spp.							
Arthropoda	Pycnogonida spp.							
Sipuncula	Sipuncula spp.							
Sipuncula	Sipunculidea spp.							
Chordata	Solea solea							
Bryozoa	Vesicularia spinosa							
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**

	Raw data Abundance Block 02				Comment								
	RED=Grab not approved YELLOW=Grab low volume, but analysed BLUE=Grab approved P=Present				B02-021 resulted in one approved grab.				B02-022 resulted in two approved grabs.				
Phylum	**Species**	**B02-021-A**	**B02-021-B**	**B02-021-C**		**B02-022-A**	**B02-022-B**	**B02-022-C**		**B02-023-A**	**B02-023-B**	**B02-023-C**	
Cnidaria	Actinaria spp.												
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.												
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans					2							
Arthropoda	Bathyporeia guilliamsoniana	7								3			
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.	1								12	1	1	
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni	1											
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.									1	1		
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum	1											
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Arthropoda	Pontoporeiidae spp.										1		
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata	3											
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis					4							
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.									5			
	Individuals	13	0	0		6	0	0		21	3	1	
	Taxa	**5**	**0**	**0**		**2**	**0**	**0**		**4**	**3**	**1**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum					1							
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.	2											
Echinodermata	Echinocyamus pusillus	7											
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.	1				2							
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	10	0	0		3	0	0		0	0	0	
	Taxa	**3**	**0**	**0**		**2**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.					1							
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica	1											
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	1	0	0		1	0	0		0	0	0	
	Taxa	**1**	**0**	**0**		**1**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Annelida	Nephtys cirrosa	1				3				1	4	6	
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.										1		
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis	1								1			
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri										1		
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata	1								1		5	
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx					1							
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	3	0	0		4	0	0		3	6	11	
	Taxa	**3**	**0**	**0**		**2**	**0**	**0**		**3**	**3**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B02-021-A	B02-021-B	B02-021-C		B02-022-A	B02-022-B	B02-022-C		B02-023-A	B02-023-B	B02-023-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

	Raw data Abundan										
	RED=Grab not approved YELLOW=Grab low volume, but ana BLUE=Grab approved P=Present	B02-024 resulted in no approved grab.			B02-025 resulted in one approved grab and one with low volume but analysed (A 3L).			B02-026 resulted in no approved grab.		
Phylum	**Species**	**B02-024-A**	**B02-024-B**	**B02-024-C**	**B02-025-A**	**B02-025-B**	**B02-025-C**	**B02-026-A**	**B02-026-B**	**B02-026-C**
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana				4	2				
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi					4				
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.					1				
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.									
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer					2				
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis									
Arthropoda	Podoceridae spp.									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.						4						
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis					4							
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		8	13	0		0	0	0	
	Taxa	**0**	**0**	**0**		**2**	**5**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus					8	14						
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis						2						
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		8	16	0		0	0	0	
	Taxa	**0**	**0**	**0**		**1**	**2**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.						1						
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	1	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui						1						
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	1	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata									
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.									
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis									
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima									
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba									
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera									
Annelida	Harmothoe clavigera									
Annelida	Harmothoe extenuata									
Annelida	Harmothoe spp.									
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis									
Annelida	Lagis koreni									
Annelida	Lanice conchilega									
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta									
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C	B02-025-A	B02-025-B	B02-025-C	B02-026-A	B02-026-B	B02-026-C
Annelida	Nephtys cirrosa				1	2				
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.									
Annelida	Notomastus latericeus									
Annelida	Ophelia borealis					2				
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa									
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa									
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum									
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis									
Annelida	Spiophanes bombyx									
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa									
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	0	0	0	1	9	0	0	0	0
	Taxa	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B02-024-A	B02-024-B	B02-024-C		B02-025-A	B02-025-B	B02-025-C		B02-026-A	B02-026-B	B02-026-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

Raw data Abundan

RED=Grab not approved
YELLOW=Grab low volume, but ana
BLUE=Grab approved
P=Present

B02-029 resulted in one approved grab and two with low volume but analysed (A 3L and B 2L)

Phylum	Species	B02-027-A	B02-027-B	B02-027-C	B02-028-A	B02-028-B	B02-028-C	B02-029-A	B02-029-B	B02-029-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans	2								
Arthropoda	Bathyporeia guilliamsoniana	1	1							
Arthropoda	Bathyporeia nana	2								
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.		1	1					1	
Arthropoda	Bathyporeia tenuipes	4								
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B02-027-A	B02-027-B	B02-027-C	B02-028-A	B02-028-B	B02-028-C	B02-029-A	B02-029-B	B02-029-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.			1						
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.				7					
Arthropoda	Galathea intermedia									
Arthropoda	Galathea spp.									
Arthropoda	Gammaridae spp.	1			1					
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata									
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer			1		3				
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.					1				
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus		1					1		
Arthropoda	Liocarcinus spp.									
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.									
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.									
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis						4			
Arthropoda	Podoceridae spp.									

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata						1						
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans	1											
Arthropoda	Urothoe marina	1											
Arthropoda	Urothoe spp.		4	1									
	Individuals	12	7	4		8	5	4		1	1	0	
	Taxa	**7**	**4**	**4**		**2**	**3**	**1**		**1**	**1**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus									6	7		
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.										1		
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		6	8	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**2**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida							1					
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica		2										
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	2	0		0	0	1		0	0	0	
	Taxa	**0**	**1**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella									1			
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		1	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		3	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum										2		
Annelida	Glycera oxycephala			1									
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis							1					
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Annelida	Nephtys cirrosa	1		1				2					
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis		1	3		1		1		2			
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa						1	11					
Annelida	Polycirrus spp.										1		
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata		1										
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx	1											
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.			1									
Annelida	Travisia forbesii												
	Individuals	2	2	6		1	1	15		8	3	0	
	Taxa	**2**	**2**	**4**		**1**	**1**	**4**		**1**	**2**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B02-027-A	B02-027-B	B02-027-C		B02-028-A	B02-028-B	B02-028-C		B02-029-A	B02-029-B	B02-029-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	

	Raw data Abundan			
	RED=Grab not approved **YELLOW=Grab low volume, but ana** **BLUE=Grab approved** **P=Present**			
Phylum	**Species**	**B02-030-A**	**B02-030-B**	**B02-030-C**
Cnidaria	Actinaria spp.			
Cnidaria	Anthozoa spp.			
Cnidaria	Campanulinidae spp.			
Cnidaria	Diphasia spp.			
Cnidaria	Hydrallmania falcata			
Cnidaria	Hydrozoa spp.			
Cnidaria	Nemertesia sp.			
Cnidaria	Obelia spp.			
Cnidaria	Rhizorhagium roseum			
Cnidaria	Sertulariidae			
Cnidaria	Tubularia indivisa			
Cnidaria	Tubularia spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	
Arthropoda	Abludomelita obtusata			
Arthropoda	Ampelisca brevicornis			
Arthropoda	Ampelisca spinipes			
Arthropoda	Ampelisca spp.			
Arthropoda	Aora gracilis			
Arthropoda	Aoridae spp.			
Arthropoda	Autonoe longipes			
Arthropoda	Balanus balanus			
Arthropoda	Balanus spp.			
Arthropoda	Bathyporeia elegans			
Arthropoda	Bathyporeia guilliamsoniana			
Arthropoda	Bathyporeia nana			
Arthropoda	Bathyporeia sarsi			
Arthropoda	Bathyporeia spp.			
Arthropoda	Bathyporeia tenuipes			
Arthropoda	Bodotria scorpioides			
Arthropoda	Brachyura spp.			
Arthropoda	Campylaspis spp.			
Arthropoda	Carcinus maenas			
Arthropoda	Copepoda spp.			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Arthropoda	Corophium spp.			
Arthropoda	Crangon allmanni			
Arthropoda	Crangon crangon			
Arthropoda	Crangon spp.			
Arthropoda	Crustacea spp.			
Arthropoda	Dendrobranchiata spp.			
Arthropoda	Dexaminidae spp.			
Arthropoda	Diastylis glabra			
Arthropoda	Diastylis rugosa			
Arthropoda	Diastylis spp.			
Arthropoda	Euphausiacea spp.			
Arthropoda	Galathea intermedia			
Arthropoda	Galathea spp.			
Arthropoda	Gammaridae spp.			
Arthropoda	Gammaridea spp.			
Arthropoda	Gammaropsis maculata			
Arthropoda	Gammarus spp.			
Arthropoda	Gastrosaccus spinifer			
Arthropoda	Haustoriidae spp.			
Arthropoda	Hippomedon denticulatus			
Arthropoda	Idotea linearis			
Arthropoda	Isopoda spp.			
Arthropoda	Leucothoe incisa			
Arthropoda	Leucothoe spp.			
Arthropoda	Liocarcinus holsatus			
Arthropoda	Liocarcinus marmoreus			
Arthropoda	Liocarcinus pusillus			
Arthropoda	Liocarcinus spp.			
Arthropoda	Lysianassidae spp.			
Arthropoda	Monoculodes carinatus			
Arthropoda	Mysidae spp.			
Arthropoda	Oedicerotidae spp.			
Arthropoda	Paguridae spp.			
Arthropoda	Pagurus bernhardus			
Arthropoda	Pagurus spp.			
Arthropoda	Pariambus typicus			
Arthropoda	Pilumnus spp.			
Arthropoda	Pinnotheres pisum			
Arthropoda	Pisidia longicornis			
Arthropoda	Podoceridae spp.			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Arthropoda	Pontoporeiidae spp.			
Arthropoda	Porcellanidae spp.			
Arthropoda	Portunidae spp.			
Arthropoda	Processa canaliculata			
Arthropoda	Processa spp.			
Arthropoda	Semibalanus balanoides			
Arthropoda	Stenothoe monoculoides			
Arthropoda	Thia scutellata			
Arthropoda	Upogebia stellata			
Arthropoda	Urothoe brevicornis			
Arthropoda	Urothoe elegans			
Arthropoda	Urothoe marina			
Arthropoda	Urothoe spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Echinodermata	Amphipholis squamata			
Echinodermata	Amphiuridae spp.			
Echinodermata	Asterias rubens			
Echinodermata	Echinocardium cordatum			
Echinodermata	Echinocardium flavescens			
Echinodermata	Echinocardium spp.			
Echinodermata	Echinocyamus pusillus	1	1	
Echinodermata	Holothurioidea spp.			
Echinodermata	Leptasterias muelleri			
Echinodermata	Ophiocten affinis		2	
Echinodermata	Ophiura albida			
Echinodermata	Ophiura ophiura			1
Echinodermata	Ophiura sarsii			
Echinodermata	Ophiura spp.			
Echinodermata	Ophiurae spp.			
Echinodermata	Ophiuroidea spp.			
Echinodermata	Psammechinus miliaris			
Echinodermata	Spatangoida spp.			
	Individuals	1	3	1
	Taxa	**1**	**2**	**1**
Mollusca	Abra alba			
Mollusca	Abra nitida			
Mollusca	Abra prismatica			
Mollusca	Abra spp.			
Mollusca	Abra tenuis			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Mollusca	Arca tetragona			
Mollusca	Bivalvia spp.			
Mollusca	Corbula gibba			
Mollusca	Ensis magnus			
Mollusca	Ensis spp.			
Mollusca	Glycymeris glycymeris		1	
Mollusca	Glycymeris spp.	1		
Mollusca	Goodallia triangularis	2		
Mollusca	Kurtiella bidentata			
Mollusca	Macoma balthica			
Mollusca	Mactridae spp.			
Mollusca	Mya spp.			
Mollusca	Mytilus spp.			
Mollusca	Mytilidae spp.			
Mollusca	Nucula nitidosa			
Mollusca	Nucula sulcata			
Mollusca	Spisula elliptica	2		
Mollusca	Tapes spp.			
Mollusca	Tellimya ferruginosa			
Mollusca	Tellina fabula			
Mollusca	Tellina pygmaea	1		
Mollusca	Tellinidae spp.			
	Individuals	6	1	0
	Taxa	**4**	**1**	**0**
Mollusca	Buccinum undatum			
Mollusca	Chauvetia brunnea			
Mollusca	Euspira montagui			
Mollusca	Euspira pulchella			
Mollusca	Gastropoda spp.			
Mollusca	Gibbula spp.			
Mollusca	Nassarius nitidus			
Mollusca	Nassarius reticulatus			
Mollusca	Odostomia unidentata			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Mollusca	Nudibranchia spp.			
	Individuals	0	0	0
	Taxa	**0**	**0**	**0**
Annelida	Alitta succinea			
Annelida	Ampharete			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Annelida	Ampharete finmarchica			
Annelida	Aonides paucibranchiata			
Annelida	Aphrodita aculeata			
Annelida	Capitella capitata-complex			
Annelida	Capitellidae spp.			
Annelida	Cauleriella alata			
Annelida	Caulleriella killariensis			
Annelida	Chaetozone setosa			
Annelida	Cirratulidae spp.			
Annelida	Dipolydora flava			
Annelida	Eteone spp.			
Annelida	Eulalia viridis			
Annelida	Eumida bahusiensis			
Annelida	Eumida sanguinea			
Annelida	Eumida spp.			
Annelida	Eunereis longissima			
Annelida	Gattyana cirrhosa			
Annelida	Glycera alba			
Annelida	Glycera capitata			
Annelida	Glycera convoluta			
Annelida	Glycera lapidum	1		
Annelida	Glycera oxycephala			
Annelida	Glycera spp.			
Annelida	Harmothoe aspera			
Annelida	Harmothoe clavigera			
Annelida	Harmothoe extenuata			
Annelida	Harmothoe spp.			
Annelida	Hesionura elongata			
Annelida	Heteromastus filiformis			
Annelida	Lagis koreni			
Annelida	Lanice conchilega			
Annelida	Lepidonotus squamatus			
Annelida	Lumbrineris aniara			
Annelida	Lumbrineris latreilli			
Annelida	Macrochaeta helgolandica			
Annelida	Magelona johnstoni			
Annelida	Mediomastus fragilis			
Annelida	Mysta picta			
Annelida	Neoamphitrite spp.			
Annelida	Nephtys assimilis			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Annelida	Nephtys cirrosa		1	
Annelida	Nephtys hombergii			
Annelida	Nephtys kersivalensis			
Annelida	Nephtys spp.			
Annelida	Notomastus latericeus			
Annelida	Ophelia borealis			
Annelida	Owenia fusiformis			
Annelida	Pherusa plumosa			
Annelida	Pholoe baltica			
Annelida	Pholoe inornata			
Annelida	Pholoe spp.			
Annelida	Phyllodoce citrina			
Annelida	Phyllodoce groenlandica			
Annelida	Phyllodoce mucosa			
Annelida	Phyllodoce spp.			
Annelida	Pisione remota			
Annelida	Polycirrus medusa			
Annelida	Polycirrus spp.			
Annelida	Polydora cornuta			
Annelida	Polygordius appendiculatus			
Annelida	Pseudopolydora pulchra			
Annelida	Pygospio elegans			
Annelida	Sabellaria spinulosa			
Annelida	Saccocirrus papillocercus			
Annelida	Scalibregma inflatum			
Annelida	Scolelepis bonnieri			
Annelida	Scoloplos armiger			
Annelida	Sphaerosyllis bulbosa			
Annelida	Spio armata			
Annelida	Spio decoratus			
Annelida	Spio filicornis			
Annelida	Spiophanes bombyx			
Annelida	Spiophanes kroyeri			
Annelida	Sthenelais boa			
Annelida	Terebellidae spp.			
Annelida	Travisia forbesii			
	Individuals	1	1	0
	Taxa	**1**	**1**	**0**
Arthropoda	Achelia echinata			
Bryozoa	Alcyonidium diaphanum			

Phylum	Species	B02-030-A	B02-030-B	B02-030-C
Chordata	Ammodytes tobianus		1	
Arthropoda	Anoplodactylus petiolatus			
Arthropoda	Ammothella longipes			
Chordata	Ascidiacea spp.			
Chordata	Branchiostoma lanceolatum			
Ctenophora	Ctenophora spp.			
Chordata	Echiichthys vipera			
Echiura	Echiura spp.			
Bryozoa	Electra pilosa			
Bryozoa	Flustra foliacea			
Chordata	Gaidropsarus spp.			
Chordata	Gobiidae spp.			
Nematoda	Nematoda spp.			
Nemertea	Nemertea spp.			
Chordata	Pomatoschistus minutus			
Chordata	Pomatoschistus spp.			
Porifera	Porifera spp.			
Cephalorhyncha	Priapulida spp.			
Arthropoda	Pycnogonida spp.			
Sipuncula	Sipuncula spp.			
Sipuncula	Sipunculidea spp.			
Chordata	Solea solea			
Bryozoa	Vesicularia spinosa			
	Individuals	0	1	0
	Taxa	**0**	**1**	**0**

	Raw data Abundance Block 03				Comment								
	RED=Grab not approved YELLOW=Grab low volume, but analysed BLUE=Grab approved P=Present							B03-033 resulted in no approved grab.					
Phylum	**Species**	**B03-031-A**	**B03-031-B**	**B03-031-C**		**B03-032-A**	**B03-032-B**	**B03-032-C**		**B03-033-A**	**B03-033-B**	**B03-033-C**	
Cnidaria	Actinaria spp.												
Cnidaria	Anthozoa spp.												
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.												
Cnidaria	Hydrallmania falcata												
Cnidaria	Hydrozoa spp.							P					
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Arthropoda	Abludomelita obtusata												
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes												
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus							1					
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus							2					
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	0	3		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**2**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus							1					
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	1		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica	1				1		1					
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea					1							
Mollusca	Tellinidae spp.												
	Individuals	1	0	0		2	0	1		0	0	0	
	Taxa	**1**	**0**	**0**		**2**	**0**	**1**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata					2							
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum		1					3					
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli					1							
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus					3		3					
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis	1											
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa					5	1						
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	1	1	0		11	1	6		0	0	0	
	Taxa	**1**	**1**	**0**		**4**	**1**	**2**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-031-A	B03-031-B	B03-031-C		B03-032-A	B03-032-B	B03-032-C		B03-033-A	B03-033-B	B03-033-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum					2	2	2					
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.					2	5	6					
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		4	7	8		0	0	0	
	Taxa	0	0	0		2	2	2		0	0	0	

Raw data Abundanc

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

B03-034 resulted in no approved grab.

B03-036 resulted in no approved grab.

Phylum	Species	B03-034-A	B03-034-B	B03-034-C	B03-035-A	B03-035-B	B03-035-C	B03-036-A	B03-036-B	B03-036-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.						1						
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus						1						
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**2**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**			**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala					1							
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Annelida	Nephtys cirrosa					1	1						
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis						1						
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	0	0	0		2	2	0		0	0	0	
	Taxa	**0**	**0**	**0**		**2**	**2**	**0**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-034-A	B03-034-B	B03-034-C		B03-035-A	B03-035-B	B03-035-C		B03-036-A	B03-036-B	B03-036-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

	RED=Grab not approved YELLOW=Grab low volume, but analy BLUE=Grab approved P=Present	B03-037 resulted in two approved grabs and one with low volume but analysed (B 3L)				B03-038 resulted in no approved grab.				B03-039 resulted in two approved grabs.			
Phylum	**Species**	**B03-037-A**	**B03-037-B**	**B03-037-C**		**B03-038-A**	**B03-038-B**	**B03-038-C**		**B03-039-A**	**B03-039-B**	**B03-039-C**	
Cnidaria	Actinaria spp.										3		
Cnidaria	Anthozoa spp.									1			
Cnidaria	Campanulinidae spp.												
Cnidaria	Diphasia spp.		P								P		
Cnidaria	Hydrallmania falcata										P		
Cnidaria	Hydrozoa spp.												
Cnidaria	Nemertesia sp.												
Cnidaria	Obelia spp.												
Cnidaria	Rhizorhagium roseum												
Cnidaria	Sertulariidae												
Cnidaria	Tubularia indivisa												
Cnidaria	Tubularia spp.												
	Individuals	0	0	0		0	0	0		1	3	0	
	Taxa	**0**	**1**	**0**		**0**	**0**	**0**		**1**	**3**	**0**	
Arthropoda	Abludomelita obtusata										1		
Arthropoda	Ampelisca brevicornis												
Arthropoda	Ampelisca spinipes										1		
Arthropoda	Ampelisca spp.												
Arthropoda	Aora gracilis												
Arthropoda	Aoridae spp.												
Arthropoda	Autonoe longipes												
Arthropoda	Balanus balanus												
Arthropoda	Balanus spp.												
Arthropoda	Bathyporeia elegans												
Arthropoda	Bathyporeia guilliamsoniana												
Arthropoda	Bathyporeia nana												
Arthropoda	Bathyporeia sarsi												
Arthropoda	Bathyporeia spp.												
Arthropoda	Bathyporeia tenuipes												
Arthropoda	Bodotria scorpioides												
Arthropoda	Brachyura spp.												
Arthropoda	Campylaspis spp.												
Arthropoda	Carcinus maenas												
Arthropoda	Copepoda spp.												

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Arthropoda	Corophium spp.									
Arthropoda	Crangon allmanni									
Arthropoda	Crangon crangon									
Arthropoda	Crangon spp.									
Arthropoda	Crustacea spp.									
Arthropoda	Dendrobranchiata spp.									
Arthropoda	Dexaminidae spp.									
Arthropoda	Diastylis glabra									
Arthropoda	Diastylis rugosa									
Arthropoda	Diastylis spp.									
Arthropoda	Euphausiacea spp.									
Arthropoda	Galathea intermedia								2	
Arthropoda	Galathea spp.								1	
Arthropoda	Gammaridae spp.								1	
Arthropoda	Gammaridea spp.									
Arthropoda	Gammaropsis maculata								4	
Arthropoda	Gammarus spp.									
Arthropoda	Gastrosaccus spinifer									
Arthropoda	Haustoriidae spp.									
Arthropoda	Hippomedon denticulatus									
Arthropoda	Idotea linearis									
Arthropoda	Isopoda spp.									
Arthropoda	Leucothoe incisa									
Arthropoda	Leucothoe spp.									
Arthropoda	Liocarcinus holsatus									
Arthropoda	Liocarcinus marmoreus									
Arthropoda	Liocarcinus pusillus									
Arthropoda	Liocarcinus spp.								1	
Arthropoda	Lysianassidae spp.									
Arthropoda	Monoculodes carinatus									
Arthropoda	Mysidae spp.							1		
Arthropoda	Oedicerotidae spp.									
Arthropoda	Paguridae spp.									
Arthropoda	Pagurus bernhardus									
Arthropoda	Pagurus spp.									
Arthropoda	Pariambus typicus									
Arthropoda	Pilumnus spp.								1	
Arthropoda	Pinnotheres pisum									
Arthropoda	Pisidia longicornis								160	
Arthropoda	Podoceridae spp.									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Arthropoda	Pontoporeiidae spp.									
Arthropoda	Porcellanidae spp.									
Arthropoda	Portunidae spp.									
Arthropoda	Processa canaliculata									
Arthropoda	Processa spp.									
Arthropoda	Semibalanus balanoides									
Arthropoda	Stenothoe monoculoides									
Arthropoda	Thia scutellata									
Arthropoda	Upogebia stellata								1	
Arthropoda	Urothoe brevicornis									
Arthropoda	Urothoe elegans									
Arthropoda	Urothoe marina									
Arthropoda	Urothoe spp.									
	Individuals	0	0	0	0	0	0	1	173	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**10**	**0**
Echinodermata	Amphipholis squamata								11	
Echinodermata	Amphiuridae spp.									
Echinodermata	Asterias rubens								3	
Echinodermata	Echinocardium cordatum									
Echinodermata	Echinocardium flavescens									
Echinodermata	Echinocardium spp.									
Echinodermata	Echinocyamus pusillus									
Echinodermata	Holothurioidea spp.									
Echinodermata	Leptasterias muelleri								1	
Echinodermata	Ophiocten affinis									
Echinodermata	Ophiura albida									
Echinodermata	Ophiura ophiura									
Echinodermata	Ophiura sarsii									
Echinodermata	Ophiura spp.							1		
Echinodermata	Ophiurae spp.									
Echinodermata	Ophiuroidea spp.	1							34	
Echinodermata	Psammechinus miliaris									
Echinodermata	Spatangoida spp.									
	Individuals	1	0	0	0	0	0	1	49	0
	Taxa	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**
Mollusca	Abra alba									
Mollusca	Abra nitida							3		
Mollusca	Abra prismatica								17	
Mollusca	Abra spp.									
Mollusca	Abra tenuis									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C		B03-038-A	B03-038-B	B03-038-C		B03-039-A	B03-039-B	B03-039-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		3	17	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**1**	**1**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus			1									
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata										2		
	Individuals	0	0	1		0	0	0		0	2	0	
	Taxa	**0**	**0**	**1**		**0**	**0**	**0**		**0**	**1**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	3		0	0	0		0	5	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Annelida	Ampharete finmarchica									
Annelida	Aonides paucibranchiata									
Annelida	Aphrodita aculeata									
Annelida	Capitella capitata-complex									
Annelida	Capitellidae spp.									
Annelida	Cauleriella alata								1	
Annelida	Caulleriella killariensis									
Annelida	Chaetozone setosa									
Annelida	Cirratulidae spp.							1		
Annelida	Dipolydora flava									
Annelida	Eteone spp.									
Annelida	Eulalia viridis								1	
Annelida	Eumida bahusiensis									
Annelida	Eumida sanguinea									
Annelida	Eumida spp.									
Annelida	Eunereis longissima								1	
Annelida	Gattyana cirrhosa									
Annelida	Glycera alba								1	
Annelida	Glycera capitata									
Annelida	Glycera convoluta									
Annelida	Glycera lapidum									
Annelida	Glycera oxycephala									
Annelida	Glycera spp.									
Annelida	Harmothoe aspera								3	
Annelida	Harmothoe clavigera								5	
Annelida	Harmothoe extenuata								3	
Annelida	Harmothoe spp.							1	11	
Annelida	Hesionura elongata									
Annelida	Heteromastus filiformis								3	
Annelida	Lagis koreni		1	3						
Annelida	Lanice conchilega							1		
Annelida	Lepidonotus squamatus									
Annelida	Lumbrineris aniara									
Annelida	Lumbrineris latreilli									
Annelida	Macrochaeta helgolandica									
Annelida	Magelona johnstoni									
Annelida	Mediomastus fragilis									
Annelida	Mysta picta								1	
Annelida	Neoamphitrite spp.									
Annelida	Nephtys assimilis									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C	B03-038-A	B03-038-B	B03-038-C	B03-039-A	B03-039-B	B03-039-C
Annelida	Nephtys cirrosa	1		1					1	
Annelida	Nephtys hombergii									
Annelida	Nephtys kersivalensis									
Annelida	Nephtys spp.		1							
Annelida	Notomastus latericeus								1	
Annelida	Ophelia borealis			2				3	1	
Annelida	Owenia fusiformis									
Annelida	Pherusa plumosa								1	
Annelida	Pholoe baltica									
Annelida	Pholoe inornata									
Annelida	Pholoe spp.									
Annelida	Phyllodoce citrina									
Annelida	Phyllodoce groenlandica									
Annelida	Phyllodoce mucosa									
Annelida	Phyllodoce spp.									
Annelida	Pisione remota									
Annelida	Polycirrus medusa									
Annelida	Polycirrus spp.									
Annelida	Polydora cornuta									
Annelida	Polygordius appendiculatus									
Annelida	Pseudopolydora pulchra									
Annelida	Pygospio elegans									
Annelida	Sabellaria spinulosa							108	1063	
Annelida	Saccocirrus papillocercus									
Annelida	Scalibregma inflatum							1		
Annelida	Scolelepis bonnieri									
Annelida	Scoloplos armiger									
Annelida	Sphaerosyllis bulbosa									
Annelida	Spio armata									
Annelida	Spio decoratus									
Annelida	Spio filicornis							1		
Annelida	Spiophanes bombyx							6	1	
Annelida	Spiophanes kroyeri									
Annelida	Sthenelais boa								3	
Annelida	Terebellidae spp.									
Annelida	Travisia forbesii									
	Individuals	1	2	12	0	0	0	122	1111	0
	Taxa	**1**	**2**	**3**	**0**	**0**	**0**	**8**	**17**	**0**
Arthropoda	Achelia echinata									
Bryozoa	Alcyonidium diaphanum									

Phylum	Species	B03-037-A	B03-037-B	B03-037-C		B03-038-A	B03-038-B	B03-038-C		B03-039-A	B03-039-B	B03-039-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.		1										
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.										1		
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.										1		
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	1	0		0	0	0		0	2	0	
	Taxa	0	1	0		0	0	0		0	2	0	

Raw data Abundanc

	RED=Grab not approved YELLOW=Grab low volume, but analy BLUE=Grab approved P=Present		**B03-040 resulted in no approved grab.**			**B03-041 resulted in no approved grab.**				**B03-042 resulted in no approved grab.**	
Phylum	**Species**	**B03-040-A**	**B03-040-B**	**B03-040-C**		**B03-041-A**	**B03-041-B**	**B03-041-C**		**B03-042-A**	**B03-042-B**	**B03-042-C**
Cnidaria	Actinaria spp.											
Cnidaria	Anthozoa spp.											
Cnidaria	Campanulinidae spp.											
Cnidaria	Diphasia spp.											
Cnidaria	Hydrallmania falcata											
Cnidaria	Hydrozoa spp.											
Cnidaria	Nemertesia sp.											
Cnidaria	Obelia spp.											
Cnidaria	Rhizorhagium roseum											
Cnidaria	Sertulariidae											
Cnidaria	Tubularia indivisa											
Cnidaria	Tubularia spp.											
	Individuals	0	0	0		0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**
Arthropoda	Abludomelita obtusata											
Arthropoda	Ampelisca brevicornis											
Arthropoda	Ampelisca spinipes											
Arthropoda	Ampelisca spp.											
Arthropoda	Aora gracilis											
Arthropoda	Aoridae spp.											
Arthropoda	Autonoe longipes											
Arthropoda	Balanus balanus											
Arthropoda	Balanus spp.											
Arthropoda	Bathyporeia elegans											
Arthropoda	Bathyporeia guilliamsoniana											
Arthropoda	Bathyporeia nana											
Arthropoda	Bathyporeia sarsi											
Arthropoda	Bathyporeia spp.											
Arthropoda	Bathyporeia tenuipes											
Arthropoda	Bodotria scorpioides											
Arthropoda	Brachyura spp.											
Arthropoda	Campylaspis spp.											
Arthropoda	Carcinus maenas											
Arthropoda	Copepoda spp.											

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Annelida	Nephtys cirrosa												
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis												
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-040-A	B03-040-B	B03-040-C		B03-041-A	B03-041-B	B03-041-C		B03-042-A	B03-042-B	B03-042-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

B03-045 resulted in no approved grab.

Phylum	Species	B03-043-A	B03-043-B	B03-043-C	B03-044-A	B03-044-B	B03-044-C	B03-045-A	B03-045-B	B03-045-C
Cnidaria	Actinaria spp.									
Cnidaria	Anthozoa spp.									
Cnidaria	Campanulinidae spp.									
Cnidaria	Diphasia spp.									
Cnidaria	Hydrallmania falcata									
Cnidaria	Hydrozoa spp.									
Cnidaria	Nemertesia sp.									
Cnidaria	Obelia spp.									
Cnidaria	Rhizorhagium roseum									
Cnidaria	Sertulariidae									
Cnidaria	Tubularia indivisa									
Cnidaria	Tubularia spp.									
	Individuals	0	0	0	0	0	0	0	0	0
	Taxa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arthropoda	Abludomelita obtusata									
Arthropoda	Ampelisca brevicornis									
Arthropoda	Ampelisca spinipes									
Arthropoda	Ampelisca spp.									
Arthropoda	Aora gracilis									
Arthropoda	Aoridae spp.									
Arthropoda	Autonoe longipes									
Arthropoda	Balanus balanus									
Arthropoda	Balanus spp.									
Arthropoda	Bathyporeia elegans									
Arthropoda	Bathyporeia guilliamsoniana									
Arthropoda	Bathyporeia nana									
Arthropoda	Bathyporeia sarsi									
Arthropoda	Bathyporeia spp.									
Arthropoda	Bathyporeia tenuipes									
Arthropoda	Bodotria scorpioides									
Arthropoda	Brachyura spp.									
Arthropoda	Campylaspis spp.									
Arthropoda	Carcinus maenas									
Arthropoda	Copepoda spp.									

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer												
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.												
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.												
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.			1									
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.												
	Individuals	0	0	1		0	0	0		0	0	0	
	Taxa	**0**	**0**	**1**		**0**	**0**	**0**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.												
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.												
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba												
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis												
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.												
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica												
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum												
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica												
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Annelida	Nephtys cirrosa					1		1					
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis		2			3	1						
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata	1											
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.												
Annelida	Travisia forbesii												
	Individuals	1	2	0		4	1	1		0	0	0	
	Taxa	**1**	**1**	**0**		**2**	**1**	**1**		**0**	**0**	**0**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-043-A	B03-043-B	B03-043-C		B03-044-A	B03-044-B	B03-044-C		B03-045-A	B03-045-B	B03-045-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

B03-048 resulted in one approved grab and two with low volume but analysed (B 4L and C 4L)

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C
Cnidaria	Actinaria spp.											
Cnidaria	Anthozoa spp.											
Cnidaria	Campanulinidae spp.											
Cnidaria	Diphasia spp.											
Cnidaria	Hydrallmania falcata											
Cnidaria	Hydrozoa spp.											
Cnidaria	Nemertesia sp.											
Cnidaria	Obelia spp.											
Cnidaria	Rhizorhagium roseum											
Cnidaria	Sertulariidae											
Cnidaria	Tubularia indivisa											
Cnidaria	Tubularia spp.											
	Individuals	0	0	0		0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**
Arthropoda	Abludomelita obtusata											
Arthropoda	Ampelisca brevicornis											
Arthropoda	Ampelisca spinipes											
Arthropoda	Ampelisca spp.											
Arthropoda	Aora gracilis											
Arthropoda	Aoridae spp.											
Arthropoda	Autonoe longipes											
Arthropoda	Balanus balanus											
Arthropoda	Balanus spp.							20				
Arthropoda	Bathyporeia elegans											
Arthropoda	Bathyporeia guilliamsoniana											
Arthropoda	Bathyporeia nana											
Arthropoda	Bathyporeia sarsi											
Arthropoda	Bathyporeia spp.					2						
Arthropoda	Bathyporeia tenuipes											
Arthropoda	Bodotria scorpioides											
Arthropoda	Brachyura spp.											
Arthropoda	Campylaspis spp.											
Arthropoda	Carcinus maenas											
Arthropoda	Copepoda spp.											

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Arthropoda	Corophium spp.												
Arthropoda	Crangon allmanni												
Arthropoda	Crangon crangon												
Arthropoda	Crangon spp.												
Arthropoda	Crustacea spp.												
Arthropoda	Dendrobranchiata spp.												
Arthropoda	Dexaminidae spp.												
Arthropoda	Diastylis glabra												
Arthropoda	Diastylis rugosa												
Arthropoda	Diastylis spp.												
Arthropoda	Euphausiacea spp.												
Arthropoda	Galathea intermedia												
Arthropoda	Galathea spp.												
Arthropoda	Gammaridae spp.												
Arthropoda	Gammaridea spp.												
Arthropoda	Gammaropsis maculata												
Arthropoda	Gammarus spp.												
Arthropoda	Gastrosaccus spinifer		1										
Arthropoda	Haustoriidae spp.												
Arthropoda	Hippomedon denticulatus												
Arthropoda	Idotea linearis												
Arthropoda	Isopoda spp.												
Arthropoda	Leucothoe incisa												
Arthropoda	Leucothoe spp.												
Arthropoda	Liocarcinus holsatus												
Arthropoda	Liocarcinus marmoreus												
Arthropoda	Liocarcinus pusillus												
Arthropoda	Liocarcinus spp.												
Arthropoda	Lysianassidae spp.							1					
Arthropoda	Monoculodes carinatus												
Arthropoda	Mysidae spp.												
Arthropoda	Oedicerotidae spp.												
Arthropoda	Paguridae spp.												
Arthropoda	Pagurus bernhardus												
Arthropoda	Pagurus spp.							1					
Arthropoda	Pariambus typicus												
Arthropoda	Pilumnus spp.												
Arthropoda	Pinnotheres pisum												
Arthropoda	Pisidia longicornis												
Arthropoda	Podoceridae spp.							1					

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Arthropoda	Pontoporeiidae spp.												
Arthropoda	Porcellanidae spp.												
Arthropoda	Portunidae spp.												
Arthropoda	Processa canaliculata												
Arthropoda	Processa spp.												
Arthropoda	Semibalanus balanoides												
Arthropoda	Stenothoe monoculoides												
Arthropoda	Thia scutellata												
Arthropoda	Upogebia stellata												
Arthropoda	Urothoe brevicornis												
Arthropoda	Urothoe elegans												
Arthropoda	Urothoe marina												
Arthropoda	Urothoe spp.	3											
	Individuals	3	1	0		2	0	23		0	0	0	
	Taxa	**1**	**1**	**0**		**1**	**0**	**4**		**0**	**0**	**0**	
Echinodermata	Amphipholis squamata												
Echinodermata	Amphiuridae spp.						1						
Echinodermata	Asterias rubens												
Echinodermata	Echinocardium cordatum												
Echinodermata	Echinocardium flavescens												
Echinodermata	Echinocardium spp.												
Echinodermata	Echinocyamus pusillus												
Echinodermata	Holothurioidea spp.												
Echinodermata	Leptasterias muelleri												
Echinodermata	Ophiocten affinis												
Echinodermata	Ophiura albida												
Echinodermata	Ophiura ophiura												
Echinodermata	Ophiura sarsii												
Echinodermata	Ophiura spp.												
Echinodermata	Ophiurae spp.												
Echinodermata	Ophiuroidea spp.							1					
Echinodermata	Psammechinus miliaris												
Echinodermata	Spatangoida spp.												
	Individuals	0	0	0		0	1	1		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**1**	**1**		**0**	**0**	**0**	
Mollusca	Abra alba												
Mollusca	Abra nitida												
Mollusca	Abra prismatica												
Mollusca	Abra spp.												
Mollusca	Abra tenuis												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Mollusca	Arca tetragona												
Mollusca	Bivalvia spp.												
Mollusca	Corbula gibba						1						
Mollusca	Ensis magnus												
Mollusca	Ensis spp.												
Mollusca	Glycymeris glycymeris												
Mollusca	Glycymeris spp.												
Mollusca	Goodallia triangularis							1					
Mollusca	Kurtiella bidentata												
Mollusca	Macoma balthica												
Mollusca	Mactridae spp.												
Mollusca	Mya spp.												
Mollusca	Mytilus spp.												
Mollusca	Mytilidae spp.			20		7		30					
Mollusca	Nucula nitidosa												
Mollusca	Nucula sulcata												
Mollusca	Spisula elliptica			2		1		3					
Mollusca	Tapes spp.												
Mollusca	Tellimya ferruginosa												
Mollusca	Tellina fabula												
Mollusca	Tellina pygmaea												
Mollusca	Tellinidae spp.												
	Individuals	0	0	22		8	1	34		0	0	0	
	Taxa	**0**	**0**	**2**		**2**	**1**	**3**		**0**	**0**	**0**	
Mollusca	Buccinum undatum												
Mollusca	Chauvetia brunnea												
Mollusca	Euspira montagui												
Mollusca	Euspira pulchella												
Mollusca	Gastropoda spp.												
Mollusca	Gibbula spp.												
Mollusca	Nassarius nitidus												
Mollusca	Nassarius reticulatus												
Mollusca	Odostomia unidentata												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Mollusca	Nudibranchia spp.												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**		**0**	**0**	**0**	
Annelida	Alitta succinea												
Annelida	Ampharete												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Annelida	Ampharete finmarchica												
Annelida	Aonides paucibranchiata												
Annelida	Aphrodita aculeata												
Annelida	Capitella capitata-complex												
Annelida	Capitellidae spp.												
Annelida	Cauleriella alata												
Annelida	Caulleriella killariensis												
Annelida	Chaetozone setosa												
Annelida	Cirratulidae spp.												
Annelida	Dipolydora flava												
Annelida	Eteone spp.												
Annelida	Eulalia viridis												
Annelida	Eumida bahusiensis												
Annelida	Eumida sanguinea												
Annelida	Eumida spp.												
Annelida	Eunereis longissima												
Annelida	Gattyana cirrhosa												
Annelida	Glycera alba												
Annelida	Glycera capitata												
Annelida	Glycera convoluta												
Annelida	Glycera lapidum					1							
Annelida	Glycera oxycephala												
Annelida	Glycera spp.												
Annelida	Harmothoe aspera												
Annelida	Harmothoe clavigera												
Annelida	Harmothoe extenuata												
Annelida	Harmothoe spp.												
Annelida	Hesionura elongata												
Annelida	Heteromastus filiformis												
Annelida	Lagis koreni												
Annelida	Lanice conchilega												
Annelida	Lepidonotus squamatus												
Annelida	Lumbrineris aniara												
Annelida	Lumbrineris latreilli												
Annelida	Macrochaeta helgolandica					2							
Annelida	Magelona johnstoni												
Annelida	Mediomastus fragilis												
Annelida	Mysta picta												
Annelida	Neoamphitrite spp.												
Annelida	Nephtys assimilis												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Annelida	Nephtys cirrosa	1								1		1	
Annelida	Nephtys hombergii												
Annelida	Nephtys kersivalensis												
Annelida	Nephtys spp.												
Annelida	Notomastus latericeus												
Annelida	Ophelia borealis	1				2	2				2	1	
Annelida	Owenia fusiformis												
Annelida	Pherusa plumosa												
Annelida	Pholoe baltica												
Annelida	Pholoe inornata												
Annelida	Pholoe spp.												
Annelida	Phyllodoce citrina												
Annelida	Phyllodoce groenlandica												
Annelida	Phyllodoce mucosa												
Annelida	Phyllodoce spp.												
Annelida	Pisione remota												
Annelida	Polycirrus medusa												
Annelida	Polycirrus spp.												
Annelida	Polydora cornuta												
Annelida	Polygordius appendiculatus												
Annelida	Pseudopolydora pulchra												
Annelida	Pygospio elegans												
Annelida	Sabellaria spinulosa												
Annelida	Saccocirrus papillocercus												
Annelida	Scalibregma inflatum												
Annelida	Scolelepis bonnieri												
Annelida	Scoloplos armiger												
Annelida	Sphaerosyllis bulbosa												
Annelida	Spio armata												
Annelida	Spio decoratus												
Annelida	Spio filicornis												
Annelida	Spiophanes bombyx												
Annelida	Spiophanes kroyeri												
Annelida	Sthenelais boa												
Annelida	Terebellidae spp.						1						
Annelida	Travisia forbesii												
	Individuals	2	0	0		5	3	0		1	2	2	
	Taxa	**2**	**0**	**0**		**3**	**2**	**0**		**1**	**1**	**2**	
Arthropoda	Achelia echinata												
Bryozoa	Alcyonidium diaphanum												

Phylum	Species	B03-046-A	B03-046-B	B03-046-C		B03-047-A	B03-047-B	B03-047-C		B03-048-A	B03-048-B	B03-048-C	
Chordata	Ammodytes tobianus												
Arthropoda	Anoplodactylus petiolatus												
Arthropoda	Ammothella longipes												
Chordata	Ascidiacea spp.												
Chordata	Branchiostoma lanceolatum												
Ctenophora	Ctenophora spp.												
Chordata	Echiichthys vipera												
Echiura	Echiura spp.												
Bryozoa	Electra pilosa												
Bryozoa	Flustra foliacea												
Chordata	Gaidropsarus spp.												
Chordata	Gobiidae spp.												
Nematoda	Nematoda spp.												
Nemertea	Nemertea spp.												
Chordata	Pomatoschistus minutus												
Chordata	Pomatoschistus spp.												
Porifera	Porifera spp.												
Cephalorhyncha	Priapulida spp.												
Arthropoda	Pycnogonida spp.												
Sipuncula	Sipuncula spp.												
Sipuncula	Sipunculidea spp.												
Chordata	Solea solea												
Bryozoa	Vesicularia spinosa												
	Individuals	0	0	0		0	0	0		0	0	0	
	Taxa	0	0	0		0	0	0		0	0	0	

Raw data Abundance

RED=Grab not approved
YELLOW=Grab low volume, but analy
BLUE=Grab approved
P=Present

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Cnidaria	Actinaria spp.					4	2	
Cnidaria	Anthozoa spp.							7
Cnidaria	Campanulinidae spp.							
Cnidaria	Diphasia spp.							
Cnidaria	Hydrallmania falcata							
Cnidaria	Hydrozoa spp.							
Cnidaria	Nemertesia sp.							
Cnidaria	Obelia spp.							
Cnidaria	Rhizorhagium roseum							
Cnidaria	Sertulariidae							
Cnidaria	Tubularia indivisa							
Cnidaria	Tubularia spp.			P				
	Individuals	0	0	0		4	2	7
	Taxa	**0**	**0**	**1**		**1**	**1**	**1**
Arthropoda	Abludomelita obtusata							
Arthropoda	Ampelisca brevicornis					1		3
Arthropoda	Ampelisca spinipes							
Arthropoda	Ampelisca spp.						3	
Arthropoda	Aora gracilis							
Arthropoda	Aoridae spp.					3	2	
Arthropoda	Autonoe longipes							
Arthropoda	Balanus balanus							1
Arthropoda	Balanus spp.							
Arthropoda	Bathyporeia elegans							
Arthropoda	Bathyporeia guilliamsoniana		2					
Arthropoda	Bathyporeia nana		1					
Arthropoda	Bathyporeia sarsi							
Arthropoda	Bathyporeia spp.			2				
Arthropoda	Bathyporeia tenuipes							
Arthropoda	Bodotria scorpioides							
Arthropoda	Brachyura spp.							
Arthropoda	Campylaspis spp.					1		
Arthropoda	Carcinus maenas					1		
Arthropoda	Copepoda spp.							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Arthropoda	Corophium spp.						2	
Arthropoda	Crangon allmanni							
Arthropoda	Crangon crangon							
Arthropoda	Crangon spp.							
Arthropoda	Crustacea spp.							
Arthropoda	Dendrobranchiata spp.							
Arthropoda	Dexaminidae spp.			1				
Arthropoda	Diastylis glabra					2		
Arthropoda	Diastylis rugosa							
Arthropoda	Diastylis spp.							1
Arthropoda	Euphausiacea spp.							
Arthropoda	Galathea intermedia							
Arthropoda	Galathea spp.							
Arthropoda	Gammaridae spp.					10		12
Arthropoda	Gammaridea spp.							
Arthropoda	Gammaropsis maculata							
Arthropoda	Gammarus spp.							
Arthropoda	Gastrosaccus spinifer							
Arthropoda	Haustoriidae spp.							
Arthropoda	Hippomedon denticulatus							
Arthropoda	Idotea linearis							
Arthropoda	Isopoda spp.							
Arthropoda	Leucothoe incisa							
Arthropoda	Leucothoe spp.							
Arthropoda	Liocarcinus holsatus							
Arthropoda	Liocarcinus marmoreus							
Arthropoda	Liocarcinus pusillus							
Arthropoda	Liocarcinus spp.							
Arthropoda	Lysianassidae spp.							
Arthropoda	Monoculodes carinatus							
Arthropoda	Mysidae spp.							
Arthropoda	Oedicerotidae spp.							
Arthropoda	Paguridae spp.							
Arthropoda	Pagurus bernhardus						1	
Arthropoda	Pagurus spp.							
Arthropoda	Pariambus typicus							
Arthropoda	Pilumnus spp.							
Arthropoda	Pinnotheres pisum							
Arthropoda	Pisidia longicornis					3	2	
Arthropoda	Podoceridae spp.							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Arthropoda	Pontoporeiidae spp.							
Arthropoda	Porcellanidae spp.							
Arthropoda	Portunidae spp.					1		
Arthropoda	Processa canaliculata							
Arthropoda	Processa spp.							
Arthropoda	Semibalanus balanoides							
Arthropoda	Stenothoe monoculoides							
Arthropoda	Thia scutellata							
Arthropoda	Upogebia stellata							
Arthropoda	Urothoe brevicornis		6	7				
Arthropoda	Urothoe elegans							
Arthropoda	Urothoe marina							
Arthropoda	Urothoe spp.	2	1					
	Individuals	2	10	10		22	10	17
	Taxa	**1**	**4**	**3**		**8**	**5**	**4**
Echinodermata	Amphipholis squamata					8	7	
Echinodermata	Amphiuridae spp.							
Echinodermata	Asterias rubens							
Echinodermata	Echinocardium cordatum							
Echinodermata	Echinocardium flavescens							
Echinodermata	Echinocardium spp.							
Echinodermata	Echinocyamus pusillus							
Echinodermata	Holothurioidea spp.							
Echinodermata	Leptasterias muelleri							
Echinodermata	Ophiocten affinis							
Echinodermata	Ophiura albida						1	
Echinodermata	Ophiura ophiura							
Echinodermata	Ophiura sarsii							
Echinodermata	Ophiura spp.					2	4	1
Echinodermata	Ophiurae spp.							
Echinodermata	Ophiuroidea spp.							
Echinodermata	Psammechinus miliaris							1
Echinodermata	Spatangoida spp.							
	Individuals	0	0	0		10	12	2
	Taxa	**0**	**0**	**0**		**2**	**3**	**2**
Mollusca	Abra alba					5		5
Mollusca	Abra nitida		1					
Mollusca	Abra prismatica							
Mollusca	Abra spp.						10	
Mollusca	Abra tenuis							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Mollusca	Arca tetragona							
Mollusca	Bivalvia spp.							1
Mollusca	Corbula gibba					2	1	
Mollusca	Ensis magnus						2	4
Mollusca	Ensis spp.							
Mollusca	Glycymeris glycymeris							
Mollusca	Glycymeris spp.							
Mollusca	Goodallia triangularis							
Mollusca	Kurtiella bidentata							
Mollusca	Macoma balthica					1		
Mollusca	Mactridae spp.							
Mollusca	Mya spp.							
Mollusca	Mytilus spp.							
Mollusca	Mytilidae spp.	2		1				
Mollusca	Nucula nitidosa					4	10	14
Mollusca	Nucula sulcata						1	
Mollusca	Spisula elliptica						2	
Mollusca	Tapes spp.							
Mollusca	Tellimya ferruginosa					1		
Mollusca	Tellina fabula							
Mollusca	Tellina pygmaea							
Mollusca	Tellinidae spp.							
	Individuals	2	1	1		13	26	24
	Taxa	**1**	**1**	**1**		**5**	**6**	**4**
Mollusca	Buccinum undatum						1	1
Mollusca	Chauvetia brunnea							
Mollusca	Euspira montagui							
Mollusca	Euspira pulchella							
Mollusca	Gastropoda spp.							
Mollusca	Gibbula spp.						1	1
Mollusca	Nassarius nitidus							1
Mollusca	Nassarius reticulatus							
Mollusca	Odostomia unidentata							
	Individuals	0	0	0		0	2	3
	Taxa	**0**	**0**	**0**		**0**	**2**	**3**
Mollusca	Nudibranchia spp.					1		
	Individuals	0	0	0		0	0	0
	Taxa	**0**	**0**	**0**		**0**	**0**	**0**
Annelida	Alitta succinea							
Annelida	Ampharete	1				1		1

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Annelida	Ampharete finmarchica					2	1	
Annelida	Aonides paucibranchiata							
Annelida	Aphrodita aculeata						2	1
Annelida	Capitella capitata-complex							
Annelida	Capitellidae spp.							
Annelida	Cauleriella alata					1	1	
Annelida	Caulleriella killariensis					1		
Annelida	Chaetozone setosa							
Annelida	Cirratulidae spp.						5	1
Annelida	Dipolydora flava							
Annelida	Eteone spp.							1
Annelida	Eulalia viridis							
Annelida	Eumida bahusiensis							
Annelida	Eumida sanguinea					1		
Annelida	Eumida spp.							
Annelida	Eunereis longissima					1	1	2
Annelida	Gattyana cirrhosa					1		
Annelida	Glycera alba						2	
Annelida	Glycera capitata	2						
Annelida	Glycera convoluta							
Annelida	Glycera lapidum							
Annelida	Glycera oxycephala	2		1				
Annelida	Glycera spp.							1
Annelida	Harmothoe aspera							
Annelida	Harmothoe clavigera						1	
Annelida	Harmothoe extenuata					1		
Annelida	Harmothoe spp.							
Annelida	Hesionura elongata							
Annelida	Heteromastus filiformis					7	5	2
Annelida	Lagis koreni	1		1		5	2	4
Annelida	Lanice conchilega					1	7	
Annelida	Lepidonotus squamatus							1
Annelida	Lumbrineris aniara	1					2	1
Annelida	Lumbrineris latreilli							
Annelida	Macrochaeta helgolandica							
Annelida	Magelona johnstoni							
Annelida	Mediomastus fragilis							
Annelida	Mysta picta						1	
Annelida	Neoamphitrite spp.					1		
Annelida	Nephtys assimilis							

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Annelida	Nephtys cirrosa	1	2	1				
Annelida	Nephtys hombergii							1
Annelida	Nephtys kersivalensis					1		
Annelida	Nephtys spp.					2	1	8
Annelida	Notomastus latericeus	1				10	16	10
Annelida	Ophelia borealis	3	1	2				
Annelida	Owenia fusiformis							
Annelida	Pherusa plumosa							
Annelida	Pholoe baltica							1
Annelida	Pholoe inornata							
Annelida	Pholoe spp.							
Annelida	Phyllodoce citrina							
Annelida	Phyllodoce groenlandica							
Annelida	Phyllodoce mucosa	1					1	2
Annelida	Phyllodoce spp.							
Annelida	Pisione remota							
Annelida	Polycirrus medusa					2	2	
Annelida	Polycirrus spp.							
Annelida	Polydora cornuta							
Annelida	Polygordius appendiculatus							
Annelida	Pseudopolydora pulchra							
Annelida	Pygospio elegans							1
Annelida	Sabellaria spinulosa							
Annelida	Saccocirrus papillocercus							
Annelida	Scalibregma inflatum					4	1	
Annelida	Scolelepis bonnieri							
Annelida	Scoloplos armiger					1	3	3
Annelida	Sphaerosyllis bulbosa							
Annelida	Spio armata	2	1	1				
Annelida	Spio decoratus							
Annelida	Spio filicornis							
Annelida	Spiophanes bombyx							2
Annelida	Spiophanes kroyeri	1						
Annelida	Sthenelais boa						1	
Annelida	Terebellidae spp.							
Annelida	Travisia forbesii			1				
	Individuals	16	4	7		44	61	52
	Taxa	**11**	**3**	**6**		**19**	**19**	**18**
Arthropoda	Achelia echinata					1		
Bryozoa	Alcyonidium diaphanum					P		P

Phylum	Species	B03-049-A	B03-049-B	B03-049-C		B03-050-A	B03-050-B	B03-050-C
Chordata	Ammodytes tobianus							
Arthropoda	Anoplodactylus petiolatus					5	7	7
Arthropoda	Ammothella longipes						1	
Chordata	Ascidiacea spp.							
Chordata	Branchiostoma lanceolatum							
Ctenophora	Ctenophora spp.							
Chordata	Echiichthys vipera							
Echiura	Echiura spp.							
Bryozoa	Electra pilosa							
Bryozoa	Flustra foliacea							P
Chordata	Gaidropsarus spp.							
Chordata	Gobiidae spp.							
Nematoda	Nematoda spp.							
Nemertea	Nemertea spp.					1		
Chordata	Pomatoschistus minutus							
Chordata	Pomatoschistus spp.							
Porifera	Porifera spp.							
Cephalorhyncha	Priapulida spp.							
Arthropoda	Pycnogonida spp.	5				1		
Sipuncula	Sipuncula spp.							
Sipuncula	Sipunculidea spp.							
Chordata	Solea solea							
Bryozoa	Vesicularia spinosa	P	P					
	Individuals	5	0	0		8	8	7
	Taxa	2	1	0		5	2	3

Photo transect ID	Easting	Northing	Type of Sampling	Comments
100702-NEMO-DDV-B03_039_001, South to North				
100702-NEMO-DDV-B03-039_001_001	406212	5687069	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_002	406229	5687056	Photo	
100702-NEMO-DDV-B03-039_001_003	406247	5687044	Photo	
100702-NEMO-DDV-B03-039_001_004	406265	5687032	Photo	
100702-NEMO-DDV-B03-039_001_005	406281	5687020	Photo	
100702-NEMO-DDV-B03-039_001_006	406195	5687080	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_007	406178	5687092	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_008	406162	5687103	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_009	406146	5687114	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_010	406129	5687125	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_011	406112	5687137	Photo	
100702-NEMO-DDV-B03-039_001_012	406096	5687149	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_013	406080	5687159	Photo	
100702-NEMO-DDV-B03-039_001_014	406064	5687171	Photo	
100702-NEMO-DDV-B03-039_001_015	406048	5687181	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_016	406032	5687196	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_017	406015	5687208	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_018	405998	5687219	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_019	405981	5687232	Photo	
100702-NEMO-DDV-B03-039_001_020	405963	5687240	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_021	405946	5687252	Photo	
100702-NEMO-DDV-B03-039_001_022	405930	5687263	Photo	A few sabellaria tubes
100702-NEMO-DDV-B03-039_001_023	405914	5687273	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_024	405897	5687286	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039_001_025	405881	5687299	Photo	
100702-NEMO-DDV-B03-039_001_026	405865	5687311	Photo	
100702-NEMO-DDV-B03_039_002, East to west				
100702-NEMO-DDV-B03-039-002_001	406046	5687270	Photo	
100702-NEMO-DDV-B03-039-002_002	406036	5687253	Photo	
100702-NEMO-DDV-B03-039-002_003	406023	5687236	Photo	
100702-NEMO-DDV-B03-039-002_004	406012	5687219	Photo	
100702-NEMO-DDV-B03-039-002_005	406000	5687203	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039-002_006	405989	5687186	Photo	Sabellaria reef
100702-NEMO-DDV-B03-039-002_007	405980	5687169	Photo	
100702-NEMO-DDV-B03-039-002_008	405968	5687152	Photo	
100702-NEMO-DDV-B03-039-002_009	405955	5687137	Photo	
100702-NEMO-DDV-B03-039-002_010	405943	5687118	Photo	
100702-NEMO-DDV-B03-039-002_011	405932	5687100	Photo	

Photo transect ID	Easting	Northing	Type of Sampling	Comments
100702-NEMO-DDV-B03_040-001, East to west				
100702-NEMO-DDV-B03-040-001_001	404311	5686856	Photo	
100702-NEMO-DDV-B03-040-001_002	404294	5686853	Photo	
100702-NEMO-DDV-B03-040-001_003	404275	5686853	Photo	
100702-NEMO-DDV-B03-040-001_004	404254	5686851	Photo	
100702-NEMO-DDV-B03-040-001_005	404234	5686850	Photo	
100702-NEMO-DDV-B03-040-001_006	404214	5686850	Photo	
100702-NEMO-DDV-B03-040-001_007	404194	5686849	Photo	
100702-NEMO-DDV-B03-040-001_008	404174	5686849	Photo	
100702-NEMO-DDV-B03-040-001_009	404157	5686848	Photo	
100702-NEMO-DDV-B03-040-001_010	404137	5686848	Photo	
100702-NEMO-DDV-B03-040-001_011	404117	5686848	Photo	
100702-NEMO-DDV-B03-040_002, North to south				
100702-NEMO-DDV-B03-040-002_001	404296	5686930	Photo	
100702-NEMO-DDV-B03-040-002_002	404297	5686908	Photo	
100702-NEMO-DDV-B03-040-002_003	404299	5686888	Photo	
100702-NEMO-DDV-B03-040-002_004	404301	5686870	Photo	
100702-NEMO-DDV-B03-040-002_005	404302	5686849	Photo	
100702-NEMO-DDV-B03-040-002_006	404304	5686831	Photo	
100702-NEMO-DDV-B03-040-002_007	404305	5686811	Photo	

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-GS-B01-001	No		No		No	Sand and silt
100702-NEMO-GS-B01-002	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-003	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-004	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-005	No		No		No	Fine sand and silt
100702-NEMO-GS-B01-006	No		No		No	Fine sand and silt. Shell fragments
100702-NEMO-GS-B01-007	No		No		No	Sand with shell fragments
100702-NEMO-GS-B01-008	No		No		No	Sand and silt. Shell fragments
100702-NEMO-GS-B01-009	No		No		No	Fine sand and silt with occasional pebbles
100702-NEMO-GS-B01-010	No		No		No	Fine sand and gravel
100702-NEMO-GS-B01-011	No		No		No	Fine sand and gravel
100702-NEMO-GS-B01-012	No		No		No	Fine sand
100702-NEMO-GS-B01-013	No		No		No	Sand and shell fragments
100702-NEMO-GS-B01-014	No		No		No	Sand and a couple of cobbles
100702-NEMO-GS-B01-015	No		No		No	Sand and a couple of cobbles
100702-NEMO-GS-B01-016	No		No		No	Fine sand
100702-NEMO-GS-B01-017	No		No		No	Fine sand
100702-NEMO-GS-B01-018	No		No		No	Fine sand and very soft clay

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-GS-B01-019	No		No		No	Sandy clay and silt
100702-NEMO-GS-B01-020	No		No		No	Sandy clay and silt
100702-NEMO-GS-B02-021	No		No		No	Sand and cobbles
100702-NEMO-GS-B02-022	No		No		No	Fine sand and occasional cobbles
100702-NEMO-GS-B02-023	No		No		No	Fine sand
100702-NEMO-GS-B02-024	No		No		No	Fine sand and occasional cobbles
100702-NEMO-GS-B02-025	No		No		No	Fine sand, gravel and occasional cobbles
100702-NEMO-GS-B02-026	No		No		No	Sand, gravel and cobbles
100702-NEMO-GS-B02-027	No		No		No	Sand and gravel
100702-NEMO-GS-B02-028	No		No		No	Sand, gravel and pebbles
100702-NEMO-GS-B02-029	No		No		No	Sand and gravel
100702-NEMO-GS-B02-030	No		No		No	Sand and shell fragments
100702-NEMO-DDV-B03-031	No		No		No	Sand and gravel with shell fragments
100702-NEMO-DDV-B03-032	No		No		No	Fine and coarse sand
100702-NEMO-DDV-B03-033	No		No		No	Sand and pebbles
100702-NEMO-DDV-B03-034	No		No		No	Sand and pebbles
100702-NEMO-DDV-B03-035	No		No		No	Fine sand
100702-NEMO-DDV-B03-036	No		No		No	Fine sand and occasional cobbles

ID	Possible *Sabellaria* present Yes/No	Coverage of possible *Sabellaria* in image (%)	Possible *Modiolus modiolus* present	Coverage of possible *Modiolus modiolus* in image (%)	Possible Cobble reef present Yes/No	Comment
100702-NEMO-DDV-B03-037	No		No		No	Fine sand and silt
100702-NEMO-DDV-B03-038	No		No		No	Sand and cobbles
100702-NEMO-DDV-B03-039	Yes	50%	No		No	Sabellaria reef
100702-NEMO-DDV-B03-040	Yes	40%	No		No	Sabellaria reef
100702-NEMO-DDV-B03-041	No		No		No	Cobbles and coarse sand
100702-NEMO-DDV-B03-042	No		No		No	Pebbles and fine sand
100702-NEMO-DDV-B03-043	No		No		No	Pebbles and fine sand
100702-NEMO-DDV-B03-044	No		No		No	Fine sand
100702-NEMO-DDV-B03-045	No		No		No	Probably cobbles and sand
100702-NEMO-DDV-B03-046	No		No		No	Fine sand and gravel
100702-NEMO-DDV-B03-047	No		No		No	Sand and shell gravel
100702-NEMO-DDV-B03-048	No		No		No	Fine sand
100702-NEMO-DDV-B03-049	No		No		No	Sand
100702-NEMO-DDV-B03-050	No		No		No	Soft mixed sediment and shell fragments

100702-NEMO-TRAWL-B03-001				
Depth:	34 - 40 m		Start	Stop
Distance:	1200 m	Easting	431618	431195
Sample volume:	10 L	Northing	5686686	5686248

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CRUSTACEA			**VARIA**		
Crangon crangon	80		*Pleuronectes platessa*	12	22
Gastrosaccus spinifer	2		*Pleuronectes platessa*		22
Liocarcinus holsatus	7		*Pleuronectes platessa*		24
Liocarcinus marmoreus	26		*Pleuronectes platessa*		16
Pagurus bernhardus	1		*Pleuronectes platessa*		34
Processa spp.	4		*Pleuronectes platessa*		24
ECHINODERMATA			*Pleuronectes platessa*		14
Asterias rubens	2		*Pleuronectes platessa*		22
Ophiura ophiura	1		*Pleuronectes platessa*		20
MOLLUSCA-GASTROPODA			*Pleuronectes platessa*		20
Buccinum undatum	1		*Pleuronectes platessa*		26
POLYCHAETA			*Pleuronectes platessa*		16
Nepthys longosetosa	1		*Pomatoschistus spp.*	55	~3
VARIA			*Solea solea*	3	20
Arnoglossus laterna	3	12	*Solea solea*		18
Arnoglossus laterna		10	*Solea solea*		18
Arnoglossus laterna		10	*Trachinus draco*	13	~6
Callionymus lyra	2	6			
Callionymus lyra		2			

100702-NEMO-TRAWL-B03-002				
Depth:	40 - 42 m		Start	Stop
Distance:	610 m	Easting	426267	426207
Sample volume:	4L	Northing	5686965	5686362

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CNIDARIA			**VARIA**		
Flustra foliacea	1		*Arnoglossus laterna*	1	
Nemertesia spp.	P*		*Callionymus lyra*	6	14
Hydrallmania falcata	P		*Callionymus lyra*		6
CRUSTACEA			*Callionymus lyra*		4
Pagurus bernhardus	55		*Callionymus lyra*		3
Balanus balanus	1		*Callionymus lyra*		6
Crangon spp.	80		*Callionymus lyra*		4
Liocarcinus holsatus	1		*Hyperoplus lanceolatus*	1	6
Liocarcinus marmoreus	14		*Pleuronectes platessa*	5	20
Processa spp.	4		*Pleuronectes platessa*		18
ECHINODERMATA			*Pleuronectes platessa*		18
Asterias rubens	2		*Pleuronectes platessa*		18
Ophiuroidea	3		*Pleuronectes platessa*		18
MOLLUSCA-BIVALVIA			*Pomatochistus spp.*	140	~3
Aequipecten opercularis	6		*Solea solea*	3	25
Spisula elliptica	1		*Solea solea*		24
MOLLUSCA-GASTROPODA			*Solea solea*		14
Cryptonatica affinis	1		*Trisopterus minutus*	1	12
Crepidula fornicata	11				
MOLLUSCA-CEPHALOPODA					
Sepiola atlantica	4				

100702-NEMO-TRAWL-B03-003				
Depth:	40 m		Start	Stop
Distance:	600 m	Easting	416314	416909
Sample volume:	2L	Northing	5686883	5686778

SPECIES	Count	length (cm)	**SPECIES**	Count	length (cm)
CNIDARIA			**ECHINODERMATA**		
Abietinaria abietina	P*		*Amphipholis squamata*	1	
Actiniaria	2		*Asterias rubens*	3	
Alcyonium spp.	P		Holothurioidea	1	
Campanulariidae	P		*Ophiothrix fragilis*	2	
Clytia hemisphaerica	P		Ophiuroidea	11	
Hydrallmania falcata	P		*Psammechinus miliaris*	48	
Obelia sp.	P		**MOLLUSCA-BIVALVIA**		
Plumulariidae	P		*Aequipecten opercularis*	2	
Sertularia cupressina	P		**MOLLUSCA-NUDIBRANCHIA**		
CRUSTACEA			*Adalaria proxima*	P	
Pisidia longicornis	6		*Aeolidiella sp.*	1	
Ampelisca sp.	1		**MOLLUSCA-CEPHALOPODA**		
Aoridae	4		*Sepiola atlantica*	1	~0.5
Balanus crenatus	12		**POLYCHAETA**		
Caridea	6		*Eusyllis blomstrandi*	1	
Crangon allmanni	2		*Harmothoe extenuata*	1	
Crangon crangon	4		*Lepidonotus squamatus*	2	
Crangon sp.	1		**VARIA**		
Galathea intermedia	2		*Actinopterygii sp.*	1	
Galathea spp.	4		*Alcyonidium diaphanum*	P	
Gammaridea	1		Ascidiacea	4	
Gastrosaccus spinifer	2		Calloporidae	P	
Hippolyte varians	1		*Flustra foliacea*	P	
Iphimedia sp.	1		*Solea solea*	1	21
Ischyroceridae	1		*Trachurus trachurus*	1	9.5
Liocarcinus holsatus	1		*Trisopterus minutus*	1	12
Macropodia tenuirostris	6				
Pandalina spp.	44				

** P refers to present*

100702-NEMO-TRAWL-B03-004_C				
Depth:	34 m		Start	Stop
Distance:	640 m	Easting	413827	413933
Sample volume:	2L	Northing	5686470	5687099

SPECIES	Count	length (cm)	SPECIES	Count	length (cm)
CRUSTACEA			**VARIA**		
Pagurus bernhardus	28		*Trachinus draco*	9	12
ECHINODERMATA			*Trachinus draco*		9.5
Asterias rubens	2		*Trachinus draco*		10.5
MOLLUSCA-CEPHALOPODA			*Trachinus draco*		13
Sepiola atlantica	2		*Trachinus draco*		11
VARIA			*Trachinus draco*		9
Hyperoplus lanceolatus	2	17	*Trachinus draco*		8
Hyperoplus lanceolatus		12.5	*Trachinus draco*		8
			Trachinus draco		3.5

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-001	B01-002	B01-003	B01-004	B01-005
Total weight of sample:		[g]	432.99	516.02	325.72	555.64	678.93
FW	**< 0.063 mm**	[g]	74.36	36.90	167.17	34.84	20.55
FW	**0.063-0.250 mm**	[g]	20.69	18.97	11.28	13.11	13.33
FW	**0.125-0.250 mm**	[g]	213.20	348.91	116.54	251.10	174.42
FW	**0.250-0.500 mm**	[g]	82.96	75.58	26.25	158.03	331.99
FW	**0.500-1.000 mm**	[g]	21.26	13.95	1.27	14.97	74.63
FW	**1.000-2.000 mm**	[g]	9.00	7.31	1.03	10.28	28.68
FW	**> 2.000 mm**	[g]	11.52	14.40	2.18	73.31	35.33
q	**< 0,002 mm**	[%]	1.26	0.61	3.76	0.44	0.29
q	**0.002-0.004 mm**	[%]	1.68	0.87	5.75	0.68	0.44
q	**0.004-0.008 mm**	[%]	2.70	1.30	9.46	1.16	0.64
q	**0.008-0.016 mm**	[%]	3.86	1.78	14.12	1.75	0.80
q	**0.016-0.032 mm**	[%]	3.65	1.38	10.45	1.23	0.48
q	**0.032-0.063 mm**	[%]	4.02	1.21	7.78	1.01	0.37
q	**0.063-0.125 mm**	[%]	4.78	3.68	3.46	2.36	1.96
q	**0.125-0.250 mm**	[%]	49.24	67.62	35.78	45.19	25.69
q	**0.250-0.500 mm**	[%]	19.16	14.65	8.06	28.44	48.90
q	**0.500-1.000 mm**	[%]	4.91	2.70	0.39	2.69	10.99
q	**1.000-2.000 mm**	[%]	2.08	1.42	0.32	1.85	4.22
q	**> 2.000 mm**	[%]	2.66	2.79	0.67	13.19	5.20
Q	**< 0,002 mm**	[%]	1.26	0.61	3.76	0.44	0.29
Q	**< 0.004 mm**	[%]	2.94	1.48	9.51	1.12	0.73
Q	**< 0.008 mm**	[%]	5.65	2.78	18.98	2.28	1.37
Q	**< 0.016 mm**	[%]	9.50	4.56	33.10	4.03	2.18
Q	**< 0.032 mm**	[%]	13.15	5.94	43.55	5.26	2.65
Q	**< 0.063 mm**	[%]	17.17	7.15	51.32	6.27	3.03
Q	**< 0.125 mm**	[%]	21.95	10.83	54.79	8.63	4.99
Q	**< 0.250 mm**	[%]	71.19	78.44	90.57	53.82	30.68
Q	**< 0.500 mm**	[%]	90.35	93.09	98.62	82.26	79.58
Q	**< 1.000 mm**	[%]	95.26	95.79	99.01	84.96	90.57
Q	**< 2.000 mm**	[%]	97.34	97.21	99.33	86.81	94.80

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-006	B01-007	B01-008	B01-009	B01-010
Total weight of sample:		[g]	631.88	677.41	675.83	733.31	689.40
FW	**< 0.063 mm**	[g]	18.20	9.20	0.29	4.26	0.26
FW	**0.063-0.250 mm**	[g]	8.88	8.92	0.73	2.82	0.55
FW	**0.125-0.250 mm**	[g]	187.23	55.59	5.74	147.50	17.80
FW	**0.250-0.500 mm**	[g]	326.84	334.58	103.03	532.53	562.29
FW	**0.500-1.000 mm**	[g]	78.78	185.65	291.66	33.07	27.73
FW	**1.000-2.000 mm**	[g]	7.71	71.42	219.23	5.84	7.02
FW	**> 2.000 mm**	[g]	4.24	12.04	55.16	7.29	73.74
q	**< 0,002 mm**	[%]	0.34	0.11	0.00	0.05	0.00
q	**0.002-0.004 mm**	[%]	0.50	0.18	0.00	0.07	0.00
q	**0.004-0.008 mm**	[%]	0.67	0.28	0.01	0.12	0.01
q	**0.008-0.016 mm**	[%]	0.77	0.38	0.01	0.17	0.01
q	**0.016-0.032 mm**	[%]	0.40	0.23	0.01	0.11	0.01
q	**0.032-0.063 mm**	[%]	0.19	0.18	0.01	0.07	0.01
q	**0.063-0.125 mm**	[%]	1.41	1.32	0.11	0.38	0.08
q	**0.125-0.250 mm**	[%]	29.63	8.21	0.85	20.11	2.58
q	**0.250-0.500 mm**	[%]	51.73	49.39	15.24	72.62	81.56
q	**0.500-1.000 mm**	[%]	12.47	27.41	43.16	4.51	4.02
q	**1.000-2.000 mm**	[%]	1.22	10.54	32.44	0.80	1.02
q	**> 2.000 mm**	[%]	0.67	1.78	8.16	0.99	10.70
Q	**< 0,002 mm**	[%]	0.34	0.11	0.00	0.05	0.00
Q	**< 0.004 mm**	[%]	0.84	0.29	0.01	0.12	0.01
Q	**< 0.008 mm**	[%]	1.51	0.57	0.01	0.24	0.01
Q	**< 0.016 mm**	[%]	2.28	0.95	0.03	0.40	0.02
Q	**< 0.032 mm**	[%]	2.69	1.18	0.04	0.51	0.03
Q	**< 0.063 mm**	[%]	2.88	1.36	0.04	0.58	0.04
Q	**< 0.125 mm**	[%]	4.29	2.68	0.15	0.97	0.12
Q	**< 0.250 mm**	[%]	33.92	10.88	1.00	21.08	2.70
Q	**< 0.500 mm**	[%]	85.64	60.27	16.24	93.70	84.26
Q	**< 1.000 mm**	[%]	98.11	87.68	59.40	98.21	88.29
Q	**< 2.000 mm**	[%]	99.33	98.22	91.84	99.01	89.30

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-011	B01-012	B01-013	B01-014	B01-015
Total weight of sample:		[g]	630.27	587.73	637.86	663.84	826.48
FW	**< 0.063 mm**	[g]	6.34	6.13	0.41	0.26	0.60
FW	**0.063-0.250 mm**	[g]	1.04	2.74	0.64	0.76	0.41
FW	**0.125-0.250 mm**	[g]	33.20	50.23	28.83	36.99	21.21
FW	**0.250-0.500 mm**	[g]	558.31	315.68	303.81	539.08	589.72
FW	**0.500-1.000 mm**	[g]	18.66	126.70	137.96	52.70	147.35
FW	**1.000-2.000 mm**	[g]	6.27	49.48	57.73	10.44	36.83
FW	**> 2.000 mm**	[g]	6.45	36.77	108.47	23.61	30.36
q	**< 0,002 mm**	[%]	0.09	0.09	0.00	0.00	0.01
q	**0.002-0.004 mm**	[%]	0.14	0.15	0.00	0.00	0.01
q	**0.004-0.008 mm**	[%]	0.22	0.22	0.00	0.01	0.02
q	**0.008-0.016 mm**	[%]	0.29	0.30	0.01	0.01	0.02
q	**0.016-0.032 mm**	[%]	0.20	0.22	0.01	0.01	0.01
q	**0.032-0.063 mm**	[%]	0.06	0.06	0.04	0.01	0.01
q	**0.063-0.125 mm**	[%]	0.17	0.47	0.10	0.11	0.05
q	**0.125-0.250 mm**	[%]	5.27	8.55	4.52	5.57	2.57
q	**0.250-0.500 mm**	[%]	88.58	53.71	47.63	81.21	71.35
q	**0.500-1.000 mm**	[%]	2.96	21.56	21.63	7.94	17.83
q	**1.000-2.000 mm**	[%]	0.99	8.42	9.05	1.57	4.46
q	**> 2.000 mm**	[%]	1.02	6.26	17.01	3.56	3.67
Q	**< 0,002 mm**	[%]	0.09	0.09	0.00	0.00	0.01
Q	**< 0.004 mm**	[%]	0.23	0.24	0.01	0.01	0.02
Q	**< 0.008 mm**	[%]	0.45	0.46	0.01	0.01	0.03
Q	**< 0.016 mm**	[%]	0.74	0.76	0.02	0.02	0.05
Q	**< 0.032 mm**	[%]	0.94	0.98	0.03	0.03	0.07
Q	**< 0.063 mm**	[%]	1.01	1.04	0.06	0.04	0.07
Q	**< 0.125 mm**	[%]	1.17	1.51	0.17	0.15	0.12
Q	**< 0.250 mm**	[%]	6.44	10.06	4.69	5.73	2.69
Q	**< 0.500 mm**	[%]	95.02	63.77	52.32	86.93	74.04
Q	**< 1.000 mm**	[%]	97.98	85.32	73.94	94.87	91.87
Q	**< 2.000 mm**	[%]	98.98	93.74	82.99	96.44	96.33

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-016	B01-017	B01-018	B01-019	B01-020
Total weight of sample:		[g]	671.42	617.21	26.26	21.00	21.21
FW	**< 0.063 mm**	[g]	0.56	6.80	8.27	10.21	16.72
FW	**0.063-0.250 mm**	[g]	1.67	80.06	3.83	1.55	1.00
FW	**0.125-0.250 mm**	[g]	94.16	155.11	11.96	8.83	3.07
FW	**0.250-0.500 mm**	[g]	521.89	283.78	1.61	0.28	0.25
FW	**0.500-1.000 mm**	[g]	43.76	82.73	0.33	0.08	0.11
FW	**1.000-2.000 mm**	[g]	8.26	7.46	0.14	0.05	0.06
FW	**> 2.000 mm**	[g]	1.12	1.27	0.12	0.00	0.00
q	**< 0,002 mm**	[%]	0.01	0.11	2.35	3.11	4.86
q	**0.002-0.004 mm**	[%]	0.01	0.17	3.67	5.04	7.72
q	**0.004-0.008 mm**	[%]	0.01	0.26	6.41	9.78	13.87
q	**0.008-0.016 mm**	[%]	0.02	0.33	8.97	14.86	21.58
q	**0.016-0.032 mm**	[%]	0.02	0.21	5.65	9.32	17.17
q	**0.032-0.063 mm**	[%]	0.01	0.02	4.44	6.51	13.64
q	**0.063-0.125 mm**	[%]	0.25	12.97	14.58	7.38	4.70
q	**0.125-0.250 mm**	[%]	14.02	25.13	45.55	42.05	14.48
q	**0.250-0.500 mm**	[%]	77.73	45.98	6.13	1.33	1.18
q	**0.500-1.000 mm**	[%]	6.52	13.40	1.26	0.38	0.52
q	**1.000-2.000 mm**	[%]	1.23	1.21	0.53	0.24	0.28
q	**> 2.000 mm**	[%]	0.17	0.21	0.46	0.00	0.00
Q	**< 0,002 mm**	[%]	0.01	0.11	2.35	3.11	4.86
Q	**< 0.004 mm**	[%]	0.02	0.29	6.02	8.15	12.58
Q	**< 0.008 mm**	[%]	0.03	0.55	12.43	17.93	26.45
Q	**< 0.016 mm**	[%]	0.06	0.87	21.40	32.79	48.03
Q	**< 0.032 mm**	[%]	0.08	1.08	27.05	42.11	65.20
Q	**< 0.063 mm**	[%]	0.08	1.10	31.49	48.62	78.84
Q	**< 0.125 mm**	[%]	0.33	14.07	46.07	56.00	83.54
Q	**< 0.250 mm**	[%]	14.36	39.20	91.62	98.05	98.02
Q	**< 0.500 mm**	[%]	92.09	85.18	97.75	99.38	99.20
Q	**< 1.000 mm**	[%]	98.60	98.59	99.01	99.76	99.72
Q	**< 2.000 mm**	[%]	99.83	99.79	99.54	100.00	100.00

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B01-022	B02-021	B02-023	B02-025	B02-027
Total weight of sample:		[g]	652.80	828.78	668.15	640.82	691.15
FW	**< 0.063 mm**	[g]	1.38	1.92	0.41	3.64	0.00
FW	**0.063-0.250 mm**	[g]	0.85	0.96	0.29	0.68	1.01
FW	**0.125-0.250 mm**	[g]	57.24	78.15	36.93	39.84	71.35
FW	**0.250-0.500 mm**	[g]	539.40	522.74	616.59	483.87	465.53
FW	**0.500-1.000 mm**	[g]	34.53	133.87	10.39	85.37	92.54
FW	**1.000-2.000 mm**	[g]	9.57	49.60	2.59	16.77	28.19
FW	**> 2.000 mm**	[g]	9.83	41.54	0.94	10.65	32.21
q	**< 0,002 mm**	[%]	0.02	0.02	0.00	0.05	0.00
q	**0.002-0.004 mm**	[%]	0.03	0.03	0.01	0.08	0.00
q	**0.004-0.008 mm**	[%]	0.04	0.05	0.01	0.13	0.00
q	**0.008-0.016 mm**	[%]	0.06	0.07	0.02	0.17	0.00
q	**0.016-0.032 mm**	[%]	0.04	0.04	0.02	0.11	0.00
q	**0.032-0.063 mm**	[%]	0.02	0.02	0.01	0.03	0.00
q	**0.063-0.125 mm**	[%]	0.13	0.12	0.04	0.11	0.15
q	**0.125-0.250 mm**	[%]	8.77	9.43	5.53	6.22	10.32
q	**0.250-0.500 mm**	[%]	82.63	63.07	92.28	75.51	67.36
q	**0.500-1.000 mm**	[%]	5.29	16.15	1.56	13.32	13.39
q	**1.000-2.000 mm**	[%]	1.47	5.98	0.39	2.62	4.08
q	**> 2.000 mm**	[%]	1.51	5.01	0.14	1.66	4.66
Q	**< 0,002 mm**	[%]	0.02	0.02	0.00	0.05	0.00
Q	**< 0.004 mm**	[%]	0.05	0.05	0.01	0.13	0.00
Q	**< 0.008 mm**	[%]	0.09	0.10	0.02	0.26	0.00
Q	**< 0.016 mm**	[%]	0.15	0.17	0.03	0.43	0.00
Q	**< 0.032 mm**	[%]	0.19	0.21	0.05	0.54	0.00
Q	**< 0.063 mm**	[%]	0.21	0.23	0.06	0.57	0.00
Q	**< 0.125 mm**	[%]	0.34	0.35	0.11	0.67	0.15
Q	**< 0.250 mm**	[%]	9.11	9.78	5.63	6.89	10.47
Q	**< 0.500 mm**	[%]	91.74	72.85	97.92	82.40	77.83
Q	**< 1.000 mm**	[%]	97.03	89.00	99.47	95.72	91.22
Q	**< 2.000 mm**	[%]	98.49	94.99	99.86	98.34	95.29

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B02-028	B02-029	B02-030	B03-031	B03-032
Total weight of sample:		[g]	834.37	550.32	640.25	570.16	544.29
FW	**< 0.063 mm**	[g]	0.16	0.95	0.39	0.00	2.37
FW	**0.063-0.250 mm**	[g]	0.56	0.76	0.54	0.10	0.57
FW	**0.125-0.250 mm**	[g]	526.95	45.94	19.04	2.61	31.26
FW	**0.250-0.500 mm**	[g]	142.17	270.37	465.64	240.80	231.67
FW	**0.500-1.000 mm**	[g]	46.91	88.41	79.63	191.78	126.37
FW	**1.000-2.000 mm**	[g]	40.83	46.85	24.47	30.84	48.08
FW	**> 2.000 mm**	[g]	76.79	97.04	50.54	104.03	103.97
q	**< 0,002 mm**	[%]	0.00	0.01	0.00	0.00	0.03
q	**0.002-0.004 mm**	[%]	0.00	0.02	0.01	0.00	0.05
q	**0.004-0.008 mm**	[%]	0.00	0.03	0.01	0.00	0.08
q	**0.008-0.016 mm**	[%]	0.00	0.05	0.02	0.00	0.12
q	**0.016-0.032 mm**	[%]	0.01	0.04	0.01	0.00	0.08
q	**0.032-0.063 mm**	[%]	0.00	0.03	0.01	0.00	0.06
q	**0.063-0.125 mm**	[%]	0.07	0.14	0.08	0.02	0.10
q	**0.125-0.250 mm**	[%]	63.16	8.35	2.97	0.46	5.74
q	**0.250-0.500 mm**	[%]	17.04	49.13	72.73	42.23	42.56
q	**0.500-1.000 mm**	[%]	5.62	16.07	12.44	33.63	23.22
q	**1.000-2.000 mm**	[%]	4.89	8.51	3.82	5.41	8.83
q	**> 2.000 mm**	[%]	9.20	17.63	7.89	18.24	19.10
Q	**< 0,002 mm**	[%]	0.00	0.01	0.00	0.00	0.03
Q	**< 0.004 mm**	[%]	0.00	0.03	0.01	0.00	0.08
Q	**< 0.008 mm**	[%]	0.01	0.06	0.02	0.00	0.17
Q	**< 0.016 mm**	[%]	0.01	0.11	0.04	0.00	0.29
Q	**< 0.032 mm**	[%]	0.01	0.14	0.05	0.00	0.37
Q	**< 0.063 mm**	[%]	0.02	0.17	0.06	0.00	0.44
Q	**< 0.125 mm**	[%]	0.09	0.31	0.15	0.02	0.54
Q	**< 0.250 mm**	[%]	63.24	8.66	3.12	0.48	6.28
Q	**< 0.500 mm**	[%]	80.28	57.79	75.85	42.70	48.85
Q	**< 1.000 mm**	[%]	85.90	73.85	88.28	76.34	72.06
Q	**< 2.000 mm**	[%]	90.80	82.37	92.11	81.74	80.90

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B03-035	B03-037	B03-039	B03-042	B03-043
Total weight of sample:		[g]	588.24	715.91	633.93	458.63	693.53
FW	**< 0.063 mm**	[g]	0.00	12.52	19.25	15.35	0.95
FW	**0.063-0.250 mm**	[g]	0.51	6.79	18.98	34.50	4.13
FW	**0.125-0.250 mm**	[g]	42.98	93.01	104.40	340.33	199.41
FW	**0.250-0.500 mm**	[g]	523.07	600.19	407.69	39.48	261.08
FW	**0.500-1.000 mm**	[g]	17.71	1.15	48.11	3.14	94.74
FW	**1.000-2.000 mm**	[g]	1.90	0.82	18.70	3.32	52.35
FW	**> 2.000 mm**	[g]	2.07	1.42	16.80	22.51	80.88
q	**< 0,002 mm**	[%]	0.00	0.18	0.30	0.35	0.01
q	**0.002-0.004 mm**	[%]	0.00	0.25	0.44	0.49	0.02
q	**0.004-0.008 mm**	[%]	0.00	0.32	0.60	0.67	0.02
q	**0.008-0.016 mm**	[%]	0.00	0.40	0.73	0.81	0.03
q	**0.016-0.032 mm**	[%]	0.00	0.26	0.45	0.50	0.03
q	**0.032-0.063 mm**	[%]	0.00	0.34	0.52	0.52	0.03
q	**0.063-0.125 mm**	[%]	0.09	0.95	2.99	7.52	0.60
q	**0.125-0.250 mm**	[%]	7.30	12.99	16.47	74.21	28.75
q	**0.250-0.500 mm**	[%]	88.88	83.84	64.31	8.61	37.64
q	**0.500-1.000 mm**	[%]	3.01	0.16	7.59	0.68	13.66
q	**1.000-2.000 mm**	[%]	0.32	0.11	2.95	0.72	7.55
q	**> 2.000 mm**	[%]	0.35	0.20	2.65	4.91	11.66
Q	**< 0,002 mm**	[%]	0.00	0.18	0.30	0.35	0.01
Q	**< 0.004 mm**	[%]	0.00	0.43	0.73	0.84	0.03
Q	**< 0.008 mm**	[%]	0.00	0.75	1.33	1.51	0.05
Q	**< 0.016 mm**	[%]	0.00	1.15	2.06	2.32	0.08
Q	**< 0.032 mm**	[%]	0.00	1.41	2.51	2.82	0.11
Q	**< 0.063 mm**	[%]	0.00	1.75	3.04	3.35	0.14
Q	**< 0.125 mm**	[%]	0.09	2.70	6.03	10.87	0.73
Q	**< 0.250 mm**	[%]	7.39	15.69	22.50	85.08	29.48
Q	**< 0.500 mm**	[%]	96.27	99.53	86.81	93.68	67.13
Q	**< 1.000 mm**	[%]	99.28	99.69	94.40	94.37	80.79
Q	**< 2.000 mm**	[%]	99.60	99.80	97.35	95.09	88.34

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

Sample ID:			B03-044	B03-046	B03-047	B03-048	B03-049
Total weight of sample:		[g]	602.03	844.02	569.89	826.62	79.22
FW	**< 0.063 mm**	[g]	0.98	1.69	3.48	1.17	0.72
FW	**0.063-0.250 mm**	[g]	5.51	5.35	3.06	5.60	1.60
FW	**0.125-0.250 mm**	[g]	177.41	20.24	102.54	148.56	13.33
FW	**0.250-0.500 mm**	[g]	416.41	503.69	112.17	670.58	55.02
FW	**0.500-1.000 mm**	[g]	0.88	217.79	214.58	0.61	7.03
FW	**1.000-2.000 mm**	[g]	0.09	57.60	61.11	0.10	0.80
FW	**> 2.000 mm**	[g]	0.75	37.66	72.95	0.00	0.72
q	**< 0,002 mm**	[%]	0.01	0.02	0.05	0.01	0.07
q	**0.002-0.004 mm**	[%]	0.02	0.03	0.09	0.02	0.11
q	**0.004-0.008 mm**	[%]	0.03	0.04	0.11	0.02	0.15
q	**0.008-0.016 mm**	[%]	0.04	0.05	0.17	0.03	0.22
q	**0.016-0.032 mm**	[%]	0.03	0.03	0.13	0.03	0.17
q	**0.032-0.063 mm**	[%]	0.03	0.03	0.06	0.03	0.19
q	**0.063-0.125 mm**	[%]	0.91	0.63	0.54	0.68	2.02
q	**0.125-0.250 mm**	[%]	29.47	2.40	17.99	17.97	16.83
q	**0.250-0.500 mm**	[%]	69.17	59.68	19.68	81.12	69.45
q	**0.500-1.000 mm**	[%]	0.15	25.80	37.65	0.07	8.87
q	**1.000-2.000 mm**	[%]	0.01	6.82	10.72	0.01	1.01
q	**> 2.000 mm**	[%]	0.12	4.46	12.80	0.00	0.91
Q	**< 0,002 mm**	[%]	0.01	0.02	0.05	0.01	0.07
Q	**< 0.004 mm**	[%]	0.03	0.05	0.13	0.03	0.18
Q	**< 0.008 mm**	[%]	0.06	0.08	0.24	0.05	0.33
Q	**< 0.016 mm**	[%]	0.10	0.13	0.42	0.08	0.54
Q	**< 0.032 mm**	[%]	0.13	0.17	0.55	0.11	0.71
Q	**< 0.063 mm**	[%]	0.16	0.20	0.61	0.14	0.91
Q	**< 0.125 mm**	[%]	1.08	0.83	1.15	0.82	2.93
Q	**< 0.250 mm**	[%]	30.55	3.23	19.14	18.79	19.75
Q	**< 0.500 mm**	[%]	99.71	62.91	38.82	99.91	89.21
Q	**< 1.000 mm**	[%]	99.86	88.71	76.48	99.99	98.08
Q	**< 2.000 mm**	[%]	99.88	95.54	87.20	100.00	99.09

FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

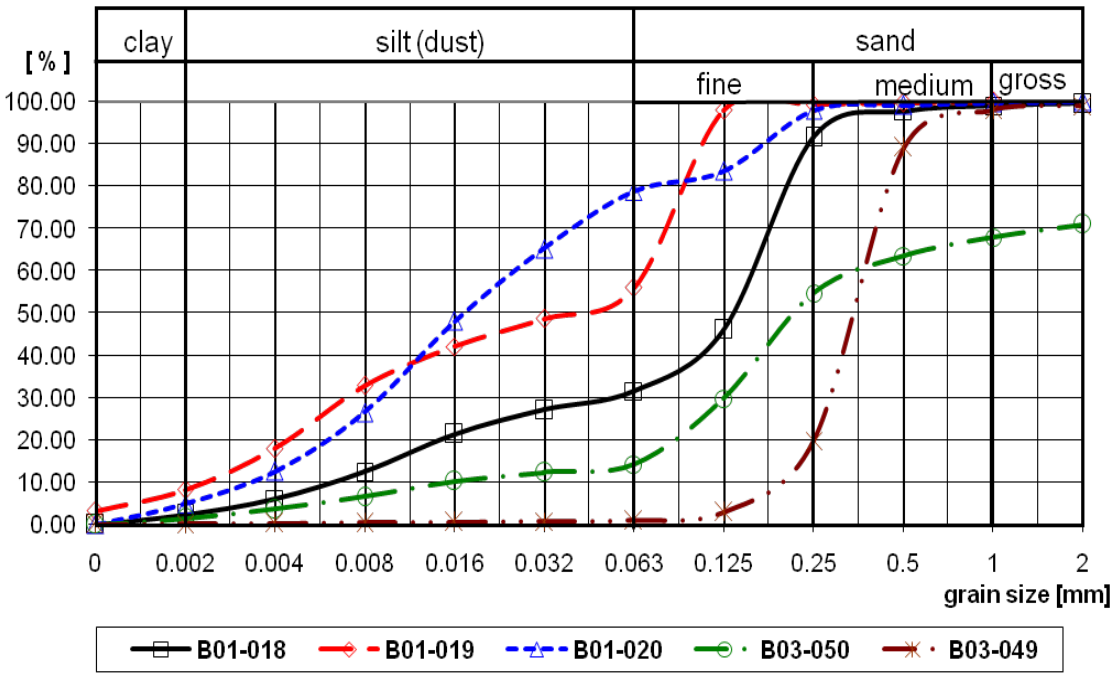
Analyzed by: ALS Czech Republic, s.r.o., Laboratory Česká Lípa
Bendlova 1687/7, CZ-470 03 Česká Lípa, Czech Republic

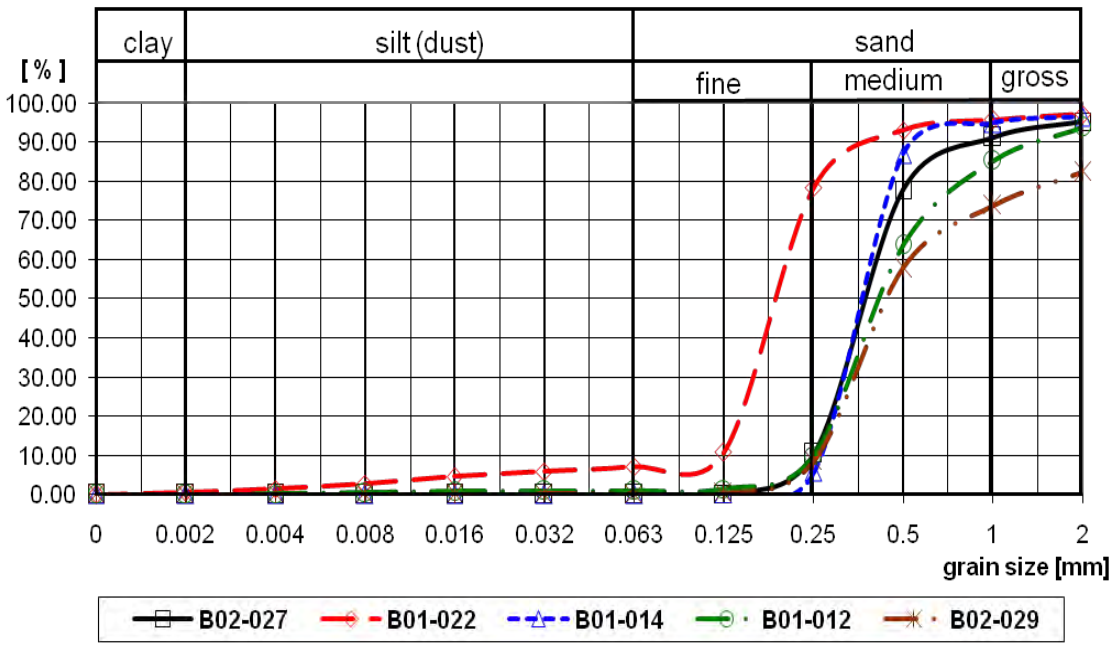
Sample ID:			B03-050
Total weight of sample:		[g]	30.35
FW	**< 0.063 mm**	[g]	4.29
FW	**0.063-0.250 mm**	[g]	4.73
FW	**0.125-0.250 mm**	[g]	7.60
FW	**0.250-0.500 mm**	[g]	2.65
FW	**0.500-1.000 mm**	[g]	1.34
FW	**1.000-2.000 mm**	[g]	0.93
FW	**> 2.000 mm**	[g]	8.81
q	**< 0,002 mm**	[%]	1.34
q	**0.002-0.004 mm**	[%]	2.21
q	**0.004-0.008 mm**	[%]	2.93
q	**0.008-0.016 mm**	[%]	3.68
q	**0.016-0.032 mm**	[%]	2.16
q	**0.032-0.063 mm**	[%]	1.83
q	**0.063-0.125 mm**	[%]	15.57
q	**0.125-0.250 mm**	[%]	25.04
q	**0.250-0.500 mm**	[%]	8.73
q	**0.500-1.000 mm**	[%]	4.42
q	**1.000-2.000 mm**	[%]	3.06
q	**> 2.000 mm**	[%]	29.03
Q	**< 0,002 mm**	[%]	1.34
Q	**< 0.004 mm**	[%]	3.55
Q	**< 0.008 mm**	[%]	6.48
Q	**< 0.016 mm**	[%]	10.16
Q	**< 0.032 mm**	[%]	12.32
Q	**< 0.063 mm**	[%]	14.15
Q	**< 0.125 mm**	[%]	29.72
Q	**< 0.250 mm**	[%]	54.76
Q	**< 0.500 mm**	[%]	63.49
Q	**< 1.000 mm**	[%]	67.91
Q	**< 2.000 mm**	[%]	70.97

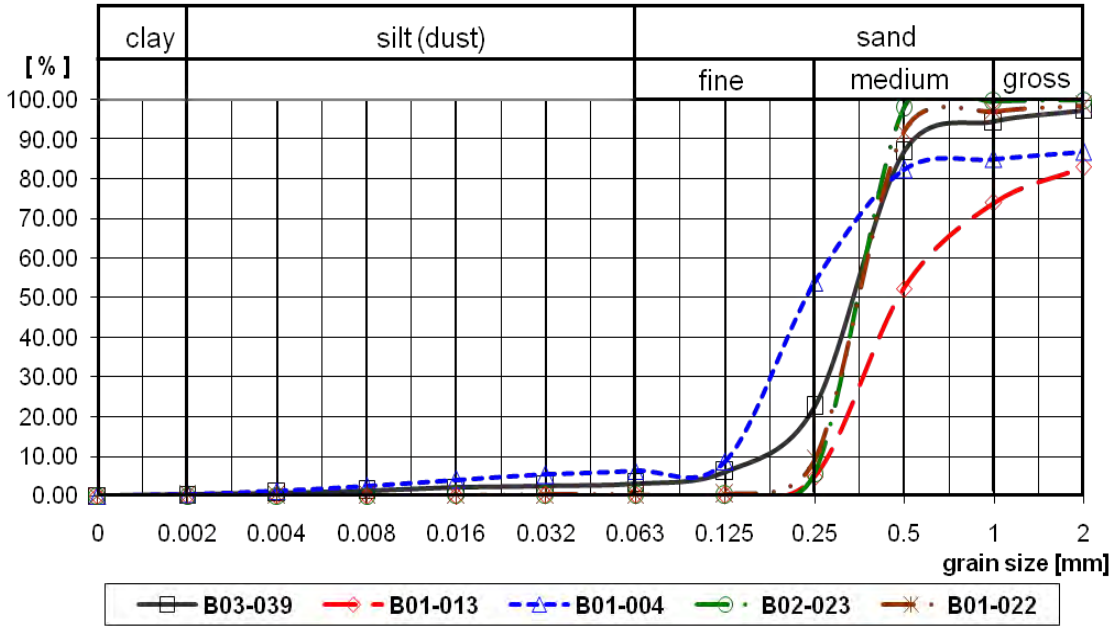
FW - fraction weight, **q** -fraction percentage part, **Q** - fraction cumulative part.

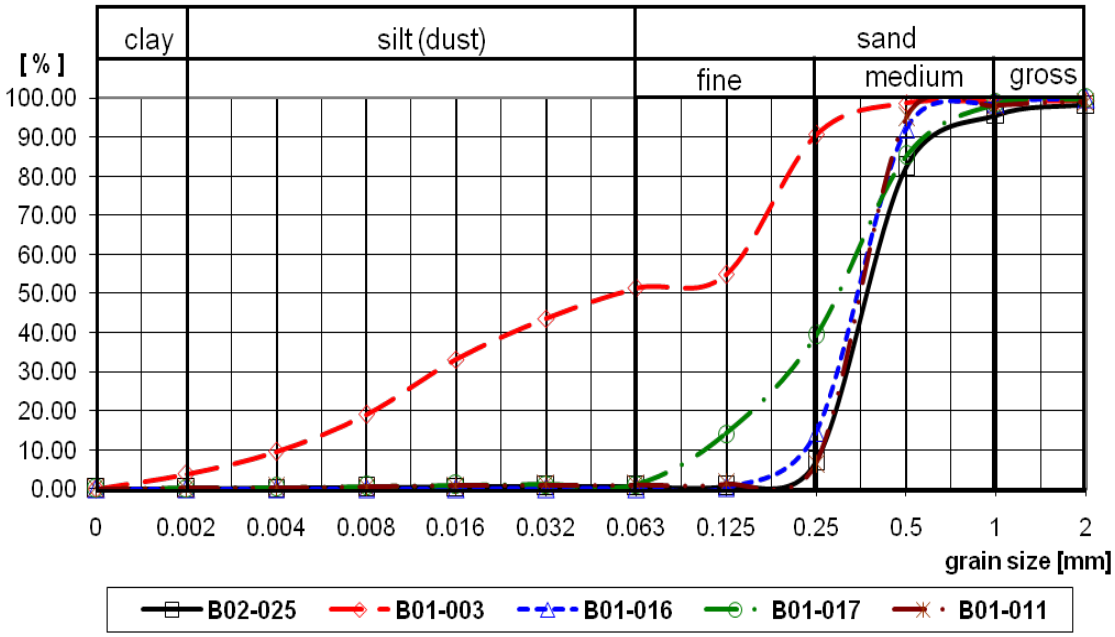
Test method specification: CZ_SOP_D06_07_N11 Grain size analysis. Fractions > 2 mm, 1-2 mm, 0.5-1 mm, 0.25-0.50 mm, 0.125-0.25 mm and 0.063-0.125 mm were determined by wet sieving method, other fractions were determined from the fraction "<0.063 mm" by laser particle size analyzer using liquid dispersion mode.

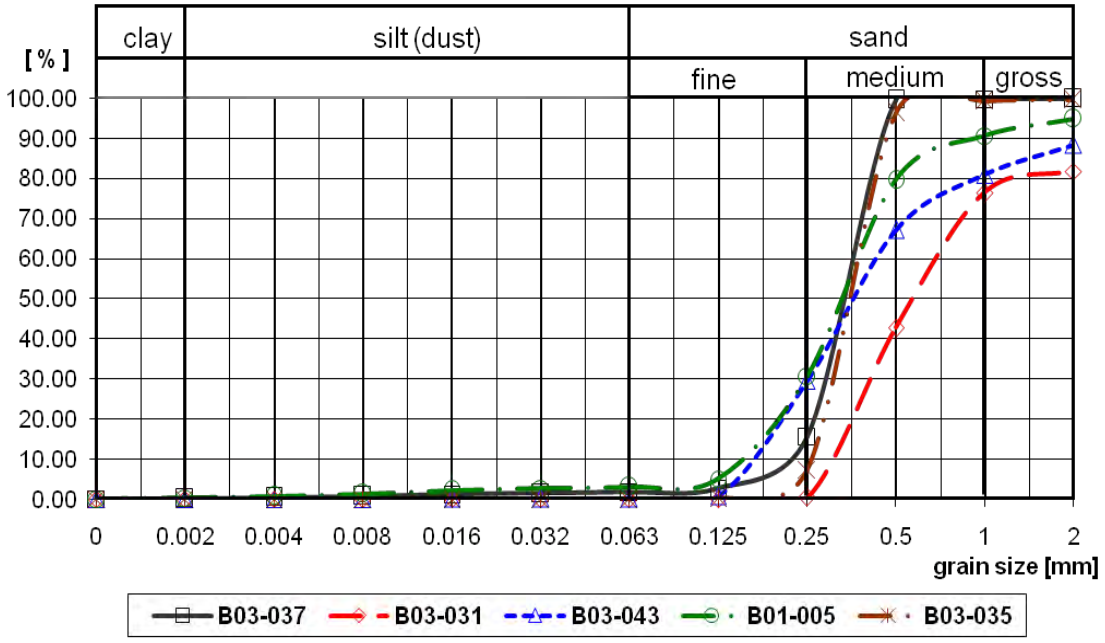
Test specification, deviations, additions to or exclusions from the test specification: Results of this method are not accredited.

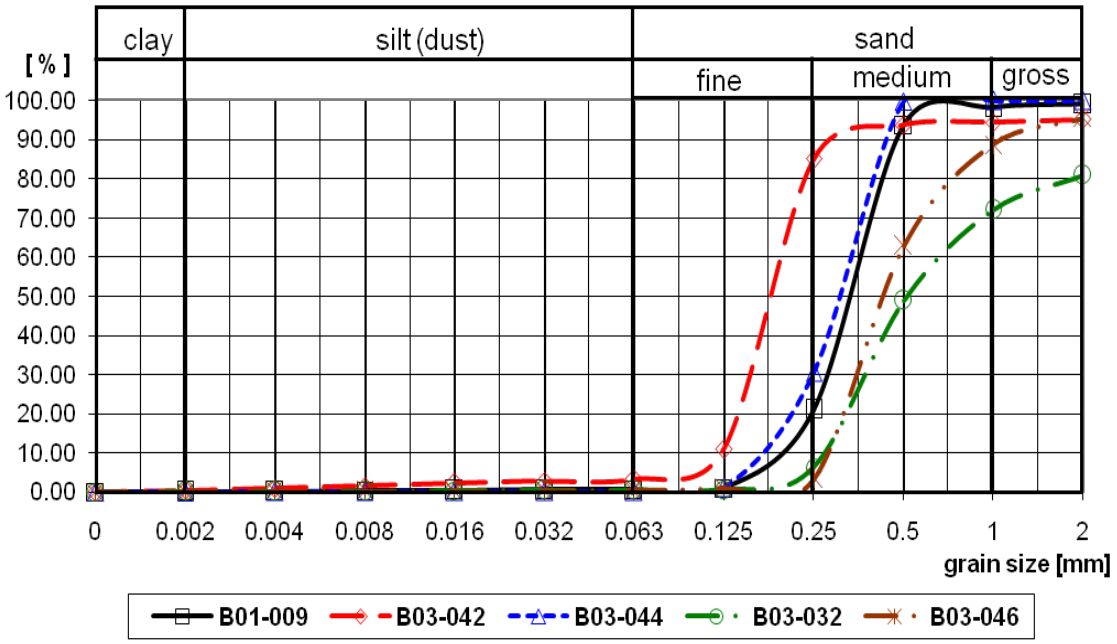

clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B01-018
B01-019
B01-020
B03-050
B03-049

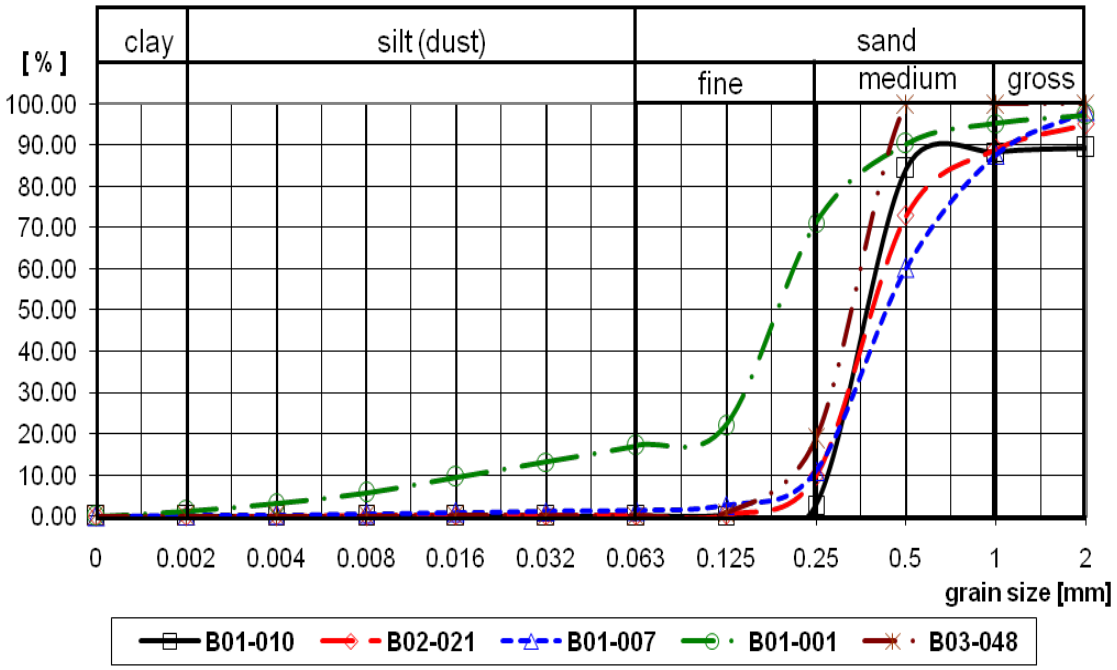

clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B02-027
B01-022
B01-014
B01-012
B02-029

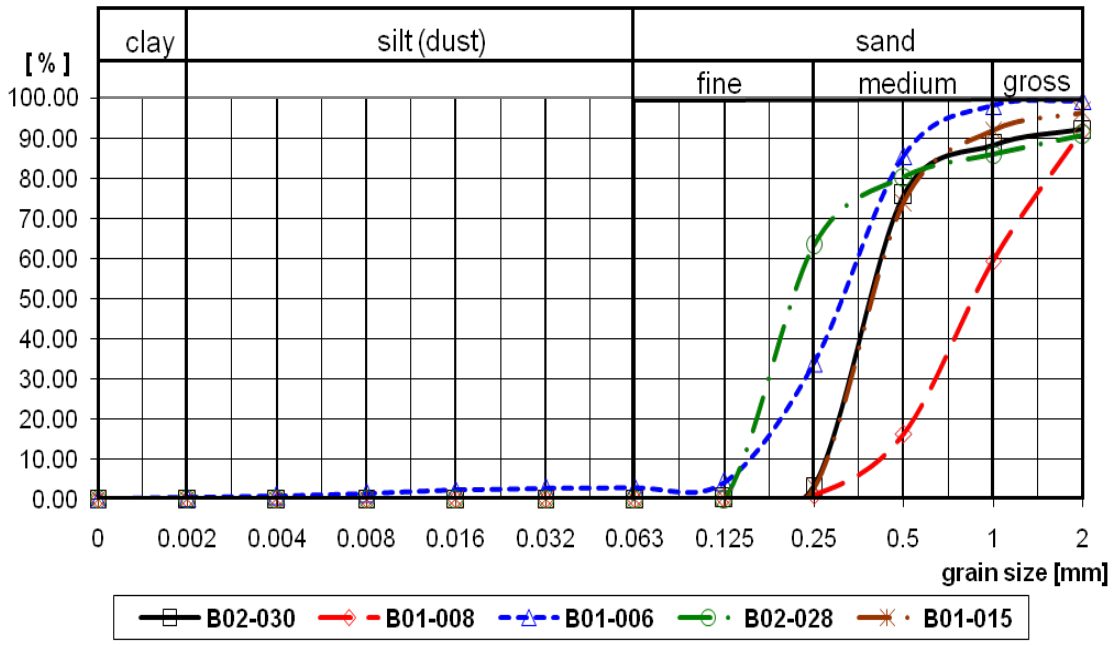

clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B03-039
B01-013
B01-004
B02-023
B01-022

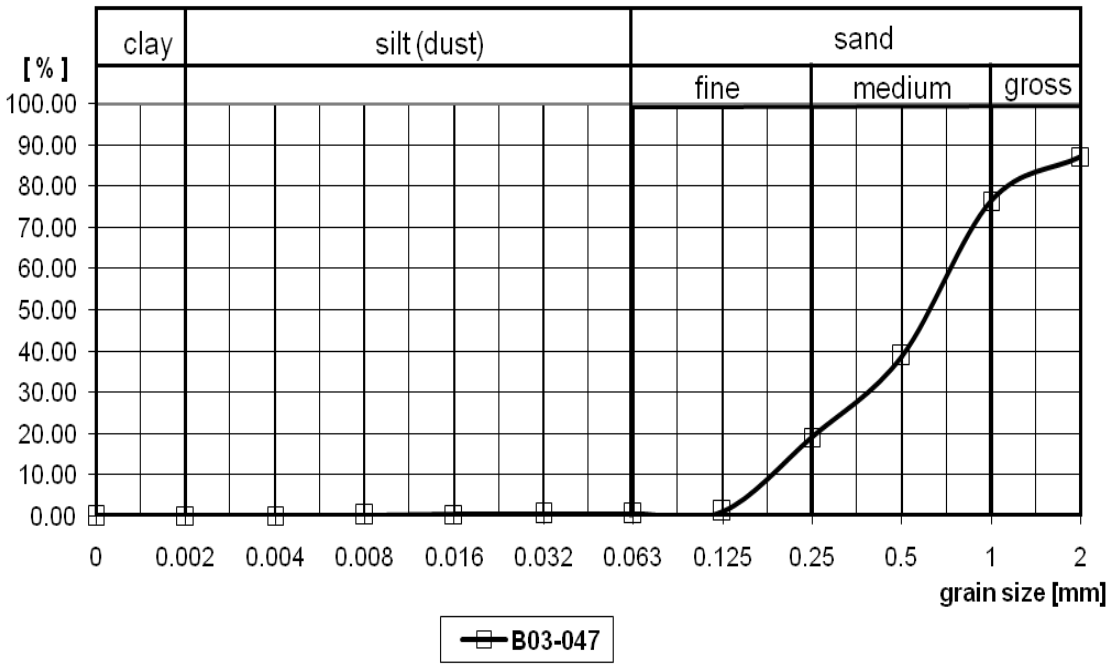

clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B02-025
B01-003
B01-016
B01-017
B01-011


clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B03-037
B03-031
B03-043
B01-005
B03-035


clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B01-009
B03-042
B03-044
B03-032
B03-046


clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B01-010
B02-021
B01-007
B01-001
B03-048


clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B02-030
B01-008
B01-006
B02-028
B01-015


clay
silt (dust)
sand
fine
medium
gross
[%]
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
0.002
0.004
0.008
0.016
0.032
0.063
0.125
0.25
0.5
1
2
grain size [mm]
B03-047

Appendix 12: Archaeological EIA

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR
RICHBOROUGH TO WEST-ZEEBRUGGE

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

Volume I: Report

(*cf.* Volume II: Appendices)

Prepared for:

PMSS

by
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Portway House
Old Sarum Park
Salisbury
SP4 6EB

Report reference: 73390.03

March 2011

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Title:	Project Nemo: UK-Belgium Electrical Interconnector – Richborough to West-Zeebrugge Archaeological Environmental Impact Assessment
Principal Author(s):	[redacted]
Managed by:	[redacted]
Origination date:	March 2011
Date of last revision:	March 2011
Version:	73390.03 – Volume I
Wessex Archaeology QA:	[redacted]
Status:	Final Report
Summary of changes:	Final Report produced from first draft with client comments as well as additional amendments received the 24/03/2011
Associated reports:	73390.01 – Volume I, 73390.02 – Volume I, 73390.03 – Volume II
Client Approval:	[redacted] PMSS

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Vlaams Instituut voor het Onroerent Erfgoed (VIOE)

De Centrale Archeologische Inventaris is een inventaris van tot nog toe gekende archeologische vindplaatsen. Vanwege het specifieke karakter van het archeologisch erfgoed dat voor ons verborgen zit in de ondergrond, is het onmogelijk om op basis van de Centrale Archeologische Inventaris uitspraken te doen over de aan- of afwezigheid van archeologische sporen. De aan- of afwezigheid van archeologische sporen dient met verder onderzoek vastgesteld te worden.

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PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

Summary

Wessex Archaeology was commissioned by PMSS, on behalf of Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL), to carry out an archaeological desk-based assessment for the Project Nemo UK-Belgium Electrical Interconnector cable route.

This assessment comprises an archaeological baseline study, including an archaeological assessment of geophysical and geotechnical data and an assessment of the effects of the cable route development on archaeological receptors. This will ultimately form part of the Environmental Statement for the proposed Project Nemo development. This present assessment does not include an evaluation of the intertidal data because they have not been made available at the writing stage of this report, however once accessible these data will be archaeologically assessed and included in an updated report.

The cable route extends from the English Landfall at Pegwell Bay in Kent to the Belgian Landfall in West-Zeebrugge, and a wide variety of local, regional, national, and international guidance and legislation applies. Therefore, this report has been structured to facilitate the interpretation of the archaeological resource within this legislative framework. The Study Areas comprised the Kent Landfall (inland of the mean high water mark level), English Waters (from mean high water, including the 12 nm limit and EEZ), French Waters (EEZ), Belgian Waters (from mean high water, including the 12 nm limit and EEZ), and the Belgian Landfall (inland of the mean high water mark level). Within this report, the known and potential archaeological resource of each area is individually examined. The combined results of the desk-based assessment of archaeological data sources and archaeological geophysical and geotechnical assessments revealed:

- At the Kent Landfall:
  - 2 Listed Buildings
  - 67 other archaeological sites and findspots, dating from the Neolithic to modern period
- In English, French and Belgian Waters:
  - 8 sites of anthropogenic origin of archaeological interest identified or confirmed with the archaeological assessment of geophysical survey data including:
    - 3 wreck sites recorded by the UKHO, SHOM and VIOE;
    - 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;
  - 254 additional geophysical anomalies of possible archaeological interest;

  - A number of channels of probable prehistoric date and potential archaeological interest; and
  - 24 additional wrecks recorded by the UKHO, SHOM and VIOE but outside of the geophysical survey coverage.
- At the Belgian Landfall:
  - 37 archaeological sites and findspots dating from the Roman period to the modern period, plus numerous findspots on the beach.

The baseline study also revealed further potential for as yet undiscovered sites and material dating from the Palaeolithic to modern period, including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material.

The impact assessment outlines the nature of the likely direct, indirect and secondary impacts on the known and potential archaeological sites during the course of the construction, operation and decommissioning of the Project Nemo interconnector cable. With the exception of a few modern wrecks, the effects of all potential direct and secondary impacts on the known archaeological receptors (including terrestrial sites and findspots, submerged prehistoric material, shipwrecks, aircraft crash sites and related material) are judged to be significant where an unmitigated impact occurs. The effects resulting from all potential indirect or cumulative impacts are expected to be negligible.

Although it is not possible to assess the significance of impacts on potential archaeological sites and material, as the magnitude of effects and the sensitivity of the receptor cannot be evaluated until further details regarding the presence/absence and nature of each receptor have been established, any damage or destruction to them would be permanent and effects are likely to be judged to be significant. If sites or findspots are discovered during the development, each would need to be considered on a site by site basis.

All known wrecks were avoided during the cable route design phase, but further mitigation measures proposed in the impact assessment include:

- Temporary Archaeological Exclusion Zones with a 50 m diameter around the extents of 8 known wreck sites and geophysical anomalies of anthropogenic origin identified in the geophysical survey data:

WA ID	Easting	Northing	Description	Study Area
7024	389786	5685532	Previously unrecorded wreck	English Waters
7027	391279	5685143	Geophysical anomaly of anthropogenic origin	English Waters
7047	394777	5685245	Geophysical anomaly of anthropogenic origin	English Waters
7049	395957	5685445	Geophysical anomaly of anthropogenic origin – recorded by the UKHO as a live obstruction	English Waters
7098	416527	5686440	Geophysical anomaly of anthropogenic origin	English Waters
7141	438175	5686526	Live wreck, possibly the HMS *Westella*, recorded by the UKHO and SHOM	French Waters
7151	446702	5685213	Live wreck recorded by the UKHO and SHOM	French Waters
7200	460851	5689298	Live wreck, *Tringa*, recorded in by the UKHO and VIOE	Belgian Waters

- Buffers around the location of 18 wrecks or archaeological importance recorded by the UKHO, SHOM or VIOE, which are located outside of the

geophysical survey data area. The buffers provide a guide as to the potential extents of the wrecks, in order to protect them from secondary impacts such as vessel anchorages. A full list can be found in **Table 12.2**;

- Further investigation of identified anomalies (rated High or Medium) that are likely to be impacted along the cable route, as specified in the WSI, including in the intertidal zone during watching briefs, in the offshore area during a pre-lay grapnel run, and by the Archaeological Reporting Protocol;
- The establishment of a Written Scheme of Investigation and an Archaeological Reporting Protocol, in order to minimise impact on potential sites, which will ensure that any finds are promptly reported, archaeological advice is obtained, and any recovered material is stabilised, recorded and conserved;
- A watching brief for intertidal works, pre-lay grapnel runs, and cable installation;
- Further examination of potential prehistoric deposits identified in the geoarchaeological investigations, including Stage 3 to 5 geoarchaeological recording of recovered sub-samples, and archaeological input into any future sampling programme, particularly in the intertidal or foreshore areas; and
- Should they be planned, then archaeological assessment of any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo.

It is expected that with the implementation of mitigation, based on the assessment outlined in this report, the residual effects of the development on any archaeological receptors will be minor.

Glossary

Dead wreck: according to the UKHO it refers to a wreck which has not been detected by repeated surveys and is considered to not exist (or be absent) from the designated location.

Devensian: this term is used by British geologist and archaeologist in order to refer to the most recent glacial period.

Eocene: it refers to a geological epoch comprised between 55.8 Ma and 33.9 Ma.

Holocene: is a geological period beginning approximately 11700 years BP.

Live wreck: according to the UKHO this terms gather all wrecks which are not dead of which have not been lifted, either charted or uncharted.

Mesolithic: is a period in the human development of human technology between the Palaeolithic and the Neolithic.

Neolithic: this is a period of human evolution and specifically which sees the passage from a nomadic to sedentary life style.

Palaeocene: it refers to a geological epoch comprised between 65.5 Ma and 55.8 Ma.

Pleistocene: is the name of a geological period that spans over the recent repeated glaciations between 2.588 Ma and 12000 years BP.

Palaeolithic

Lower Palaeolithic: this term comprise the first subdivision of the Palaeolithic from 2.5 Ma until approximately 300,000 years BP.

Middle Palaeolithic: it refers to the second subdivision of the Palaeolithic which spans from 300,000 years BP to 30,000 years BP.

Abbreviations

BP: Before Present

EEZ: Exclusive Economic Zone

HER: Historic Environment Record

NMR: National Monuments Record

UKHO: United Kingdom Hydrographic Office

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

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PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

Contents

1 INTRODUCTION 1
2 STUDY AREA 1
3 METHODOLOGY 1
3.1 APPROACH 1
3.2 SOURCES 2
3.3 LEGISLATION 2
3.4 PRODUCTION OF BASE-LINE – RESEARCH AND ASSESSMENT 3
3.5 ARCHAEOLOGICAL INTERPRETATION OF GEOPHYSICAL DATA 3
3.6 ARCHAEOLOGICAL INTERPRETATION OF GEOTECHNICAL DATA 7
3.7 IMPACT ASSESSMENT 8
4 REGIONAL ARCHAEOLOGICAL OVERVIEW 11
4.1 INTRODUCTION 11
4.2 CHRONOLOGIES 12
4.3 OVERVIEW 12
4.4 REGIONAL MARINE GEOLOGICAL ASSESSMENT – FROM SUB-BOTTOM PROFILER AND GEOTECHNICAL VIBROCORE DATA 31
4.5 REGIONAL SEABED FEATURES ASSESSMENT – FROM MAGNETOMETER, SIDESCAN AND MULTIBEAM DATA 31
5 KENT LANDFALL, ENGLAND 32
5.1 INTRODUCTION 32
5.2 GEOLOGY 33
5.3 COASTAL CHANGE 33
5.4 HISTORIC LANDSCAPE CHARACTER 33
5.5 KNOWN TERRESTRIAL SITES 34
5.6 POTENTIAL 39
6 ENGLISH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY 39
6.1 INTRODUCTION 39
6.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT 39
6.3 KNOWN WRECKS AND OBSTRUCTIONS IN ENGLISH WATERS 40
6.4 POTENTIAL 45
7 FRENCH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY 47
7.1 INTRODUCTION 47
7.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT 47
7.3 KNOWN WRECKS AND OBSTRUCTIONS IN FRENCH WATERS 47
7.4 POTENTIAL SITES IN FRENCH WATERS 49
8 BELGIAN WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY 51
8.1 INTRODUCTION 51
8.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT 51
8.3 KNOWN WRECKS AND OBSTRUCTIONS IN BELGIAN WATERS 52
8.4 POTENTIAL 56

9 BELGIAN LANDFALL – KNOWN AND POTENTIAL TERRESTRIAL ARCHAEOLOGY 58
9.1 INTRODUCTION 58
9.2 GEOLOGY 58
9.3 KNOWN SITES 58
10 IMPACT ASSESSMENT 61
10.1 DESCRIPTION OF POTENTIAL IMPACTS 61
10.2 IDENTIFICATION OF EFFECTS 64
11 MITIGATION AND MONITORING 71
11.1 MITIGATION 71
11.2 MONITORING 76
12 RESIDUAL IMPACT 76
13 REFERENCES 81

Figures

Figure 1: Study Area
Figure 2: Glaciation and sea level changes in the UK during the Palaeolithic and Mesolithic
Figure 3: Map of the proposed cable route showing geological features of potential archaeological interest and vibrocore locations
Figure 4: Kent Landfall – map regression (BNG)
Figure 5: Known sites in the Kent Landfall Study Area - (BNG)
Figure 6: 1940s aerial photographs of the Kent Landfall Study Area (Photographs courtesy of NMR)
Figure 7: Sub-bottom profiler and multibeam bathymetry data examples illustrating palaeochannels in the UK sector
Figure 8: Known wrecks and geophysical anomalies of known or possible archaeological potential in the English Waters Study Area
Figure 9: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7024 (UK Sector)
Figure 10: Sidescan sonar images illustrating debris 7047 (top) and 7049 (bottom) (UK Sector)
Figure 11: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7027 (UK Sector)
Figure 12: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7098 (UK Sector)
Figure 13: Known wrecks and geophysical anomalies of known or possible archaeological potential in the in the French Waters Study Area
Figure 14: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7141 (French Sector)
Figure 15: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7151 (French Sector)
Figure 16: Sub-bottom profiler data example illustrating palaeochannels in the Belgian sector
Figure 17: Known wrecks and geophysical anomalies of known or possible archaeological potential in the Belgian Waters Study Area
Figure 18: Sidescan sonar and multibeam bathymetry data examples illustrating wreck 7200 (Belgian Sector)
Figure 19: Known sites in the Belgian Landfall Study Area
Figure 20: Mitigation – temporary archaeological exclusion zones and buffers (English Waters Study Area)
Figure 21: Mitigation – temporary archaeological exclusion zones and buffers (French Waters Study Area)
Figure 22: Mitigation – temporary archaeological exclusion zones and buffers (Belgian Waters Study Area)

Plates

Plate 1 Access to foreshore prohibited as it is a Sensitive Wildlife Area
Plate 2 Kent Landfall looking north towards petrol station
Plate 3 Overview of Kent Landfall from Petrol Station looking SE
Plate 4 Area of unstable ground immediately to NE of petrol station
Plate 5 Overview of Kent Landfall, looking SW from the former hoverport
Plate 6 Closeup of overview of Kent Landfall, looking SW from former hoverport
Plate 7 Line of posts extending towards cliffs on NE side of Pegwell Bay
Plate 8 Remains of WWI train ferry (**WA1043**), photo taken facing south across intertidal area
Plate 9 Blankenberge pier – photo taken from top of dunes
Plate 10 View of West-Zeebrugge port from top of dyke/dune systems
Plate 11 Dyke / dune system taken from shore
Plate 12 Facing dyke / dune systems
Plate 13 Beach access – facing dyke/dune systems
Plate 14 View of Zeebrugge port from the shore
Plate 15 Example of a modern breakwater dating from the 1960's, near Blankenberge, facing NW
Plate 16 Example of a modern breakwater dating from the 1960's, near Blankenberge, facing dyke/dune systems

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT
Volume I: Report

Ref: 73390.03

1 INTRODUCTION

1.1.1 Wessex Archaeology was commissioned by PMSS, on behalf of Elia Asset S.A. (Elia) and National Grid International Ltd (NGIL), to carry out an archaeological desk-based assessment of the Project Nemo UK-Belgium Electrical Interconnector.

1.1.2 The aim of the archaeological assessment is to inform the overall Environmental Statement for the Project. The assessment comprises a baseline study, incorporating a review of existing geophysical and geotechnical data, an assessment of the impact of the cable route on the known and potential archaeological resource, and suggested mitigation measures.

1.1.3 Due to the unavailability of intertidal data, this report does not provide such assessment, but once accessible these data will be archaeologically assessed and the results included in an updated report.

2 STUDY AREA

2.1.1 The proposed Nemo electrical interconnector cable will extend approximately 130 km between Pegwell Bay in Kent to the West-Zeebrugge in Belgium.

2.1.2 The archaeological Study Area comprises a composite of the original route and further iterations buffered to 500 m on either side (**Figure 1**). Additional buffers were applied to the potential landfalls. The buffers provide confidence that all relevant sites are considered, given the relatively poor positional data of known marine and terrestrial archaeological sites and material.

2.1.3 A Regional Archaeological Overview provides a backdrop and context for the general area, however, to assist with regulatory divisions the known and potential archaeological resource has been examined in more detail within five sub-study-areas: Kent Landfall, English Waters, French Waters, Belgian Waters, Belgian Landfall.

3 METHODOLOGY

3.1 APPROACH

3.1.1 This assessment was carried out in a manner consistent with available guidance, including the Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development, in line with Defra's *Explanatory Memorandum to The Marine Works* (*Environmental Impact Assessment) Regulations 2007 No. 1518*, and European Directives for Environmental Impact Assessments (85/337/EEC, 97/11/EC 2003/35/EC), DETR 02/99, Meylemans *et al.* 2005, and with the Institute

for Archaeologists (IfA) Standard and Guidance for Desk-based Assessment (IfA 2008).

3.2 SOURCES

3.2.1 The principal sources consulted in drafting this desk-based assessment comprised:

- United Kingdom Hydrographic Office (UKHO) wreck record;
- English Heritage's National Monuments Record (NMR);
- Kent Historic Environment Record (Kent HER);
- Service Hydrographique et Oceanographique de la Marine (SHOM) wreck record;
- Vlaams Instituut voor het Onroerent Erfgoed (VIOE) wreck record;
- Centrale Archeologische Inventaris (CAI) terrestrial sites record;
- 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 2004) 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 2008) 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.

3.3 LEGISLATION

3.3.1 The Cable Route Study Area falls within several different jurisdictions, each covered by different legislation and guidance and under the responsibility of different curators

and heritage agencies. The Kent Landfall to low water is covered by English Heritage, Kent County Council and local councils. English Heritage is responsible for the archaeological resource within England's Territorial Waters (to the 12 nm limit) and is consultee for the resource in the UK Exclusive Economic Zone (EEZ). The Study Area is located beyond French Territorial Waters (the 12 nm limit), and the archaeological resource in the French EEZ is administered by Pas de Calais, with the support of DRASSM if requested. In the Belgian EEZ and within Belgian Territorial Waters (to the 12 nm limit), the archaeological resource is administered by VIOE. At the Belgian Landfall to low water, the archaeological resource is also administered by VIOE with local councils.

3.3.2 Details about the applicable legislation and guidance for England, France, Belgium, the Exclusive Economic Zones are presented in **Appendix I** in **Volume II**.

3.4 PRODUCTION OF BASE-LINE – RESEARCH AND ASSESSMENT

3.4.1 Searches of third party data sources, outlined above, were carried out to establish the archaeological baseline. These searches requested data regarding known terrestrial sites and marine sites (including ship and aircraft wrecks) and documented losses (casualties). Further information was obtained from published sources and available unpublished reports relevant to the study areas.

3.4.2 The spatial data has been imported into ESRI ArcGIS 9.3 software package. The use of GIS allows spatial comparison of the data in relation to mapping, charts and bathymetry and facilitated interpretation of the known sites with respect to the available secondary sources. Information that could not be mapped in the GIS was compiled in a project archive and used qualitatively.

3.4.3 The spatial data from the Kent Landfall were supplied in British National Grid, and have been conserved in that format in the GIS, appendices and figures. The spatial data for English Waters were supplied in WGS84 lat/long, French Waters in WGS84 lat/long and French National Grid (RGF 1993 Lambert 93), Belgian Waters in WGS84 lat/long and the Belgium Landfall in Belgium National Grid Projection (Belge Lambert 72 datum). These spatial data were converted to WGS84 UTM Zone 31N using Quest Geodetic calculator by Quest Geo Solutions, and are presented in WGS84 UTM Zone 31N in the GIS, appendices and figures, although the Belgian Landfall co-ordinates are also presented in Belgium National Grid in the appendices. Further details about the transformation parameters are included in Volume II Appendix X.

3.4.4 The known archaeology has been examined in five separate areas to facilitate review by statutory consultees and to best manage and assess the terrestrial and marine data and the potential development impacts. The areas are the English Landfall, English Waters (from high water including the English 12 nm limit and English EEZ), French Waters (comprising the French EEZ), Belgian Waters (from high water including the Belgian 12 nm limit and Belgian EEZ), and Belgian Landfall. The known archaeological data was queried in combination with secondary sources in order to contribute to the assessment of the archaeological potential of the area.

3.5 ARCHAEOLOGICAL INTERPRETATION OF GEOPHYSICAL DATA

Data Sources

3.5.1 As part of the EIA of the proposed scheme, Wessex Archaeology (WA) carried out an archaeological assessment of marine geophysical data previously collected by Marin Mätteknik (MMT) AB.

3.5.2 The aims of this assessment were to carry out an archaeological interpretation of the marine geophysical data acquired from the survey area. This has resulted in an archaeological review of the effects of the proposed development upon sites of archaeological interest. The objectives were as follows:

- To assess geophysical data acquired by MMT in order to identify any material of archaeological interest lying within the limits of the survey area.
- To locate, identify and characterise any previously unrecorded archaeological sites, and confirm the presence and condition of any known sites within the survey area.
- To identify the presence of any sedimentary deposits of archaeological potential.
- To propose future mitigation for material of archaeological interest within the survey area.

3.5.3 The geophysical data used for this report were assessed for quality and were rated as variable using the following criteria (**Table 3.1**):

Table 3.1: Criteria for assigning data quality rating.

Data Quality	Description
Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in the data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good to average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

3.5.4 A particular issue which adversely affected the quality of all data sets appears to have been variable weather conditions encountered during the survey. This has resulted in varying degrees of noise being present on both the sub-bottom profiler and sidescan sonar data sets. Additionally, a large amount of periodic noise from an unknown source, possibly electrical noise or interference from the other geophysical equipment, was visible on the marine magnetometer data set, though it proved possible to remove a large portion of this during data processing. As a result of these factors, it is not possible to guarantee that all the potential archaeological features in the data have been correctly identified during archaeological assessment at WA.

Geophysical Data – Technical Specifications

3.5.5 The data assessed were obtained by MMT between the 15th and 29th August 2010 on the *MV IceBeam* (offshore) and the *MV Ping* (near shore), and consisted of

sidescan sonar, sub-bottom profiler (sparker and boomer), multibeam bathymetry and marine magnetometer data sets.

3.5.6 MMT used an Edgetech 4200 dual frequency sidescan sonar system operated at 75 m (near shore) and 100 m (offshore) ranges, with towfish positioning provided by a USBL system offshore and by fixed layback near shore. The data were digitally recorded using Edgetech Discover software, and provided to WA as *.xtf* files.

3.5.7 The sub-bottom profiler data were acquired using a boomer system for the near shore, and a sparker for the offshore section. The data were digitally recorded using Triton software as *.SGY* files. These were converted into *.cod* files by WA using Coda File Utilities software.

3.5.8 The magnetometer data were acquired using a Geometrics G-882 caesium vapour marine magnetometer.

3.5.9 The multibeam bathymetry data were acquired using a Kongsberg EM3002D system. The data were digitally recorded by Kongsberg SIS acquisition software and provided to WA as *.txt* files.

3.5.10 Both near shore and offshore vessel positioning was provided by a POS MV 320 system with a C-Nav RTG IALA, with an additional Fugro Starfix system used offshore (this would give a submeter accuracy for the vessel position).

Geophysical Data - Processing

3.5.11 The sidescan sonar data were processed by WA using Coda Geosurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were initially scanned to give an understanding of the geological nature of the area and were then interpreted for any objects of possible anthropogenic origin: the position and dimensions of any such objects were recorded in a gazetteer, and an image of each anomaly was acquired. Only the key anomalies are illustrated within the present report, however the remaining images are held in the project archive for future reference).

3.5.12 During this stage of the interpretation, the sidescan sonar anomalies were ascribed an archaeological flag in order to record the geophysicist's initial assessment of each anomaly. These flags were ascribed as follows (**Table 3.2**):

Table 3.2: Criteria for assigning archaeological potential rating

Flag	Description
High	Ascribed only where the geophysical anomalies clearly represent a wreck site or were very near to a previously known site.
Medium	Geophysical anomalies with no directly corroborating data but being of a size, shape or amplitude such as to suggest that they possibly relate to archaeological sites or features.
Low	Small, isolated, geophysical anomalies of uncertain origin, which are likely to be 'artefacts' in the data or natural features.
Very Low	Anomalies that are known or are highly likely to be of modern origin, and which are not archaeologically interesting (e.g. moorings, etc)

3.5.13 The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. A single, small, but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges

of a buried but intact feature, or it may be all that remains of a feature as a result of past impacts from, for example, dredging or fishing. The application of a ratings system is therefore a means of prioritising sites in order to inform further staged of the interpretation process, and on its own is not definitive.

3.5.14 The shallow seismic data were studied in order to detect any in-filled palaeochannels, ravinement surfaces and peat/fine-grained sediment horizons that may have archaeological potential.

3.5.15 The shallow seismic data were processed by WA using Coda Seismic+ software. This software allows the data to be visualised with user selected filters and gain settings in order to optimise the appearance of the data for interpretation. The software then allows an interpretation to be applied to the data by identifying and selecting a sedimentary boundary that might be of archaeological interest.

3.5.16 The shallow seismic data were interpreted with a two-way travel time (TWTT) along the z-axis. In order to convert from TWTT to depth, the velocity of the seismic waves was estimated to be 1,600 ms^{-1}. This is a standard estimate for shallow, unconsolidated sediments.

3.5.17 Any small reflectors which appear to be buried material, such as a wreck site covered by sediment were also recorded, the position and dimensions of any such objects noted in a gazetteer, and an image of each anomaly acquired. It should be noted that anomalies of this type are rare, as the sensors must pass directly over such an object in order to produce an anomaly.

3.5.18 The magnetometer data were processed by WA using Geometrics MagPick software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures such as wrecks.

3.5.19 The software enables both visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map. Smoothed averages of the data were first calculated, and then subtracted from the raw data values in order to reduce the effect of natural variations in the magnetic field such as changes in geology or water depth.

3.5.20 The multibeam bathymetry data were used to provide a vertical reference for the sub-bottom profiler data, and were fully analysed to identify any unusual seabed structure that could be shipwrecks or other anthropogenic debris. The data were gridded and analysed using Fledermaus software, which enables 3-D visualisation of the acquired data and geo-picking of seabed anomalies.

Geophysical Data – Anomaly Grouping and Discrimination

3.5.21 The previous section describes the initial interpretation of all available geophysical data sets, which were conducted independently of each other. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different data sets and apparently overstating the number of archaeological features in the study area.

3.5.22 To address this fact, the anomalies were grouped together along with the results of the desk-based study of known archaeological sites. This allows one ID number to be assigned to a single object for which there may be, for example, a UKHO record, a magnetic anomaly, and multiple sidescan sonar anomalies.

3.5.23 Once all the geophysical anomalies and desk-based information have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed as follows (**Table 3.3**):

Table 3.3: Criteria discriminating relevance of feature to proposed scheme.

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

3.5.24 All the sites that have been identified within the study areas are presented in gazetteers in **Volume II** and discussed in this report. Recommendations have been made for mitigation measures should the sites be impacted by the proposed development scheme.

3.5.25 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment, enabling further evaluation should more information become available.

3.5.26 All the geophysical data sets are handled in the same way, beginning by discerning what is present, then qualifying the initial interpretation and finally characterising the output. For sidescan sonar and magnetic data sets this results in point data, while sub-bottom profiler data produces an interpretation with a wider spatial extent. However, including the start and end co-ordinates for each reflector in the sub-bottom profile gazetteer would be misleading as the anomalies are not simply straight lines between these points. The spatial distribution and extent of these sub-bottom anomalies is shown in the report figures and can be made available as a shapefile. The sidescan sonar, magnetometer and sub-bottom profile anomalies are all taken as screen dumps with an associated ID and stored within the project folder. This allows us to view the image for any WA# when requested. This applies to all anomalies identified during the initial interpretation, not just those later classified as A1 or A2's. Also the sidescan sonar and sub-bottom profile tags are stored within the Coda project. The original data can then be replayed and skip to any given anomaly if there are questions which can't be answered by looking at the screen dump, without the need to replay the entire data set.

3.6 ARCHAEOLOGICAL INTERPRETATION OF GEOTECHNICAL DATA

3.6.1 The geoarchaeological investigation of geotechnical data followed a staged approach, where each stage of the process is dependent on the results from the preceding stage, including recommendations as to the need for further work. For this assessment, Stage 1, Stage 2 and part of Stage 3 were completed, comprising:

- Stage 1: archaeological assessment of geotechnical logs – a review of all the vibrocore fieldwork logs (100) upon completion of the geotechnical ground investigation. Of these, ten were positioned specifically to assess sediments identified as having archaeological potential. The sediments described within the vibrocores were then grouped into a number of sedimentary units (and sub-units) based on the observed sedimentary characteristics;
- Stage 2: archaeological recording of available vibrocores (10) – detailed description of the sediments contained within the cores; examination of the sediments for a range of palaeoenvironmental indicators and dating material; identification of sediments with archaeological potential; interpretation of sedimentary descriptions to place them within a stratigraphic framework. The sediments described within the vibrocores were then grouped into a number of sedimentary units based on the observed sedimentary characteristics, and compared with the sub-bottom profiler geophysical survey data;
- Stage 3: subsampling of vibrocores to retain material of archaeological interest for potential further assessment.

3.6.2 Vibrocore logs were provided for 92 core logs, and 10 vibrocores were physically provided for geoarchaeological assessment. All of the vibrocore locations were plotted in the GIS (see **Figure 3**), and all of the vibrocore logs were assessed by Wessex Archaeology.

3.6.3 The 10 vibrocores (acquired in clear liners) were split longitudinally using an angle grinder and carefully prised open with a knife in order to preserve sedimentary structure. One half of each core was cleaned where necessary and photographed.

3.6.4 Each of the 10 vibrocores were then geoarchaeologically recorded and the descriptions are given in full in **Appendix III** in **Volume II.** The vibrocore descriptions provided details to the depth to each sediment horizon and the character of the sediment. Sedimentary characteristics were recorded including texture, colour, stoniness and depositional structure (*cf.* Hodgson 1976).

3.6.5 The 92 core logs generated on board by the geotechnical contractor during vibrocore sampling provide basic sedimentary detail noted whilst the vibrocores were cut into 1 metre lengths. These basic core logs have been compared to the interpreted sub-bottom geophysical data in order to gain further detail upon the interpreted sedimentary sequence. The 92 vibrocore logs confirm the geophysical interpretation of sedimentary units detailed in **Section 4.4**.

3.7 IMPACT ASSESSMENT

3.7.1 This section sets out the method of Environmental Impact Assessment used to determine the significance of the effects of the installation and operation of the Project Nemo cable system. There is no specific archaeological guidance that refers to laying power interconnector cables, however, as cable laying is a routine part of offshore wind farm construction, the impact assessment refers to guidance developed for the Offshore Renewable Energy sector (COWRIE 2007, 2008, 2010). This methodology has been applied in similar cable laying situations, such as for the BritNed Interconnector on the Isle of Grain, Kent. In addition, development impacts on the terrestrial archaeological resource have been assessed using the guidance on the assessment of the impacts of road projects (DoT 2007). The assessment has also been based on professional archaeological judgement and best practice that has been applied to numerous consented offshore wind farms and cable routes.

This situation stands for England Exclusive Economic Zone, but there is not similar type of guidance for France and Belgium.

Nature of Effect

3.7.2 The magnitude of the effect is assessed using the following criteria (**Table 3.4**):

Table 3.4: Nature of Effect

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
	Immediate vicinity	At source of impact only	1
Level of Change	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 or 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

These effects are defined as:

- 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

3.7.3 Using these criteria, an impact is given a value of magnitude using the scoring system below (**Table 3.5**). 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 is determined using the thresholds below (the magnitude of the impact described above would be Severe):

Table 3.5: Magnitude of Effect

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

Description of Receptor

3.7.4 In order to identify the level of impact on each receptor or feature, the following will be described (**Table 3.6**):

- 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.

Table 3.6: Description of Receptor

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
	High	Recovery to baseline conditions within weeks or months
Importance	High	Receptor is either rare, and/or significant in conservation or commercial terms
	Low	Receptor is neither rare or significant in conservation or commercial terms

3.7.5 Using the criteria above, a Receptor Value has been determined. The definition of Value (High, Medium, Low) has been defined by reference to the three aspects of Sensitivity, Recoverability and Importance (**Table 3.7**).

Table 3.7: Receptor Value

Receptor Value	Definition
High	Damage or loss to the structure/integrity of an archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material) identified as being of high importance. Feature will not recover.
Medium	Damage or loss to the structure/integrity of an archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material). Small-scale, peripheral disturbance to sites identified as being of moderate archaeological importance.
Low	No measurable direct or indirect impacts that would affect an existing archaeological receptor (terrestrial sites and material, submerged prehistoric archaeological material, shipwreck, aircraft crash site or associated material).

Impact Assessment

3.7.6 The impact significance is a function of the Magnitude of the effect and the Value of the receptor, as illustrated below (**Table 3.8**):

Table 3.8: Impact Assessment

	Value of Receptor		
Sensitivity	High	Medium	Low
High	Significant	Significant	Moderate
Moderate	Significant	Moderate	Minor
Low	Moderate	Minor	Minor

3.7.7 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).

3.7.8 The effects of impacts on known and potential archaeological receptors are complex and subjective, and therefore do not generally fit neatly into tables of value or significance. Because of this, a subjective scale based on professional judgement and good practice guidelines has also been used, and to provide transparency, the **Impact Assessment** section further discusses the reasoning behind the assessment of effect, value and significance.

4 REGIONAL ARCHAEOLOGICAL OVERVIEW

4.1 INTRODUCTION

4.1.1 The Study Area extends between England and Belgium, crossing the French EEZ. There has been hominin (humans and our ancestors) presence in the area for almost a million years: in the Palaeolithic and early Mesolithic, 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. Although both landfalls and each area of territorial sea and EEZ will be examined individually in the following sections, providing details about the specific known and potential archaeological receptors of each area, the data needs to be seen within a wider context, where the historic environment of the Kent coast, Belgian coast and waters in between are viewed as more of a continuum, since the

activities that shaped the cultural heritage land and seascape are intertwined. This Regional Archaeological Overview not only provides context for the known archaeological receptors, but also indicates archaeological potential, by examining land use patterns, trade routes, military conflicts and the ideologies that governed human activity.

4.2 CHRONOLOGIES

4.2.1 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 4.1**). 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).

Table 4.1: Chronologies

	England	France	Belgium
Palaeolithic	~900,000 BP-9500 BC	1,000,000 BP – 10500 BC	500,000 BP -11500 BC
Mesolithic	9500-4000BC	10500 BC – 7000 BC	11500 BC – 8200 BC
Neolithic	4000-2200 BC	7000 BC – 2500 BC	8200 BC – 2300 BC
Copper Age		2500 BC – 1800 BC	
Bronze Age	2200-700 BC	1800 BC – 1100 BC	2300 BC – 900 BC
Iron Age	700 BC – AD 43	1100 BC – 52 BC	900 BC – 52 BC
Romano-British/Gallo-Roman	AD 43- AD 410	52 BC – AD 476	52 BC – AD 476
Anglo-Saxon	AD 410-1066		
Medieval	1066 – 1500	476 – 1492	476 - 1600
post-medieval	1500 – 1800	1492 – 1789	1600 - 1800
Modern	1800 – present	1789 - Present	1800 - present

4.3 OVERVIEW

Palaeolithic

4.3.1 The occupation of the Study Areas by hominins (humans and early ancestors) during the Palaeolithic was dependent on sea level fluctuations, and the numerous glacial and marine transgressions and regressions that determined when the area was habitable. There were several periods during the Lower and Middle Palaeolithic (1,000,000 BP to 18,000 BP) when the Study Areas 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 (Panels A, B, C **Figure 2**). The glaciations and sea level changes also affect whether archaeological evidence survives, as glacial outwash and rising sea levels cause erosion or deposition of sediment, which often moves artefacts from their primary (original) locations to secondary locations.

4.3.2 The Lower Palaeolithic begins with the earliest hominin occupation of an area: in Britain, evidence from the site at Happisburgh suggest that it could have begun over 900,000 years ago (Parfitt *et al*. 2010, Roberts and Grün 2010); in the northern tip of France (Nord-Pas de Calais), the first attested known appearance of hominins is

dated from 700,000 BP and was found in the vicinity of present day Wimereux (Region NPC website); and in Belgium the earliest evidence dates to around 500,000 BP from the Belle-Roche cave at Sprimont.

4.3.3 The Happisburgh site, in Norwich, Norfolk, was revealed by coastal erosion. The analysis of plant and animal remains, as well as knapped flint artefacts, indicate that hominins occupied a forest-fringed estuary of the ancient River Thames. The climate during this warm interglacial period was similar to Britain today, indicating that hominins could live in the cooler-than-Mediterranean climes previously thought to be uninhabitable (Roberts and Grün 2010). The site joins a list of sites dating to around a million years ago in Germany and northern France (Roberts & Grün 2010). Closer to the Study Area, 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 forming high energy meltwater rivers that deposited enormous spreads of gravel in their lower courses from which much of the evidence of the activities of Palaeolithic people have been recovered (Scott 2004: 7). The commonest surviving material from this period is worked flint from the Acheulean tradition, including flake production and hand-axe manufacture. At Swanscombe, the remains of an early hominin were discovered close to a series of Acheulian worked flint tools (Wymer 1982: 9).

4.3.4 The discoveries near Wimereux, France, like Happisburgh, were also from a present day coastal location with high cliffs. They represent the oldest Acheulean industry within the Septentrional part of France, where unifacial and bifacial flint tools as well as bones have been recovered (Somme & Tuffereau 1978).

4.3.5 The stone tools from the cave of Belle-Roche at Sprimont, Belgium, are the earliest example of tools within the whole Benelux regional complex, and are thought to have been made by *Homo Erectus*.

4.3.6 Although the ice sheets of the Anglian or Elsterian Glaciation (478,000 – 423,000 BP) did not reach as far south as the Study Area, major changes to the landscape were caused as the Thames and its tributaries were diverted southwards, and the Yser and Leie were also redirected (Quaternary Palaeoenvironmental Group website). A massive ice-dammed lake formed in the southern North Sea (Marine Isotope Stage 12), and the overspill of this lake initiated the Dover Straits and greatly enlarged the Channel River System (*ibid*).

4.3.7 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).

4.3.8 According to Somme & Tuffreau (1978), it is important not to separate the remains of lithic industries from the North of France from those of the Picardy region, because during the Lower and Middle Palaeolithic, the Septentrionale regions of France (located on the north side of the River Seine) present a certain unity, and informative sites from the River Somme valley in the vicinity of the city of Amiens have been used to develop the Palaeolithic chronology and classification of the region. This unity helped the identification of the transition period showing a degree of contemporaneousness between Acheulean and Levallois industries.

4.3.9 The emergence of *Homo neanderthalensis* (Neanderthals) in the Middle Palaeolithic (around 300,000 – 40,000 BP) led to European-wide changes in technology and the emergence of 'Levallois' flaking (Scott 2004: 7) and the Mousterian tool traditions.

4.3.10 Middle Palaeolithic deposits dating to around 320,000 BP have been found at the site of Biache-St-Vaast, France (Biache-St-Vaast website), which revealed Levallois tools and an animal bone assemblage made by hunting, not scavenging, implying a greater social cohesion within the group. Also in France, Neanderthal skull fragments have been discovered, dating to approximately 250,000 BP). The presence of Neanderthals in Belgium is attested by the cave of Scladina and Spy. In Kent, assemblages of 'Levallois' tools found during quarrying are some of the most prolific in Britain (Scott 2004: 7).

4.3.11 In Picardy, France, lithic remains have been found underwater (Scuvee & Verague, 1988), and represent important but not well known examples of the presence of submerged prehistoric remains along the French coast of the English Channel. Located on the North side of the Cotentin Peninsula (Normandy, France), from the Anse de la Mondree at Fermanville near Cherbourg, the finds comprised more than 2000 Levallois-Mousterian lithic artefacts discovered at a depth of 20m. The finds date to around 45,000 BP, and indicate that Neanderthals had developed strategies that enabled them to endure a harsher climate – thus extending the window of opportunity for exploitation of other nearby areas. At the date of occupation, the site strategically overlooked the confluence of the extension of the Seine River and the Great Channel River, which met 15 km to the north. The site is unique in Europe, as it contains primary context archaeological material embedded in peat and clay within a submerged location that pre-dates the last glacial maximum. Not only did it survive the periglacial worsening conditions as the climate deteriorated, but the artefacts survived the rising sea level around 7-8,000 BP and modern oceanographic conditions of coastal currents and waves. The site demonstrates both the potential of the prehistoric archaeological resource within the area and the ability for such sites to withstand climatic changes and transgressive/regressive events witnessed during past glacial cycles.

4.3.12 The Upper Palaeolithic (roughly 40,000 BP to 10,500 BP) provides evidence for the emergence of *Homo Sapiens* in northern Europe. Traces of *Homo Sapiens* in France have been recovered in Nord Pas de Calais dating to approximately 40,000 BP. In Belgium, evidence of the Aurignacien culture has been found in caves such as La Princess, and the Gravettian culture, which spread all over Europe with only small regional variations, is visible at the rich site of Maisieres-canal.

4.3.13 During the Devensian glacial maximum (roughly from 20,000 - 15,000 BP), sea levels in Belgium were 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 climactic 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. However, as soon as climatic conditions ameliorated, humans reoccupied the landscape.

4.3.14 In Belgium, the Magdalanian culture flourished from 14,000 BP to the Mesolithic period, and although most of the Upper Palaeolithic discoveries have been localised around the Meuse valley and in the Hainault and Hesbaye regions, evidence from Flanders to Gent suggest that Neanderthals occupied the wider region. In Britain reoccupation appears to have begun around 13,000 BP (Scott 2004: 8). The similarity of 'Cresswell' and 'Cheddar' points to the Magdalenian industries on the Continent and illustrates the geographic continuity of the region (Scott 2004: 8). However, some of the differences between the assemblages may reflect limited sharing of ideas and techniques.

4.3.15 Considerable quantities of flint artefacts have been recovered from the beach at Raversijde and at neighbouring Mariakerke (Pieters *et al.* 2010: 182). Flint artefacts have also been recovered from the beaches at Westende, Middlekerke, Oostende, Bredende, Wenduine and Blankenberge, although the assemblage from Blankenberge and the mouth of the River Zwin has been called into question and may be natural (*ibid*: 183). Although difficult to date, the finds appear to date to the latest stages of the stone ages, and similar finds to the east of the Belgian border have been dated to the Middle Palaeolithic (*ibid*).

Mesolithic

4.3.16 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; BGS 1992: 116). 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). However, 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.

4.3.17 A considerable amount of this now-drowned landscape is preserved underwater, and has been explored through projects such as Doggerland (Gaffney *et al.* 2009). No such intensive investigation has taken place in the Study Area, however, geological assessments suggest considerable potential, and Mesolithic sites located on the present coast or further inland have been explored in greater detail.

4.3.18 Many coastal sites in northern Europe are marked by shell-middens, the accumulated rubbish from many generations. In addition to gathering shell fish, line fishing and fishing nets were used, and evidence of the nets has survived. The period corresponds to the last hunter-gatherers in northern Europe, with the lithic tools and weapons becoming increasingly smaller and more suitable for the new forest environment (Scladina website). With the increasing management of woodland and its wildlife and the concentration in coastal areas on marine resources, some settlements seem to have become more permanent. At the site of Verrebroek in Belgium, several small huts, supported by wooden poles at the corners and with hollowed out floors, have been found in the same location.

4.3.19 In Belgium, the most well known occupation site is located at the Remouchamps cave. In France, additional work has been undertaken in the Somme Bassin area of northern France, where Mesolithic settlement sites have been identified on silt formation plateaux as well as at the bottom of slopes or valleys, and although most of the sites were located well inland, some sites have also been identified under the coastal sand dunes of Equihen and Hardelot (Dutertre, 1936). 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). Although, further work in marshy areas such as east Kent could increase the body of evidence (Scott 2004: 9).

4.3.20 At the end of the Mesolithic period, there are further signs of permanent settlement in the form of pottery. Because pottery is cumbersome to transport, it is normally associated with settled farming communities. The pottery is perhaps the first indication of the transfer of new ideas from farming populations in southern and central Europe.

4.3.21 By the end of the Mesolithic, the majority of the cable route would have been completely submerged, and further human activity would have been of a maritime nature. The southern part of the Kent Landfall would also have been submerged, as part of the Wantsum Channel, which was not reclaimed until the post-medieval period. However, the northern part of the Kent Landfall (on the historic Thanet Island) remained dry land, and at the Belgian Landfall, the habitable land surface would have extended quite some ways seawards beyond the present Mean Low Water.

4.3.22 Although there is no direct archaeological evidence for seafaring during the Mesolithic, the technologies in place would have been sufficient for the construction of skin boats made of hides and bent small-wood (Cunliffe 2009: 81).

Neolithic

4.3.23 The Neolithic saw a fundamental shift across Europe in the way people lived. Over the period, agriculture and the domestication of animals spread across the continent and beyond the sea to England; most of the population slowly stopped relying on hunting and gathering and instead invested in farming as their main form of subsistence. Regional variations appeared as each area adopted farming, however, broad patterns appear indicating the development of long distance trade networks.

4.3.24 In Belgium, the earliest evidence for agriculture comes from around 8200 BC (Scladina website). At this time, the first communities gathered in villages, with massive collective houses such as the one found in the site of Darion. The late Neolithic (starting around 6300 BC) is mainly characterised by the presence of megaliths which could be seen in many locations, such as the site of Weris. By about 5000 BC, the large scale cultivation of cereal crops the herding of domestic animals had become widespread on the Continent by about 5000 BC.

4.3.25 Flint tools were still dominant. In some areas, such as Grimes Graves in England, mines were dug to exploit the resource, while in other areas, such as at Grand Pressingny, Indre-et-Loire in France, flint closer to the surface could be quarried from outcrops. In Belgium, flint mines appear around 7,500 BC, and the site of Spiennes is one of the most well known examples in Europe. Material from these quarries could then be traded, as flint does not naturally occur in all areas across the region, and communities unable to obtain it locally acquired raw materials as well as finished goods through trade and exchange networks. Some flint is very distinctive, and it is often possible to trace how far an object has travelled from its source. The flint from Grand Pressigny has a particular honey colour and was distributed over hundreds of kilometres, in some areas it was evidently preferred to the local materials.

4.3.26 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. 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. 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. There is evidence for pottery and a causewayed enclosure near Ramsgate (Ashbee 2004: 11).

4.3.27 During the Neolithic, maritime transport was characterised by log boats and skin boats which are likely to have continued in use. Some of the oldest archaeological

examples of logboats in Europe are from Noyen-sur-Seine, France, and date to c. 7190-6540 BC, and other examples of early logboats have been found from Denmark, through north-west Germany and the Low Countries to north-west France (McGrail 2004: 173). These early logboats are from a time when sizeable trees and appropriate tools were just becoming available. The earliest logboat in Britain dates to the fourth millennium BC (Delgado 1997: 438).

Copper Age (Chalcolithic) and Bronze Age

4.3.28 The Copper Age, or Chalcolithic, is characterised by the use of early copper tools alongside the use of stone tools and the first appearance in Europe of unequal, hierarchical societies (Carozza & Mille 2007: 195). A few early metal finds have been discovered in the northern half of France, with the oldest recovered from the Paris Basin, dating to the second half of the fourth millennium BC. However, metal use appears to have been relatively localised, with the use of metal in the Paris Basin remaining a secondary phenomenon which had little or no effect on the mutation of the local cultural groups.

4.3.29 The Bronze Age is characterised by more widespread use of metal tools and social change, as well as the expansion of trade networks. 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).

4.3.30 Possibly as a result of this exchange, there was cultural continuity from Normandy to Flanders with strong connections on both sides of the Channel and North Sea (Bourgeois & Talon, 2005, 2009; Marcigny & Guesniere 2003), and cultural similarities include pottery styles and decoration, and architectural similarities in dwellings and funerary enclosures (Samson, 2006; Bourgeois & Talon, 2005). 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). For example, pottery from the River Canche and its estuary displays characteristics of an original British tradition and indicates a close relationship with the British Isles. The settlement where the pottery was discovered dates to between 2000 and 1800 BC, and may have been a centre of Bronze Age maritime trade, playing an important role in the route across the Southern North Sea, within the established trading relations between the coastal settlements of the Continent and the British Isles.

4.3.31 The archaeological evidence from Kent shows that there were clear advantages to being on the western side of this 'outward looking world', as the eastern and southern shorelines dominated both coastal and cross-Channel traffic, leading to strong long-distance alliances (Yates 2004:13). The coastal communities in Kent benefited directly from contacts as far west as Cornwall and from trade and the movement of people along the Thames valley and with mainland Europe. 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). Concentrations of deliberately placed finds recovered from the Wantsum Channel and Great Stour valley, including a wide variety of weapons and ornaments originating from the great river communities of North West Europe (particularly along the Seine and the Somme) suggest close relationships between peoples on either side of the Channel.

4.3.32 Trade across the Channel was accomplished using boats such as the Dover boat (Clark 2004), a 3000 year old sewn plank boat capable of crossing the channel while carrying a substantial cargo of supplies, livestock and passengers. Such watercraft were especially adapted to the coastal and riverine environment of this area (Pomey & Rieth, 2005). However, 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. The cargo comprised a collection of bronze artefacts, including the types of tools, weapons and ornaments made in France but rarely found in Britain, dating to around 1100 BC.

4.3.33 The study of Bronze implements in the Low Countries, an area that was far removed from copper and tin sources, shows that trade networks were even further reaching, with copper and bronze implements being imported not only from Britain but also from other sources on the Continent, and that trade was established by at least 2300 BC (Fontijn 2009: 130). In Belgium, finds in the intertidal zone from the period include worked flints discovered along the beach between Westende and Knokke. Additionally, a possible Bronze Age paddle or shovel has been found underwater, although this seems more likely to have been a baker's shovel, maybe re-used as a paddle (Pieters *et al.* 2010).

4.3.34 At the end of the Bronze Age, cross-Channel exchange appears to have collapsed, resulting in widespread social dislocation, which reflects wider European disruption (Yates 2004: 15).

Iron Age

4.3.35 The Iron Age is characterised by the spread of iron making and iron tools, which gradually replaced bronze as the preferred material, and was accompanied by a significant growth in population and the introduction of wheel made pottery and coinage. 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. However, by the Late Iron Age, contact between Britain and the Roman Empire had increased (Parfitt 2004: 16). The distribution of Late Iron Age Gallo-Belgic coins type A&B around the Thames Estuary illustrates contact between the Continent and Britain.

4.3.36 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). Finds of Italian amphorae on Late Iron Age settlements in Kent, which indicate wine imports, illustrate trade links with the Mediterranean (Parfitt, 2004:17). While the numerous coastal creeks and inlets would have provided conditions suitable for saltmaking (*ibid*). In Belgium, coastal sites were also important, and the rim of an Iron Age pot was discovered on the beach at Bredene (Pieters *et al.* 2010: 186).

4.3.37 In 55 and 54 BC, Julius Caesar led Roman expeditions to Kent, and provided one of the earliest written accounts of the native population (Parfitt 2004: 16). In addition, the historical record indicates that during one of the expeditions, many of the ships were lost during a storm, and possibly indicate the first recorded shipwrecks on the Kent coast.

Romano-British/Gallo-Roman Period

4.3.38 The Romano-British/Gallo-Roman period in each area began with Roman conquest. In Belgium, around Bruges, the first Roman fortifications were built after Julius Caesar's conquest in the first century BC. A Gallo-Roman colony developed, and the Roman military presence continued until the end of the 3rd century AD or the beginning of the 4th century AD (Bruges city website). Numerous Gallo-Roman artefacts have been recovered from the beaches of Raversijde-Mariakerke and Wenduine, and in both cases finds and features suggest the location of settlements that go back to the Flavian period (Pieters *et al.* 2010: 192). A wide variety of features have been identified at Raversijde-Mariakerke, including rubbish pits, a wooden trackway, ploughmarks, traces of saltings (including wooden construction in connection with a ditch system), features related to the production of iron (including slag filled pits) as well as an oven flue filled with limestone from Tournai (*ibid*). More isolated finds, predominantly scatters of pottery fragments, have been reported from the beaches at Nieuwport, Westende, Oostende, Bredende, Zeebrugge, Heist and Knokke, indicating Roman activity across the area. Discoveries of Roman finds made during the first half of the 20th century indicate that there had been peat banks along the coast, which some years were covered in sand. This, and the fact that A. Chocqueel has observed Roman artefacts and structures located 266 m seawards from the dyke of the church at Mariakerke demonstrates beyond a doubt that the Roman coastline in this area was considerably further seawards than at present (Pieters *et al.* 2010: 193). Furthermore, the potential for Roman military fortifications along the coast of Belgium must be considered.

4.3.39 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). Estimates suggest that between AD 120 and the middle of the 3rd century, 400 tons of iron were transported each year from Britain to the continent (Seillier *et al.* 2004). 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, and Richborough comprised a major settlement with coastal fortification (Andrews 2004: 21).

4.3.40 In France, too, coastal settlements were the key to trade and defence. Following Roman conquest, the town of Boulogne-sur-mer (Nord Pas de Calais), known as *Bononia-Gesioracum*, became a trading centre and the main customs post of the Dover Straits area (Phillipe 2009), and hence a compulsory stop en-route to Dover and Richborough. It was a port of call for the Roman military fleet *Classis Britannica*, (City of Boulogne website) and until AD 85, the fleet participated in combat missions in the adjacent area, and later, in logistic missions such as the control of coal transportation from the mines of the Weald.

4.3.41 The shortest travelling distance between the Continent and Britain was between Wissant or Boulogne and Dover, and likely became the most used sailing route. Although the two terminal areas were probably more the focus of military activities than commercial ones, the stretches of coastline to either side had landing places which would have satisfied the seamen, traders and political authorities (Mc Grail 1987). While the locations of settlement sites in the terminal areas can only be tentatively identified, the locations of landing places associated with international trading settlements are even more difficult to determine (*ibid*).

4.3.42 Roman finds have been recovered from the sea point to Gallo-Roman and Romano-British trade. In Belgian waters, an intact amphora from the Westhinderbank (Pieters *et al.* 2010) and fragments of a pottery bowl from Kwinte Bank (Wessex Archaeology 2008) have been discovered. The pottery bowl fragments were recovered during dredging operations on the Kwinte Bank, and were reported through the BMAPA/EH Protocol. The fragments are Rheinzabern ware, a type of Samian ware, stamped with 'CATULLUZ' which suggests they were made by Catallus V between AD 170 and 260. Samian ware was manufactured in central Gaul from the Augustan period onwards, and the height of the industry was during the 2nd century AD, when products were widely distributed across Gaul, the Danube provinces, and across the English Channel to Britain. The fact that these two pottery fragments are similar in form and bare identical stamps may suggest that they come from the same cargo. Both the amphora and the pottery finds could indicate the presence of yet-to-be-discovered Roman shipwrecks.

4.3.43 In addition to international trade, there was considerable traffic along the coast as well, for example Ragstone, a building material quarried in the Maidstone area (Kent), was not only widely used locally, but also transported 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*).

4.3.44 The remains of a Roman shipwreck were discovered near Bruges in 1899, during the construction work for Bruges' seaport and were radiocarbon dated to the 2nd or early 3rd century AD (Marsden 1976, Pieters 2010). The boat is representative of regional Romano-Celtic shipbuilding characteristics of the west of the Rhine (*ibid*): with close spaced framing, large nails and sewn planking laid flush, edge to edge, but not joined together (McGrail 2004). 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*). Boats of the 1st century BC are described by Julius Caesar in an account of the Venetic fleet as solidly built with high sided and square rigged sails of raw hide, and representations of such vessels can been seen on coins of Cunobelin, suggesting the type was widespread (Cunliffe 2001). In addition, wooden fragments of watercraft discovered in 2005 on the beach of the Chatelet (Tardinghen, Nord Pas-de-Calais) are the only known remains of a watercraft from the antiquity conserved along the septentrional shore of France. This assemblage is dated from the 2nd century AD and, as it has evidence for paddles, it may represent the remains of a Roman galley from the Classis Britannicus fleet, based in Boulogne and having been involved in maritime traffic in the Channel and North Sea.

4.3.45 The shipwreck of Ploumanac'h is also relevant. It lies five nautical miles from the French coast, in front of Perros-Guirec (Côte d'Armor, Brittany). The wreck of Ploumanac'h has been studied by the Département des Recherches Archéologiques Subaquatiques et Sous-Marines (DRASSM) since 1983 (DRASSM website). The wreck lies at a depth of 10 m, and its cargo of lead ingots bears witness to the maritime trade of raw material in the English Channel during antiquity. An epigraphic study of the ingot's inscriptions has enabled the identification of some of the names of Celtic Tribes from Great Britain and date the wreck to a period between the High Roman Empire and the Late Roman Empire (between 2nd and 4th century AD).

Anglo-Saxon & Medieval

4.3.46 At the end of Roman rule, both Belgium and France entered the medieval period, however, in Britain, there was an intermediate period known as the Anglo-Saxon period. 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.

4.3.47 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). In AD 597, St. Augustine and the Christian missionaries arrived. With the reign of King Aethelberht in the later 6th century, Kent emerged as a political entity. The distribution of luxury goods in Kent throughout the 6th and 7th centuries, including glassware and wheel-thrown pottery, suggests that of all the Anglo-Saxon kingdoms in England, Kent had a near monopoly on certain elements of Continental trade and exchange (*ibid*). The trade and production centres of Kent in the Middle-Saxon period (*c*. AD 650 – 850) are small and, in relation to comparable sites such as Southampton, have not been well excavated, although there is thought to be an Anglo-Saxon settlement at Sandwich, it is probably situated within the medieval and modern town, and little evidence has been uncovered.

4.3.48 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). Most of the sites where Ipswich ware has been found are coastal or have strong links with the coast, emphasising the importance of maritime trade. The ware itself reflects the importance of monasteries which appear to have formed a part of the same trading network (*ibid).* 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.

4.3.49 The earliest Viking landings on the Kent coast took place by the end of the 8th centuries, and the first substantial raid took place in 835 on Sheppey (Lawson 2004: 23). For the next 30 years, the coast was under threat and monastic sites were pillaged, and in 851 and 865, the Vikings had a strong enough hold to overwinter on Sheppey and Thanet (*ibid*). However, in 851, the Anglo-Saxons won a victory against the Vikings in a seabattle in Sandwich Harbour. There were additional naval engagements around Stourmouth in 885, and Vikings plundered Thanet's Minster Abbey in 980 and 1009 (*ibid*). Scandinavian ships in the 9th and 10th centuries are represented by the archaeological discoveries at Gokstad, and comprise double-ended clinker built wooden boats (McGrail 2004: 216). But 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). Similar to the Nordic or Scandinavian boats, the Graveney boat was a also a clinker-built, double-ended boat that possibly had a square sail however, she is almost flat-bottomed and much more heavily built, and was built with plank-fastening nails driven through treenails, demonstrating a mix of boat building traditions.

4.3.50 Viking activity on the Kent coast ceased in 1017, and the medieval period began with Duke William's Conquest in 1066. The Domesday Book from 1086 mentions that there were more than 200 households at Minster, and Sandwich, a port mentioned under the manor to which it was subordinate, had a population of around

2,500 (Lawson 2004: 36-38). There was a Carmelite Friary at Sandwich, and it was also a market town. By the 13th and early 14th century, local markets had begun to play a significant role in the development of the economy (Lawson 2004: 50). Stonar, to the north of Sandwich, was also a market town by 1350 (*ibid*: 51).

4.3.51 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). Dover port was by far the longest established, having begun in the Roman period, but their height of influence was in the period 1150-1350 when the Ports worked to suppress piracy and were on occasion called on to transport soldiers. Sandwich was a transhipment point for goods from the Mediterranean, and fishing also played an important economic role (Lawson 2004: 52). Some authors have described Sandwich in the medieval period as 'the principle port in the South East outside London (Bower 2004: 66). As a result of heavy French raiding on the English coast, the Ports themselves became vulnerable, but their greatest threat was due to coastal change: by 1500, all of the Cinque Ports had been seriously affected, as their harbours silted up or were cut off by the growth of shingle banks (Lawson 2004: 52).

4.3.52 In France, from the post-Roman period onwards, the history of maritime related activities and events in Nord Pas-de-Calais is best followed by the developments and engagements of the city of Dunkerque, which played a strategic role for the various sovereignties that governed this fortified place (City of Dunkerque website). The first settlement was set on the shore of a natural cove in the 7th century for the purpose of fishing. The place quickly became a mariner's community, from its origin and during the first centuries of its existence, it was under the Flanders rule. Because of its strategic location, the city needed defences, and a fortified wall was erected in 960. However, the sheltered and strategic position of Dunkerque contrasts with the fact that the population had to continually fight the natural elements with the development of drainage and tidal protection which were initiated in the 12th century. Progressively, Dunkerque became a privileged port for the interior lands as an essential access to Holland or across the Channel to England. The true commercial expansion of the city and in effect the whole region began during the second half of the 14th century. At this time shipping traffic involved in importation expanded rapidly, with goods being imported from England and Holland (such as beer), South of France (wine), Denmark and Sweden (wood and iron). This prosperity was symbolised in the construction of a new fortified wall of protection in the 15th century.

4.3.53 The City of Gravelines, France, also expanded rapidly due to an active herring fishery in addition to being the first location in the region to serve as a transit port for salt, fruits and wine. However, by the beginning of the 14th century, Gravelines predominance faded as a result of multiple and consecutive military attacks and the increasing importance of Dunkerque (City of Gravelines website).

4.3.54 Bruges may have been continuously inhabited during the transition period between the Roman period and the medieval period, and could have been the most important fortification in the Flemish coastal area by around AD 650, when St Eligius arrived to spread Christianity (Bruges city website). In the 8th and 9th century, a commercial relationship with Scandinavia began, and in fact, the name 'Bruges' comes from the old Norse 'Bryggia' which means landing stage (*ibid*). The city developed into an international port and was considered one of the main European business centres.

Around 1050, gradual siltation resulted in the city losing its direct access to the sea but, in 1134 a storm re-established access by creating a natural channel at the Zwin, and the city was linked to the coast until the 15th century by a canal. Outer harbours, such as Damme and Sluis developed at this time to cope with the quantity of commercial traffic (*ibid*). During the medieval period, Flanders was one of the most urbanised areas of Europe, with between 40,000 and 45,000 inhabitants in the sole city of Bruges. By the 14th century, Bruges was a rich port city, with merchants coming from all over Europe to engage in commercial negotiations. The city was famed for its high quality textiles, but it was also a centre for artisanal art. However, during the 14th century, the city suffered multiple crises, insurrections, epidemics, political instabilities and wars, which ended in 1384 with the start of the Burgundian era. The textile industry was gradually replaced by high value products, banking services and the artisanal industry, and Bruges reinforced its international economic power, developing impressive prosperity and wealth. The Burgundian era ended just before the turn of the 16th century, and was accompanied by diminishing presence of international merchants and the start of political instability and military violence.

4.3.55 On the coast, the village of Ostend became a city in 1265 when the construction of a market hall was allowed. In 1359, the city was relocated further inland, and was protected from threats of the North Sea by the establishment of large dykes. Fishing was a major source of income for coastal communities, such as Ostend as well as Heist, Bredene, Wenduine and Revrsijde-Mariakerke (Pieters *et al.* 2010). Blankenberge developed as a small fishing village on the coast and the Saint-Anthony church was established in the 14th century, although the church was destroyed during the religious troubles in the 16th and 17th centuries (Trabel website).

4.3.56 Medieval finds have been recovered from the beaches between Middekerke and Raversijde, largely as a result of coastal erosion. Finds have included a golden tremisses of the Byzantine emperor Justinian II (AD527-565) as well as fragments of Badorf-pottery and red-painted ware. Late medieval coastal settlements are indicated by archaeological finds, and were located on the beaches and adjacent areas of Walraversijde-Mariakerke, Bredene, Wenduine and Heist (Pieters *et al.* 2010: 195-196).

4.3.57 In the medieval period, there were former islands off the mouth of the River Schelde, and although no archaeological traces of them have been recovered, their location is indicated by coastline reconstruction (Pieters *et al.* 2010: 195).

4.3.58 Belgian medieval finds from the sub-tidal zone of the North Sea include a globular grey ware pot that has been dated to the 10th or 11th century, and its high level of preservation could suggest the location of a previously undiscovered shipwreck (Pieters *et al.* 2010: 195). Other finds include a late medieval tripod skillet caught by fishermen near Raversijde-Mariakerke, a mortar in purbeck marble, a sherd of red-ware pottery found by a fishing boat c. 1.6 km to the north of Mariakerke, a stoneware jar fished up between the Plate-diep and the buoy of de Geule and two metal pitchers and a bronze skillet discovered by a fishing vessel near Nieuwport (*ibid*). All of the medieval finds were recovered within 10 km of the coast, and these may suggest that medieval shipping was, to a large extent, characterised by coastal traffic.

4.3.59 The Nordic or 'Keel' tradition of boat building, with double-ended clinker built wooden vessels, continued into the later medieval period. Examples of ship's timbers have been recovered from re-use-locations such as waterfront structures in

London (McGrail 2004: 223). In addition, ships of this tradition are 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.

4.3.60 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. The Bremen cog, discovered in Bremen, Germany, provides a famous example of this type of vessel, and ships similar to that cog appear on the 13th to 15th century seals from many ports, from Elbing in the east to Damm, near Bruges and possibly Ipswich in the west (McGrail 2004: 233).

4.3.61 In France, the EPI-Canche wreck was discovered within the River Canche approximately 5 km from the estuary where the port of Etaples-sur-Mer (Nord Pas-de-Calais) is located (Rieth, 2009). The remains of the wreck are those of a clinker-built boat that has been radiocarbon dated to 1426. According to its structures and shape, the boat seems to have been adapted to coastal and fluvial navigation, and could belong to a regional architectural group of cogs.

4.3.62 Two medieval Doel Cogs were discovered in 2000 on the left bank of the river Scheldt in Antwerp, during an excavation for a construction site (MUA website). The larger of the two measures 20 m in length and 7 m in width. Since historical information concerning Doel Cogs is rare, these examples are of great importance, and in addition, they symbolise the trading role these ships played across Europe throughout the medieval period.

Post-medieval

4.3.63 The post-medieval period is well documented historically, however, archaeological discoveries continue to provide additional information. The period encompassed rapid population growth, urban expansion, colonisation, intensification of international trade, and major political struggles.

4.3.64 As a result of English privateering against French and Spanish vessels and the ensuing diplomatic rows, the Elizabethan government conducted a national survey of ports in 1566 in order to assess the tonnages of shipping and maritime employment (Lawson 2004: 91). In 1566, the shipping tonnage of Sandwich was 500 tons, and in Ramsgate the shipping tonnage was around 200 tons and fishing employment around 50. Some 293 vessels were counted in the survey, most of which were fairly small (under 10 tons). At Dover, the largest vessel of the time was 120 tons, and of the 1,000 mariners, about 600 were employed in fishing and roughly 400 in cargo carrying (Lawson 2004: 91). In the 16th century, maritime trade in Sandwich began to decline, as Sandwich Haven was increasingly restricted by the silting of the Stour (Bower 2004: 68, Lawson 2004: 91), however, some trade did continue with the Low Countries and the Baltic through the 17th century (Bower 2004: 66). As Sandwich's port declined, the economy of Sandwich developed in new directions with the arrival of Flemish, Walloon and German immigrants (Bower 2004: 66, Edwards 2004: 86).

4.3.65 Around 1700, the merchant ships in service were still relatively small - ships in London averaged 150 tons, and those for Kent ports were considerably less (Killingray & Compton 2004: 129 onwards). However, by this time, Ramsgate and Margate had easily overtaken Sandwich in the tonnage of vessels based there, and in 1701, shipping tonnage in Sandwich had increased to around 1000 tons, while at Ramsgate it had increased to 2500 tons (Lawson 2004: 91). The ships from

Ramsgate were involved in the Baltic trade, bringing help and timber for the increasingly busy royal dockyards, and handled coal imports from the North East, while Margate was prominent for coastal trade (Lawson 2004: 91). Fishing also remained important with mackerel and herring the chief catches (Lawson 2004: 92). 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). Although it was generally the larger ships that made international journeys, occasionally even the smaller ships that were usually engaged in coastal trade would turn to deeper waters if economic conditions made it worthwhile (*ibid*). In the 18th century, fisheries in Kent operated on a small scale, and most boats operated in local waters, but some, principally from the Thanet ports worked the North Sea for herring and even Icelandic waters for cod (Killingray & Crompton 2004: 129).

4.3.66 Despite the difficulties at the end of the 15th century, Bruges succeeded in maintaining a regional commercial importance, with a multitude of foreign contacts and an expanding artistic sector. But the definitive split with the Netherlands precipitated the decline of Bruges. During the 16th century, Bruges' international importance decreased, and only a modest maritime function remained. However, in the 17th and 18th century, trade increased again, with local merchants trading mainly with the Spanish empire and the British West and East Indian colonies (Bruges city website).

4.3.67 The coastal location of Ostend had advantages as a strategic point, but was also seen as an easy access for conquering armies. Ostend was taken or destroyed on numerous occasions, such as the three year siege between 1601 and 1604. In the early 18th century, Ostend took advantage of the closing of the harbour of Antwerp by the Dutch in 1722 to provide an alternative route to the sea. The Austrian Emperor Charles VI granted a trade monopoly for the Ostend Trade Company with Africa and the Far East to found colonies overseas. But the Dutch and British pressure on international trade forced the city to put an end to this activity in 1727.

4.3.68 The small fishing village of Blankenberge continued to develop, and the oldest preserved civil building in the town is the Old Town Hall which was built between 1679 and 1680, and was constructed using materials from a former Spanish fortress (Trabel website).

4.3.69 At the end of the 16th century, the herring fishing fleet of Dunkerque was destroyed as a result of a Dutch revolt (Dunkerque city website), and fishing crews took up the 'course', also known as piracy or privateer activity for the Spanish crown from 1567 onwards. The strategy involved taking property of a seized ship's cargo in order to be sold. This new maritime activity became legalised by the Dunkerque's magistrate as a method of war in 1585, and regulated by the Spanish 'code of catches' in 1590. During the first half of the 17th century, between 600 and 1000 Dutch herring vessels were destroyed, and during the reign of Louis XIV (1643-1715) this type of war intensified.

4.3.70 In 1679, a royal arsenal was created in Dunkerque and further fortification developed under the lead of Vauban. During the early 18th century, the port of Dunkerque remained the first pirate port of France, and during the American War for Independence, Dunkerque was an American pirate base in order to conduct operations against England. However, piracy was not the only activity of the port, and mariners from Dunkerque were involved in commercial activity from Cap North to Sicily, and the Icelandic cod fishing industry developed rapidly, generating intense economic activity. In April 1792, the French Revolution declared war on the hostile

European monarchies, which disturbed the maritime relationships in the Dover Straits area.

4.3.71 The post-medieval period witnessed some major battles at sea – and many of them took place within the vicinity of the Study Area. For example: the English versus the Spanish in the Spanish Armada (1588); the English versus the French during the 100 years war in the Battle of Sandwich/Battle of Dover (1217) and the Battle of Damme (1213); and the English versus the Dutch in battles from the second Anglo-Dutch war, including the St. James Day Battle (1666) and the Four Days Battle (1666).

4.3.72 Three post-medieval sites in Belgian waters dating from the 16th to 18th centuries have been archaeologically investigated (Pieters *et al.* 2010: 196): the Zeebrugge site, the wreck of the *'t Vliegend Hert* and a wreck on the Buiten Ratel sandbank. All three sites have been examined by divers and a large number of finds have been recovered. Despite the lack of hull remains at the Zeebrugge site, many hundreds of finds have been recovered, most of which date to the late 15th to early 16th century. The most outstanding find is a wrought-iron bombard, which was found strapped to its gun-carriage with the original ropework. The *'t Vliegend Hert* was built in 1729 on the Dutch East India Company (VOC) wharf at Middelburg and sank, along with the *Anna Catharina*, on its second journey in the night of 3-4 February 1735, in the area of the 'Vlakte van de Raan. Shortly after the sinking, the vessel's cargo of barrels of ginever, beer and oil washed up on beaches at Blankenberge and Nieuwport. The day after the accident, a pilot boat reported that the masts were still sticking out of the water, and the VOC undertook a number of salvage attempts. The 18th century wreck on the Buiten Ratel sandbank likely carried a Dutch cargo, and has been archaeologically investigated since 1997.

4.3.73 In England, a carvel built vessel known as the 'Gresham Wreck' because of its possible connection with Sir Thomas Gresham (1518-1579), a successful merchant and entrepreneur who served Henry VIII, Edward IV and Elizabeth I, 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.

4.3.74 The nearest archaeologically investigated shipwrecks of this period to the French Study Area were five vessels wrecked during the battle of la Hougue (DRASSM website). These vessels are associated with Louis XIV and his plans to regain his throne in 1692. The plan was to gather an invasion army, and admiral Trouville was asked to go to Saint-Vaast-la-Hougue with a 44 vessel squadron. It is there in the close vicinity of the Ile de Tatihou that 12 French vessels disappeared on the 3rd of June 1692, after engaging in a battle against the Anglo-Dutch fleet. The underwater excavation of the five shipwrecks of First Rate vessels revealed the characteristics of the French Navy vessels from the end of the 17th century. The detailed analysis of the ships' hulls showed a trend at the time for improvement and homogenisation of vessels' construction.

4.3.75 Also located along the French coast of the English Channel, is the site of the shipwreck of la Natiere (Adramar, 2010), a significant archaeological example from the post-medieval period. The site comprises two wrecks and is located on the immediate border of the main shipping channel accessing the port of Saint-Malo. It was discovered in 1995 by a spear fisher. The wrecks have been identified as two

privateers' frigates from the beginning of the 18th century, *la Dauphine* from the port of Le Havre, lost on its return voyage from a campagne in 1704, and *l'Aimable Grenot* from Granville foundered in 1749 whilst on its way to Cadix. The abundance of information generated by the study of artefacts in context and the preserved hulls offers data relative to the naval construction techniques used, trades undertaken, and life on board these frigates that sailed in European waters at the beginning of the 18th century. The study of these vessels has put into perspective their role in the increasing commercial exchanges and the emergence of a common material culture for the entire Atlantic maritime area during the post-medieval period.

Modern

4.3.76 The modern period witnessed unprecedented change and development, driven by the Industrial Revolution, increased international trade and communication, and considerable upheaval and military action during the two World Wars.

4.3.77 During the first half of the 19th century, Bruges remained quiet and passive in the commercial context. Around 1850, Bruges was the poorest city in Belgium, and had not been reached by the Industrial Revolution. The rebirth of the city was initiated by the construction of the new maritime port of Zeebrugge, inaugurated in 1907 (Bruges city website).

4.3.78 Conversely, Ostend continued to grow. In 1810, Napoleon ordered the construction of a fort in the vicinity of Ostend, which was completed in 1814 after the fall of his empire (Ostend Tourisme website). The wall had been built in preparation of an anticipated English invasion which never happened. As a result of transportation improvements with the 1838 connection of Ostend to Brussels by rail, the harbour continued to expand, and in 1846, Ostend became a transit harbour for ferries from England.

4.3.79 The modern history of Dunkerque is representative of the main events that took place in the Nord-Pas-de-Calais region. The Icelandic cod fishing industry from Dunkerque and Gravelines reached its peak between 1850 and 1870, partly because of the use of a new and more rapid schooner (*Geolette Balaou*) derived from an American schooner, which became the emblematic boat of Dunkerque. During this time, more than 35,000 mariners worked at Dunkerque, however, soon after the traditional way of fishing was overtaken by more modern techniques, which from 1880 started the decline of the Dunkerque cod fishing industry. During this period, the region was central in industrial Europe, and with the development of railways in the second half of the 19th century, Dunkerque was rapidly connected to the metropolis of Paris. Additionally, the creation of modern shipyards in Dunkerque allowed the intensive construction of steel and steam ships, such as cargo ships, ferries and fishing vessels in great numbers until the start of World War I.

4.3.80 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). Resorts developed along the north coast, and after 1820, steamships carried millions of passengers down the Thames to the resorts. 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. With the development of the railways in the 1830s, there were considerable changes to settlement patterns and the transport of people and goods (Andrews & Crompton 2004: 124). 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. However, not all trade was with ports and harbours, and small ships continued to be beached at low tide on open beaches to discharge cargoes for local markets (Killingray & Crompton 2004: 129). The towns in East Kent provided numerous services to shipping: these included everything from gathering marine intelligence such as the news of arrivals and departures, to supplying able seamen or embarking passengers. The towns could also provide ships with supplies or repairs, and made available the pilots who navigated the ships past the Goodwin Sands and the shallows of the Thames Estuary. Fishing slumped during the Napoleonic Wars (1792-1815) and did not recover until after the 1850s when railways enabled fresh catches to be sent directly to the market (*ibid*: 130). 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 (*ibid*), however, steam trawlers grew in popularity after 1919. From Broadstairs to Sandwich, the main catch included cod, lobsters, herring, turbot, sole, cod and halibut. Faversham concentrated on oysters and had a brisk export trade with the Low Countries (*ibid*). The lifeboat station at Ramsgate attests to the potentially hazardous nature of the sea and the Kent coast. The village of Cliffsend, Kent, developed in the 20th century within 3 km of Ramsgate.

4.3.81 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. From 1817-1831, a Royal Naval preventative force was stationed at regular points (Killingray & Crompton 2004: 130).

4.3.82 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.

4.3.83 Political conflicts continued to be played out on the seas, including the Napoleonic Wars (1803-1815). An archaeological example of a shipwreck from the American Civil War (1861-1865) has been located off Cherbourg: the CSS (Confederate State Ship) *Alabama* was built in 1862 at Birkenhead by the naval shipyard John Laird & Sons, and during the American Civil War (1861-1865), after having sunk 64 Union commercial and war vessels, the *Alabama* sank during a naval battle with the USS (United State Ship) Kearsarge. Discovered in 1985 at a depth of 58 m, the wreck, which is the property of the United States of America, is being excavated by a Franco-American team, and the work is being followed by the "Comité scientifique paritaire franco-américain de l'Alabama" (DRASSM website).

4.3.84 A wooden shipwreck was exposed on the beach of Knokke, Belgium as a result of changing currents on the beach (Pieters *et al.* 2010: 200). The wreck is thought to be the brig *Manning of London,* which was built in 1809 and which ran ashore in 1831. The ship was recorded while it was exposed, however, it was later re-covered by sand. The vast majority of known wreck sites from the Belgian part of the North Sea date to the 20th century (Pieters *et al.* 2010: 198). In the UK as well, the vast majority of known shipwrecks date to the modern period.

World War I

4.3.85 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).

4.3.86 During World War I, the coast of the Nord Pas-de-Calais region escaped many of the direct effects of the war, but the front line was only 40 km away. Dunkerque, which was bombed over 200 times, became an English logistic rear base with 200 seaplanes and a fleet squadron in charge of maintaining the collaboration with the British navy in order to avoid the German U-boats and marine mines. All along the coast, defences were reinforced. The 'Dove Patrol', composed of requisitioned and armed fishing trawlers, monitored the Dover Straights and cruised along the Nord Pas-de-Calais coast. It is also important to mention that from the beginning of September 1914, boats of refugees coming from Belgium were arriving by the thousands to the French ports of the region. Additionally, since the coal mines of Belgium and Northern France were occupied by the Germans, coal had to be imported by maritime convoys.

4.3.87 During World War I, Zeebrugge port was the main German Navy base for U-boats in the southern North Sea region, which were a major threat to the Allied forces, especially in the English Channel. On 23 April 1918, the Royal British Navy made an attempt to neutralise the port entrance, by sinking three old cruisers to block the flow of traffic in and out of the port. However, the blockade ships only managed to stop the flow for two days.

4.3.88 A small number of German U-boats from World War I have been identified from Belgian waters, including *U-11, U-37, UB-13, UB-20, UC-3, UC-7, UC-14* and the *UC-62* (Pieters *et al.* 2010: 198). All of these vessels were lost as a result of enemy action, having either been mined, bombed or rammed. Other World War I wrecks in Belgian waters include the British destroyer HMS *Maori* which ran into a mine in 1915, and the German Torpedo boat *A10* which ran into a mine in 1918. The most documented shipwreck from World War I is the German outpost boat (*Vorpostenboot)* SMS *Prangenhof*. The ship was recovered and dismantled onshore. It provided a detailed example of the changes and adaptations made to the fishing vessel to convert it into a warship.

World War II

4.3.89 When war was declared in September 1939, Kent once again became the frontline against German attack or invasion. The front line comprised beach defences such as mines and scaffolding, pillboxes, gun batteries, trenches, and anti-tank obstacles. Piers were breached, and coastal hotels were commandeered. There were considerable coastal defences around Pegwell Bay, Richborough and Ramsgate.

4.3.90 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.

4.3.91 The city of Ostende also suffered aerial bombardment during the war (Trabel website).

4.3.92 In France and Belgium, an extensive system of coastal fortifications was built by Nazi Germany between 1942 and 1944 in order to defend the coast against Allied attack and invasion. The 'Atlantic Wall' extended along the entire western coast of Europe and was comprised of pillboxes, marine and terrestrial minefields and antitank obstacles.

4.3.93 As a city of high strategic importance in World War II, Dunkerque was a prime target and was bombed during the Blitzkrieg (18-19 May 1940). As a response, the British initiated a gigantic rescue called 'Operation Dynamo' from the port of Dunkerque between 26 May and 4 June 1940, under the constant bombing of the Luftwaffe. An article in the *Scotsman* from the time wrote that an Admiralty communiqué stated that 222 naval vessels and 665 other British craft took part in the evacuation of the British Expeditionary Force from Dunkerque, and these numbers did not include the French naval and merchant ships that took part (4 June 1940). Shallow water, narrow channels and strong tides all made the operation more difficult. As the evacuation by sea took place, three swept navigational channels were maintained, these were located between Dover and Calais; north of the Goodwin Sands to west of Dunkerque; and north of the Goodwin Sands around Kwinte Buoy and south to Dunkerque (Devine 1959). Overall, 338,000 soldiers were rescued and sent to England. During the German occupation, the city remained a strategic point and was reinforced to the point of being a total fortress.

4.3.94 The long list of ships that took part in 'Operation Dynamo' can be found in Devine (1959) and in Pieters (2010: 199), and the Annuaire des Epaves de la Manche (2010) lists a vast number of vessels which were sunk during the operation. Mainly, the vessels were of French or English origin, and were either requisitioned civilian vessels or military ships. Most of the wreck sites are now known and are regularly dived recreationally. One example is the French torpedo ship *Bourrasque* that was hit by a German coastal gun on 30 May 1940, and sank in front of Nieuwpoort with 600 men on board. The site is of significance not only for its involvement in the World War II 'Operation Dynamo' but also for its graveyard status. A number of wrecks relating to 'Operation Dynamo' have been discovered in Belgian waters in addition to the *Bourrasque*, including, three British Destroyers: HMS *Wakeful*, HMS *Basilisk*, and HMS *Grafton,* and the French *Sirocco*. The vessels lost during the operation represent a snapshot of British and French military and non-military vessels: British and French destroyers, British paddle minesweepers, one British ferry, one French merchant vessel and a whole range of British trawlers.

4.3.95 Shipwrecks in Belgian waters also represent a number of ships of the Kriegsmarine, including sweepers, blockade runners (*Sperrbrecher),* outpost boats, minesweepers, tug boats and yachts. The end of the war is also represented, by landing vessels, so-called Liberty ships and other merchant vessels.

4.3.96 Wrecks of World War I and World War II are not limited to ships – many of the aircraft responsible for aerial bombardment were lost, often as a result of enemy fire from other aircraft or the strategically situated anti-aircraft gun batteries.

4.3.97 World War II airplane material has been recovered from the beach at Oostende (Pieters *et al. 2010: 200).*

4.3.98 A German Dornier 17 of the 'Blitz' Geschwader, KG3 crashed on the Sandwich Flats on 31 August 1940 after attacking Manston, and a photograph of the air craft crash

site in Pegwell Bay has been uploaded onto flickr (www.flickr.com, http://forum.12oclockhigh.net). 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).

4.4 REGIONAL MARINE GEOLOGICAL ASSESSMENT – FROM SUB-BOTTOM PROFILER AND GEOTECHNICAL VIBROCORE DATA

4.4.1 A chirp system, a boomer and a sparker system were used by MMT to acquire the shallow seismic data from the survey area, with the boomer used for the near shore sections and the sparker used offshore. Of this data, only the centre line along the entire route was interpreted for this report. A towed chirp was used by MMT for the inshore sections of the survey, however, these data were not evaluated by WA.

4.4.2 102 vibrocore samples were also taken along the route. The location of 10 of these were chosen by WA and examined in detail, whilst the offshore logs from the remainder were also examined. The results from all of these core samples have been used as ground-truthing to aid the geophysical interpretation for this report.

4.4.3 The broad geological sequence across the entire survey area can be summarised as follows (**Table 4.2**) (interpreted from the current geophysical and core sample data, Cameron *et al*. 1992 and BGS 1992).

Table 4.2: General geological sequence from the survey area

Unit	Description
1	Recent (Holocene) seabed sediments, gravelly shelly sand.
2	Post-Devensian terrestrial (UK sector) and estuarine (Belgian sector) clay, silt and fine sand with organic inclusions and peat layers
3	Eocene clay (**London Clay Formation**)
4	Palaeocene sand and sandy clay (**Thanet Formation**)
5	Campanian (Upper Cretaceous) chalk

4.4.4 Not all of the sequence described above is present across the entire survey area, with some being only sporadically present. More detail about the geological sequence of each area is found in each the following sections on the individual cable route segments.

4.5 REGIONAL SEABED FEATURES ASSESSMENT – FROM MAGNETOMETER, SIDESCAN AND MULTIBEAM DATA

4.5.1 A total of 223 sidescan sonar anomalies plus 242 magnetometer anomalies and 12 bathymetric anomalies were individually identified within the geophysical survey area along the entire proposed route. These were grouped, together with any recorded wrecks and obstructions within the area covered by the geophysical data, to produce a list of 270 sites of potential archaeological interest. Additionally, 38 recorded wrecks or obstructions were found by UKHO, NMR, VIOE and SHOM searches to be located outside of the geophysical survey area. These were all assigned archaeological potential ratings as follows (**Table 4.3**):

Table 4.3: Archaeological Potential Ratings

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	46	Anthropogenic origin of archaeological interest
A2	254	Uncertain origin of possible archaeological interest
A3	8	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	**308**	

4.5.2 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (**Table 4.4**):

Table 4.4 Anomaly Classifications

Anomaly Classification	Number of Anomalies
Recorded Wreck / Obstruction	8
Wreck	4
Debris	50
Seafloor Disturbance	1
Dark Reflector	48
Bright Reflector	3
Rope / chain	13
Magnetic	143
Recorded Wreck / Obstruction outside of geophysical survey area	38
Total	**308**

4.5.3 The sites identified in the geophysical survey are discussed below, with full details provided in **Appendix V, VII, VIII** in **Volume II** and **Figures 8, 11, 13**. The data will be examined in more detail in the **English Waters Study Area, French Waters Study Area** and **Belgian Waters Study Area** sections that follow.

5 KENT LANDFALL, ENGLAND

5.1 INTRODUCTION

5.1.1 The Kent Landfall Study Area comprises a loosely-C-shaped polygon that covers a strip of coast between Ramsgate and the Sand Hills extending roughly 1 km inland from Mean High Water (**Figure 4, Figure 5**). It was designed to cover a range of potential landfall options and to provide additional detail about the local heritage resource.

5.1.2 The selected Nemo cable route Kent Landfall location is within a 200 m wide strip of land between the Service Station North and Service Station South potential landfall locations (PMSS 2010).

- Service Station North: This is the area to the north of the petrol station located at the west of Pegwell Bay on the A256. The Thanet Offshore Wind Farm cables make 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 Offshore Wind Farm Project (Wessex Archaeology 2007).

- Service Station South: This is the area to the south of the petrol station located at the west of Pegwell Bay on the A256. Installation of the cables may require HDD underneath a standing pool of water in this area.

5.1.3 Because the intertidal data have not been received at the writing stage of this report, the later does not include such assessment, but once available these data will be archaeologically assessed and the results included in the present report.

5.2 GEOLOGY

5.2.1 The majority of the geology at the landfall comprises alluvium with some Thanet sand (Oxford Archaeological Unit 2001). These comprise Blackheath/Oldhaven/Woolwich and Thanet Beds, laid down between 65 to 45 Ma during the Palaeocene and Eocene, although a small area of the northern part of the Kent Landfall Study Area consists of Cretaceous chalk laid down between 140 to 65 Ma (Young 2004: 1).

5.3 COASTAL CHANGE

5.3.1 The historic environment at the Kent Landfall is intrinsically linked with the area's geography and coastal change. The northern two-thirds of the Kent Landfall Study Area are part of the historic Isle of Thanet, which was cut off from the mainland by the Wantsum Channel (Young 2004: 5). The southern third of the Kent Landfall Study Area is situated at the eastern mouth of the Wantsum Channel, where in the distant past a narrow shingle bank extended southwards from the Isle of Thanet towards the mainland. During the late medieval period, the Wantsum Channel began to silt up, and additional sea defences were constructed to reclaim the low lying marsh land, thus rendering the area suitable for occupation. By the 1700's, much of the former channel had been reclaimed, although further reclamation activities at the mouth of the River Stour, in the southern part of the Kent terrestrial area, are visible on the 1872, 1896, 1908 and 1938 Ordnance Survey maps (**Figure 4**).

5.4 HISTORIC LANDSCAPE CHARACTER

5.4.1 An Historic Landscape Character (HLC) assessment has been developed by Oxford Archaeological Trust (2001) and by Jacobs Babtie (2004) for Kent County Council. The Kent Landfall Study Area forms part of three Historic Landscape Character Areas defined by Oxford Archaeological Trust as 34 (Wantsum Coastal Belt), the edges of 18 (Isle of Thanet) and 19 (Wantsum Channel).

5.4.2 HLC area 34 is located immediately on the coast, and comprises a small distinct area of coastal land types, such as coastal wetlands, saltmarsh, salterns, reclaimed land, marshes, shingle and dunes, mudflats, wave-cut platforms and creeks, with significant expanses of recreational land use.

5.4.3 HLC area 18 comprises the Isle of Thanet, which is characterised by two Historic Landscape types: post-1801 settlement and irregular fields bounded by roads, tracks and paths. After Wantsum Channel silted up, the Isle of Thanet joined the mainland, however, it still retains an island feel, resulting from the way the landscape of Thanet rises out of the marshes. The sloping edge of the flat plateau runs around the south and west of the chalk outlier from Cliffsend and Minster

onwards, and the slope and plateau top give long views over Pegwell Bay and the adjacent marshes.

5.4.4 HLC area 19 is slightly inland of 34, and is comprised of a well-defined area composed almost entirely of marshland reclaimed from the sea. Reclamation in this area began in the 12th or 13th century in connection with the ecclesiastical estates in the region.

5.4.5 The silted up course of the Wantsum Channel and the former mouth of the River Stour have formed marshlands, and the flat and open landscape continues around the coast to the Sandwich flats. The marshes around Sandwich have a more coastal influence, with views open to the sea. This area is bordered by the sand dunes and coastal mudflats of Sandwich Bay. Sandwich itself was an important port and still has a remarkably complete medieval town centre. Nearby Richborough has been strategically important since Roman invaders built a castle on a promontory within the marshes. Over the last 100 years, a major port has developed. Along the coast, a long barrier of Aeolian sand dunes lie between the marshes and the sea, forming a small but individual character area on the edge of the marsh, and are characterised by grasses and maritime influences. The coastal mudflats of Pegwell Bay and Sandwich Bay are designated within the Site of Special Scientific Interest (SSSI) which covers the Hacklinge marshes and the sand dunes.

5.5 KNOWN TERRESTRIAL SITES

5.5.1 The following section is only a preliminary examination intended to provide information on the archaeological potential of the intertidal zone. A complete terrestrial archaeological assessment is being undertaken by TEP and the results will form a separate report.

5.5.2 A complete gazetteer of terrestrial sites at the Kent Landfall can be found in **Appendix IV** in **Volume II**. The gazetteer is derived from information provided by the NMR and Kent HER, and the sites are numbered (**WA1001 – WA1069**) (**Figure 5**). The following section provides a brief synopsis to establish the known archaeological resource and to provide context for the identification and understanding of any potential components of the historic environment which may survive. The **WA** is not included on the figure to assist drawing clarity.

5.5.3 There are no Scheduled Ancient Monuments within the Kent Landfall Study Area, however, there are **2 listed buildings**:

- **WA1039:** 53 and 55 Foad's Lane
- **WA1040:** Saint Augustine's Cross

Prehistoric Period (Palaeolithic to AD 43)

5.5.4 The earliest known archaeological evidence in the Kent Landfall Study Area dates to the Neolithic. All of the sites are located on the historic Isle of Thanet, and many are clustered on areas of higher ground that would have been dry land throughout the period. The density and richness of sites indicates relatively intensive occupation of the area from the Neolithic onwards, probably as a result of this being a prime location for landing material and people from the Continent. This section will examine the known archaeological material from the Neolithic to the end of the Iron Age by site, starting from the north end of the Study Area, as many of the sites were either occupied continuously or reoccupied several times throughout the Prehistoric period.

5.5.5 A range of late Neolithic or early Bronze Age features and archaeological material have been discovered across the Kent Landfall Study Area, and include late Neolithic or early Bronze Age barrows (**WA1001 – WA1004**), a crouched inhumation (**WA1005**), a late Neolithic or Bronze Age settlement (**WA1006**), a Bronze Age enclosure and ring ditch visible as crop marks (**WA1007**) and two Bronze Age hoards (**WA1008-WA1009**). Sites **WA1002, WA1005** and **WA1007** may be associated, and they are situated within a wider landscape of barrows, enclosures and a system of field ditches indicating Neolithic and Bronze Age activity throughout the area. To the north-west of Hollins Bottom, post-holes and pits (**WA1011**) were located within a late-Neolthic / early Bronze Age barrow (**WA1004**).

5.5.6 The combined quarry working and funerary deposits encountered at the nearby Cliffsend Meadows development could be related to the possible settlement (**WA1006**). Remains indicating a possible long-lived domestic settlement, dating between the late Neolithic and medieval period, were discovered during an excavation at Oaklands nursery north of Cliffsend (**WA1061**). The late Neolithic material from the site included ditches, pits, flint objects and Late Neolithic Peterborough ware, and the site may have been part of a ditched enclosure. Finds include Late Bronze Age pottery sherds, and a curved ditch revealed an Iron Age pot. An Iron Age burial was discovered in Mount Green Avenue, Cliffsend, Ramsgate in 1959 (**WA1019**), and the site included skeletal remains and pottery. Archaeological excavations at Cliffs End Farm have revealed abundant evidence that the site was used for funerary and ceremonial purposes in the Bronze Age (**WA1062**). The evidence included four early Bronze Age round barrows; and a series of horseshoe shaped enclosures containing disarticulated skeletons and ritual deposits has been dated to the later Bronze Age.

5.5.7 Neolithic flakes and worked flints have also been recovered from farmed fields after ploughing, and rare prehistoric pottery was discovered in pits (**WA1023**).

5.5.8 Prehistoric pottery and worked flint were discovered during an excavation at Cottington Hill (**WA1059**). Cottington Hill remained an important site throughout the prehistoric period, and Iron Age and Romano-British artefacts have also been found (**WA1063,** Andrews *et al.* 2009: 104-105). Metal detectorists have discovered numerous Iron Age coins on the hill, representing a range of dates, from 100 BC to AD 20 (**WA1012 – WA1018**). To the south of Cottington Hill, a late Bronze Age or early Iron Age midden included pottery sherds and associated material (**WA1010**).

5.5.9 There has been occupation around the present-day Ebbsfleet farm since at least the Bronze Age, when the site would have occupied a coastal position on the edge of the Wantsum Channel. Finds at the site have included a Bronze Age founder's hoard (**WA1009**), comprising 181 weapons and implements, and excavations at the site have revealed another Late Bronze Age hoard, comprising five copper alloy objects and a range of other artefacts (**WA1060**). Nearby, two middens with Bronze Age pottery have been excavated (**WA1058**). Iron Age finds have also been recovered from the area around Ebbsfleet Farm. Excavations in 1990 revealed a Bronze Age beaker burial and Iron Age occupation site (**WA1064**). The Iron Age site comprised pits, ditches a possible hut and occupation layers dating to c. 200-50BC.

5.5.10 There are a number of undated, but possibly prehistoric, sites within the Kent Landfall Area, including the remains of possible late Bronze Age hut circles with a boundary ditch near Cliffs End Hall (**WA1065**). Other sites include an undated crouched inhumation burial found during a watching brief at Cliffsend (**WA1066**),

ring ditch cropmarks identified from aerial photographs (**WA1067-WA1068**) and a large area of cropmark features also identified from aerial photographs (**WA1069**).

Romano-British (AD 43-410)

5.5.11 The Kent Landfall Study Area was also intensively occupied during the Romano-British Period. A large number of ditches in the vicinity of Ebbsfleet farm have been dated to the prehistoric, Romano-British and medieval periods, and are thought to be enclosure and boundary ditches (**WA1058**). The site was excavated as part of the Margate to Weatherlees Hill Wastewater Treatment Works Twin Pipeline. Other excavations at Ebbsfleet farm have identified remains and traces of a Romano-British or medieval structure (**WA1060**).

5.5.12 At Ebbsfleet farm, occupation of an Iron Age site appears to have continued into the Romano-British period (**WA1064**), and Iron Age occupational layers are overlain by a large Roman building dating to the late 2nd century AD. Surface finds from the surrounding area included Romano-British pottery, brick, tile, a coin, rotary quern and buckles. The site may be the same as or related to the find of a Romano-British building and associated pottery at Cottington Hill (**WA1063**). The remains of a Romano-British building and associated pottery, dating to the late 2nd century, were discovered at Cottington Hill, and they are located within a Romano-British landscape of ditches forming a rectilinear enclosure system (**WA1056**).

5.5.13 Three further Romano-British sites are located immediately to the east of Cottington Hill. Site **WA1020** comprised drainage ditches, a hearth and two inhumations, and excavations at the site revealed an area of rammed chalk and flint which is thought to have been used to consolidate an area of boggy ground, and excavations around the graves indicate that they were dug into an area of marshy ground (Andrews *et al.* 2009: 104-105), indicating that these relatively low-lying areas remained quite marshy prior to reclamation activities in the medieval and post-medieval periods. Site **WA1021** comprised pits and associated materials. An occupation site that could indicate a possible villa (**WA1022**) had evidence for building materials, Samian pottery and other fine wares, and the Belgic material that highlights trade links with the Continent during the Romano-British period. Romano-British ditches, a sunken featured building and two cemeteries (**WA1023**) were discovered less than 300 m to the north.

5.5.14 A sherd of Samian ware was recovered during excavations at Oaklands nursery north of Cliffsend (**WA1061**). A Romano-British grave and associated material including a nail, a Belgic sherd, animal bones and shells (**WA1024**) was discovered to the east of Cliffsend. Nearby, Romano-British coins, a brooch and key were recovered (**WA1025**).

5.5.15 The discovery of a Samian cup, dredged up in Pegwell Bay in 1902 (**WA1026**) probably represents material discarded in the bay from shore or thrown overboard from a Romano-British vessel, rather than evidence for a previously undiscovered shipwreck. However, the discovery of further material in the bay could represent a shipwreck, as often the hard finds, like pottery, are all that survive.

Anglo-Saxon (410–1066)

5.5.16 Pegwell Bay represents the traditional landing site of the Saxons in AD 449 (**WA1027**), according to the Anglo-Saxon Chronicle, and it is thought that St Augustine may also have landed there in AD 597. A natural spring marks the traditional spot where St Augustine camped with his monks on reaching England (**WA1028**). Although the shape of the bay has changed considerably since the

Saxon period as a result of land-reclamation activities, these traditions indicate that the bay has historically been an optimal spot for landing the typical boats of the time.

5.5.17 Anglo-Saxon archaeological evidence has also been discovered in the Kent Landfall Study Area. Finds include an Ipswich Ware pot dated to AD 700-900, discovered during excavations at Oaklands nursery, north of Cliffsend (**WA1061**). The excavations also revealed pits, postholes, animal bone, pottery, comb fragments and building material, possibly suggesting a domestic settlement. Excavations at Cliffs End Farm have revealed 24 Saxon burials and more than 60 pits dated to the Middle Saxon period (**WA1062**).

Medieval (1066-1499)

5.5.18 On the eastern side of the Kent Landfall Study Area, around Little Cliffsend farm, there are a number of medieval features, including two well-shafts (**WA1029 – WA1030**), with **WA1030** associated with a small cave entrance leading northward into a complex system of tunnels reputed to be smugglers caves. A possible medieval wall (**WA1031**) and medieval remains dating to the 13th and 14th century which were discovered when a pipe trench was being excavated (**WA1036**), were located nearby.

5.5.19 A domestic settlement, with evidence for occupation dating back to the Neolithic, was located at Oaklands nursery, north of Cliffsend (**WA1061**). Medieval finds from the site include a dyke/bund of flint pebbles and cobbles, which has been interpreted as a possible revetment or seawall or 'boarded groin'. This indicates that the medieval coast could have been as much as 500 m further inland than at present.

5.5.20 To the south of Cottington Hill, there are a number of other sites, including an early medieval pit (**WA1032**), a possible medieval farmstead indicated by infilled ditches and pottery sherds (**WA1033**), a possible sunken medieval building with associated 12th to 13th century pottery and shellfish remains (**WA1034**), and the remains of a ditch enclosing a 13th and 14th century farmstead (**WA1035**).

5.5.21 During the medieval period, the land at the Kent Landfall Study Area was being reclaimed from the sea, and a seawall (**WA1037**) was built as the result of an inundation of the sea between Cliffsend and Stonar in 1365. The remains of boarded groin structures and earthen embankment extend over 1.5 km, and are located between the eastern extent of Minster parish on the border with Thanet and the northern area of Sandwich parish. Although the seawall is no longer continuous, it is recorded to be in reasonable condition where it survives.

Post-Medieval (1500-1800)

5.5.22 The Ordnance Survey maps record a number of former landscape features, such as a post-medieval chalk pit to the north of Cliffsend (**WA1038**) and areas of saltings located on either side of the mouth of the River Stour (**WA1057**).

5.5.23 A pair of cottages built in 1737 in Cliffsend are Listed (**WA1039**).

5.5.24 Post-medieval material, including the remains of flint wall foundations, iron-working artefacts and 16th-17th century pottery has also been recovered at excavations at Cottington Hill (**WA1059**).

Modern (1800 – present)

5.5.25 Ordnance Survey maps illustrate that even in the modern period, the coastline was continuing to change. Slight changes to the main channel of the River Stour are visible around No Man's Island in the southern part of the Kent Landfall Study Area

on the 1877, 1898, and 1908 Ordnance Survey maps. However, by 1946, the river channel had changed considerably: its course had been straightened, with relict channels infilled, and No Man's Island along with a considerable area of intertidal area had been reclaimed and joined the mainland.

5.5.26 In addition, the landscape was transformed by military activities during the two World Wars. The majority of sites and monuments in the modern period relate to the two Wars, with a single exception: a carved celtic cross that was erected in 1884 to commemorate the landing of St Augustine in AD 597 (**WA 1040**).

5.5.27 Military sites likely related to the two World Wars, but without date ranges specified in the Kent HER include the Richborough RAF Salvage Yard (**WA1055**) and an area of slit trenches (**WA1054**) identified from aerial photographs.

5.5.28 During World War I, a train ferry dock (**WA1043**) located on the banks of the River Stour was part of a secret 'Q' port, the starting point of a ferry service for troops and munitions sent to France and Flanders (www.open-sandwich.co.uk).

5.5.29 During World War II, a vast array of coastal defences blanketed the landscape. The Kent HER records numerous pillboxes (**WA1041-WA1051**) that dotted the coast and surrounded Cliffsend. In addition, there was a coastal battery (**WA1052**), gun emplacements (**WA1053**), slit trenches (**WA1055**), a possible World War II anti-aircraft station at Cottington Hill (**WA1056**) and a minefield on the coast at the mouth of the River Stour (**WA1057**). In addition, the South East Rapid Coastal Zone Assessment Survey (Wessex Archaeology, in progress) has identified and mapped numerous other defences, including lines of anti-tank cubes, barbed wire obstructions, additional gun pits and gun batteries, lines of posts representing anti-landing obstacles in the intertidal zone, possible beach scaffolding, bomb craters, and to the south of the River Stour, there was a rifle range and fields of anti-landing obstructions.

5.5.30 Aerial photographs taken in the 1940s illustrate the extent of the World War II beach defences (**Figure 6**) at the immediate terminus of the cable route landfall, including lines of anti-tank cubes immediately to the south-east of the petrol station buildings, as well as lines of beach scaffolding extending across the intertidal zone. In addition, the aerial photographs illustrate that the intertidal marsh area has developed since the 1940s, as in the aerial photographs, the area comprises a sandy beach that is covered at high tide.

5.5.31 The walkover survey for the landfall of the Thanet Offshore Wind Farm cable route (Wessex Archaeology 2007) followed the A256 between the north side of Pegwell Bay and the disused Richborough Power Station. The survey identified a number of archaeological features, including World War II coastal defences including a line of anti-tank pimples, an earthen bank and a pillbox.

Walkover Survey

5.5.32 A walkover survey was conducted in November 2010. The walkover survey started at the carpark on the A256 (Sandwich Road) south of the Jet petrol station, and continued north-east towards the cliffs at the northern side of Pegwell Bay. Access to the foreshore around the petrol station is prohibited by Kent Wildlife Trust as it is a Sensitive Wildlife Area (**Plate 1**). However, limited access was gained to the area on a concrete footpath. The area comprises overgrown marshland mudflats (**Plate 2, Plate 3**). No archaeological material was readily visible, however, it could be obscured by vegetation or buried in the mudflats. An area marked 'danger unstable

ground' is located in the marshland immediately to the north-east of the petrol station (**Plate 4**).

5.5.33 The walkover survey continued to the former hoverport, in order to photograph the site from the north (**Plate 5, Plate 6**), and continued along the cliffs. A line of posts was visible leading up to the cliff (**Plate 7**).

5.5.34 The walkover survey then returned along the coast and continued following the coastal path beyond the car park to the south until the path turned to the west. No further material was discovered, however, the remains of the World War I train ferry were photographed across the estuary (**Plate 8**).

5.6 POTENTIAL

5.6.1 As illustrated in the **Regional Archaeological Overview** and highlighted by the known sites in the area, there is high potential for discoveries of archaeological finds, sites and deposits. Many of the known sites were discovered through development activities: out of the 69 sites and findspots identified in the Kent HER and NMR records, 23 (about a third) are attributed to development.

5.6.2 In the northern part of the Kent Landfall Study Area, there is potential for the discovery of material dating from the Palaeolithic to the modern period. Although no Palaeolithic or Mesolithic material has previously been discovered on this part of the coast, finds of these periods have been recovered from other sites on the Isle of Thanet. The density of sites and findspots from the Neolithic to the Romano-British period also emphasises the potential for sites from these periods, and there is also potential for Anglo-Saxon, medieval, post-medieval and modern material.

5.6.3 In the southern part of the Study Area there is also potential for Palaeolithic or Mesolithic material, and any evidence from the Neolithic to medieval period would likely be of a maritime nature. There is also potential for post-medieval and modern material in the area of the in-filled Wantsum Channel and adjacent to the now settled course of the River Stour.

6 ENGLISH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

6.1 INTRODUCTION

6.1.1 The English Waters Study Area extends roughly 48 km in an irregular linear corridor surrounding the cable route between Mean Low Water and the French Waters Study Area (**Figure 7, Figure 8**). It comprises English Territorial Waters (within 12 nm) and the UK EEZ.

6.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

6.2.1 The basement geology across the entire UK sector of the cable route is expected to comprise Campanian Chalk (**Unit 5**) (**Figure3** & **7**). This basement is also the shallowest geological unit along a large portion of the route, and is often directly overlain by only the superficial seabed sediments (**Unit 1**) (Section 4.4.3 and **Table 4.2**).

6.2.2 **Unit 4** (**Thanet Formation**) is restricted to the near shore section of the route, where it forms an offshore extension of the same formation observed on land (Cameron *et al.* 1992). The unit is expected to comprise sand and sandy clay and to directly overlay **Unit 5**, though no ground truthing has yet been undertaken along

this section of the route, so this is unconfirmed. In this area, **Unit 4** is directly overlain by **Unit 1**. As the **Thanet Formation** is Palaeocene (Thanetian) in age, it is considered to be too old to be of possible archaeological importance.

6.2.3 **Unit 3** (**London Clay Formation**) has only been observed at the far eastern end of the UK sector. The unit is characterised on seismic records by numerous sub-parallel internal reflectors, and has been observed as a relatively thin unit which steadily thickens towards the east. Ground truthing has confirmed the unit to comprise stiff clay. In this area, **Unit 3** is directly overlain by **Unit 1**. As the **London Clay Formation** is Eocene (Ypresian) in age, it is not considered to be of possible archaeological importance.

6.2.4 **Unit 2** in the UK sector of the cable route comprises a sequence of terrestrial deposits located directly west of the Lobourg Channel (see below). A complex of under filled palaeochannels has been observed in this area on both the multibeam bathymetry and sub-bottom profiler records (**WA7500** and **WA7501**) (**Figure 7**). Samples from core **VC WA VC7** have confirmed the presence of sandy clay with organic inclusions, and at least one peat layer containing fresh water molluscs, directly overlying the chalk bedrock within channel **WA7500**.

6.2.5 This unit is interpreted as being a fluvial/flood plain deposit, probably of post-Devensian (early Holocene) age, overlain by possible estuarine sediments (**Appendix II, III** in **Volume II**). These deposits therefore have the potential to contain both *in-situ* and derived archaeological material, alongside preserved organic remains of potential importance to palaeoenvironmental studies.

6.2.6 Although the Lobourg Channel marks the eastern most edge of **Unit 2**, the basal reflector is very poorly defined and inconsistent (**WA7502**) (**Figure 7**) and the western extent of the unit could not be identified. Coring has not yet been carried out along this portion of the route to aid with the interpretation.

6.2.7 **Unit 1** is present across most of the UK Waters Study Area of the proposed cable route, where it generally comprises shelly gravelly sands and sandy gravels. It is of varying thickness along the route, ranging from a thin veneer to sand waves and banks a few metres in height. Of particular note is the South Falls, a large sand bank approximately 30 m in height which crosses the proposed route at the eastern edge of the Lobourg Channel. The seabed sediments are not considered of archaeological importance in themselves, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

6.2.8 A final feature of note is the Lobourg Channel (**Figure 7**), a large, broad, roughly north-south trending channel that cuts across the proposed route. The western edge of this channel is marked by a large, rapid bathymetry change, with water depths suddenly increasing by approximately 30 m whilst the eastern edge is tentatively marked by the South Falls bank. This is a large, under filled palaeochannels feature which is interpreted as being intermittently active throughout the Pleistocene. It is a major bathymetric feature, though the sub-bottom profiler data and core samples indicate there are no surviving terrestrial deposits at the base of the channel and so it is of limited archaeological interest.

6.3 KNOWN WRECKS AND OBSTRUCTIONS IN ENGLISH WATERS

6.3.1 Records of wrecks and seabed obstructions within the UK Territorial Waters Marine Study Areas were collated using information provided by the UKHO, the NMR, and through the archaeological interpretation of geophysical survey data (**Table 6.1**)

(**Figure 8**). A total of 129 sites of possible archaeological potential were identified along the UK section of the proposed cable route. Of these, five were classified as A1 sites, 123 classified as A2 and 1 was classified as A3.

Table 6.1: Sites in English Waters

Description	Number
'A1' previously unrecorded wreck	1
'A1' geophysical anomalies of anthropogenic origin and of archaeological interest - observed in geophysical data	4
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	123
'A3' wreck recorded as 'Live' by the UKHO but not observed in geophysical data	1
'A3' wrecks recorded as 'Live' by the UKHO, outside of the geophysical survey area	8
'A3' wrecks recorded as 'Lift' by UKHO, outside geophysical survey area	2
'A3' obstructions recorded as 'Live' by UKHO, outside of the geophysical survey area	8
'A3' obstruction recorded as 'Dead' by the UKHO, outside geophysical survey area	1
TOTAL	**148**

6.3.2 A complete list of wrecks and obstructions (**WA7000 – WA7128, WA7270 – WA7288)** can be found in **Appendix V** in **Volume II**.

Geophysical Survey Data

6.3.3 Only one definite wreck, site **WA7024**, was observed along within the English Waters Study Area. The wreck was identified by all of the geophysical equipment, and appears as a mostly buried structure measuring 31.4 m x 4.8 m x 0.8 m with a 66nT magnetic anomaly. The wreck itself is orientated approximately NNE – SSW, and is located on the edge of a large sand wave within a scour measuring approximately 30 m x 11 m x 0.4 m. The wreck appears to be previously unrecorded, and it's location on the edge of a sand wave suggests it is periodically buried and exposed as the sand waves in the area move. Due to the wreck being mostly buried little can be said about its structure, though the magnetic anomaly observed suggest it is at least partially ferrous in construction. The wreck is illustrated on **Figure 9**.

6.3.4 The *Pisces* (**WA7017**) was a British motor fishing vessel that sunk on the 8t^{h} December 1995. The single crew member was recovered alive. The UKHO record indicates that there were plans for a salvage attempt. The *Pisces* measured 5.5 m by 2.4 m. Diver reports have indicated that the hull lies flat on the seabed in sand, and the engine block lies in a trench by a chalk ridge. However, although site **WA7017** is the given location of the wreck of the fishing vessel *Pisces*, the wreck was not identified by any of the geophysical survey equipment during the archaeological geophysical assessment. As with wreck **WA7024**, a number of large sand waves were observed at the site indicating the structure could be in the correct location but completely buried at the present time. Given that the UKHO report the wreck to be very small (5.5 m x 2.4 m), this is considered to be possible.

6.3.5 A total of 30 sites have been classified as debris within the UK sector of the proposed route. Most of these have been classified as A2 sites, though four (**WA7027**, **WA7047**, **WA7049** and **WA7098**) have been designated as A1. Site **WA7027** is an area of dark reflectors with shadows measuring 21.9 m x 17.6 m, and associated with a 59nT magnetic anomaly. The site is located in an area of sand

ripples, indicating a larger, at least partially ferrous, structure could be buried beneath the seabed.

6.3.6 **WA7047** is an area of angular bright reflectors approximately 22.2 m x 10.7 m and associated with a 43nT magnetic anomaly (**Figure 10**). This has been interpreted as a debris field, which potentially represents the remains of a degraded wreck or other structure. The magnetic anomaly suggests the debris is at least partially ferrous in nature.

6.3.7 **WA7049** is a large dark reflector with a large shadow measuring approximately 7.2 m x 6.5 m x 0.9 m and associated with a 6nT magnetic anomaly (**Figure 10**). Multibeam bathymetry data indicate the structure to be located within a large depression measuring 22 m x 15 m x 0.5 m. The site is at the location of a known obstruction recorded as foul ground, though the results from the data here indicate it could be the remains of a wreck or other anthropogenic structure.

6.3.8 **WA7098** has been identified as two short, parallel, linear alignments of dark reflectors with shadows measuring 9.3 m x 9.4 m x 0.6 m and associated with a 16nT magnetic anomaly. This has been interpreted as an area of debris or potentially a partially buried, badly degraded structure of an at least partially ferrous nature.

6.3.9 Of the remaining debris sites, 17 (**WA7010**, **WA7016**, **WA7029**, **WA7030**, **WA7034**, **WA7041**, **WA7044**, **WA7051**, **WA7057**, **WA7075**, **WA7079**, **WA7080**, **WA7088**, **WA7091**, **WA7102**, **WA7109** and **WA7116**) appear as individual large, angular dark reflectors with large acoustic shadows and are interpreted as possible individual pieces of debris rather than debris fields or structures. **WA7075**, **WA7079**, **WA7088** and **WA7091** are associated with small magnetic anomalies and so are probably ferrous in nature, whilst the rest are interpreted as being non-ferrous. **WA7080** is also associated with a mound identified on the multibeam bathymetry data and so is probably a substantial feature, though its appearance in the data and lack of a magnetic anomaly mean that it may not represent a wreck site.

6.3.10 Five of the debris sites (**WA7031**, **WA7035**, **WA7043**, **WA7059** and **WA7067**) comprise relatively short, linear alignments of closely spaced dark reflectors with shadows, and could represent separate pieces of debris or the same piece of linear, partially buried debris. None have been found associated with a magnetic anomaly and so all are interpreted as non-ferrous in nature.

6.3.11 **WA7038**, **WA7045**, **WA7061** and **WA7074** are small areas containing numerous irregular dark reflectors, and are interpreted as small debris fields. Only one (**WA7038**) is associated with a magnetic anomaly and so is interpreted as being ferrous in nature, whilst the rest are interpreted as areas of non-ferrous debris.

6.3.12 Eight of the sites (**WA7022**, **WA7052**, **WA7053**, **WA7054**, **WA7058**, **WA7066**, **WA7089** and **WA7092**) comprise curvilinear dark reflectors, generally with small shadows, and have been interpreted as lengths of rope or chain. **WA7022**, **WA7089** and **WA7092** are associated with magnetic anomalies, and so are likely to be chains, whilst the remainder are more likely to be non-ferrous in nature. **WA7052** has a large dark reflector located at one end, possibly indicative of an anchor.

6.3.13 Sites **WA7056** and **WA7070** are both relatively small, elongated bright reflectors without any associated magnetic anomalies. These are of an uncertain origin, and could be either natural features or non-ferrous debris composed of a material that absorbs acoustic waves rather than reflects them.

6.3.14 A total of 20 sites (**WA7011**, **WA7019**, **WA7020**, **WA7037**, **WA7042**, **WA7050**, **WA7055**, **WA7060**, **WA7063**, **WA7064**, **WA7073**, **WA7077**, **WA7085**, **WA7086**, **WA7087**, **WA7090**, **WA7100**, **WA7108**, **WA7120** and **WA7127**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is either non-ferrous in nature or has a magnetic field which was too small to be detected by the survey.

6.3.15 The remaining 67 sites (see **Appendix V** in **Volume II** for full list) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but 16 (**WA7002**, **WA7004**, **WA7014**, **WA7025**, **WA7033**, **WA7040**, **WA7046**, **WA7072**, **WA7082**, **WA7084**, **WA7094**, **WA7095**, **WA7096**, **WA7107**, **WA7125** and **WA7126**) are considerably larger and more likely to represent pieces of buried ferrous debris than natural features. **WA7002**, **WA7004** and **WA7094** are particularly large (87nT, 140nT and 80nT respectively) and suggest the presence of large pieces or scatters of debris buried within the seabed sediments.

Live and Lifted Wrecks not observed in the Geophysical Data

6.3.16 Additional live and lifted wrecks recorded in the UKHO, NMR and HER records, but not observed in the geophysical data, are detailed below. Many of these wrecks were not observed because they lay outside of the geophysical survey area. Although wrecks recorded as 'Lifts' by the UKHO have been salvaged, they are included here because material from the wreck may still be located on the seabed.

6.3.17 The *Harvest Moon* (**WA7270**) was a British Blockship, formerly a trawler, recorded in the Kent HER for UKHO wreck data. It was lost 9 September 1940. The record indicates that the wreck was largely intact apart from a broken stern, and that it showed at low water, partially buried in mud. The wreck of the *Alfred Colebrook* is also thought to be located nearby. Wrecksite website records the vessel as 'dead'.

6.3.18 **WA7271** is an abandoned four wheel drive vehicle, largely reclaimed by the mud. It was surveyed in 2007. Despite the possibility of the vehicle being recovered, it has been charted as an obstruction.

6.3.19 **WA7272** is an unknown wood and iron wreck mostly buried in sand. First surveyed in 1959, the vessel dries at 11 feet (3.4 m). A survey in 1974 indicated that the vessel measured 42 feet (12.8 m) in length, and a survey in 1995 indicated that the wreck was spread over an area 20 m by 10 m, with three distinct structures protruding up to 0.6 m above the seabed.

6.3.20 **WA7273** is a steel tank sunk into the seabed that was discovered during a 1974 geophysical survey and examined by divers. The tank measured 7.3 m by 7.3 m. A geophysical survey in 1982 did not locate the tank, and there are local reports of the tank having been salvaged. However, a geophysical survey in 1995 rediscovered the tank.

6.3.21 *LCP 586* (**WA7274**) was a British landing craft that broke away from alongside SS *Asa Lothrop* and sunk in 1946. The craft measured 11 m by 3 m with a draught of 0.9 m. The LCP (Landing Craft Personnel) were wooden assault craft or sometimes also used for ferry work and ancillary services (Royal Marines Museum website). Landing craft were flat-bottomed and designed to be able to run up onto suitable

beaches. Geophysical surveys in 1960, 1969, 1974 and 1995 revealed no trace of the wreck, and it is thought to have either broken up or become buried in sand.

6.3.22 The *Bravore* (**WA7275**) was a Norwegian merchant steamship that struck an aerial mine 4 nautical miles off Ramsgate on 22 April 1940. The *Bravore*, previously named the *Belibrook, Polberg* and *Bergvik*, was built in 1916 by Kockums Mekaniska Verkstads A/B in Malmo Sweden (Wrecksite website). The vessel had a triple expansion engine of 156 HP for a maximum speed of 9 knots, two boilers and single screw propulsion. It measured 71.63 m in length by 11.49 m in width with a draught of 4.97 m. At time of loss, the *Bravore* was operated by A/S Vore, and was en-route from Tyne to Rouen as part of a convoy, carrying a cargo of 1993 tons of coal. At the mouth of the Thames, the convoy split up with some of the ships heading for London, while the *Bravore* and four other vessels continued to The Downs. Four passengers and 14 crew were lost. Geophysical surveys undertaken by the UKHO indicate that the wreckage is dispersed over an area 100 m by 55 m with its highest point roughly 1 m above the seabed. A geophysical survey in 1991 indicated that the scattered wreckage lay just proud of the seabed.

6.3.23 The *Rydal Force* (**WA7276**) was a British steamship collier with a gross tonnage of 1101. The *Rydal Force* was built in 1924 by Caledon Shipbuilders in Dundee, a company that throughout the 1920s built large cargo-liners, tankers, coastal steamers and ferries (British Coastal Shipping website, Grace's Guide website). The vessel was owned by Kennaugh W.S. & Co (Wrecksite website), a company that began owning steamships in 1883, moved to Liverpool in the 1890s, and was consolidated into West Coast Shipping Ltd. in 1905 (Fenton 1979: 3). Their ships continued to be registered at Whitehaven, and many of the names of the ships were taken from the Lake District, followed by 'Force', a North Country name for waterfall that derives from Old Norse (*ibid*). The *Rydal Force* was mined on 24 April 1940 while carrying 1250 tons of coal. The vessel was on passage from Sunderland for Cowes when it was lost, and 11 men lost their lives. Geophysical surveys have indicated scattered wreckage in a seabed depression measuring 65 m by 38 m with a shadow height of 1.7 m. The wreck was wire swept in 1950 and 1961. Surveys in 1968 and 1971 did not locate the wreck, however, surveys in 1974, 1981, 1986, 1991, 1995 and 1997 located the wreck, noting that it was a small, dispersed wreck sitting in an area of scour that only just showed above the general seabed level.

6.3.24 **WA 7277** is a Dutch schooner that was sunk 30 May 1940. Surveys in 1940 did not locate the wreck, however, it was located in 1949 and swept clear. In 1959 the survey indicated a pronounced scour extending at least a mile roughly north-south. Survey in 1979 indicated a wreck measuring 69 m in length with a height of 6.31 m. The wreck was swept clear again in 1995, and the survey indicated that the wreck had a length of 58 m, width of 11 m and that it lay in pronounced scour that extended 500 m south and 100 m north. The wreck has a strong magnetometer deflection.

6.3.25 An abandoned Suzuki Jeep (**WA7286**) surveyed in 2007. In August 2007, the vessel was located in the intertidal area in Pegwell Bay, and as it was submerged at Mean High Water, it posed a hazard to small craft operating in the Bay. Once the insurance claims were dealt with, the vehicle was removed. It had been salvaged by 14 September 2007, and is recorded by the UKHO as a 'Lift'.

6.3.26 A dredger hopper barge (**WA7287**) sunk 30 August 1986 while in tow of the tug *Influence*. A salvage attempt in October 1986 failed, however, the barge was raised in November 1986.

6.4 POTENTIAL

Submerged prehistory

6.4.1 There is potential for archaeological evidence of now submerged terrestrial deposits. The geophysical survey revealed a complex of palaeochannels directly to the west of the Lobourg Channel. Vibrocore **VC-WA-VC7 (Figure 3),** taken from this area, contained the sedimentary **Unit 2** comprising at least one peat layer and interpreted as being a fluvial/flood plain deposit of probable post-Devensian (early Holocene) age. The presence of peat highlights the time when this area was dry land and suitable for human occupation, and its survival suggests high potential for the survival of other archaeological material. The deposits have the potential to contain both *in situ* and derived archaeological material, alongside preserved organic remains of potential importance to palaeoenvironmental studies.

6.4.2 However, as **Unit 2** directly overlaid bedrock eroded by glacial action, it is unlikely that earlier Palaeolithic material will be found *in situ*, although it could be discovered in secondary contexts.

Shipwrecks

6.4.3 There is high potential for archaeological remains of watercraft from the Mesolithic to the present. Near shore, the **Regional Archaeological Overview** has indicated the importance of maritime trade for the coast of Kent, and Pegwell Bay and Sandwich have been important landing places for goods for thousands of years. The mud flats of the bay present a considerable navigational hazard, but also provide an opportunity for high levels of preservation. Within the Bay, there are also numerous obstructions, posts and stakes across the Sandwich Flats and Pegwell Bay that may prove to be of archaeological interest (Admiralty Chart 1825 from 1965).

6.4.4 There are two Named Locations to which Recorded Losses have been ascribed, and details of the Recorded Losses can be found in **Appendix VI** in **Volume II**. Although the exact location of these wrecks is not known, they indicate the potential to discover previously unrecorded wrecks in the area. The first Named Location indicates the loss of 10 French fishing vessels that were stranded in Pegwell Bay during a hurricane in 1752. The second Named Location represents 25 Recorded Losses. The earliest date to the Roman period, when an unknown number of Roman transport vessels and warships were lost during a sudden storm during Caesar's first invasion in 55BC (**WA1201-WA1202**) (**Figure 8**). The three medieval wrecks were cargo vessels of English, French and Spanish nationality that were lost in the 14th century, illustrating the importance of European trade during the period (**WA1203 -1205**). The post-medieval wrecks indicate the wide variety of ships operating in the area, including a British Fourth or Fifth rate ship of the line, a Dutch East Indiaman, a brigantine and various cargo vessels (**WA1206 – 1226**). Their destinations also highlight important issues of the period, with expanding trade networks indicated by a wreck en-route from Jamaica to London, military activity denoted by the British warship, and the dangerous nature of shipping illustrated by a possible privateer and a prize of Ostend privateers. There is little information available about the wrecks from the modern period (**WA1227 – WA1234**), however, they include a galliot and a variety of cargo vessels. Across the periods, the most common causes for loss were due stranding/beaching and to weather events, such as the storm that sunk the Roman ships.

6.4.5 In addition, the wider area comprises a navigational route that provides a relatively short distance between England and Europe, and thus has been key in maritime trade since the Mesolithic. Once naval technology had improved to the level where battles at sea were truly a possibility, this area of sea became a battleground,

witnessing, for example, the Spanish Armada (English vs Spanish 1588), the St. James Day and Four Days battles (Second Anglo-Dutch war, 1666), and the Battle off Sandwich / Battle of Dover (100 years war, English vs French, 1217).

6.4.6 The Goodwin Sands represent an area of very shallow mobile sandbanks that are a hazard to shipping of all types, and in English waters, it has one of the greatest reputations for ship losses (Bournemouth University 2007). Current work undertaken by Wessex Archaeology for English Heritage has revealed considerable quantities of shipwreck material dating from the medieval period onwards. The seabed in the Goodwin Sands area has a predominance of fine grained sediments indicating the area also has a high potential for preservation, and although the mobility of the sandbanks may counteract this to some degree, this area is considered to be an Area of Maritime Archaeological Potential (Bournemouth University 2007). In addition, the shifting sands also have the potential to reveal previously undiscovered wrecks.

6.4.7 In addition, the cable route will cross the South Falls, a large sand bank approximately 30 m high. Large sand waves and banks have the potential to cover archaeological material such as shipwrecks.

6.4.8 The geophysical survey has identified numerous geophysical anomalies of potential anthropogenic origin and archaeological potential, however, it must also be recognised that it is difficult to identify wooden shipwrecks, scattered shipwrecks or buried shipwrecks through geophysical survey methods, and therefore there is the potential to discover previously unidentified sites.

Aircraft

6.4.9 The **Regional Archaeological Overview** above has indicated the high potential for previously undiscovered aircraft crash sites in the Study Area. The skies over the Study Area saw considerable air-borne action during the two World Wars, and there were several important airfields in Kent.

6.4.10 One of the Recorded Losses is a British Spitfire MK IIA P7386 from 1940 (**WA1235**), and the distribution of World War II British Air/Sea Rescue Operations indicates hot spots of activity around the coast of Kent throughout the war (Wessex Archaeology 2008) (**Figure 8**). The locations of these lost aircraft are unknown, but they indicate the considerable potential for the discovery of other 20th century aircraft lost in the study area as a result of military activities during the two World Wars. Aircraft lost while in military service are automatically protected under the Protection of Military Remains Act (1986).

6.4.11 The Dornier 17 that is known to have crashed in Pegwell Bay is not recorded in the NMR, HER or UKHO records, and while material from this wreck could be encountered, it also underscores the potential for other unrecorded wrecks in the area.

6.4.12 The Goodwin Sands protect not only shipwrecks, but also aircraft, as attested by the discovery of an incredibly intact Dornier 17 (Wessex Archaeology). The South Falls sand bank could also protect aircraft material.

6.4.13 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

7 FRENCH WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

7.1 INTRODUCTION

7.1.1 The French Waters Study Area extends roughly 20 km across the French EEZ in an irregular linear corridor surrounding the cable route across French Territorial Waters between the English and Belgian Waters Study Areas (**Figure 13**).

7.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

7.2.1 The French sector is the shortest section of the proposed cable route, and it is also the least complex geologically. The underlying basement of this section of the route is expected to be **Unit 5**, but, though it was identified on the sub-bottom profiler data, it is present at depth and was not sampled during the coring program in this area.

7.2.2 **Unit 3** directly overlies **Unit 5**, and is the dominant shallow geology type within this area. Identified on seismic records by numerous sub-parallel internal reflectors, the unit is relatively thin in the west but rapidly thickens to the east. Ground truthing has confirmed the unit to comprise stiff clay. As the unit is Eocene (Ypresian) in age, it is not considered of potential archaeological importance.

7.2.3 Recent seabed sediments (**Unit 1**) directly overlay **Unit 3**, and generally comprise shelly gravelly sands and sandy gravels. The sediments are of varying thickness across the route, ranging from a thin veneer in some areas to sand waves a few metres in height. The seabed sediments themselves are not considered of archaeological importance, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

7.2.4 No geological features of possible archaeological potential were observed within the French sector of the cable route.

7.3 KNOWN WRECKS AND OBSTRUCTIONS IN FRENCH WATERS

7.3.1 Records of wrecks and seabed obstructions within the French Waters Study Area were collated using information from the UKHO and SHOM as well as the archaeological assessment of geophysical data (**Table 7.1**). The French sector is the shortest section of the proposed cable route and subsequently contains the smallest number of sites of potential archaeological interest. 34 sites have been identified along this section, with two being classified as A1 sites, 30 as A2, and two as A3 (**Figure 13**).

Table 7.1: Sites in French Waters

Description	Number
'A1' wrecks recorded by the UKHO and SHOM, observed in geophysical data	2
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	30
'A3' Wrecks recorded as 'Live' by the UKHO outside of the geophysical survey area	1
'A3' Obstructions recorded as 'Live' by UKHO, outside of the geophysical survey area	2
'A3' Obstruction recorded as 'Dead' by the UKHO, outside geophysical survey area	2
TOTAL	**37**

7.3.2 A complete list of wrecks and obstructions (**WA7129 – WA7162, WA7289 – 7291**) can be found in **Appendix VII** in **Volume II**. Details about the live wrecks can be found below.

Geophysical Survey Data

7.3.3 Two know wrecks were observed by the geophysical equipment. Site **WA7141** is the given location of the wreck possibly identified as the HMS *Westella*, which was only detected as a 149nT magnetic anomaly. Multibeam bathymetry data show large sand waves are currently located at the position of the wreck, indicating it is completely buried, but still present, at the given location. The wreck has previously been located by the UKHO, SHOM and VIOE through geophysical survey. The HMS *Westella* was a British steam trawler 36.6 m in length with a gross tonnage of 413. The vessel was built in 1934 by Cochrane & Sons Shipbuilders Ltd, a shipyard founded in 1884 that moved to Selby in 1898 (Uboat.net website; Wrecksite website). Cochrane & Son made their reputation building trawlers and coasters for the Hull and Grimbsy fishing fleets. In 1965, control of the yard passed to Ross Group Ltd. The *Westella* had a triple expansion engine by Amos Smith of Hull, a single boiler and single screw propulsion (Wrecksite website). The vessel was purchased as an anti-submarine trawler in August 1939. The HMS *Westella* sunk 2 June 1940, approximately an hour and a half after the *Blackburn Rovers* (**WA7289**), possibly having been hit by a torpedo from the same U-boat or having also hit a mine (Divine 1959: 215, Hulltrawler website). Survivors were recovered by the trawler *Saon* (Wrecksite website). Past geophysical surveys indicated that the steel wreck lies on a seabed of gravel, sand and shell, close to a large sandwave, which now appears to have covered the wreck.

7.3.4 **WA7151** is the location of the known but unidentified wreck. The actual UKHO location for this wreck lies outside of the geophysical survey area, but it was partially imaged by multibeam bathymetry data and associated with a 13nT magnetic anomaly. As it was only partially imaged, the provided position for this structure should be used with caution as the extent of the wreck is unknown, though a large NE – SW trending scour, measuring 74 m x 40 m x 2 m was clearly identified on the northern side of the structure. Wreck records from the UKHO indicate that **WA7151** was a freighter lost in 1940 that lies on its starboard side, with its stern badly damaged. Past geophysical surveys have suggested that the wreck site measures 130 m in length by 18 m in width. A survey in 1967 indicated that the wreck lies on a seabed of fine sand, gravel and shell, and it appears to be sanded in. That same year, the wreck was cleared at 73 feet (22 m). A geophysical and diver survey in 1971 indicated that the wreck was almost buried.

7.3.5 Two recorded obstructions (**WA7148** and **WA7162**) were not identified by any of the geophysical equipment. **WA7148** is recorded as an unidentified obstruction, and could either be covered by seabed sediments at the present time or was an ephemeral feature that now no longer exists.

7.3.6 **WA7162** is recorded by the UKHO as an 'unclassified non-sub contact', however, in the surveying details it is described as a 'probable wreck' with sonar dimensions 137.2 m in length with a shadow height of 1.8 m. The surveying details from 1945 indicate that the site had a moderate echo, and that the identification was 'rather woolly'. This description and the fact that geophysical survey data and the relative positional accuracy of the co-ordinates based on surveys in the 1940s suggest that this point may not, in fact, be a wreck, and/or that the wreck material could actually be located at some distance away. There are no records of later geophysical surveys in the area either proving or disproving the wreck, there is no record of a wreck or an obstruction at this location in the SHOM dataset, and the recent MMT

multibeam bathymetry data show large sand waves at the site at the present time, so if any structure exists at this location, it is likely to be completely buried.

7.3.7 Four sites (**WA7143**, **WA7154**, **WA7156** and **WA7157**) have been interpreted as pieces of debris. All are isolated, angular dark reflectors with acoustic shadows, though none have been found associated with any magnetic anomalies so are interpreted as pieces of non-ferrous debris.

7.3.8 Site **WA7159** is characterised as a linear alignment of short, linear dark reflectors with small shadows. It is interpreted and classified as a length of rope or chain, periodically buried and exposed by a series of large sand ripples. The presence of an 18nT magnetic anomaly indicates it is possibly more likely to be a length of chain.

7.3.9 Six sites (**WA7129**, **WA7130**, **WA7134**, **WA7149**, **WA7150** and **WA7155**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is expected to be non-ferrous in nature.

7.3.10 The remaining 19 sites (**WA7131**, **WA7132**, **WA7133**, **WA7135**, **WA7136**, **WA7137**, **WA7138**, **WA7139**, **WA7140**, **WA7142**, **WA7144**, **WA7145**, **WA7146**, **WA7147**, **WA7152**, **WA7153**, **WA7158**, **WA7160** and **WA7161**) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but **WA7146**, **WA7158** and **WA7160** are noticeably larger (54nT, 36nT and 45nT respectively) and more likely to represent pieces of buried ferrous debris than natural features.

Live Wrecks not observed in the Geophysical Data

7.3.11 The wreck of the HMS *Blackburn Rovers* (**WA7289**) lies just outside of the French Waters Study Area. It has been included in this assessment because although it lies outside of the geophysical survey data area, its wreckage could extend into the French Waters Study Area. The British steam trawler measured 45.7 m in length and 422 gross tons. It was built in 1934 by Smiths Dock Co. Ltd (South Bank-on-Tees, UK) for Consolidated Fisheries and was one of a group of trawlers known as the 'Football Fleet' (Uboat.net website, Wrecksite website). The vessel was requisitioned by the Admiralty in 1939 and was used as an anti-submarine trawler. The HMS *Blackburn Rovers* took part in the Dunkerque evacuation with a crew of 17, during which, on 2 June 1940, the vessel was torpedoed by a U-boat or mined (UKHO, Wrecksite website, Divine 1959: 214). One crew member died (Wrecksite website). At the time of sinking, the *Blackburn Rovers*' depth charges were primed, and many of the survivors were injured in the resulting explosion (U-boat.net website). Survivors were rescued by HMT *Saon*. Geophysical and diver surveys undertaken by the UKHO in 1971 and 1972 indicate a small steel wreck 45 m in length, with a gun on the fo'c'sle, laying on a seabed of fine sand and broken shell. French and Dutch surveys have also covered the wreck.

7.4 POTENTIAL SITES IN FRENCH WATERS

Submerged prehistory

7.4.1 This part of the Study Area was once dry land, with hominin occupation during inhabitable periods. However, the archaeological geophysical and geotechnical

assessments did not reveal sediments of potential archaeological importance. Additionally there are no geological features of possible archaeological potential.

7.4.2 Any Palaeolithic or Mesolithic material discovered in the area would derive from secondary contexts having been transported in the shallow seabed sediments.

Shipwrecks

7.4.3 The Study Area has been crossed by ships from the Mesolithic to the modern period, and there is potential for previously undiscovered wrecks. The area is part of a major shipping route between England and the Continent, and as such has seen considerable levels of maritime activity. As this is an area of open sea with no known navigational hazards, the main causes of wrecking would be due to storm events, technical difficulties, collision, naval engagements or human error. The types of ships, levels of shipping, and maritime conflicts have been discussed in more detail in the **Regional Archaeological Overview** above. However, notable military events that could have caused wrecks in the area are detailed below:

- A number of post-medieval maritime battles took place in the area, including the Spanish Armada (English vs Spain 1588), and the St. James Day and Four Days battles (Second Anglo-Dutch war 1666).
- During World War I and World War II there was considerable maritime activity. All three of the known wrecks were lost during World War II, two as a result of direct military action including mines or torpedoes. Although there is insufficient data to indicate the manner of loss of the third wreck, a military cause is likely.

7.4.4 In some areas of the Study Area, the seabed comprises sand waves up to a few metres in height. In these areas, the sand waves could potentially cover archaeological sites such as shipwrecks.

7.4.5 The geophysical survey has identified geophysical anomalies of potential anthropogenic origin and archaeological potential, however, it must also be recognised that it is difficult to identify wooden shipwrecks, scattered shipwrecks or buried shipwrecks, particularly in areas of sandwaves, through geophysical survey methods, and therefore there is the potential to discover previously unidentified sites.

Aircraft

7.4.6 The **Regional Archaeological Overview** has indicated the high potential for previously unidentified aircraft crash sites in the Study Area. Although there are no known aircraft crash sites or Recorded Losses of aircraft in the French Territorial Waters Study Area, the skies would have been full of activity during the two World Wars with aircraft crossing the Channel between England and the Continent. The proximity of Dunkerque, and the military aviation activities related to the city's strategic importance and attacks on the city indicate a peak in potential for aircraft losses in the vicinity.

7.4.7 In some areas of the Study Area, the seabed comprises sand waves up to a few metres in height. In these areas, the sand waves could potentially cover archaeological sites such as aircraft crash sites.

7.4.8 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

8 BELGIAN WATERS – KNOWN AND POTENTIAL ARCHAEOLOGY

8.1 INTRODUCTION

8.1.1 The Belgian Waters Study Area extends roughly 60 km in an irregular linear corridor surrounding the cable route between the Belgian Landfall west of Zeebrugge and French Territorial Waters (**Figure 16, Figure 17**). It comprises Belgian Territorial waters (to the 12 nm limit) and Belgian EEZ.

8.1.2 The geophysical data for the Belgian Waters Study Area was not yet available when this report was written. However, as there has been no information from the Belgian authorities or curators regarding a requirement for the archaeological assessment of the Belgian intertidal geophysical data, it is unlikely that it will be archaeologically assessed.

8.2 SUB-BOTTOM PROFILER AND GEOTECHNICAL ASSESSMENT

8.2.1 The dominant shallow geology in the Belgian sector of the cable route is the **London Clay Formation** (**Unit 3**) (**Table 4.2**). It is expected that **Unit 5** lies at depth below this, but it is present beyond the depth of penetration of both the geophysical and coring equipment and so was not sampled. Ground truthing has confirmed **Unit 3** to comprise stiff clay. As the unit is Ypresian (Eocene) in age (between 56-48.6 Ma), it is not considered of potential archaeological importance.

8.2.2 One isolated cut and fill (**WA7503**) (**Figure 16**) has been identified cutting into the top of **Unit 3**, the fill of which has been found by coring (**VC-0046**) to comprise fine silty sand. This feature is possibly part of a terrestrial palaeochannels system created during a period of low sea level, and could potentially contain both *in situ* and derived archaeological material.

8.2.3 **Unit 2** is possibly present in two areas towards the eastern end of the Belgian sector. Features **WA7505** and **WA7508** are strong, sub-horizontal reflectors interpreted as erosion surfaces and the basal reflectors of **Unit 2**. In this sector, the unit has been found by coring to comprise well-sorted fine sand and is interpreted as a possible post-Devensian estuarine deposit. Above surface **WA7508** the unit appears complex, with obvious internal structure and a palaeochannels (**WA7507**, below) cutting into it, whilst above surface **WA7505** the presence of the unit is less certain and has not been confirmed by coring. Here, the reflector identified could just represent the base of the Holocene seabed sediments (**Figure 16).**

8.2.4 Two possible small channels (**WA7504** and **WA7506**) have been identified below surfaces **WA7505** and **WA7508** respectively. The nature of the features has not been definitively determined by coring, though they could represent palaeochannels cut into the surface of the **London Clay** and could therefore contain deposits of both archaeological and palaeoenvironmental potential. Their relatively deeper position within the stratigraphy, however, possibly places them beyond the vertical footprint of the proposed scheme.

8.2.5 Channel feature **7507** cuts into **Unit 2** above erosion surface **WA7508** and has been interpreted as a terrestrial palaeochannels deposit of post-Devensian age (**Figure 16**). Core samples have confirmed the channel fill to comprise silty fine sand and clayey silt with flood couplets and organic material (**VC WA VC3**) and an organic odour (**VC-0003**). The presence of organic material is supported by gas blanking within the channel identified on the sub-bottom profiler records.

8.2.6 Both feature **WA7507** and **Unit 2** are considered of possible archaeological and palaeoenvironmental potential.

8.2.7 Recent seabed sediments (**Unit 1**) form the uppermost unit over this entire sector, and generally comprise shelly gravelly sands and sandy gravels. The sediments are of varying thickness across the route, ranging from a thin veneer in some areas to sand waves a few metres in height. The seabed sediments themselves are not considered of archaeological importance, though where they form large sand waves and banks they can potentially cover archaeological sites such as shipwrecks.

8.3 KNOWN WRECKS AND OBSTRUCTIONS IN BELGIAN WATERS

8.3.1 Records of wrecks and seabed obstructions within the Belgian Territorial Waters Marine Study Area were collated using information from the UKHO and VIOE as well as the archaeological assessment of geophysical data (**Table 8.1**). A total of 106 sites of possible archaeological potential were identified within the geophysical survey coverage along the Belgian section of the proposed route. Of these, 1 was designated an A1 site, 101 were designated A2, and 4 were designated A3.

Table 8.1: Sites in Belgian Waters

Description	Number
'A1' wrecks and geophysical anomalies of anthropogenic origin and of archaeological interest - observed in geophysical data	1
'A2' geophysical anomalies of possible anthropogenic origin and archaeological interest observed in geophysical data	101
'A3' obstruction recorded as 'Dead' by UKHO and/or VIOE, not visible in geophysical survey data	4
'A3' wrecks recorded as 'Live' by the UKHO and/or VIOE, **outside** of the geophysical survey area	6
'A3' wrecks recorded as 'Dead' by UKHO and/or VIOE, **outside** geophysical survey area	6
'A3' obstructions recorded as 'Live' by UKHO and/or VIOE, **outside** of the geophysical survey area	2
'A3' obstruction recorded as 'Dead' by UKHO and/or VIOE, **outside** of geophysical survey area	3
TOTAL	**123**

8.3.2 A complete list of wrecks and obstructions (**WA7163 – 7269, WA7292 – 7307**) can be found in **Appendix VIII** in **Volume II**. Details about the live and dead wrecks can be found below.

Geophysical Survey Data

8.3.3 Only one wreck (**WA7200**) was located along this section of the route. The structure was identified by all of the geophysical equipment at the known location of the wreck of the *Tringa*, data examples of which are illustrated in **Figure 18**. The wreck site measures approximately 90.7 m x 32.1 m x 4.4 m and is associated with a 64nT magnetic anomaly, and appears badly broken up with little coherent structure remaining, though still exhibits significant height. The structure is orientated approximately NE – SW, and is located in an area with very little superficial seabed sediment so no scour was identified. The *Tringa* was a British steamship measuring 88.7 m in length by 13.1 m in width, with a draught of 5.8 m and 1930 gross tons. The vessel was built in 1925 by Van Der Giesson & Zonen, and had a triple expansion engine of 335 NHP for a maximum speed of 11 knots. At the time of loss, the vessel was owned by British & Continental Steamship Co, and was carrying a cargo of potash and iron ore from Antwerp to Glasgow (Mercantile Marine website).

On 11 May 1940, the *Tringa* was torpedoed and sunk by *U9*, with a loss of the Captain, 15 crew and a Belgian pilot. Six crew were rescued by the Destroyer HMS *Malcolm* and landed at Ramsgate. In May 1940, the wreck's position was estimated from floating wreckage recovered in the areas. In 1944, the wreck was swept clear at 42 feet (12.8 m).

8.3.4 **WA7259** is the recorded location of the wreck of a fishing vessel (also described as 'foul ground' by the UKHO and as a submerged wreck by the VIOE), though it was not identified by any of the geophysical equipment. The wreck is situated right at the edge of the geophysical survey area, so is possibly located just outside of the range of the equipment used. The wreck site was first surveyed in 1952, and again in 1956, 1958, 1979, 1990 and 1995, however, no additional details about the site are provided in the UKHO or VIOE records.

8.3.5 Four previously recorded obstructions (**WA7189**, **WA7206**, **WA7207** and **WA7242**) were also not identified by the geophysical equipment. All are recorded by UKHO as dead and so are probably either ephemeral features that no longer exist or inaccurately positioned obstructions that are actually located elsewhere.

8.3.6 Of the sites, 16 (**WA7163**, **WA7164**, **WA7177**, **WA7182**, **WA7183**, **WA7188**, **WA7191**, **WA7195**, **WA7225**, **WA7228**, **WA7234**, **WA7237**, **WA7256**, **WA7258**, **WA7263** and **WA7265**) have been classified as debris. Out of these, only **WA7195**, **WA7234** and **WA7237** have been found associated with magnetic anomalies and so are interpreted as at least partially ferrous in nature. The rest are likely to be non-ferrous. Most are isolated, angular dark reflectors with large acoustic shadows, many of which are present on the edges of sand waves and so are potentially only small parts of larger buried features. **WA7182**, **WA7237** and **WA7263** are short, curvilinear dark reflectors that could represent short sections of rope or chain or other linear debris. **WA7188**, **WA7191** and **WA7265** are small areas of angular dark reflectors, interpreted as small scatters of debris.

8.3.7 Four long, curvilinear dark reflectors with small shadows have been identified and classified as probable lengths of rope or chain. **WA7247**, **WA7248** and **WA7246** have all been found associated with magnetic anomalies, and so are likely to be lengths of chain, whilst **WA7230** has not and is therefore more likely to be non-ferrous in nature.

8.3.8 **WA7232** is a relatively small, elongated bright reflector without any associated magnetic anomaly. This is of uncertain origin, and could be either a natural feature or non-ferrous debris composed of a material that absorbs acoustic waves rather than reflects them. Similarly, **WA7257** is a small area of seafloor disturbance which could be natural or indicate the presence of buried debris. No magnetic anomaly has been identified associated with this site, so any debris present is likely to be non-ferrous in nature.

8.3.9 Some 22 of the sites (**WA7165, WA7166, WA7168, WA7169, WA7170, WA7171, WA7172, WA7173, WA7174, WA7175, WA7176, WA7178, WA7180, WA7181, WA7186, WA7193, WA7196, WA7199, WA7202, WA7203, WA7266** and **WA7268**) have been classified as dark reflectors, which are contacts of uncertain origin which could be either natural features or pieces of debris. None of the sites have been found associated with a magnetic anomaly, so any debris is expected to be non-ferrous in nature.

8.3.10 The remaining 57 sites (see **Appendix VIII** in **Volume II** for full list) are the locations of magnetic anomalies that have not been attributed to any sidescan sonar or

multibeam bathymetry contacts. These could represent natural variations in the seabed sediments or shallow geology, bathymetric changes, or pieces of buried ferrous debris. Most are relatively small in size, but 17 (**WA7179**, **WA7185**, **WA7201**, **WA7209**, **WA7210**, **WA7211**, **WA7214**, **WA7215**, **WA7224**, **WA7226**, **WA7229**, **WA7233**, **WA7235**, **WA7240**, **WA7243**, **WA7244** and **WA7245**) are considerably larger and more likely to represent pieces of buried ferrous debris than natural features. **WA7226**, **WA7229**, **WA7243** and **WA7244** are particularly large (109nT, 93nT, 109nT and 83nT respectively) and suggest the presence of large pieces or scatters of debris buried within the seabed sediments.

Live and Dead Wrecks in the Belgian Territorial Waters Study Area

8.3.11 A wreck, possibly the *Mariner* (**WA7292**), sank 17 December 1979 after taking water during a storm while on its way home from a three week fishing trip. The *Mariner* was a Belgian motor stern trawler, built in 1969, with a length of 29.3 m, a beam of 7.3 m, a draught of 3.0 m and a gross tonnage of 150. The ship was powered by a 500 HP engine. The wreck was not found on the initial survey in 1980, however, subsequent surveys the same year located and identified the wreck. A note in 1980 indicates that there was no intention to salvage the wreck. The wreck has undergone further geophysical and diver surveys.

8.3.12 A wreck (**WA7293**) possibly identified as the *A-15* in the UKHO records, is recorded as a very small object, possibly a sunken buoy in the VIOE records. The *A-15* was a World War I German torpedo boat, measuring 41.8 m in length, with a beam of 4.6 m and a draught of 1.5 m. The vessel had a displacement of 137 tons. The *A-15* was an *A-1* class torpedo boat, built by Stettiner Oderwerke, Stettin, Germany, Ships number 668 (Wrecksite website). The vessel was armed with one 5.2 cm SKL/55, two 45 cm T.T., four mines and sweeping material. The vessel had a single propeller, 1.8 m in diameter. The torpedo boat was owned by the Imperial-Kaiserliche (the name for the German Navy between 1903 and 1919). The *A-15* was sunk on 23 August 1915, although the cause of sinking is disputed. The *Warships of World War I* (referenced in the UKHO Record) notes that the *A-15* was sunk by gunfire from British destroyers, however, other sources suggest that it was sunk by gunfire and torpedoes from the French destroyers *Oriflamme* and *Branlebas* (Worldwar1 website, R. Verpoorte, referenced in the UKHO Record). Nine crew were rescued near the Oostendbank by *A-12*.

8.3.13 The *Empire Path* (**WA7294**) was a British steam ship that measured 123.7 m in length, with a beam of 16.2 m, a draught of 10.1 m and was 6410 gross tons. The vessel was built by Readhead John & Sons Ltd (Readhead Standard Design), South Shields, as part of the Liberty EC2-S-C1 class (Wrecksite website). John Readhead started the shipbuilding company in 1865, and built the *Empire Path* in 1943 (John Readhead website). The ship had two oil-fired boilers, a triple expansion steam engine, single screw propulsion and 2,500 HP. The ship first operated for the Moller Line which was founded in 1882 in Shanghai (Wrecksite website). At the time of loss, the vessel was armed with a single stern mounted 4”/102 mm deck gun, and was owned by the Ministry of War Transport (MOWT) of London. From November to December 1944, the ship sailed from London through the Scheldt and arrived in Antwerp, Belgium and unloaded its cargo. On the 24th December 1944, the vessel left to return to the UK, but was mined by a ratchet mine in the Scheldt Estuary off Ostend while in ballast. Five people were killed. The survivors (44 crew and 10 DEMS gunners) were taken to Ostende and billeted in an army transit camp and on 27 December, they were taken by LST back to England (Gordon Mumford website). A book about the wrecking has been written by one of the survivors of the incident: *The Black Pit and Beyond* (Mumford 2000). The *Empire Path* had sunk almost on top of the *Boscobel* (**WA7302**), and initial survey reports in 1945 indicated that two

masts were visible above high water. On 5 July 1945, the *Emeraude* collided with part of the wreckage and wrecked nearby. In order to prevent further accidents, the *Empire Path* wreck site was levelled with dynamite (Gordon Mumford website) and in 1953, the wreck was drift swept clear at 28 feet (8.5 m). The wreck lies on a seabed of even sand, and in 1953 there was no scour around the wreck. In 1961, salvage operations were completed and the wreck was swept clear at 15 m. A 1996 geophysical survey indicated that the wreck was in two pieces.

8.3.14 An unnamed wreck (**WA7295**) surveyed in September 2010 has recently been added to the UKHO wreck database. No other data is presently available.

8.3.15 The *Gold Shell* (**WA7296**) was a British motor tanker measuring 137.5 m in length with a beam of 8.9 m and a draught of 10.4 m. The *Gold Shell* was built in 1931 by Bremen Vulkan, a German shipbuilding company, and at the time of loss was owned by Anglo-Saxon Petroleum Co. (Shell/British Petroleum). The vessel had an oil engine of 714 NHP for a speed of 12.5 knots. The vessel had a gross tonnage of 8208 and was carrying 8300 tons of high octane fuel when it was mined or torpedoed on 16 April 1945. 35 men were lost. The tanker had been part of convoy ATM 126, consisting of 30 ships, en-route from England to Antwerp (Wrecksite website). During the war, tankers were priority targets for enemy attacks, and they were described as 'floating volcanoes' when transporting fuel (mercantile-marine.org website). The *Gold Shell* is just one of 44 British Petroleum tankers sunk during the war, and of the 44 British Petroleum tankers, 657 crew were lost and with 260 others taken prisoner of war (British Petroleum website). The wreck has been surveyed a number of times since 1945, and in 1960 a salvage operation was undertaken. It is now recorded as a live foul on Belgian charts, however, as wreck material likely still remains on the seabed, it is considered a live wreck for this assessment.

8.3.16 The following wrecks are considered to be 'dead' by the UKHO as they have not been discovered during recent surveys. However, as the wreck material could be buried or material could remain on the seabed from salvaged or dispersed wrecks, they are included here.

8.3.17 The record of the SS *Kilmare* & *West Hinder* LTV (**WA7299**) comprises the loss locations of two vessels. In 1905, records indicate that a vessel reported hitting an obstruction in the area, and in 1906 a wreck with mast still showing was reported, thought to be the SS *Kilmare*. The *West Hinder* LTV sunk in the area on 14 December 1912, and in 1913, the SS *Wiedand* reported hitting a wreck. There are numerous wrecks and obstructions known to exist in the vicinity, and the UKHO record was amended to 'several obstructions hereabouts'. In 1930 the record was amended to 'dead'.

8.3.18 The *FL5* German motor launch (**WA7300**) has been described as a remote controlled vessel that sank on the 25th September 1916 following a fire (R. Verpoorte referenced in UKHO record). The *FL5* had petrol engines of 420 HP capable of 30 knots and twin screw propulsion. The vessel measured 13.3 m in length, 1.8 m in breadth and had a 6 ton displacement. The area was surveyed in 1969 and the record was amended to 'for filing only'.

8.3.19 The *FL8* (**WA7301**) was a German motor launch 13.3 m in length, 1.8 m in width with 6 ton displacement. The vessel was described as a remote controlled vessel that was sunk by gunfire during an attack by a British monitor (R. Verpoorte, referenced in UKHO record). The launch had petrol engines of 420 HP capable of 30 knots and twin screw propulsion. The vessel sunk the 6th September 1917. In 1969, the record was amended to 'for filing only.

8.3.20 The *Boscobel* (**WA7302**) was a British Coaster of 232 gross tons carrying a cargo of pig iron or iron fence wire when it foundered on the 29th May 1937. It was lost near Wanelaar Lightship while on passage from Antwerp for London. The *Boscobel* was built as a steel steam trawler in 1906 by J. Duthie & Sons, Aberdeen for Tettenhall Steam Fishing Co of Fleetwood Ltd (Aberdeen Ships website; Fleetwood Trawlers website). The yard's output from the 1880s onwards was mostly trawlers, and the yard closed in 1907. In 1913 *Boscobel* was mortgaged to J. Marr & Son Ltd, Fleetwood, and in 1914, the tonnage was altered to 92.13 net under provision of the Merchant Shipping Act 1907. In 1915, the vessel was requisitioned and converted to a minesweeper. In 1918, *Boscobel* was sold to the Active Fishing Co Ltd, Fleetwood, then sold in 1928 to [redacted], Aberdeen, and again in 1934 to [redacted], Aberdeen. In 1934 the vessel was converted to a cargo vessel. The record was charted in 1937, but was amended to 'dead' in 1962.

8.3.21 A yacht (**WA7303**) is recorded to have sunk in the vicinity – 285 degrees / 725 m from Promenade Pier, Blankenberge. The record was created in 1974 when the site was marked with a buoy.

8.3.22 The *Saint Patrice* (**WA7306**) was a British steam tanker built in 1920 by Antwerp Engineering Co, Hoboken for Societe Navale de L'Ouset, Harve (Wrecksite website). It measured 87 m in length and 14 m in width, with gross tonnage of 1968 tons. The vessel had a triple expansion engine with single screw propulsion and a maximum speed of 11 knots. On the 17th June 1923, the vessel ran aground. In 1972, a small wreck in two pieces was found during survey work for a proposed cable route. Later surveys in 1972 and 1973 did not relocate the wreck, and the record was amended to 'dead'. In spite of this, a diver has reported that he has recovered the bell near the wreck's original location (Wrecksite website), suggesting that more wreckage could still remain on the seabed.

8.4 POTENTIAL

Submerged Landscapes

8.4.1 There is high potential for the discovery of submerged prehistoric material dating from the Palaeolithic to the Mesolithic. Palaeozoological remains have been discovered in Belgian waters, and are particularly frequent between the Brown Bank and the Deep Water Channel (Pieters *et al.* 2010: 181-184). Although there have not yet been any discoveries in Belgian waters of hominin remains or worked flints, a worked core dating from the Palaeolithic to Neolithic has been recovered from Dutch waters, and there are numerous finds of lithic artefacts on Belgian beaches.

8.4.2 The extent of the drowned landscape and evidence for palaeochannels has been revealed by archaeological assessment of geophysical and geotechnical data. Core **VC-0046** contained an isolated sedimentary unit cutting into the top of **Unit 3**, which has been interpreted as part of a terrestrial palaeochannels system created during a period of low sea level and could potentially contain both *in situ* and derived archaeological material. In addition, sedimentary **Unit 2,** (exhibited in **VC WA VC3**) which has been interpreted as a terrestrial palaeochannel deposit of post-Devensian age, is also considered to be of possible archaeological and palaeoenvironmental potential.

8.4.3 The archaeologically interesting material in core **VC WA VC3** was located relatively close to the surface of the seabed (0.29 m below seabed), indicating the high potential for the discovery of additional archaeological and palaeoenvironmental material along the cable route trench in this area.

8.4.4 Even within the historic period, the land surface extended into what is now the intertidal zone. Roman artefacts and structures have been observed 266 m into the intertidal zone, and indicate the potential for further discoveries of archaeological sites and material in a now drowned landscape.

Shipwrecks

8.4.5 Searches of Belgian data did not reveal an easily accessible 'Recorded Losses' dataset indicating ships recorded as having been lost off the coast through history, and therefore, as the information would be costly and time consuming to obtain, it has not been included in this section. However, despite not having names and dates of ships lost off the coast, it is still possible to provide an overview of the types of ships, shipping hazards, and areas of potential for the discovery of shipwrecks.

8.4.6 These waters have been busy with shipping traffic from the Neolithic to present, as indicated in the **Regional Archaeological Overview** however, the majority of known wrecks in the area date to the modern period. It is difficult to discover post-medieval and earlier wrecks on the seabed, as they are generally made of wood and buried beneath the seafloor, making them difficult to detect by magnetometer, sidescan sonar or other means (Pieters *et al.* 2010: 197). However, the discovery of Roman pottery on Kwinte Bank (Wessex Archaeology 2008), Roman roof tiles from Wenduinebank or Smal Bank (Pieters *et al.* 2010: 187), and medieval pottery from Wenduinebank (*ibid:* 194), could indicate the presence of shipwrecks, and highlight the potential for further discoveries of all periods in the wider area.

8.4.7 Most of the known shipwrecks are modern, and have arrived on the seabed as a result of warfare, although it remains to be seen whether this conclusion can also be inferred for earlier periods (Pieters *et al.* 2010: 197). There were numerous losses during the two World Wars, and as Pieters notes, earlier maritime engagements in the area, such as the Battle of Damme (English vs French 1213), could have also resulted in a number of losses.

8.4.8 The intertidal zone comprises considerable tidal flats and the banks offshore could constitute navigational hazards. There are also likely hazards associated with the approaches to the Zeebrugge harbour. Additionally, the geology in these areas indicates that they could represent areas with high levels of preservation, and therefore much of the area can be considered an Area of Maritime Archaeological Potential.

8.4.9 The seabed in the Belgian Waters Study Area comprises areas of sand waves up to a few metres in height, which could potentially cover archaeological material such as shipwrecks.

8.4.10 Other material related to maritime activities, although not constituting actual shipwrecks includes an ammunition dump in an area off Zeebrugge called the 'Paardenmarkt' (the horse market).

Aircraft Crash Sites

8.4.11 There is considerable potential for aircraft crash sites relating to the two World Wars, as indicated by the **Regional Archaeological Overview**. Additionally, aircraft, like wooden shipwrecks, can be difficult to detect on the seabed through geophysical or other survey methods.

8.4.12 The seabed in the Belgian Waters Study Area comprises areas of sand waves up to a few metres in height, which could potentially cover archaeological material such as aircraft crash sites.

8.4.13 In addition, aircraft crash sites are notoriously difficult to identify through geophysical survey alone, particularly if the debris is scattered across the seabed, and therefore there is potential for the discovery of previously unreported finds.

9 BELGIAN LANDFALL – KNOWN AND POTENTIAL TERRESTRIAL ARCHAEOLOGY

9.1 INTRODUCTION

9.1.1 The Belgian Landfall Study Area comprises an irregular polygon surrounding the cable route landfall variations, and includes an approximately 6 km stretch of beach from Zeebrugge to just beyond Blankenberge and extending inland approximately 1 km from Mean High Water. (**Figure 19**).

9.2 GEOLOGY

9.2.1 The geography of West Flanders comprises a coast that extends along the Southern North Sea, with a flat polder landscape inland. The dune area and adjacent low polders at Wenduine-Uitkerke have been hydrogeologically and hydrogeochemincally investigated (Walraevens *et al.* undated). The dune belt between Wenduine and Blankenberge measures no more than 50 m in width. The polders inland are of two types: those which are located at former creeks where Dunkerque clay was deposited on the sand of the creek, and the lower clay-on-peat sediments also known as 'pool grounds' (*ibid*).

9.2.2 The Tertiary surface of the Polder of Uitkerke was originated by Early Pleistocene erosion (Saalian).

9.2.3 The Quaternary geology developed during the Eemian interglacial stage (130,000 – 114,000 BP), when the Oostende sediments were deposited, comprising gravel sand and shell. Late Pleistocene sediments include the deposit of Uikerke (sand) and the deposit of Wenduine (sand and gravel). The Pleistocene was followed by a period of peat growth that was later eroded during the Flandrian Transgression. Deposits from the Flandrian Transgression include the deposit of Calais, which comprises a sandy deposit of Houtave (base) and a deposit of Zuienkerke (top) which has a sandy character but also contains some clay.

9.2.4 The peat at Nieuwmunster formed behind the dune belt and was progressively removed by the Dunkerque Transgressions, in particular, the Dunkerque II transgression not only removed the peat, but formed creeks at Wenduine and Blankenberge The creek beds remain as 'creek ridges' (clay on sand), where formerly lower level sites are now higher than their surroundings. More recent changes to the local relief occurred from the medieval period through to the late 19th century as a result of peat digging, and clay digging for bricks. A practice which took place up to the middle of the 20th century.

9.2.5 Along the coast, the surface geology largely comprises dune systems which have accreted since the medieval period. Around the River Ijzer, on the west, deposition takes place and the coast builds up slowly, while on the east the coast gradually retreats (Pieters *et al*. 2010).

9.3 KNOWN SITES

9.3.1 The known sites and findspots in the Belgian Landfall Study Area has been compiled using data from the CAI (Central Archaeological Inventory) database from

the VIOE, and is summarised in **Appendix IX** in **Volume II**. In addition, findspots of archaeological material on the beaches have been derived from the 'De Noordzee' chapter in *Relicta 6* (Pieters *et al.* 2010: 177-218) (**Figure 19**).

Prehistoric Period

9.3.2 Flint material has been recovered from the beaches at Wenduine and Blankenberge, although the find from Blankenberge could be natural (Pieters *et al.* 2010: 183). It is not known to what extent beach replenishment could be responsible for the location of finds on the beach, however, if beach replenishment is actively ongoing, some of the discovered finds could derive from the dredged or quarried sand and gravel deposits located elsewhere.

Roman Period

9.3.3 The Belgian Landfall Study Area demonstrates a small but obvious occupation during the Roman Period. The most preponderant example is the remains of the floor of wooden building made of baked tiles (**WA1301**) at Harendjke in the county of Blankenberge. Other evidence of the Roman presence includes finds of fragments of pottery, which have been identified as Terra Sigillata (**WA1325, WA1326**) or contemporary with the Camp Esmeralda (**WA1301**), and a Roman fire place dated approximately from the 2nd century AD (**WA1302**).

9.3.4 Scatters of Roman pottery fragments have been reported from the beaches at Zeebrugge, and the recent find of a young man's jaw bone has been dated to the 4th century (Pieters *et al.* 2010: 193).

9.3.5 The beach of Wenduine is well known for discoveries of Roman artefacts, and these may indicate material from a Roman settlement going back to the Flavian period (Pieters *et al.* 193). It is thought that Wenduine had even developed into an important trade centre, and the finds from this area are notably richer than at other locations on the coast.

Medieval Period

9.3.6 The medieval period is well represented within the extent of the Belgian Landfall Study Area. This period is identified with the presence of several concentrations or isolated instances of pottery of the type Verhaeghe Group A (**WA1303, WA1325, WA1326, WA1327, WA1329**).

9.3.7 There is also evidence for medieval dykes (**WA1311**, **WA1312**, **WA1313**). The first dyke on the beach was constructed around 1200 (Administratie Waterwegen en Zeewezen information plaque). However, it was not strong enough to prevent flooding from the sea. A new dyke was constructed in the 14th century, however, this dyke was in danger of flooding as well. In the 15th century, the inhabitants of Polderland built a new dyke, 'Graaf Jansdijk', running parallel to the previous one. This formed a system of double dykes, consisting of a 'watcher' (the original sea wall) and a 'sleeper' (the new rear dyke). As a result of the construction of these dykes, dunes were established on the foreshore.

9.3.8 A series of sites with moats (**WA1306**, **WA1307**, **WA1308**, **WA1309**, **WA1310, WA1330**), and a flattened mound (**WA1320**) are also located within the Study Area. Additionally, occupation locations encompass sites of former medieval farms such as **WA1305**, **WA1314**, **WA1315**, **WA1331**, **WA1332**, and **WA1333**. The last two examples were still in use up to the post-medieval period.

9.3.9 Late medieval coastal settlements are also indicated by archaeological finds from the beaches and adjacent areas of Wenduine (Pieters *et al.* 2010: 195).

9.3.10 Other medieval structures within the study area consist of a mill (**WA1318**), a waste well (**WA1304**), a tannery craft place (**WA1316**), a footbridge (**WA1317**), a Motte Castrale (**WA1328**), a lock which continued to be used throughout the post-medieval period (**WA1334**), and a fortress associated with farm and a circular moat (**WA1328**). Small finds from the Belgian Landfall Study Area comprise medieval faience pottery (**WA1306**), roof tile (**WA1306**), Verhaeghe Group A pottery (**WA1325**, **WA1326**, **WA1327**, **WA1329**), Badorf type pottery (**WA1326**, **WA1327**).

9.3.11 A reconstruction of the Schelde Estuary around 1300 shows that the former coastline between Blankenberge and Knokke was located further seawards at present, and the 'Vlaakte van de Raan' northwest of Zeebrugge is likely to derive from this situation (Pieters *et al.* 2010: 195).

Post-medieval Period

9.3.12 The post-medieval period at the Belgian Landfall Study Area is sufficiently well represented. Several sites show the remains of occupation such as a homestead (**WA1321**), a 17th century non-walled farm (**WA1323**), and a 16th century farm (**WA1324**). Other structures include a brickyard (**WA1322**), a well (**WA1319**), and a flattened mound (**WA1320**).

9.3.13 Some isolated finds also show evidence of post-medieval activity such as fragment of Raeren Majolica stoneware (**WA1331**) and various fragments of pots, dishes, barrels, and faience (**WA1332**).

Undated

9.3.14 Known sites that do not have dates indicated in their records include a brickyard (**WA1335**), a water place (**WA1336**), and a farmhouse (**WA1337**).

9.3.15 Human bones of unknown date have also been recovered from the beaches of Zeebrugge (Pieters *et al.* 2010: 201)

Walkover Survey

9.3.16 A walkover survey was conducted in October 2010. The walkover survey started from the 20th century Belgian Pier of Blankenberge (**Plate 9**) in the NE direction towards to western side of Zeebrugge port. The walk was conducted on the sea shore first from west to east and then again on top of the dykes (sand dunes) from east to west.

9.3.17 During the course of the walk, apart from the 15th century dykes/dune systems (**Plates 10 - 14**), no other artefacts or monuments of archaeological interest were observed. The only features present are two low elevated stone and concrete longitudinal structures located in the intertidal zone (**Plates 15** & **16**) (approximately 200 to 300 m east of the Belgian Pier of Blankenberge), which have been identified by VIOE staff members as a breakwater from the 1960's, apparently very common all along the Belgian coast.

Potential

9.3.18 There is high potential for the discovery of archaeological sites and material dating from the Palaeolithic to the present, as illustrated in the **Regional Archaeological Overview**. Lithic finds are frequently discovered on Belgian beaches, and the Neolithic to Iron Age discoveries from Raversijde indicate that further finds could be expected (Pieters *et al.* 2010). Roman finds are also regularly discovered on the beaches near Raversijde-Mariakerke and Wenduine, and reports from the first half of the 20th century suggest that peat banks were visible in the intertidal zone or sometimes covered by sand (Pieters *et al.* 2010: 192), indicating the potential not

only for the discovery of material, but also the potential for a high level of preservation.

9.3.19 There is also potential for medieval finds, as indicated by the discovery of medieval material in Middelkerke and Raversijde revealed by coastal erosion. Medieval material associated with the construction of the dykes could also be discovered. The potential for post-medieval and modern material relating to the use of the beaches, maritime trade and military activity to survive must also be considered.

9.3.20 From time to time, there have been discoveries of human remains on Belgian beaches, such as at Zeebrugge, Nieuwport, Middelkerke, Raversijde, and at sites such as Mariekerke, Bredene, and De Haan (Pieters *et al.* 2010:201). These finds suggest the possibility of additional discoveries during construction work.

10 IMPACT ASSESSMENT

10.1 DESCRIPTION OF POTENTIAL IMPACTS

10.1.1 The assessment of impacts has been based on the project overview (PMSS 2010 Version 1). There is potential for impact to the known and potential archaeological receptors from route preparation, construction, operation and decommissioning activities.

10.1.2 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.

10.1.3 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.

10.1.4 The optimal cable route has been determined based on an initial feasibility assessment undertaken by Metoc in 2007, followed by an assessment of comparative cost analysis and a review of consenting requirements, and an engineering study. All known wrecks were avoided.

10.1.5 The most likely cable system configuration is the bipole system, where cables are installed in a bundled configuration in the same trench, with no separation between them (PMSS 2010).

Construction

10.1.6 There is potential for direct and secondary impact to archaeological receptors from route preparation activities, including:

- Use of grapnel hook dragged across the seabed to clear out-of-service telecommunications cables that cross the cable route;
- Construction of bridging and separation structures over any pre-existing cables and pipelines that the Nemo cable route crosses. Typically crossing designs involve placement of crushed rock on the seabed above the crossed asset by a specialist vessel that uses a fall pipe to precisely guide the rock to the seabed. Alternatively, 'link-lock' type mattresses could be used. The footprint of cable crossings will be circa 100 m by 30 m;
- Cutting trenches in areas of the seabed where bed rock (such as chalk) is present. It is possible that the trench can be cut during cable laying, alternatively a specialist rock cutting plough will be used. Archaeological receptors in the sediment above bedrock could be impacted;
- Pre-sweeping by dredging to reduce the height of sandwaves because they inhibit burial equipment and, if mobile, decrease the efficacy of burial. The pre-sweeping would normally be 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. Sandwaves are areas of high archaeological potential, possibly covering wreck material. The width of the path would vary, but could be 10 m to 20 m. If adopted, pre-sweeping would be undertaken just a few days in advance of cable laying operations to ensure the dredged path remains open for the installation. The resulting spoil volumes from pre-sweeping are typical of dredging operations for channel or port maintenance and therefore relatively small. It is assumed that spoil will be deposited back on the seabed in the immediate vicinity.

10.1.7 There is also potential for direct and secondary impact to known or potential archaeological receptors during the intertidal and subtidal cable laying:

- Cables will be buried into the seabed either by a plough or trenching machine, with three generic types of equipment possibly to be used: ploughs (towed), jetting machines (towed, free swimming or tracked), and mechanical trenchers. Cable will be buried to a depth of circa 1 – 2 m. 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.
- Where joints are required between cable sections, the joints will be made on board the cable lay vessel or barge, during which time the vessel is likely to anchor in position.
- There is also potential for impact where the Cable Laying Vessel (CLV) has to anchor for other reasons. Cable laying in deep waters will be undertaken by a Cable Laying Vessel (CLV), likely employing simultaneous lay and burial. These vessels can operate between the 10 m depth contours on either end of the route.
- In shallower waters, there would be additional impact along the cable route, as the main CLV would not be capable of approaching close enough to the beach, so a shallow water spread would be needed. Shallow water spreads are normally based on flat-top pontoon barges that can be fitted with all necessary cable storage and working gear. A four to six point mooring system will be used to manoeuvre the barge during cable work.

10.1.8 At the landfall installation, activities that could impact the known or potential archaeological receptors are dependent on the type of method used for cable laying. The options are:

- Open cut, using mechanical excavators; which is often the most straightforward option;
- Coffer dam which is similar to open cut but with sheet piling used to support the trench walls; or
- HDD where a drill is used to install conduits from dry land to a point further down the foreshore. This would probably also require a cofferdam.
- Sometimes a combination of all three techniques is needed because of the physical conditions, environmental sensitivities or the preferences of regulators or curators. Based on previous work at Richborough by the Thanet Offshore Wind Farm operations, a marine burial cable will likely be possible between 1.5 - 2.0 km from the beach. Inshore of this, the Thanet cables were mostly buried using the land based spider plough, with the last 100-200 m being trenched with tracked excavators.

10.1.9 The construction of converter stations located onshore could also have direct, secondary and cumulative/visual impacts on the known and potential terrestrial archaeological receptors. Although the proposed location in the UK is likely to be the already existing disused Richborough Power Station, which would minimise impact, there would still be impact from the development of a cable route to the converter. In addition, the converter station in Belgium, and associated cable route link, is still being discussed.

Operation

10.1.10 Following installation, routine maintenance work to the cables is not anticipated, however, some work may be required to maintain the burial of the cable (PMSS 2010). Routine survey of the cables 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 nearby dredging activity), survey of specific areas of the Nemo cable route may be initiated.

10.1.11 Cable repairs are predicted to be infrequent, and the most common reason for repair will likely be due to damage caused by trawlers and commercial ship's anchors. A repair would typically be carried out by a single vessel. The phases of a repair operation that could impact on archaeological receptors are: cable de-burial, cable recovery, cable re-deployment onto the seabed and reburial.

10.1.12 Additionally, there is the potential for direct and secondary impact from the anchorages of repair vessels during operation.

10.1.13 Potential indirect impacts include changes to the erosion and sedimentation regime in the area. The majority of cable will be buried, so this will not be an issue, however, at cable crossings, the cable could be lifted far enough off the seabed to result in changes to local erosion and sedimentation regimes.

Decommissioning

10.1.14 Should decommissioning be required, the operation will be planned and conducted according to the standard industry protocol at the time (PMSS 2010). The objectives of the decommissioning process will be to minimise both the short and long term effects on the environment while making the sea safe for others to navigate. Based on current regulations and available technology, the following decommissioning is expected:

- 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*

10.1.15 Should the cables be decommissioned, the following operations would typically take place. The cable would be exposed using a gripper or cable 'under-roller', and the cable recovery process would essentially be the reverse of the cable laying operation. After decommissioning, it is expected that the survey route would be surveyed to ensure all cable had been removed.

10.1.16 Potential direct/secondary impacts could result from the removal of the cable system and the anchorages of the cable removal vessels.

10.1.17 Onshore decommissioning operations have not yet been determined, however, they would also be planned and conducted according to the standard industry protocol at the time.

10.2 IDENTIFICATION OF EFFECTS

10.2.1 The assessment of effects is based on the methodology set out above. This section provides a detailed discussion of the impacts and effects, and a summary is provided at the end of the section in **Table 12.3**.

10.2.2 As a result of pre-construction, construction, operation and decommissioning impacts, the following effects are possible:

- Potential damage or destruction of known marine or terrestrial archaeological receptors (terrestrial sites and findspots; submerged prehistoric archaeological material; shipwreck; aircraft crash sites; associated material; and geophysical anomalies of possible anthropogenic origin) from direct or secondary impacts;
- Potential damage or destruction of potential marine or terrestrial archaeological receptors from direct or secondary impacts;
- Potential damage or destruction of the relationships between known or potential marine or terrestrial 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 negative effects resulting from the visual impact of the converter stations and impacts on the concept of setting;
- Potential cumulative effects from a combination of seabed developments being undertaken in the area (ie: other cable routes, offshore wind farm developments, port / harbour dredging, etc).

Nature / Magnitude of Impact

10.2.3 The nature or magnitude of the potential impacts has been assessed based on their likelihood, spatial extent, level of change and duration. Sensitivity, recoverability and Importance are dealt with in **Descriptor of Receptor** below.

Likelihood

10.2.4 The Nemo Project Design (PMSS 2010) has indicated that all known wrecks will be avoided. Therefore, the likelihood that known wrecks will be impacted by the cable route construction is unlikely.

10.2.5 However, archaeological interpretation of geophysical and geotechnical data has indicated a number of geological features of potential archaeological interest along the proposed cable route, including the submerged terrestrial/estuarine deposits and palaeochannels identified in the UK and Belgium sectors, and the likelihood of impact is possible to certain. In particular, the archaeologically interesting sedimentary unit identified in **WA VC3** was situated between 0.29 m and 5.6 m below the seabed, and therefore is certain to be impacted by cable installation. The archaeologically interesting material from **WA VC7** was located 4.28 m below seabed and is unlikely to be impacted by the cable route, however, shallower sediments could be impacted.

10.2.6 The likelihood for secondary impacts on the known archaeological receptors from anchorages of construction vessels or other ancillary development activities is possible.

10.2.7 In addition, many areas of the cable route have high potential for the discovery of previously unreported archaeological material, and therefore it is possible that previously unknown archaeological receptors could be affected by direct and secondary impacts.

10.2.8 It is possible that impacts could occur that would damage or destroy relationships between archaeological receptors and their wider surroundings.

10.2.9 Indirect impacts, resulting from changes to the sedimentation and erosion regimes are unlikely to occur, as any changes to the regimes are expected to be within the natural variation of the baseline.

10.2.10 There will be temporary visual impact during the construction phase, however, this is unlikely to be significant as the marine area comprises a busy shipping lane and both terrestrial landfalls are urban in character with modern developments and construction activities. The likelihood of more permanent visual impact at the Landfalls will depend on the location of the converter station. At the Kent Landfall, the reuse of the Richborough Power Station will be unlikely to impact the setting of terrestrial archaeological receptors in the area. However, as the converter station at the Belgian landfall has not yet been identified, it is not possible to comment on the likelihood of impact.

Spatial Extent

10.2.11 The proposed development plan involves the emplacement of a cable the length of a long section of the seabed, and although impact along the route will be extensive, there will be limited impact laterally and vertically.

10.2.12 The overall quantity of seabed impacted by the Nemo cable route is low when examined in a regional context, and the direct or secondary impacts are expected to be within the immediate vicinity.

10.2.13 There is a slight possibility that the construction of bridging and separation structures could result in changes to erosion and sedimentation regimes, but if these occur, they would be expected to be local.

10.2.14 The damage or destruction of the relationships between known or potential archaeological receptors and the wider environment would have a regional spatial extent. Archaeological receptors have relationships not only with material in the immediate vicinity, but also with receptors of a similar date range or site type across a much wider area – with regional, national, and sometimes even international connections.

10.2.15 As the proposed converter station at the Kent Landfall already exists, there would be no additional visual impact. However, as the converter station at the Belgian Landfall has not yet been determined, its impact could have a local spatial extent.

Level of Change

10.2.16 The level of change of known and potential archaeological receptors from direct and secondary impacts would be high, as any change would be considerably more than what is predicted as part of the natural baseline. In addition, as will be discussed below, the recoverability of the archaeological receptors is low, which increases the significance of the high level of change.

10.2.17 The damage or destruction of relationships between known or potential archaeological receptors would be medium to high. Many of the changes may only be noticeable or measurable against the overall archaeological baseline, however, for sites of high interest with strong relationships to other receptors, the change would be high.

10.2.18 Indirect impacts such as increased sedimentation or erosion are expected to be unlikely, however, even localised erosion could expose archaeological material and lead to degradation that would be large compared with the natural variations in the baseline. Increased localised sedimentation, from changes to sedimentation regimes or dredge plumes, could afford temporary additional protection to archaeological receptors

10.2.19 The level of change for the visual impact at the Kent Landfall will be low as a pre-existing building is being used, however, it is not yet possible to determine the level of visual impact at the Belgian Landfall, and depending on the selection of converter station location and building type, it could be anything from low to high.

Duration

10.2.20 The key consideration when examining the nature or magnitude of impact with regard to archaeological receptors is that all damage or destruction to archaeological receptors through direct, secondary or indirect impacts 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.

10.2.21 The visual impact of construction activities would be short term, lasting for the length of the construction period. In contrast, the visual impact of the converter stations would endure for at least the length of the Nemo cable operational phase. For the pre-existing Richmond Power Station at the Kent Landfall, the impact has already occurred. However, structures built for the Belgian Landfall would last for the length of the Nemo cable operational phase and may not be removed during deconstruction. Therefore, the duration of impact at the Belgian Landfall would be long term.

Magnitude of Effect

10.2.22 The unmitigated magnitude of direct or secondary impacts on known or potential archaeological receptors during pre-construction or construction activities would be severe, as the level of change would be high and the impact permanent.

10.2.23 The visual impact of the construction activities is expected to be low, as the marine area is already a busy shipping channel and the landfalls are modern urban areas where modern construction activities are not unknown.

10.2.24 The magnitude of the long term visual impact on the terrestrial archaeology at the Kent Landfall will likely be low as the converter will likely be the disused Richborough Power Station. However, the magnitude of visual impact related to the converter at the Belgian landfall cannot yet be determined until further details become available.

10.2.25 The magnitude of the indirect impacts will likely be low to moderate. Any changes in scour or sedimentation will likely be very localised, and changes are probably likely to remain within natural variations. However, if scour or erosion resulted in damage or destruction to archaeological receptors, the effects could be severe. Increases in sedimentation could positively affect the archaeological receptors by providing additional protection.

10.2.26 The magnitude of direct impacts on known or potential archaeological receptors or the relationships between the receptors and the wider surroundings from repairs during operation or from decommissioning activities will likely be low to moderate, as any archaeological receptors within the immediate vicinity of the cable route will likely already have been affected.

10.2.27 However, the secondary impacts of anchorages of vessels during operation, repairs or decommissioning, on known and potential archaeological receptors and relationships between receptors and the wider surroundings has the potential to be severe.

Description of Receptor: Sensitivity and Recoverability

10.2.28 All archaeological receptors have the potential to be damaged or destroyed if they are exposed to direct or secondary impacts during seabed preparation, construction, operation or decommissioning activities associated with the Nemo cable route. As such, all sites and material should be regarded as vulnerable and of high sensitivity.

10.2.29 All damage to archaeological receptors would be permanent, and recovery is limited to stabilisation or re-burial limiting further impact. As such recoverability should be considered low. Additionally, any visual impact from the converters at the landfall would endure for at least the entire period of operation, and as structures could be left standing during decommissioning, the impact could be permanent. As such recoverability should be considered low.

Description of Receptor: Importance

10.2.30 The following section assesses the general importance of the archaeological receptors based on available guidance, as discussed in the methodology section.

Statutory Restrictions

10.2.31 Pegwell Bay is part of the Sandwich Bay to Hacklinge Marshes Natural England Site of Special Scientific Interest (SSSI), and is important not only for its biodiversity but also for its geological interest.

10.2.32 In the Kent Landfall Study Area, there are two Listed Buildings, **WA 1039** and **WA1040**.

10.2.33 There are no sites in the English Waters, French Waters, Belgian Waters or Belgian Landfall Study Areas that are currently subject to statutory protection.

10.2.34 However, 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 UK 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.

10.2.35 British vessels in military service at their time of loss (such as **WA7141, WA7289,** and **WA7294**) could be considered for designation under the Protection of Military Remains Act (1986), whether in British waters or international waters.

Importance of Known or Potential Terrestrial or Submerged Prehistoric Receptors

10.2.36 Until recently in Belgium the integration of archaeological values in spatial planning legislation, guidelines and frameworks has been limited to those protected by legislation, such as protected archaeological zones or monuments (Meylemans *et al.* 2005), and there are no European Union (EU) directives covering cultural heritage or the historic environment with regards to establishing value. In 2006, recommendations were made for the development of consistent approaches and techniques for valuing cultural heritage assets (Jones *et al.* 2006: 46). In the UK, the criteria for scheduling ancient monuments is based on a site's period, rarity, documentation, group value, survival/condition, fragility/vulnerability, diversity and potential.

10.2.37 Although the majority of known sites at the Landfalls are not 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, or Centrale Archeologische Inventaris indicates that they have at least some value as historic and archaeological resources.

10.2.38 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). In Belgian waters, the discovery of palaeozoological remains are considered important, because although they do not demonstrate direct interaction between our human ancestors and animals, they are nevertheless considered part of the archaeological archive (Pieters *et al.* 2010: 182).

10.2.39 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 English Waters and Belgian Waters Study Areas. The discovery of peat (**WA VC7**) and evidence for an estuarine environment (**WA VC3**) 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.

10.2.40 There are a wide range of known sites from the Neolithic to post-medieval period across the Landfall Study Areas. 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.

10.2.41 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), based on their 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.

10.2.42 The coast of Belgium was also greatly impacted by the two World Wars, and military material from these periods and earlier is likely to be of heightened importance. The World War archaeology of Western Flanders is actively promoted by the Association for World War Archaeology in cooperation with VIOE (http://www.a-w-a.be/).

Importance of Known and Potential Shipwrecks

10.2.43 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), 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).

10.2.44 Due to the recent development of Belgian legislation for the protection of maritime cultural heritage, there has been only a limited amount of investigation within Belgian territorial waters, and accordingly there is not a specially dedicated list of importance or of protection in place in Belgium. However, the potential for discoveries is substantial, particularly within the area of the sand banks, and all new sites being uncovered should be considered to be of high importance unless proved otherwise.

10.2.45 The French legislation on the protection of maritime cultural heritage specifies that all new discovered sites are of importance, and accordingly would become recognised as of great interest. More specifically, the section of the study area crossing French Waters has been subject to minimal archaeological investigation, and consequently could be of crucial interest, particularly in regards to the importance of the traffic in this region over centuries and millennia. Moreover, the presence of the two vessels within the French study area lost during 'Operation Dynamo' during World War II (**WA7141** and **WA7289**) would be of heightened importance based on their involvement with this operation.

10.2.46 Nine of the known wrecks in the Study Areas were lost due to acts of war (**WA7141, WA7200, WA7275, WA7276, WA7289, WA7293, WA7294, WA7296,** and **WA7301**), and four known wrecks had been in military use at some point in their careers (**WA7270, WA7274, WA7300, WA7302**). The military associations of all of these vessels would indicate high importance.

10.2.47 The *Saint Patrice* (**WA7242**) could also be of medium archaeological importance as a 1920s steam tanker. Although the wreck is considered 'dead' by the UKHO, the

recovery of the ship's bell by divers suggests that more material could remain on the seabed.

10.2.48 The four relatively recent wrecks (**WA7017** (1995)**, WA7287** (1986), **WA7292** (1979), and **WA7303** (marked in 1974)) 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).

10.2.49 It is not possible to assess the importance of the seven wrecks with the limited information available (**WA7151, WA7162, WA7259, WA7272, WA7277, WA7295,** and **WA7299)**, or the wreck discovered through the archaeological assessment of geophysical data (**WA7024**). 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.

10.2.50 It is also not possible to assess the importance of potential sites, however, there is general guidance available that indicates the likely importance of these sites, based on their age and rarity (Wessex Archaeology 2008c). 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.

Importance of Potential Aircraft

10.2.51 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 Wrecks Act (1986).

10.2.52 However, 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).

Value

10.2.53 There is no cohesive guidance for assessing the value of the archaeological receptors or historic environment resource in the context of developmental effects or in the wider environmental impact assessment process. The assessment in this report recognises that whilst within the known resource there are statutorily designated sites of national significance, there are also examples of well preserved sites and monuments which do not have statutory protection. In addition, there are sites which, while not suitable for statutory protection or particularly significant in isolation, combine to inform the wider understanding of past human activity in the region and have value as a sum of parts. The value of any one of these elements of the resource is entirely dependent on the context in which it is being assessed.

10.2.54 The assessment also considers the fact that archaeological receptors and the historic environment resource is both finite and non-renewable; of high sensitivity and low recoverability. In addition, there is often limited information available about each of the known or potential archaeological receptors, making it difficult to fully assess or analyse a site's individual or collaborative importance. Therefore, in terms of the value of the archaeological receptors, they are generally considered to be of high value unless proven to be otherwise.

Significance of Impacts and Effects Assessment

10.2.55 The significance of impacts and effects has been assessed in relation to the magnitude of effect and the value of the receptor. Although assessed as 'major', 'moderate' and 'minor', in terms of the EIA any 'moderate' significance will be considered 'major'.

10.2.56 Direct or secondary impacts to the late 20th century wrecks (**WA7017, WA7287**, **WA7292**, and **WA7303**) and other 'wrecks' of low archaeological importance (**WA7271, WA7273,** and **WA7286**) would cause effects of moderate negative significance.

10.2.57 Direct and secondary impacts to all other known and potential archaeological receptors (terrestrial sites and findspots, submerged prehistoric archaeological material, shipwrecks, aircraft crash sites, associated material, and geophysical anomalies of possible anthropogenic origin) or the relationships between receptors and the wider surroundings will result in significant negative effects. Although it is difficult to assess the significance of effects caused by the direct and secondary impacts to potential archaeological receptors, the damage or destruction of these sites will be permanent, and therefore the effects have been judged to be of major adverse significance.

10.2.58 As indirect impacts are expected to be minor and localised, the effects are likely to be of moderate to low significance. Localised erosion causing damage or destruction to known or potential archaeological receptors would be of low to moderate negative significance. Localised sedimentation affording additional protection to known or potential archaeological receptors would be of low to moderate positive significance.

10.2.59 The significance of the visual impact of the terrestrial converter stations will depend on their locations. At the Kent Landfall where pre-existing buildings are being re-used, the visual impact will be of low significance, however, at the Belgian Landfall, the significance could range between low and high negative significance depending on the selection of the location and building of the converter station.

11 MITIGATION AND MONITORING

11.1 MITIGATION

11.1.1 With regards to the archaeological resource, international best practice and government policy favours preservation *in situ.* As part of the Nemo cable route design, all known wrecks were avoided. This section identifies further mitigation measures or investigations required to address the additional data gaps identified in this report.

11.1.2 A number of geological features of potential archaeological and palaeoenvironmental interest have been identified along the proposed cable route, namely the terrestrial/estuarine deposits and palaeochannels identified in the UK

and Belgian sectors. With regards to cores **WA VC7** (peat) and **WAVC3** (estuarine environment), 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.

11.1.3 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 palaeoenvironental 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.

11.1.4 No additional vibrocores are needed to complete the Stage 3 scientific dating and palaeoenvironmental work. Due to the waterlogged nature of the sediments this work should be undertaken before the environmental remains degrade. Removing the sediments from beneath the seabed begins this process of decay. Dating and palaeoenvironmental work should be undertaken ideally within 6 – 12 months of vibrocore retrieval although this period can be extended with specific storage methods.

11.1.5 If possible, extra care and vigilance should be taken where possible during works in the vicinity of the **WA VC3** core. In this case 'extra care and vigilance' indicates that in the vicinity of this core, any material that is recovered during development (such as during the pre-lay grapnel run) should be reported through the Archaeological Reporting Protocol. Not only has this area demonstrated its potential for the discovery of archaeologically interesting palaeoenvironmental material, the sedimentary unit it is derived from is located very close to the seabed surface, and therefore will definitely be impacted by the development.

11.1.6 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 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 should be undertaken in line with the methodologies outlined in COWRIE 2010 (forthcoming), and access to core samples would be advantageous to further investigate the nature, age and archaeological potential of these features, especially ones of an ambiguous nature (*e.g.* **WA7505**).

11.1.7 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 eight wrecks and geophysical

anomalies of archaeological interest (A1s) identified during the archaeological assessment of geophysical survey data (**Table 12.1**) (**Figures 16, 17 and 18**). 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.

Table 12.1 – 'A1' wrecks assigned Temporary Archaeological Exclusion Zones

Class	WA_ID	Type	Name	Easting	Northing
A1	7024	Wreck	-	389786	5685532
	7027	Debris		391279	5685143
	7047	Debris		394777	5685245
	7049	Debris		395957	5685445
	7098	Debris		416527	5686440
	7141	Wreck	HMS *Westella*	438175	5686526
	7151	Wreck	-	446702	5685213
	7200	Wreck	*Tringa*	460851	5689298

11.1.8 For the known wreck sites (**WA7141, WA7151,** and **WA7200**) 50 m Temporary Archaeological Exclusion Zones are recommended around the known extents of the wreck sites, as part of impact mitigation strategies during development. This should especially be the case for **WA7141**, as the wreck is completely buried at the present time and its exact location and extent could not be confirmed.

11.1.9 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.

11.1.10 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. 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.

11.1.11 For the wreck sites of archaeological importance that are recorded in UKHO, SHOM or VIOE data, but that were not identified in the geophysical data, buffers have been suggested (**Table 12.2**) (**Figures 16, 17 and 18**). 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 can assist in planning, for example, the location of anchorages. As the project progresses, the buffers can evolve, and if impacts to buffered areas cannot be avoided, measures to reduce, remedy or offset disturbance should be agreed.

Table 12.2 - 'A3' wrecks assigned temporary buffers

WA_ID	Type	Name	Easting	Northing
7259	Recorded Wreck	-	506371	5686959
7270	Recorded Wreck	*Harvest Moon*	386196	5685927
7272	Recorded Wreck	-	386928	5685054
7274	Recorded Wreck	*LCP 586*	389454	5685030
7275	Recorded Wreck	-	396314	5685228
7276	Recorded Wreck	*Rydal Force*	396458	5686183
7277	Recorded Wreck	-	404300	5687128
7289	Recorded Wreck	HMS *Blackburn Rover*	437854	5685881
7293	Recorded Wreck	*A-15* (possibly)	483250	5688250
7294	Recorded Wreck	*Empire Path*	488866	5689873
7295	Recorded Wreck	-	488905	5689964
7296	Recorded Wreck	*Gold Shell*	493001	5688721
7299	Recorded Wreck	SS *Kilmare* & *West Hinder* LTV	465186	5689793
7300	Recorded Wreck	*FL5*	476787	5688800
7301	Recorded Wreck	*FL8*	479108	5688790
7302	Recorded Wreck	*Boscobel*	489266	5689685
7303	Recorded Wreck	-	508791	5685728
7306	Recorded Wreck	*St Patrice*	454723	5687712

11.1.12 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 254 geophysical anomalies, rated A2 (of possible anthropogenic origin and archaeological interest) that were identified (**Figures 16, 17 and 18**). However, some of the A2 or A3 anomalies could in reality represent features of high archaeological importance and would require further archaeological investigation if they are likely to be impacted by the development activities to confirm or deny their origin or importance. These sites should be assessed on a case by case basis. Once they have been assessed, appropriate action can be taken. If further assessment will not be undertaken prior to installation, these records indicate key areas to be aware of and where some form of monitoring may be appropriate.

11.1.13 Although site **WA7162**, has been described in the UKHO surveying details as a 'probable wreck', a buffer has not been assigned to this point. The site is recorded by the UKHO as an 'unclassified non-sub contact', there is no further record of any survey activities over the site since the initial 1945 survey, the SHOM database does not indicate an obstruction or wreck in this vicinity and the site was not identified during the recent geophysical survey. It is possible that the initial geophysical survey data were unclear or that the positional information was either vague or in error, or, if there is any material in the area, it is completely buried. Although a buffer has not been assigned to this record, the area should be monitored closely during installation activities.

11.1.14 Where preservation *in situ* is not practicable, disturbance of archaeological sites or material should be offset by appropriate and satisfactory measures, such as preservation by record, where the effects of the development can be remedied by carrying out excavation and recording prior to the impact occurring (Wessex Archaeology 2007). The impact of development may also be remedied by restabilising sites that have been destabilised but not destroyed, or by offsetting damage to a site by detailed analysis and safeguarding of otherwise comparable sites elsewhere.

11.1.15 In response to the Scoping Document, English Heritage has recommended the implementation of an Archaeological Written Scheme of Investigation, to be agreed with English Heritage that will support the delivery of any necessary mitigation measures (English Heritage 2010). The Written Scheme of Investigation would address pre-construction 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.

11.1.16 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 or the Kwinte Bank areas. Hence, measures should be taken to reduce the development impact in this instance. A formal Archaeological Reporting Protocol should 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.

11.1.17 Watching briefs may be appropriate at the landfalls or where seabed material is brought to the surface, for example during pre-lay grapnel runs and during trenching for the cable route.

11.1.18 Archaeological assessment is recommended for any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo, and archaeological advice should be sought in designing the methodologies for these activities (English Heritage 2010). In this regard a new process should be put in place (WSI, Archaeological Reporting Protocol), in order for each discovered feature that the appropriate mitigation could be proposed (the later will depend on the nature, size, importance and location of the feature) and discussed between the client, contractor and curator. The reporting protocol needs to outline not just communications but also actions in regards of the responsibility in the instance of a feature being discovered.

11.1.19 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. However, any positive effects must be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available.

11.1.20 English Heritage has recommended (English Heritage 2010) that the developer ensure that a copy of any archaeological reports, agreed with English Heritage, are deposited with English Heritage's National Monuments Record (NMR). To enable deposit of reports with the NMR, the developer must ensure that an English Heritage OASIS (Online AccesS to the Index of Archaeological Investigations) form is completed for the whole consented project, and all copies of completed and agreed archaeological reports are attached as PDF files. All further advice on completing this condition is to be directed to English Heritage's NMR (oasis@english-heritage.org.uk). Notification of the completion of the OASIS form is also to be sent to Kent County Council for inclusion within the locally maintained Historic Environment Record (HER).

11.1.21 Similarly, it should be expected that any archaeological reports will also be agreed with and deposited with the French and Belgian authorities.

11.2 MONITORING

11.2.1 The project design (PMSS 2010) indicates that only limited monitoring will be undertaken during operation, basically determined by perceived changes to the environment in areas of high seabed mobility or as a result of the need for cable repairs, and no monitoring has been recommended post-decommissioning.

11.2.2 Monitoring may provide opportunities to assess the effect of any impact on archaeological receptors that may be due to the effects of cable installation. .

11.2.3 Additionally, once the cable is in operation, the main source of direct or secondary impact will be related to the need for cable repairs, so monitoring undertaken at these times will also benefit the management of the archaeological resource.

11.2.4 Archaeological assessment is recommended for any further geophysical, geotechnical, dropdown camera, video or diver survey undertaken for the construction, operation or decommissioning of Project Nemo, and archaeological input should inform the methodologies of these activities (English Heritage 2010).

12 RESIDUAL IMPACT

12.1.1 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 minor.

Table 12.3: Impact Assessment

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation	Cable installation	Damage or destruction of submerged prehistoric material below the seabed	100	1	100	100	301 Severe	High	Low	High	High	Significant (negative)	Geotechnical samples from the cable route area have been archaeologically assessed – and Stage 3 assessment could provide further information	100	1	100	100	301 Severe	Shallow sections of the resource will still be impacted by development, however, information about the submerged prehistoric resource will be gained from geotechnical assessment (as explained in section **11.1.3**) – and the area of impact on the feature is comparatively small.	Minor (negative)
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of late 20th century wrecks (**WA7017, WA7287**, **WA7292**, and **WA7303**) and other 'wrecks' of low archaeological importance (**WA7271, WA7273,** and **WA7286**)	1	1	100	100	202 Moderate	High	Low	Low	Low	Minor (negative)	None required, however, to prevent damage to cable laying equipment, wrecks should be avoided.	1	1	100	100	202 Moderate	None	Minor (negative)

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of other known archaeological receptors	100	1	100	100	301 Severe	High	Low	High to Medium	High	Significant (negative)	All known wrecks and terrestrial sites have been avoided in the cable route design. Buffers have been placed around A3 wrecks of archaeological potential, however, A2 geophysical anomalies of potential archaeological interest may still be impacted, and these will either undergo further assessment or will be considered during watching briefs and through the Archaeological Reporting Protocol.	10	1	100	100	211 Severe	Known wrecks, and terrestrial sites will be avoided, and therefore will not be impacted. A2 geophysical anomalies of archaeological potential will be dealt with on a case by case basis.	Minor (negative)
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of potential archaeological receptors	10	1	100	100	211 Severe	High	Low	High	High	Significant (negative)	Archaeological Reporting Protocol will ensure that any material discovered during the development will be reported, recorded, stabilised and conserved.	10	1	100	100	211 Severe	Potential archaeological sites and material may still be affected by installation activities, however, reporting of discoveries through the Archaeological Reporting Protocol will considerably lessen impact	Minor (negative)

Description of Impact			Nature of Effect					Description of Receptor				Impact Significance	Consideration of Mitigation	After Mitigation					Residual Impact Significance
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value		Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	
Installation	Pre-sweeping of sandwaves, use of grapnel hook to clear obstructions, construction of bridging and separation structures, landfall installation activities, trenching for cables, cable laying, cable burial, use of anchors to maintain position of installation vessels	Damage or destruction of relationships between known or potential archaeological receptors and the wider environment	10	10	100	100	220 Severe	High	Low	High	High	Significant (negative)	Known sites will be avoided and discovered sites will be reported, therefore impacts to relationships will be lessened.	10	10	100	100	220 Severe	Mitigation measures will considerably lessen impact	Minor (negative)
Installation	Construction activities	Visual impact or impact on setting of known terrestrial archaeological receptors	100	10	10	1	121 Moderate	Moderate	High	Low to High	Low	Minor (negative)	The visual impact during construction will be temporary. The marine area is a busy shipping channel with consistent impact, and the terrestrial landfalls are urban areas with modern construction activities already taking place.	100	10	10	1	121 Moderate	None expected	Minor (negative)
Installation and Operation	Location of conversion stations	Visual impact or changes to setting on terrestrial archaeological receptors	100	10	100	100	310 Severe	High	Moderate to Low	High	High	Significant (negative)	The re-use of the existing Richborough Power Station will minimise impact – the location of the Belgian Landfall conversion station could also be selected to minimise impact	10	10	10	100	130 Moderate	If Belgian Landfall conversion station is a pre-existing building, impact would be minor, however, construction of new buildings could result in moderate effects.	Minor to Moderate (negative)

Description of Impact			Nature of Effect					Description of Receptor					Consideration of Mitigation	After Mitigation						
Project Phase	Activity	Potential Impact	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Sensitivity	Recoverability	Importance	Value	Impact Significance	Identified Mitigation	Likelihood of potential impact	Spatial Extent	Level of Change	Duration	Magnitude	Residual Impact after mitigation	Residual Impact Significance
Installation and Operation	Changes to erosion regimes at bridging structures	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	100	100	202 Moderate	High	Low	High	High	Moderate (negative)	Changes to erosion regimes are expected to be minimal – areas of high sediment movement will be monitored	1	10	100	100	202 Moderate	Changes are expected to be minimal, monitoring in areas of high sediment movement will considerably lessen impact	Minor (negative)
Installation and Operation	Changes to sedimentation regimes at bridging structures	Indirect impacts on known or potential archaeological receptors and their relationships with the wider environment	1	1	100	100	202 Moderate	High	Low	High	High	Moderate (positive)	Changes to sedimentation regimes are expected to be minimal	1	10	10	100	121 Moderate	Changes to sediment regimes are expected to be minimal	Minor (negative)
Operation and Decommissioning	Repair works on the cable route (cable de-burial, cable recovery, cable re-deployment) Removal of infrastructure: cable removal (cable de-burial, cable recovery)	Disturbance or destruction of known or potential archaeological receptors or the destruction of relationships between receptors	1	1	1	100	103 Moderate	High	Low	High	Low	Minor (negative)	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	1	1	1	100	103 Moderate	Any archaeological receptors in the immediate vicinity of the cable route will already have been impacted.	Minor (negative)
Operation and Decommissioning	Anchors used to maintain position of repair or decommissioning vessels	Disturbance or destruction of known and potential archaeological receptors or the destruction of relationships between receptors as a result of secondary impacts	10	1	100	100	211 Severe	High	Low	High	High	Significant (negative)	Known sites will be avoided through the maintenance of temporary exclusion zones and buffers, and any material discovered will be dealt with through the Archaeological Reporting Protocol	10	1	100	100	211 Severe	Although sites could still be impacted, the implementation of mitigation measures would greatly lessen impact	Minor (negative)

13 REFERENCES

Administratie Waterwegen en Zeewezen, undated, information plaque, Belgium.

Andrews, C. 2004, Roman Kent, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 20-24.

Andrews, P., Egging-Dinwiddy, K., Ellis, C., Hutcheson, A., Phillpotts, C., Powell, A.B., and Schuster, J., 2009, *Kentish Sites and Sites of Kent: A miscellany of four archaeological excavations*

Ashbee, P. 2004, The Neolithic in Kent, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 10-12.

Banyard, G., Duke William's Conquest of Kent in 1066, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 34-35.

BMAPA/English Heritage (EH, 2007, Protocol for reporting finds of archaeological interest, BMAPA/EH.

Bourgeois, J., Talon, M., 2009, From Picardy to Flanders : Transmanche connections in the Bronze Age, in P. Clark (ed), Bronze Age Connections : *Cultural Contact in Prehistoric Europe*, Oxbow Books, Oxford.

Bourgeois, J., Talon, M. (eds), 2005, L'age du Bronze du Nord de la France dans son contexte Europeen : Hommage a Jacques Briard, Actes du Congres National des Societes Historiques et Scientifiques, section pre et protohistorique, *archeologie,* Lille, 2000.

Bournemouth University, 2007, Enhancing our Understanding of the Marine Historic Environment: Navigational Hazards Project. Final Report. Unpublished Report. Aggregate Levy Sustainability Fund ALSF 3917.

Bournemouth University, 2008, Refining Areas of Maritime Archaeological Potential for Shipwrecks – AMAP 1. Aggregate Levy Sustainability Fund ALSF 5083.

Bower, J., The Development of the Towns and Markets 1500-1700, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 66-67.

British Geological Survey, 1992, *The Geology of the southern North Sea* (Cameron, T.D.J., Crosby, A., Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J., and Harrison, D.J.). United Kingdom Offshore Regional Report. London, HMSO.

Cameron, T. D. J., Crosby, A., Balson, P. S., Jeffery, D. H., Lott, G. K., Bulat, J. and Harrison, D. J., 1992, The Geology of the Southern North Sea. British Geological Survey United Kingdom Offshore Regional Report.

Carder, D., 2004, Anglo-Saxon Churches, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 31.

Carozza, L., Mille, B., 2007, Chalcolithique et complexification sociale: quelle place pour le métal dans la définition du processus de mutation des sociétés de la fin du Néolithique en France ?, In J. Guilaine (ed*), Le Chalcolithique et la construction des inégalités, tome 1, le continent européen*, Errance, p. 195-232.

Chalklin, C., The Growth of Urban Kent 1700-1901, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 100-102.

Clark, P. (ed), 2004, *The Dover Bronze Age Boat*, with illustrations by Caroline Caldwell, London : English Heritage.

COWRIE, 2007, *Historic Environment Guidance for the Offshore Renewable Sector* (prepared by Wessex Archaeology 2007).

COWRIE, 2008, *Guidance for Assessment of Cumulative Impact on the Historic Environment from Offshore Renewable Energy* (prepared by Oxford Archaeology 2008).

COWRIE, 2010, *Guidance: Offshore Geotechnical Investigations and Historic Environment Analysis. Guidance for the Renewable Energy Sector.* (prepared by Emu 2010).

Cunliffe, B., 2009, Looking forward : maritime contacts in the first millenium BC, in P. Clark (ed), *Bronze Age Connections : Cultural Contact in Prehistoric Europe*, Oxbow Books, Oxford.

Cunliffe, B., 2001, *Facing the ocean, the Atlantic and its peoples*, Oxford : Oxford University Press.

Defra, 2007, The Marine Works (Environmental Impact Assessment Regulations). No. 1518.

Delgado, J.P., 1997, *Encyclopedia of Underwater and Maritime Archaeology*. London: British Museum Press.

Department of the Environment, Transport and the Regions (DETR) 1999 Circular 02/99, Environmental Impact Assessment, HMSO

Department of Transport, 2007, *Design Manual for Roads and Bridges: Volume 11*: *Environmental Assessment*.

Divine, D., 1959 (reprinted 1975), *The Nine Days of Dunkirk*, Pan Books Ltd. London & Sydney.

Durocq, T., 1989, Le Mesolithique du Nord de la France : apercu sur les recherches en cours, *Revue archeologique de Picardie*, Nb 3-4, pp.9-13.

Dutertre, A., 1936, Les ateliers neolithiques avec microlithiques des dunes d'Equihen et d'Hardelat (Pas-de-Calais), Bull. *Soc. Prehist. Fr*. 33, p372-14.

Edwards, E., The Stranger Populations, Immigration and Settlement, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 86-88.

English Heritage, 1996, *England's Coastal Heritage: a statement on the management of coastal archaeology*. London, EH.

English Heritage, 1998, Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers.

English Heritage, 1998b, Monuments of War. The evaluation, recording and management of twentieth-century military sites.

English Heritage, 2003, Twentieth-Century Military Sites: Current approaches to their recording and conservation.

English Heritage, 2002, Military Aircraft Crash Sites. Archaeological Guidance on their significance and future management.

English Heritage, 2010, Letter re: Project 'Nemo' UK-Belgium Interconnector Cable EIA Scoping Report. Internal reference SE/cable. From Christopher Pater, Marine Planning Unit. 28 October 2010.

European Commission, 1985, EU Directive 85/337/EEC - as amended by 97/11/EC and 2003/35/EC – on the Assessment of the Effects of Certain Public and Private Projects on the Environment

Fentin, R.S., 1979, *W S Kennaugh & Co and the West Coast Shipping Co Ltd.*, World Ship Society, Monograph no. 1, Kendal, Cumbria.

Fontijn, D., 2009, Land at the other end of the sea? Metalwork circulation, geographical knowledge and the significance of British/Irish imports in the Bronze Age of the Low Countries, in Clark, P. *Bronze Age Connections: Cultural Contact in Prehistoric Europe*, Oxbow Books. p. 129-148.

Gaffney, V., Fitch, S., and Smith, D., 2009, *Europe's Lost World: The Rediscovery of Doggerland*. CBA Research Report 160.

Hill, J.D., and Willis, S., 2010 draft, Maritime and Marine Historic Environment Research Framework: Resource Assessment: The Late Bronze Age and Pre-Roman Iron Age c. 1250 BC to AD50. (Draft – March 2010).

Hodgson, J.M. (ed), 1976, *Soil Survey Field Handbook*, Harpenden, Soil Survey Technical Monograph No. 5. Cranfield University.

Institute for Archaeologists (IfA), 2008, *Standard and Guidance for Desk-Bsaed Assessment*.

Jacobs Babtie, 2004, *The Landscape Assessment of Kent*, prepared for Kent County Council.

JNAPC, 1995 (1998), *Code of Practice for Seabed Developers*, Joint Nautical Archaeology Policy Committee.

Jones, C., Slinn, P., Burggraaff, P., Kleefeld, K.D., Lambrick, G., 2006, *Cultural Heritage and Environmental Impact Assessment in the Planarch Area of North West Europe.*

Kent County Council, ongoing, South East Research Framework

Killingray, D., and Crompton G., 2004, Maritime Kent 1700-2000, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 129-131

Lawson, T., 2004, Domesday Population, Towns and Landholdings, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 36-39.

Lawson, T., 2004, Lathes and Hundreds, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 30.

Lawson, T., 2004, Maritime Kent 1500-1700, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 91-92.

Lawson, T. 2004, Markets in the Medieval Period, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 50-51.

Lawson, T. 2004, The Cinque Ports, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 52

Lawson, T., 2004, The Viking Incursions, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 32.

Lebecq, S., 1994, Entre Manche et Mer du Nord, entre Grande Bretagne et Continent, les relations a travers le detroit dans les premiers siecles Medievaux, in S. Curveiller and A. Lottin (eds), *Les Champs relationnels en Europe du Nord et du Nord-Ouest des origines a la fin du Premier Empire*, Calais : La Municipalite de Calais, 29-43.

Marcigny, C., Ghesquiere, E., 2003, L'ile de Tatihou a l'Age du Bronze (Manche) Habitat et Occupation du Sol, Document d'Archeologie Francaise, 96, Paris : Editions de la Maisondes Sciences de l'Homme.

Marsden, P., 1976, A boat of the Roman period found at Bruges, Belgium, in 1899, and related types, *The International of Nautical Archaeology and Underwater Exploration*, 5.1 :23-55.

Marsden, P., 1994, *Ships of the Port of London : First to Eleventh Centuries AD, London*: English Heritage.

McGrail, S., 1987, *Ancient Boats in North-West Europe, The Archaeology of Water transport to AD 1500*, Addison Wesley Longman Inc., NY.

McGrail, S., 2004, *Boats of the World*: *From the Stone Age to Medieval Times*. Oxford.

Meylemans, E., DeDecker, S., Hofkens, E., 2005, *The Environmental Impact Assessment Procedure and Archaeological Heritage Management in Flanders: Past, Present and Future: A Planarch II Report.*

Mol, D., de Vos, J., Bakker, R., van Geel, B., Glimmerveen, J., van der Plicht en Klaas Post, H., 2008, *Mammoten, Neushoorns en Andere Dieren van de Noordzeebodem,* Wetenschappelijke Bibliotheek.

Muckelroy, K., 1981, Middle Bronze Age Trade between Britain and Europe, a maritime Perspective, *Proceedings on the Prehistoric Society*, 47, 275-297.

Mumford, G., 2000, *The Black Pit and Beyond*. General Store Pub. House, pp. 138.

Needham, S., 1996, Chronology and Periodisation in the British Bronze Age, in K. Randsborg (ed), *Absolute Chronology. Archaeological Europe 2500-500 BC*, Acta Archaeologica, 67, 121-140.

O'Connor, B., 1980, *Cross Channel Relations in the Later Bronze Age*, British Archaeological Reports International Series, 91, Oxford.

Oxford Archaeological Trust, 2001, *Kent Historic Landscape Characterisation*, Final Report, Volumes 1-3. Produced for Kent County Council.

Parfitt, K., 2004, The Iron Age c. 700 BC – AD43, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 16-18.

Parfitt, S.A., Ashton, N.M., Lewis, S.G., Abel, R.L., Coope, G.R., Field, M.H., Gale, R., Hoare, P.G., Larkin, N.R., Lewis, M.D., Karloukovski, V., Maher, B.A., Peglar, S.M., Preece, R.C., Whitaker, J.E. & Stringer, C.B. (2010). Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. *Nature* **466**:229-233.

Philippe, M., 2009, The Canche Estuary (Pas-de-Calais, France) from the early Bronze Age to the emporium of Quentovic : A traditional landing place between south-east England and the continent, in P. Clark (ed), *Bronze Age Connections* : Cultural Contact in Prehistoric Europe, Oxbow Books, Oxford.

Pieters, M., 2010, De Noordzee: een waardevol archief onder water Meer dan 100 jaar onderzoek van strandvondsten en vondsten uit zee in Belgie : een overzicht, in VIOE, *Relicta 6 : Archeologie, Monumenten en Landschapsonderzoek in Vlaanderen*, Brussels.

Piningre, JF., 2005 , Un habitat de la fin de l'age du Bronze : le site d'Inghem (Pas-de-Calais), in J. Bourgeois and M. Talon (eds), *L'age du Bronze du Nord-Ouest de la France dans le contexte europeen occidental : nouvelles decouvertes et propositions de periodisation, actes de la table ronde tenue dans le cadre du 125ieme Congres national des societes historiques et scientifiques*, Lille, 2000, Pre et Protohistoire, Paris : Editions du Comite

des Travaux Historique et Scientifiques et l'Association pour la promotion des Recherches sur l'Age du Bronze, 137-158.

PMSS, 2010, Nemo Project Description, Working Document, Revision 1

Pomey, P., Rieth, E., 2005, *L'Archeologie navale*, Paris : Editions Errance.

Riddler, I., 2004, Anglo-Saxon Kent: Early Development c. 450-c.800, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 25-28.

Riddler, I. 2004, Late Anglo-Saxon Kent: Economic Development, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 33.

Rieth, E., 2009, L'epave du 15ieme siecle EP1-Canche, Beutin (Pas-de-Calais) : un premier bilan archeologique (2005-2008), Revue du Nord, 91, 383.

Roberts, A.P., & Grün, R. (2010). Early human northeners. *Nature* **466**:189-190.

Rule, M., Monaghan, J., 1993, *A Gallo-Roman Trading Vessel from Guernsey, St Peter Port*: Guernsey Museums and Galleries.

Samson, 2006, Offshore finds from the Bronze Age in North-Western Europe : The Shipwreck Scenario revisited, *Oxford Journal of Archaeology*, 25(4), 371-388.

Scotsman, 4 June 1940, 'Britain had 887 ships in Dunkirk Triumph: Only six destroyers and 24 small craft lost'.

Scott, B. 2004, Kentish Evidence of the Palaeolithic and Mesolithic Periods, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 7-9.

Scuvee, F., Verague, J., 1988, *Le gisement sous-marin du Paleolithique moyen de l'Anse de la Mondree a fermanville (Manche*), C.E.H.P. – Littus.

Seazone Solutions Ltd. (in progress). AMAP2 – Characterising the potential for Shipwrecks. ALSF 5653.

Seillier, C., Demoin, A., Leclercq, S., 2004, *Archeologie en Nord-Pas-de-Calais: Boulogne Port Romain*, DRAC Nord-Pas-de-Calais.

Smith, V. and Killingray, D., 2004, Kent and the First World War, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 140-141.

Smith, V. and Killingray, D., 2004, Kent and the Second World War, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 142-145.

Somme, J., Truffereau, A., 1978, Historique des Recherches sur le Quaternaire de la Region du Nord de la France, *Bulletin de l'Association francaise pour l'Etude du Quaternaire*, CNRS, Paris.

South East Coatal Group, 2010, Isle of Grain to South Foreland SMP Review 2010

Sweetinburgh, S., 2004, Monastic Houses, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 42-43.

Tuffereau, A., 1978, Le Paleolithique dans le Nord de la France (Nord Pas-de-Calais), *Bulletin de l'Association francaise pour l'Etude du Quaternaire*, CNRS, Paris.

United Nations, 2006, *The Law of the Sea: Training Manual for Delineation of the outer limits of the Continental Shelf Beyond 200 Nautical Miles*, United Nations, New York.

University of Southampton, 2010 draft (a), Maritime and Marine Historic Environment Research Framework: Resource Assessment: Palaeolithic. (Draft – March 2010).

University of Southampton, 2010 draft (b), Maritime and Marine Historic Environment Research Framework: Resource Assessment: Mesolithic. (Draft – March 2010).

University of Southampton, 2010 draft (c), Maritime and Marine Historic Environment Research Framework: Resource Assessment: Neolithic and Early Bronze Age. (Draft – March 2010).

University of Southampton, 2010 draft (d), Maritime and Marine Historic Environment Research Framework: Resource Assessment: The Early Medieval Period: Working Draft. (Draft – March 2010).

University of Southampton, 2010 draft (e), Maritime and Marine Historic Environment Research Framework: Resource Assessment: Medieval (c.1000-1650AD) .(Draft – March 2010).

University of Southampton, 2010 draft (f), Maritime and Marine Historic Environment Research Framework: Resource Assessment: Post-medieval and Early Modern Period 1600-1850. (Draft – March 2010).

Walsh, M., 2010 draft, Maritime and Marine Historic Environment Research Framework: Resource Assessment: Roman. (Draft – March 2010).

Walraevens, K., Clays, S., Hermans, A., & Van Camp, M., undated, Hydrogeological and Hydrogeochemical Investigation of the Dune Area and Adjacent Low Polders at Wendiune-Uitkerke, Flemish Coastal Plain. (http://www.falw.vu/~swim/pdf/swim16/walraevens.pdf)

Wessex Archaeology, 2003, England's Shipping. Year 2 Report. Unpublished report: 51552.05. Aggregate Levy Sustainability Fund: ALSF 3323.

Wessex Archaeology, 2006, On the Importance of Shipwrecks. Unpublished report 58591.02a. ALSF 3767.

Wessex Archaeology, 2007, Thanet Offshore Wind Farm Project: Walkover Survey. Unpublished Report 60073.02.

Wessex Archaeology, 2008, BMAPA/EH Protocol for reporting finds of archaeological interest: Annual Report to BMAPA 2007-2008. Unpublished report:

Wessex Archaeology, 2008b, Aircraft Crash Sites at Sea: A Scoping Study: Archaeological Desk-Based Assessment, Unpublished Report 66641.02. Aggregate Levy Sustainability Fund: ALSF 5223.

Wessex Archaeology, 2008c, Selection Guide: Boats and Ships in Archaeological Contexts. Unpublished report.

Wessex Archaeology, in progress, Assessing Boats and Ships. Aggregate Levy Sustainability Fund. ALSF 5693.

Wessex Archaeology, in progress, South East Rapid Coastal Zone Assessment Survey. (internal ref: 71330).

Whyman, J., 2004, Kent's Watering Places: Tunbridge Wells and the Seaside Resorts, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*, p. 177-180.

Wymer, J., 1982, The Palaeolithic Period in Kent, in Leach P.E. (ed) *Archaeology in Kent to AD 1500*, CBA Research Report 48: 8-11.

Wymer, J. 1999. The Lower Palaeolithic Occupation of Britain. England: Wessex Archaeology and English Heritage.

Yates, D., 2004, Kent in the Bronze Age: Land, Power and Prestige c. 1500- c.700 BC, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*. P. 13-16.

Young, C. 2004, The Physical Setting, in Lawson T. & Killingray D. (eds) *An Historical Atlas of Kent*. P. 1-6.

Websites

Aberdeen Ships, http://www.aberdeenships.com/, accessed 24 November 2010.

Adramar website, http://www.adramar.fr/, accessed October 2010.

Annuaire des Epaves de la Manche, http://phoc44.free.fr/ancien/epaves.pdf, accessed October 2010.

Association for World War Archaeology, http://www.a-w-a.be/ accessed December 2010.

Biache-Saint-Vaast website http://www.biachesaintvaast.fr/prehistoire.html, accessed October 2010.

British Coastal Shipping Companies, http://britishcoastalshippingcompanies.fotopic.net/p65474606.html, accessed 23 November 2010.

British Petroleum, http://www.bp.com/ – accessed 23 November 2010

City of Boulogne, http://www.villee-boulogne-sur-mer.fr/archeologie, accessed October 2010.

City of Bruges city, http://www.brugge.be/internet/fr/toerisme/geschiedenis.htm, accessed October 2010.

City of Dunkerque, http://www.ville-dunkerque.fr/fr/decouvrirdunkerque/histoire/index.htnl, accessed October 2010.

City of Gravelines, http://www.ville-gravelines.fr/Ville-Gravelines-2003%20Dossier/Ville-Gravelines-2003/index.htmlm accessed October 2010.

DRASSM, http://www.culture.gouv.fr/culture/archeosm/fr/ accessed October 2010.

Fleetwood Trawlers website, http://www.fleetwood-trawlers.info/, accessed 24 November 2010

Flickr: http://www.flickr.com/photos/22124479@N03/5008820468/; http://www.flickr.com/photos/22124479@N03/5008819028/in/photostream/

Forum: 12oclock high: http://forum.12oclockhigh.net/showthread.php?p=114958

Gordon Mumford, http://www.gordonmumford.com/m-navy/, accessed 24 November 2010.

Grace's Guide, http://www.gracesguide.co.uk/wiki/Caledon_Shipbuilding_and_Engineering_Co, accessed 24 November 2010.

Hulltrawler.net, http://www.hulltrawler.net/, accessed 24 November 2010

John Readhead's Shipyard website, http://www.johnbage.pwp.blueyonder.co.uk/John%20Readhead%20Shipyard%20Index.htm, accessed 24 November 2010.

Kent Landscape Information System (Kent County Council) - http://extranet7.kent.gov.uk/klis/default.asp –– accessed 25 October 2010

Mercantile Marine, http://sites.google.com/a/mercantilemarine.org/mercantile-marine/Fleets/The-Anglo-Saxon-Petroleum-Company--Shell- accessed 23 November 2010.

Mercantile Marine, http://www.mercantilemarine.org/showthread.php?t=3024 – accessed 24 November 2010.

MUA website, http://www.uri.edu/artsci/his/mua/in_the_field/europe3.shtml), accessed October 2010.

Open Sandwich Kent, History and Photos - http://www.open-sandwich.co.uk/town_history/richborough/richborough_port.htm –– accessed 26 October 2010

Ostend Tourisme website http://www.visitoostende.be/en/tourist-attractions?page=1&o=title&q, accessed October 2010.

Quaternary Palaeoenvironments Group - University of Cambridge – http://www.qpg.geog.cam.ac.uk/research/projects/nweurorivers/#The_maps accessed 11 November 2010

Region NPC website, http://www.nordpasdecalais.fr/reperes/, accessed October 2010.

Royal Marines Museum website, http://www.royalmarinesmuseum.co.uk/, accessed 24 November 2010.

Scladina website, http://scladina.be, accessed October 2010.

Trabel website, http://www.trabel.com/blankenberge/blankenberge-voorpagina.htm, accessed 1 Decebmer, 2010.

Uboat.net website, http://www.uboat.net, accessed 23 November 2010

Wessex Archaeology, http://www.wessexarch.co.uk/projects/marine/thameswreck/exhibition, accessed November 2010

Wikipedia, Bruges, http://en.wikipedia.org/wiki/Bruges,accessed October 2010.

Wikipedia Ostend, http://fr.wikipedia.org/wiki/Ostend, accessed October 2010.

Wikipedia Zeebrugge Raid, http://en.wikipedia.org/wiki/ZeebruggeRaid, accessed October 2010.

World Time website http://www.worldtimelines.org.uk/world/europe/north_west/, accessed October 2010.

World Time website, http://www.worldtimelines.org.uk/world/europe/north_west/, accessed October 2010.

WorldWar1 - http://www.worldwar1.co.uk/ - accessed 23 Nov 2010

Wrecksite, http://www.wrecksite.eu – accessed 23 Nov 2010.

Maps, charts and aerial photographs

Maps

1872 Ordnance Survey map (1:2500, 1:10,560))

1896 Ordnance Survey map (1:2500, 1:10,560)

1908 Ordnance Survey map (1:2500, 1:10,560)

1938 Ordnance Survey map (1:2500, 1:10,560)

British Geological Survey ,1989, Thames Estuary Solid Geology, Sheet 51 N-00, 1:250 000 Series.

British Geological Survey, 1990, Thames Estuary Sea Bed Sediments and Quaternary Geology, Sheet 51 N-00, 1:250 000 Series

British Geological Survey, 1991, Ostend, Seabed Sediments and Holocene Geology, Sheet 51 N-02E, 1:250000 Series.

British Geological Survey,1992, Quaternary Geology Sheet 51°N - 02°E 'Ostend', 1:250,000 Series

Charts

Admiralty Chart: 1828, Dover to North Foreland (1965)

Admiralty Chart: 1828, Dover to North Foreland (1999)

Admiralty Chart 1873, Dunkerque to Oostende (1997)

Admiralty Chart 1874, Oostende to Westkappelle (1996)

Admiralty Chart: 2182, North Sea Southern Sheet (2000)

Vlaamse Hydrografie Chart D11, Vlaamse Banken Van Gravelines Tot Oostkapelle

Aerial photographs

NMR RAF/26J/BR267 L.2 22-FEB-1941

NMR RAF/HLA/540 6051-6052 17-MAY-1942

NMR US/7PH/GP/LOC286 5008 19-APR-1944

NMR RAF/106G/UK/1131 4004 17-JAN-1946

NMR RAF/106G/UK/1110 4077 10-JAN-1946

Google Earth imagery date: 2003, 21-APR-2007

PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR
RICHBOROUGH TO WEST-ZEEBRUGGE

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

Volume II: Appendices

(*cf.* Volume I: Report)

Prepared for:

PMSS

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PROJECT NEMO
UK-BELGIUM ELECTRICAL INTERCONNECTOR

ARCHAEOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

Volume II: Appendices

Ref: 73390.03

Contents

APPENDIX I: LEGISLATION AND GUIDANCE....4
1.1 JURISDICTION....4
1.2 ENGLAND / UNITED KINGDOM....4
1.3 FRANCE....7
1.4 BELGIUM....10
1.5 INTERNATIONAL....11
APPENDIX II – SUB-BOTTOM PROFILER GAZETTEER....13
APPENDIX III – GEOARCHAEOLOGICAL ASSESSMENT OF GEOTECHNICAL DATA ..14
APPENDIX IV – ENGLISH LANDFALL – TERRESTRIAL SITES GAZETTEER (PRELIMINARY GAZETTEER, AS THESE DATA ARE FURTHER ASSESSED IN ANOTHER REPORT)....18
APPENDIX V – ENGLISH WATERS –GAZETTEER OF SITES RECORDED BY UKHO AND GEOPHYSICAL ANOMALIES (FIGURE 8-12)....24
APPENDIX VI – ENGLISH WATERS – RECORDED LOSSES....42
APPENDIX VII – FRENCH WATERS – GAZETTEER OF SITES RECORDED BY SHOM AND GEOPHYSICAL ANOMALIES (FIGURE 13, 14 AND 15)....45
APPENDIX VIII – BELGIAN WATERS – GAZETTEER OF SITES RECORDED BY VIOE AND GEOPHYSICAL ANOMALIES (FIGURE 17 AND 18)....51
APPENDIX IX – BELGIAN LANDFALL – TERRESTRIAL SITES GAZETTEER....69
APPENDIX X – COORDINATES SYSTEM INFORMATION....74

APPENDIX I: LEGISLATION AND GUIDANCE

1.1 JURISDICTION

1.1.1 This section presents the legal and policy framework applicable to archaeology in the Study Area, encompassing the territorial waters administered by England and Belgium, within the 12 nautical mile limit, and extending to those areas beyond the 12 nautical mile limit, comprising the Exclusive Economic Zone (EEZ) administered by the United Kingdom, France and Belgium.

1.1.2 It is generally accepted that states have jurisdiction in respect to heritage within their territory, and within their territorial waters to 12 nautical miles. Beyond 12 nautical miles, the situation is more complex. While there are grounds for exercising authority in respect of maritime archaeology in the EEZ, these grounds are limited by international law, such as the UNCLOS Article 149 and 303.

1.2 ENGLAND / UNITED KINGDOM

1.2.1 The NEMO electrical interconnector passes through English Territorial Waters (to the 12 nautical mile limit) and extends beyond the limit to the UK EEZ.

1.2.2 Within the 12 nautical mile limit, the archaeology and historic environment is under the responsibility of English Heritage. 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. However, military aircraft are automatically protected.

1.2.3 Legislation in England is currently under review, however the section below represents the situation at time of writing. 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). However, until it comes into effect, the following legislation remains in place.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Ancient Monuments and Archaeological Areas Act (AMAA) (1979)	Scheduled Monuments and AAIs are afforded statutory protection and the consent of the Department of Culture Media and Sport, advised by English Heritage, is required for any works.
Planning (Listed Buildings and Conservation Areas) Act (1990)	Works affecting Listed Buildings or structures and Conservation Areas are subject to additional planning controls administered by Local Planning Authorities (LPAs).
Protection of Wrecks Act (PWA) (1973)	Under the PWA (1983) Section One, wrecks and wreckage of historical, archaeological or artistic importance can be protected through designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained. Section Two provides protection for wrecks that are designated as dangerous due to their contents and is administered by the Maritime and Coastguard Agency (MCA) through the Receiver of Wreck (RoW).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Protection of Military Remains Act (PMRA) (1986)	Under the PMRA (1986) all UK aircraft that have crashed while in military service are automatically protected. This part of the Act applies to UK aircraft whether they are located in United Kingdom waters or international waters. The ministry of Defence (MoD) also has powers to protect vessels that were in military service when lost, whether located in United Kingdom waters or international waters.
Merchant Shipping Act (MSA) (1995)	This act sets out the procedures for determining the ownership of underwater finds of 'wreck' material – including flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ship, aircraft, hovercraft, parts of these, their cargo or equipment. If any such finds are brought ashore, the salvor is required to give notice to the RoW. This act covers not only finds of material discovered in English Territorial Waters, but also wreck found or taken into possession outside UK waters but brought into UK waters
Marine and Coastal Access Act (2009)	This involves the regulatory framework affecting development in the coastal area. Through Integrated Coastal Zone Management (ICZM), everyone involved in the management and use of a particular stretch of coast will be brought together within a framework that works to achieve common goals.
Planning Policy Statement 5: Planning for the Historic Environment (PPS 5)	Applies to the marine environment above the mean high water spring tide mark. PPS 5 acknowledges the potentially fragile and finite or irreplaceable nature of the historic environment resource and emphasises the desirability of preserving archaeological remains and their setting within the planning process. It notes that where preservation *in situ* is not justified it is reasonable for planning authorities to require the developer to make appropriate and satisfactory provision for the excavation and recording of remains.
Code of Practice for Seabed Developers Joint Nautical Archaeology Policy Committee 2006 (JNAPC)	This voluntary code provides a framework for seabed developers similar to the principles found in current policy and practice on land. The aim of the Code is to ensure a best practice model for seabed development. The Code offers guidance to developers on issues such as risk management and legislative implications.
England's Coastal Heritage: a statement on the management of coastal archaeology (1996)	This statement sets out a number of principles for managing coastal archaeology. These include the promotion of preservation *in situ*, that finds should be managed in accordance with the principles which apply to terrestrial archaeological remains, that marine and terrestrial remains must be considered seamlessly, that a precautionary approach should be adopted and that PPG16 (now PPS5) should be applied to the treatment of sub-tidal archaeological remains in order to ensure best practice.
Identifying and Protecting Palaeolithic Remains: Archaeolgoical Guidance for Planning Authorities and Developers (English Heritage 1998)	This draws attention to the importance of Palaeolithic remains and states that they must be considered in line with PPG 16 (now PPS 5) when potentially affected by development proposals. Palaeolithic remains are rare and therefore would be of heightened archaeological importance.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Military Aircraft Crash Sites (English Heritage 2002)	This provides archaeological guidance regarding the significance and future management of military aircraft crash sites. It outlines the importance of aircraft crash sites and indicates that they should be considered where they are affected by development proposals.
The Burial Act (1857)	If human remains, including cremated remains, are discovered in the course of site investigations or construction, they must not be exhumed unless a licence has been obtained. The Ministry of Justice is responsible for burials in England and it advises that anyone disturbing buried remains accidentally is advised to leave the remains in place and to contact them immediately.
The Treasure Act (1996)	In England, all finders of 'treasure' are under a legal obligation to report such items to a coroner for the district in which they were found. The Portable Antiquity Scheme defines treasure as: any metallic object that consists of at least 10% precious metal; any group of tow or more metallic objects of prehistoric date; all coins that are at least 300 years old; any objects associated with 'treasure' and any object that would previously have been 'treasure trove'.
Kent and Medway Structure Plan (2003)	The local planning and guidance policy addresses heritage, archaeological sites, buildings or architectural or historic importance and historic landscape within the context of development in the county of Kent.

1.3 FRANCE

1.3.1 The NEMO electrical interconnector passes through French waters beyond the 12 nautical mile limit, but within the Contiguous Zone in the French EEZ. The maritime heritage within both these zones is protected by two pieces of the same legislation which is defined as legal and practical code. The first one is specifically oriented as a legal instrument for the protection of maritime cultural properties, and the second one is defined as a code of practice under the context of rescue archaeology.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Law nº 89-874 relating to Maritime Cultural Properties (1989)	Comprised of Articles L532-1 to L532-14 from Chapitre 2, Titre III, Livre V of the Code to Patrimoine (consolidated version from the 14th of July 2010), and the Articles L544-5 to L544-11, Chapitre 4, Titre IV, Livre V of the Code du Patrimoine. The content of these articles was enacted by the Decret nº 91-1226 in 1991, and has been recently modified as part of a general revision of the Code du Patrimoine by the Ordonnance 2004-178 art 7, 14ºJORF in 2004. This law concerns all maritime cultural property such as deposits, wrecks, remains or generally all property having prehistoric, archaeological, or historical interest and which are located within either the 12 nautical mile limit or the Contiguous Zone (24 nm). It is an offence to carry out any investigative activities, prospective activities or cultural property movement without a granted permission from the French authorities, and that the latter activities have to be effectively undertaken under the direction of the permit holder. If the physical integrity of cultural maritime property is being compromised, it is declared of public interest that a Court of Justice pronounce the transfer of the property's ownership to the French government against some financial compensation. Every find within these waters must be reported by the finder. All failure to comply with the obligation of declaring all discoveries, or the making of a false declaration can lead to a fine of 3750€. Any unauthorised activity on a maritime cultural property can lead to a fine of 7500€. Any person found guilty of acquisition or selling maritime cultural properties from the French maritime public domain can be subject to a sentence of 2 years in jail and a fine of 4500€ or the double of the selling price. Each declaration of discovery to the French authorities can be subject to a reward of which the nature and amount would be determined by the administrative authorities depending on the find's importance and rarity. All maritime cultural property must be claimed by its owner within three years of discovery or ownership will automatically be shifted to the French government.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Law nº 2001-44 relating to Rescue Archaeology (2001)	Articles L521-, L522-1 to L522-8, L523-1 to L523-14, and L524-1 to L524-16 from the Chapitre 1 to 4, Titre II, Livre V of the Code du Patrimoine. These texts are the codification of law nº 2001-44 relating to rescue archaeology which has been modified by law nº 2003-707 from the 1st August 2003. This legislation establishes that rescue archaeology is a public service which is governed by applicable scientific research principles. Its objectives are to ensure on land and underwater an appropriate framework for the detection, conservation, interpretation, dissemination and rescue by scientific study the archaeological heritage affected or potentially affected by private or public development. Operationally, investigative diagnostics are generally undertaken by the governmental rescue archaeology institute INRAP (Institut National de la Recherche en Archeologie Preventive) or local council archaeological services. However, the developer can select a private archaeological operator so long as they hold the agreed accreditation from the French authorities. Financially, these operations are funded by two different sources: the rescue archaeology fee (Redevance d'Archeologie Preventive (RAP)) which funds investigative diagnostics, and the national fund for rescue archaeology (Fond National pour l'Archeologie Preventive) which helps some developers to pay the costs of excavation. This fee is due for all development projects that affect the ground or seabed and is calculated and determined by local planning services (such as the DRAC, SRA, DDE, and so forth). If excavation is required, the price that the developer has to pay to the operator is the counterpart of this excavation service accomplished by this operator.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Inter-prefectoral Decree No. 89/2010 of the Atlantic Maritime Prefet and No. 64/2010 of the Maritime Prefet of the Channel and the North Sea	Article 1: Exploration and research relating to wrecks or maritime cultural heritage situated in the economic zone, the adjacent zone and in the French EEZ offshore from the French coasts of the Atlantic Sea, the Channel and the North Sea are permitted, provided that an information dossier describing the activities planned is submitted (by registered post) to the appropriate maritime Préfet at least 3 months in advance of the commencement of the works. Article 2: Such notification becomes invalid if no activities take place within 30 days of the planned start of the works, or when the works are suspended for a period of 30 days or more. The notification may not used by any other person or organisation other than the original applicant, nor to any other ship than that which is stated in the original submission. Article 3: The information dossier must state the exact nature of the activities planned, must include a list with descriptions of the prospecting and research equipment which is to be used, the precise location (using the WGS 84 geodesic co-ordinates system) of the areas where the operations are to take place, the duration of the operations (with start and end dates), and the use to which the research or items recovered will be put. It must also include a statement setting out the description and function of the wreck or the asset, as well as any historic information which relates to them. The information dossier must include an evaluation of the impacts of the proposed operations on the marine environment. Article 4: Non-observance of the provisions of this Decree will render the operators liable to be required immediately to depart from the marine areas quoted in Article 1 or to return to a French port suitable for the carrying out of an enquiry and to such fines or other penalties which may apply in the circumstances of such non-observance. Article 5: Inter-prefectoral Decree No. 40/2010 of the Atlantic Maritime Prefet and No. 12/2010 of the Maritime Prefet of the Channel and the North Sea dated 21 April 2010 is hereby superseded by the present Decree Article 6: The Admirals commanding the Atlantic and the maritime zone of the Channel-North Sea, the inter-regional director of Rouen Customs, the inter-regional director of N.Atlantic/W.Channel sea areas, the officers and other staff responsible for policy on mines, wrecks, marine cultural heritage, navigation and continental shelf exploration are charged with the execution of the present Decree, each according to their particular areas of responsibility.

1.4 BELGIUM

1.4.1 The NEMO electrical interconnector has a Belgian terrestrial landfall, passes through Belgian Territorial Waters (within 12 nautical miles) and includes an area of the Belgian EEZ. The following legislation applies to archaeology and the historic environment, and has been provided by the VIOE (Vlaams Instituut voor het Onroerend Erfgoed) from data developed by the MACHU project (Culture 2000).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Flemish Parliament Act on the Protection of the Archaeological Patrimony (1993) (Archeologiedecreet, 1993)	This Act is enforced on a regional level on land to low water level. It regulates the protection, preservation, maintenance, restoration and management of the archaeological heritage of Flanders. In addition, it regulates archaeological excavation, prospection (whether through impact to soil or with metal detectors) and unexpected discoveries. This decree may be revised in 2010, and there is political intention to implement the European Valletta Convention and the UNESCO Convention.
Wreck Act on the Finding and Protection of Wrecks (2007) (Wrakkenwet, 2007)	This Act is enforced in federal and territorial waters. It regulates the right of property of wrecks and wreckage in the Belgian territorial sea. In addition, it creates a judicial base for the protection of shipwrecks of archaeological and historical value within the territorial sea. The legislation is based on an agreement between the Federal Ministry of Northsea Affairs and the Flemish Ministry of Spatial Planning and the environment. Although the Act has been agreed on, it has not yet been implemented.
Royal Decree concerning the exploration and exploitation of non-organic resources in the territorial sea and the continental shelf (2004) (Koninklijk Besluit betreffende de exploratie en de exploitatie van niet-levende rijkdommen in de territoriale zee en op het continentaal plat, 2004.	This decree applies to federal and territorial waters as well as the continental shelf. It concerns the conditions, geographic boundaries and procedure of attribution of concessions for the exploration and exploitation of mineral and other non-organic resources. It concerns maritime heritage because it indicates the geographic areas of exploration/exploitation in which the level of threats towards the maritime heritage rise.
Royal Decree creating special zones of protection and nature conservation in the marine area under Belgian jurisdiction (revised) (2005), (Koninklijk Besluit tot instelling van speciale beschermingszones en speciale zones voor natuurbehoud in de zeegebieden onder Belgische rechtsbevoegdheid (bijgewerkt), 2005.)	This decree is enforced in federal waters, territorial waters and on the continental shelf within the Exclusive Economic Zone beyond 12 nautical miles. It marks out the first Marine Protected Areas in the Belgian part of the Northsea: enforcing the European directive of Important Birds (1979) and the European directive of their habitats (1992). It also concerns maritime heritage, because the threats towards maritime heritage in these areas is lower (Articles 2 & 5).

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
Special law of the Reformation of the institutions (revised) (1980), (Bijzondere wet tot Hervorming der Instellingen, 1980)	This federal legislation divides Belgium into Provinces and Regions while marking out their boundaries. The border of the province of West-Flanders is at 0m LWL.
Act on the protection of the marine environment in sea areas under Belgian jurisdiction (revised) (1999) (Wet ter bescherming van het mariene milieu in de zeegebieden onder Belgische Rechtsbevoegdheid (MMM) (herzien), 1999)	This legislation applies to federal, territorial waters and the continental shelf Exclusive Economic Zone. It summarises the general principles of environmental law, and the purpose of the Act is to preserve the nature, biodiversity and untouched character of the marine environment in Belgian waters. It aims to protect the marine environment and to restore any previous damage to the marine environment. This concerns maritime heritage as it regulates human impact in the marine areas.

1.5 INTERNATIONAL

1.5.1 International heritage policies can apply to all three countries, while other international policies apply beyond each 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.

1.5.2 Material discovered on the Continental Shelf / in the EEZ may also be subject to UK legislation, such as the MSA (1995) which covers wreck found or taken into possession outside UK waters but brought into UK waters, and the PMRA (1986) which covers British controlled ships, British citizens and British companies.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
European Landscape Convention (ELC) (also known as the Florence Convention) (2000)	This became binding on the Belgium in 2005, France in 2006 and the UK in 2007. Its principle clauses require the Government to protect and manage landscapes and to integrate landscape into regional and town planning policies including its cultural, environmental, agricultural, social and economic policies. The ELC applies to land, inland water and marine areas, however it is not regarded as applying to sea areas that lie beyond territorial waters (the 12 nautical mile limit).
European Directives (85/337/EEC, 97/11/EC, 2001/42/EC)	Continental shelf activities are subject to Environmental Impact Assessments, and the effects of those activities on the archaeological heritage have to be addressed and mitigation proposed.

LEGISLATION / POLICY TITLE	GENERAL OVERVIEW
United Nations Convention on the Law of the Sea (UNCLOS) (1982) (Zeerechtenverdrag, 1982)	UNCLOS 1982 has been ratified by the UK, France and Belgium. Article 149 and 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. These articles also provides for coastal states to exert a degree of control over the archaeological heritage within the Exclusive Economic Zone.
European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (the Valletta Convention)	The Valletta Convention has been ratified by France and the UK, and came into force in 1996 in France and in 2001 in the UK. Belgium has signed the Convention, however it has not yet been ratified and therefore has not yet come into force. The convention binds countries to implement protective measures for the archaeological heritage within the jurisdiction of each party, including sea areas. The Convention identifies that archaeological interests should be included in the spatial planning process, and that preservation *in situ* should be considered as the first option. Parties to the convention are obliged to take legal measures for the protection of the archaeological heritage and to warrant the scientific quality of the archaeological research.
UNESCO Convention on the Protection of Underwater Cultural Heritage (UNESCO) (2001)	The UNESCO Convention is a comprehensive attempt to codify international law with respect to underwater archaeological heritage. Although the UK abstained in the vote on the final draft of the Convention, it has stated that it supports most of the articles, particularly the provisions in the Annex governing the conduct of archaeological investigations. Neither France nor Belgium are signatories either, however twenty States have now ratified the Convention, which therefore entered into force on 2 January 2009.
International Council on Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage (1996) (the Sofia Charter)	The Sofia Charter includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all. Belgium, France, and the UK are all members of ICOMOS.
ICOMOS Charter on the Protection and Management of Archaeological Heritage (1990)	The Charter states that archaeological heritage is a fragile and non-renewable cultural resource, and land use must therefore be controlled and developed in order to minimise the destruction of the archaeological heritage. The protection of the archaeological heritage should be integrated into planning policies at international, national, regional and local levels.

APPENDIX II – SUB-BOTTOM PROFILER GAZETTEER

This appendix includes a description of sub-bottom profiling data produced by MMT. Areas of particularly high prehistoric archaeological potential have been illustrated (see **Figure 7** & **16**). However, the remaining images are held in the project archive for future reference.

WA ID	Name / Classification	Archaeological Discrimination	Description	Sources
7500	Palaeochannel	A1	A generally NNE - SSW trending under-filled palaeochannel as identified my multibeam bathymetry. Sub-bottom profiler assessment indicates the presence of channel fill in the base of the feature, and coring has recovered intact terrestrial peat deposits. Cuts through erosion surface 7502. Depth Range: 0.0m - 3.8m BSB.	6511 (sbp)
7501	Palaeochannel	A1	An area of shallow, poorly defined, under-filled palaeochannels as identified in the multibeam bathymetry data. Only one small channel has been identified by the sub-bottom profiler, indicating the rest of the area either has very thin deposits or is filled with more homogenous material. Depth Range: 0.0m - 8.3m BSB.	6510 (sbp)
7502	Erosion Surface	A2	Poorly defined, sporadic, undulating reflector associated with an area of under-filled palaeochannels observed on the multibeam bathymetry data and two observed on the sub-bottom profiler data (7500 and 7501). Could represent the top of the bedrock, or an erosion surface within more recent deposits. Depth Range: 3.4m - 9.4m BSB.	6509 (sbp)
7503	Simple Cut and Fill	A2	Possible poorly defined simple cut and fill located beneath an area of sand waves. Possibly part of an old palaeochannel system. Depth Range: 0.7m - 11.3m BSB.	6507 (sbp)
7504	Simple Cut and Fill	A2	Possible poorly defined simple cut and fill located below erosion surface 7505 and an area of sand waves. Possibly part of an old palaeochannel system. Presence of sand waves probably ensures the feature is mostly beyond the depth of the proposed scheme, though these are likely to be ephemeral features. Depth Range: 2.9m - 15.3m BSB.	6504 (sbp)
7505	Erosion Surface	A2	Strong, sub-parallel, laterally continuous shallow reflector. Possibly represents the boundary between the bedrock and more recent, unconsolidated deposits though could just be the base of the seabed sediments. Cuts through older possible channel feature 7504. Depth Range: 0.0m - 13.7m BSB.	6503 (sbp)
7506	Simple Cut and Fill	A2	Simple cut and fill cut into the bedrock beneath erosion surface 7508. Possibly part of an old palaeochannel system. Probably mostly beyond the depth of the proposed scheme, though is fairly shallow in parts. Depth Range: 3.3m - 11.4m BSB.	6502 (sbp)
7507	Simple Cut and Fill	A1	Shallow simple cut and fill cut into the sediments overlying erosion surface 7508. Most of the internal structure is obscured by shallow gas blanking, though it seems there is a single episode of fill. The gas within the feature indicates the presence of organic material. Depth Range: 0.0m - 5.8m BSB.	6501 (sbp)
7508	Erosion Surface	A1	Strong, sub-parallel, laterally continuous reflector. Possibly represents the boundary between the bedrock and more recent, unconsolidated sediments. Core samples indicate the fill above this boundary are possible estuarine deposits. Cuts through older possible channel feature 7506. Depth Range: 0.0m - 7.0m BSB.	6500 (sbp)

APPENDIX III – GEOARCHAEOLOGICAL ASSESSMENT OF GEOTECHNICAL DATA

Vibrocore logs were provided for 92 core logs, all of which were assessed by Wessex Archaeology. 10 additional vibrocores were physically geoarchaeologically assessed by Wessex Archaeology. All the vibrocore locations were plotted in the GIS (see **Figure 3**). This section provides a list of the vibrocore numbers and their locations.

Location of Vibrocores

VC Number	Easting	Northing
VC-0001	499058.2	5687762
VC-0002	497332.9	5687896
VC-0003	496910.6	5687926
VC-0004	495903.8	5687999
VC-0005	495315.9	5688042
VC-0006	493886.9	5688209
VC-0007	492961.9	5688424
VC-0008	491986.9	5688656
VC-0009	491019.3	5688900
VC-0010	490273.8	5689078
VC-0011	490045.1	5689124
VC-0012	489079.8	5689357
VC-0013	488103.7	5689589
VC-0014	487472.6	5689584
VC-0015	486134.3	5689329
VC-0016	484773.3	5689069
VC-0017	484160.2	5688981
VC-0018	482969.1	5688456
VC-0019	482153.8	5688139
VC-0020	481353	5688174
VC-0021	480212.1	5688214
VC-0022	479043.8	5688281
VC-0023	478325.4	5688333
VC-0024	477337.6	5688399
VC-0025	476337.6	5688461
VC-0026	475441	5688515
VC-0027	474149.4	5688594
VC-0028	471788.1	5688754
VC-0029A	471279.8	5688790
VC-0030	470207.7	5688864
VC-0031	469374.7	5688980
VC-0032B	469021.9	5689140
VC-0033A	468866.4	5689396
VC-0034	468463.5	5689966
VC-0035	467633.7	5690744
VC-0036	466719.4	5690939
VC-0037	466465.3	5690932
VC-0038	465259	5690948
VC-0039	464321	5690532
VC-0040	463798.4	5690291
VC-0041A	462498	5689712
VC-0042A	462176.4	5689565
VC-0043	461654.1	5689610
VC-0044A	460114.9	5689245
VC-0046	457635.4	5688266
VC-0047	457421.9	5688181
VC-0048	455915.6	5687592
VC-0049	454522.1	5687034
VC-0050	453136.5	5686490
VC-0051	452140.6	5686078

VC Number	Easting	Northing
VC-0052	451291.4	5685741
VC-0053	450335.5	5685377
VC-0054	449407.2	5685032
VC-0055A	448045.2	5685200
VC-0057	445716.7	5685678
VC-0058	444796.7	5685869
VC-0059	444005.2	5686038
VC-0060	442943.5	5686261
VC-0061	442805.9	5686289
VC-0062	441916.3	5686393
VC-0063A	441555.6	5686395
VC-0064	440357.6	5686404
VC-0065A	439433	5686413
VC-0066A	438821.7	5686413
VC-0067	438323.2	5686413
VC-0068	437731.7	5686422
VC-0069	436562.2	5686432
VC-0070A	435930	5686434
VC-0071	435033.6	5686445
VC-0072	433832.7	5686454
VC-0073	431812	5686467
VC-0074	431644.9	5686469
VC-0075	429930.3	5686478
VC-0076	428844.6	5686488
VC-0077	428338	5686491
VC-0078	427747.8	5686502
VC-0079	427635.1	5686500
VC-0080	426006.1	5686575
VC-0081	425553.7	5686600
VC-0082	424496.3	5686655
VC-0083	423561.1	5686715
VC-0084	422310.7	5686773
VC-0085	421061.7	5686841
VC-0086	420843.9	5686852
VC-0087	420260.1	5686866
VC-0088	419233.7	5686867
VC-0089	417568.5	5686874
VC-0090	416572.2	5686883
VC-0091	415303.2	5686900
VC-0092	414539.4	5686909
WA_VC1	459043	5688820
WA_VC2	485079	5689134
WA_VC3	496458	5687963
WA_VC4	439728	5686408
WA_VC5	438782	5686421
WA_VC6	432052	5686463
WA_VC7	404296	5686691
WA_VC8	415132	5686851
WA_VC9	414021	5686961
WA_VC10	414185	5686965

Belgium

WA VC1

Depth below seabed(m)	Description
0 – 0.19	2.5Y 5/3 Light olive brown silty sand, medium to fine grain, poorly sorted, soft, with abundant broken molluscs, abundant flint inclusions and pebbles up to 4.4 cm in diameter. Gradual boundary.
0.19 – 0.32	2.5Y 4/2 Dark greyish brown sandy clay, fine grain, moderately well sorted, soft to medium hardness, abundant mollusc and flint inclusions up to 2.2 cm in diameter. This is probably a transition between the above and below sediments. Gradual boundary.
0.32 – 3.5	2.5Y 4/2 Dark greyish brown clay, well sorted, firm. Probably bedrock.

WA VC2

Depth below seabed(m)	Description
0 – 3.54	2.5Y 5/1 Grey silty sand, medium to coarse grain, poorly sorted. Abundant marine mollusc inclusions up to 0.6 cm in diameter, frequent flint sub-angular flint inclusions up to 2 cm in diameter. Gradual boundary over 6 cm.
3.54 – 4.6	2.5Y 4/1 Dark grey clay, firm, very well sorted. Probably bedrock.

WA VC3

Depth below seabed(m)	Description
0 – 0.29	2.5Y 4/1 Dark grey silty clay, very well sorted, soft, occasional shell inclusions up to 0.4 cm in diameter. Sharp boundary. Sample taken at 0.19 m. PMCI Sample taken at 0.2 – 0.3 m.
0.29 – 5.6	2.5Y 5/1 Grey silty clayey sand, fine, very well sorted, firm, very occasional flint and marine mollusc inclusions up to 0.5 cm in diameter, molluscs becoming more frequent with depth. At 0.9 – 0.92 m lenses of brown silty sands with organic material. 2.8 – 3.12m pockets of brown silty sand with abundant organic remains. 3.96 – 4.06 m pockets of brown silty sand with abundant organics. At 4.5m lenses of brown silty sands with organic material. At 4.6m lenses of brown silty sand with organic material. At 5.46 m lenses of brown silty sand with organic material. PMCI Sample taken at 2.8 – 2.9 m and at 4.3 – 4.4 m. Samples taken at 0.91m, 1.77 m, 2.48m, 3.52 m, 4.66 m, 5.12 m and 5.52 m. wood sample taken at 2.99m.

France

WA VC4

Depth below seabed(m)	Description
0 – 1.44	2.5Y 5/2 Greyish brown sand, soft, poorly to moderately sorted, medium to coarse grained, abundant flint and marine mollusc inclusion up to 2cm in diameter. Gradual boundary over 7 cm.
1.44 – 3	2.5Y 4/2 Dark greyish brown silty clay, well sorted, firm. Getting firmer with depth. Probably bedrock.

WA VC5

Depth below seabed(m)	Description
0 – 2.71	2.5Y 6/2 Light brownish grey sand, fine grained, well sorted, loose, frequent broken mollusc inclusions up to 0.2 cm in diameter, moderate flint pebbles getting larger with depth. Between 2.35 – 2.71 pockets of black anaerobic sand occur but still the same layer. Gradual boundary.
2.71 – 3.16	2.5Y 5/2 Greyish brown silty clayey sand, medium to fine grained, well sorted, abundant broken mollusc inclusions up to 0.7cm, and abundant flint inclusion, sub-angular to rounded up to 2.3 cm. Probably the transition between above and below sediments. Gradual boundary.
3.16 – 4.2	2.5Y 4/1 Dark grey silty sandy clay, very well sorted, stiff, moderate rounded flint inclusions up to 1.4 cm.

England

WA VC6

Depth below seabed(m)	Description
0 – 0.96	2.5Y 5/3 Light olive brown sand, medium to coarse grain, well sorted, loose, moderate shell and flint inclusions up to 3 cm. 2 cm boundary.
0.96 – 1.06	2.5Y 4/1 Grey sandy clay, soft, poorly sorted, with flint pebbles up to 5cm in diameter. Probably the transition between above and below sediments. Gradual boundary.
1.06 – 2.5	5Y 4/1 Dark grey clay, well sorted, fine, firm. Probably bedrock.

WA VC7

Depth below seabed(m)	Description
0 – 1.43	2.5Y 4/3 Olive brown sand, medium to coarse grain, moderately well sorted, abundant flint pebble inclusions up to 5 cm in diameter. Sharp boundary.
1.43 – 2.41	2.5Y 4/1 Dark grey sand, coarse to medium grain, poorly sorted, abundant marine mollusc inclusions and flint pebbles up to 2 cm in diameter. Sharp boundary.
2.41 – 4.28	2.5Y 3/1 Very dark grey sandy clay, well sorted, occasional marine mollusc inclusions up to 0.5 cm in diameter. Occasional wood inclusions up to 6 cm long. Sharpe boundary. P,d,f,o samples taken at 2.8m and 4.22m. P,M,C,I sample taken at 1.7 – 1.8m and 2.6 – 2.7m and 4.11 – 4.21m.
4.28 – 5.35	Brown peat, with abundant reed and root remains, and abundant fresh water molluscs. Filled in mollusc burrows on the upper boundary. Gradual horizon. P,d,f,o samples taken at 5.2m and 5.35m.
5.35 – 6	2.5Y 5/1 Grey chalk putty (silty soft clay) with large flint pebble inclusions up to 6 cm in diameter. Probably bedrock eroded by glacial action. P,d,f,o samples taken at 5.5m, 5.6m, 5.7m and 5.85m. P,M,C,I samples taken at 5.35 – 5.45m and 5.45 – 5.5m. snail sample taken at 5.36m. reed sample taken at 5.44m.

WA VC8

Depth below seabed(m)	Description
0 – 2.8	2.5Y 4/3 Olive brown sand, medium grained, loose, well sorted.

WA VC9B

Depth below seabed(m)	Description
0 – 5.6	2.5Y 5/3 Light olive brown sand, very well sorted, loose, very occasional sub-angular flint inclusions up to 0.5cm in diameter. Marine molluscs appear in same sediment later from 1m onwards up to 0.7 cm in diameter. From 5 m onwards the flint inclusions become rounded pebbles up to 0.8 cm in diameter.

WA VC10

Depth below seabed(m)	Description
0 – 5.4	2.5Y 6/6 Olive yellow sand, very well sorted, medium grained, soft, loose, very occasional sub-angular flint inclusions up to 0.5 cm in diameter, very occasional marine mollusc inclusions up to 0.6 cm in diameter. Marine mollusc inclusions disappear from 2 m onwards. The flint inclusions disappear from 4 m onwards.

APPENDIX IV – ENGLISH LANDFALL – TERRESTRIAL SITES GAZETTEER (PRELIMINARY GAZETTEER, AS THESE DATA ARE FURTHER ASSESSED IN ANOTHER REPORT)

This appendix includes a list and description of English terrestrial sites from NMR/HER (see **Figure 5** & **6**)

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1001	Neolithic	Late Neolithic barrow, North of Canterbury Road West.	Late Neolithic / early Bronze Age barrow. Contained burial accompanied by a long necked beaker, a button of jet and a flint knife.	635150	165220	HER MKE7762
1002	Prehistoric	Prehistoric barrows, enclosures etc found north of Bethlehem Farm, Minster, Thanet	Prehistoric barrows. Grave contained skeletal remains. A single sherd of flint-gritted pottery, probably of Iron Age date, was found in the ditch. Finds from three pits have included animal bone, Iron Age pottery and pot-boilers.	634700	164600	HER MKE8103
1003	Bronze Age	Bronze age round barrow, Manston	Bronze Age round barrow.	635020	165390	HER MKE7634
1004	Bronze Age	Barrow, North of Canterbury Road West, Manston	Cropmark indicating the presence of a Bronze Age barrow.	635000	165200	HER MKE7761
1005	Bronze Age	Crouched Inhumation, Cliffs End	Crouched inhumation, accompanied by bell beaker.	634550	164790	HER MKE8083
1006	Bronze Age	Possible Bronze Age features, Cliffsend, Ramsgate	Prehistoric settlement - possibly relating to the Neolithic or the Bronze Age. Artefacts included worked flint and pottery.	634950	164390	HER MKE21097
1007	Bronze Age	Bronze Age enclosure + ring ditch.	Bronze Age enclosure and ring ditch visible as cropmarks.	634810	164680	HER MKE8081
1008	Bronze Age	Bronze Age hoard, Cottington Hill, Minster - Findspot	Bronze age hoard.	633450	163450	HER MKE15874
1009	Bronze Age	Bronze Age founder's hoard, Ebbsfleet Farm, Minster parish	Bronze Age founder's hoard, discovered in 1893 on a farm at Ebbsfleet, near Minster. Consisted of 181 weapons and implements, including socketed axes, spearheads and winged axes. Findspot uncertain.	633270	163080	HER MKE8059
1010	Prehistoric	Prehistoric midden material, Cottington Hill, Minster	Evidence of a prehistoric midden was found in eroded material from the bank of a dyke. Late Bronze / Early Iron Age pottery sherds and associated material.	633850	163620	HER MKE15875

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1011	Bronze Age	Late Bronze Age/early Iron Age postholes & pits, north of Canterbury Road West, Manston	Postholes and pits within a late Neolithic/early Bronze Age barrow.	635150	165220	HER MKE19917
1012	Iron Age	Iron age coins, Cottington Hill, Minster - Findspot	Nine iron age coins, found by metal detectorist. Dated to 100-90BC. Trinovantian type, made of cast bronze.	633630	163900	HER MKE10031
1013	Iron Age	Copper Celtic coin, Cottington Hill, Minster - Findspot	A 'Celtic' coin, found by metal detectorists, dated to 10-20 AD. Trinovantes or Cunobelin type. Made from copper alloy.	633570	163900	HER MKE10032
1014	Iron Age	Gaulish iron age coins, Cottington Hill, Minster - Findspot	Three iron age coins, found by metal detectorist, dated to the mid-1st century BC. Made of copper alloy.	633660	163900	HER MKE10033
1015	Iron Age	Late iron age coin, Cottington Hill, Minster - Findsport	A late iron age coin, found by metal detectorist, Trinovantian type, dated to c. 10BC - 10AD.	633600	163900	HER MKE10034
1016	Iron Age	Late iron age coin, Cottington Hill, Minster - Findspot	A late iron age coin found by a metal detectorist. Cantian type, from the reign of Dubnovellaunus. Dated to c. 23-17BC. The coin is made of silver.	633680	163900	HER MKE10035
1017	Iron Age	Iron age coin, Cottington Hill, Minster - Findspot	A late iron age coin, found by a metal detectorist. Identified as Cantian type, it was dated to c. 100BC. It was made from cast bronze potin.	633730	163900	HER MKE10036
1018	Iron Age	Late iron age coin, Cottington Hill, Minster - Findspot	An iron age coin was found by a metal detectorist. Dated to mid to late 1st century BC. It was made of silver.	633600	163900	HER MKE10037
1019	Iron Age	Iron age burials (found 1959)	Iron Age burials. Skeletal remains dated to 300-200 BC. Some pottery was also found.	634940	164330	HER MKE8072
1020	Romano-British	Romano-British drainage ditches, hearth and two inhumations	Romano-British drainage ditches, hearth and two inhumations.	633894	164001	HER MKE21076
1021	Romano-British	Romano-British pits and associated materials, Cottington Hill, Minster parish	Romano-British pits and associated materials, including late 3rd and 4th century pottery sherds, including coarse wares and Samian wares.	633800	163900	HER MKE8114
1022	Romano-British	Romano-British occupation site, Cliffs End, Minster parish	Romano-British occupation site. Discovery of Samian pottery, other fine wares and building materials suggest a Roman villa site. Belgic remains were also reported.	633800	164100	HER MKE8118
1023	Romano-British	Romano-British ditches, sunken featured building, two cemeteries and pit containing prehistoric pottery	Romano-British ditches, sunken featured building, two cemeteries and a pit containing prehistoric pottery.	633990	164382	HER MKE21075

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1024	Romano-British	Romano-British features at Cliffsend.	The grave of a mature adult was found, finds of a nail and a Belgic sherd, animal bones and shells.	635300	164500	HER MKE15421
1025	Romano-British	Romano-British coins brooch and key	Romano-British coins, a brooch and a key.	635250	164450	HER MKE8038
1026	Romano-British	Samian Cup - Findspot	1st century Samian cup, dredged up in Pegwell Bay in 1902	635500	163500	NMR_469465
1027	Saxon	Saxon landing site, Ebbsfleet, Minster parish	The traditional landing site of the Saxons in AD 449, based on the Anglo-Saxon Chronicle. It is also thought that St Augustine may have landed here in AD 597. Site no longer suitable landing place due to land reclamation.	633600	163100	HER MKE8057
1028	Saxon	St Augustine's Well	St Augustine's Well. This natural spring is the traditional spot where St Augustine camped with his monks on reaching England in AD 597.	634370	163940	HER MKE8058
1029	Medieval	Medieval well shaft	Medieval well shaft.	635750	164380	HER MKE8036
1030	Medieval	Medieval well shaft	Medieval well shaft. The well shaft is only 4m from a small cave entrance leading northward into a complex system of tunnels, reputedly smugglers' caves.	635750	164300	HER MKE8037
1031	Medieval	Possible medieval wall	Possible medieval wall	635800	164000	NMR_469505
1032	Medieval	Early medieval/medieval pit, Cottington Hill, Minster parish	Early medieval/medieval pit. Contained pottery sherds of Tyler Hill and shell tempered pottery from Canterbury and North Kent. Dated to 1050-1100 AD.	633500	163600	HER MKE8115
1033	Medieval	Possible medieval farmstead, Ebbsfleet Farm, Ramsgate	Infilled ditches and pottery sherds - possibly a ditch-enclosed medieval farmstead.	634400	162600	HER MKE15892
1034	Medieval	Possible sunken medieval building near Ebbsfleet Farm	Remains of a possible sunken medieval building. A pit found at the site contained medieval pottery dating to the late 12th to early 13th C. Shellfish remains were also found nearby.	633336	163094	HER MKe17382
1035	Medieval	Probable medieval ditch-enclosed farmstead, near Weatherless Water Treatment Works, Minster parish	Remains of a ditch enclosing a 13th and 14th century farmstead.	633409	162616	HER MKe17355
1036	Medieval	Medieval remains	Medieval remains including fragments of jugs and flagons with dark green glaze. All pottery dated to 13th and 14th century.	635700	164400	HER MKE8027

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1037	Medieval	14th century sea wall, Minster, Ramsgate and Sandwich parishes	A 14th century sea wall. The remains of boarded groin structures extend at least 1.5km and are thought to be the remains of a seawall built in 1365 after an inundation of the sea between Cliffsend and Stonar.	634065	162995	HER MKE8053
1038	Post medieval	Site of Cliffsend Crossing chalk pit	A chalk pit, marked on Ordnance Survey maps.	634550	164750	HER MKE16441
1039	Post medieval	Grade NG listed building. Main construction periods 1737-1737	Grade NG listed building. Main construction period 1737. No. 53 and 5 Foad's Lane.	634592	164257	HER MKE34758 NMR_171743
1040	Modern	St Augustine's Cross	St Augustine's Cross. Carved Celtic cross on a stepped base, erected in 1884 to commemorate the landing of St Augustine in AD 596 at Ebbsfleet in Pegwell Bay.	634030	164160	HER MKE8085 NMR_421310
1041	Modern	Richborough RAF Salvage Yard	Richborough RAF Salvage Yard.	633700	162400	HER MKE42006
1042	Modern	Modern trench, Ebbsfleet, Minster parish	Slit Trench. The cropmarks of a zig-zagged slit trench have been identified in the fields near Ebbsfleet, and were recorded from aerial photographs.	633340	163320	HER MKE8106
1043	WWI	Richborough Train Ferry Dock	Train Ferry dock built during WWI.	633990	162190	HER MKE41999
1044	WWII	PILLBOX	Pillbox	634600	164100	HER MKE39399
1045	WWII	PILLBOX	Pillbox	634000	163800	HER MKE39400
1046	WWII	PILLBOX	Pillbox	635400	164500	HER MKE39669
1047	WWII	PILLBOX	Pillbox	635300	165300	HER MKE39694
1048	WWII	PILLBOX	Pillbox	635500	164900	HER MKE39695
1049	WWII	PILLBOX	Pillbox	635100	164500	HER MKE39696 NMR_1423869
1050	WWII	PILLBOX (TYPE FW3/24)	Standard type 24 pillbox	634000	163200	HER MKE39115

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1051	WWII	PILLBOX	Pillbox	633700	164400	HER MKE39392
1052	WWII	COASTAL BATTERY	Bethlehem Battery - 6in breech loading guns.	634000	164000	HER MKE39272
1053	WWII	GUN EMPLACEMENT	Pair of coastal artillery emplacements.	635682	164405	HER MKE39313
1054	WWII	WWII battery at Little Cliffsend Farm, Ramsgate	A pair of coastal artillery emplacements or battery bunkers.	635700	164490	HER MKE16630
1055	WWII	SLIT TRENCHES	Slit trench	635200	164300	NMR_469492
1056	Multiperiod	Romano British Landscape, inhumation burial and possible WWII anti-aircraft station	Romano-British landscape, inhumation burial and possible WWII anti-aircraft station	633509	163494	HER MKE21077
1057	Multiperiod	Site of former Saltworks, Ebbsfleet, Ramsgate	Earthworks of a salt works - located in a former WWII minefield. A Saltings is marked on Ordnance Survey maps	634100	162300	HER MKE15880
1058	Multiperiod	Prehistoric, Romano-British and Medieval enclosure and boundary ditches and two middens with Bronze Age pottery	Prehistoric, Romano-British and medieval enclosure and boundary ditches and two middens with Bronze Age pottery.	633440	163035	HER MKE21078
1059	Multiperiod	Prehistoric finds and Tudor remains, Cottington Hill, Minster parish	Two sites were found during archaeological excavation. Prehistoric pottery and worked flint. Iron-working artefacts and 16th - 17th century pottery.	633700	163900	HER MKE15864
1060	Multiperiod	Multiperiod occupation, Ebbsfleet farm.	Multiperiod occupation - Bronze Age, Iron Age, Romano-British, medieval and later periods. Settlement material and Late Bronze Age hoard, dated to 9/8 BC.	633200	163000	HER MKE15983
1061	Multiperiod	Multi period remains, Oaklands nursery, Ramsgate	Multiperiod. Ditches containing Iron Age, Romano-British and early medieval pottery. Pits, postholes and evidence of medieval revetment. Possibly the remains of a long-lived domestic settlement.	634470	164500	HER MKE17172
1062	Multiperiod	Bronze Age and Saxon evidence found at Cliffs End Farm in 2004	Bronze Age and Saxon evidence. Site appears to have been used for funerary and ceremonial purposes. Early Bronze Age evidence included four barrows. Late Bronze Age: series of horseshoe enclosures. Saxon: 24 burials.	634794	164266	HER MKE41621

WA Number	Period	Name	Description	BNG Easting	BNG Northing	NMR / HER
1063	Multiperiod	Multi period site on on Cottington Hill, Minster parish	Iron Age and Romano-British pottery was found during a rescue excavation. The remains of a Romano-British building was also identified, with a possible late 2nd century date.	633400	163300	HER MKE8113
1064	Multiperiod	Multi period site at Ebbsfleet Farm, near Ramsgate	Multiperiod site. A Bronze Age beaker burial, Iron Age occupation site comprised of pits and ditches (200-50BC) and a Romano-British building (2nd century AD). Romano-British pottery, brick, tile, a coin, rotary quern and buckles were found nearby.	634220	163370	HER MKE9058
1065	Undated	Undated archaeological features, Beech Grove, Ramsgate	Number of features located during watching brief, including possibly late Bronze Age hut circles with a drip trench. Lack of pottery may indicate low occupation.	634370	164160	HER MKE15849
1066	Undated	Undated crouched inhumation burial, Cliffsend, Ramsgate	A crouched inhumation burial was found during a watching brief.	634450	164700	HER MKE15879
1067	Undated	Ring ditch cropmark, Manston	Ring ditch cropmarks, recorded from aerial photographs.	634980	165210	HER MKE7958
1068	Undated	Ring ditch cropmarks, Ramsgate	Ring ditch cropmarks, recorded from aerial photographs.	635550	164600	HER MKE8022
1069	Undated	Area cropmark features, Ramsgate	Large feature cropmark. Identified from aerial photographs.	635560	164500	HER MKE8026

APPENDIX V – ENGLISH WATERS – GAZETTEER OF SITES RECORDED BY UKHO AND GEOPHYSICAL ANOMALIES (FIGURE 8-12)

This appendix includes a list and description of the data for the English waters produced by the UKHO and MMT (see **Figure 8**, **9** & **10**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7000	Magnetic	387232	5686828	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6361 (mag)	-
7001	Magnetic	387641	5686670	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6360 (mag)	-
7002	Magnetic	388058	5686468	A2	-	-	-	87	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6359 (mag)	-
7003	Magnetic	388087	5686618	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6357 (mag)	-
7004	Magnetic	388256	5686219	A2	-	-	-	140	Large well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6355 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7005	Magnetic	388230	5686392	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6354 (mag)	-
7006	Magnetic	388318	5686372	A2	-	-	-	21	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6353 (mag)	-
7007	Magnetic	388536	5686262	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6352 (mag)	-
7008	Magnetic	388528	5686325	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6351 (mag)	-
7009	Magnetic	388558	5686409	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6349 (mag)	-
7010	Debris	388624	5686195	A2	3.1	1.2	0.7	-	Angular dark reflector with shadow but no associated magnetic anomaly. Possibly a piece of non-ferrous debris.	6348 (sss)	-
7011	Dark Reflector	388824	5686071	A2	3.5	0.4	0.5	-	Large dark reflector with large shadow but no associated magnetic anomaly. In an area of variable seabed refelctivity, and could be natural or a piece of non-ferrous debris.	6347 (sss)	-
7012	Magnetic	388969	5686187	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6346 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7013	Magnetic	388873	5686278	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6345 (mag)	-
7014	Magnetic	388963	5685893	A2	-	-	-	49	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6344 (mag)	-
7015	Magnetic	389083	5686027	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6343 (mag)	-
7016	Debris	389174	5685947	A2	4.3	0.8	0.2	-	Short linear dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried non-ferrous debris.	6341 (sss)	-
7017	Recorded Wreck [Live]	389200	5685809	A3	-	-	-	-	Recorded location of the wreck of the *Pisces* (lost 1995), not identified by any of the geophysical equipment. Could be an inaccurate location, or the wreck could be covered by the sand waves currently present at the site.	6340 (db), 2005	15159 (UKHO)
7018	Magnetic	389479	5686018	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6339 (mag)	-
7019	Dark Reflector	389477	5685848	A2	1.4	0.4	0.3	-	Isolated dark reflector with a shadow but no associated magnetic anomaly. Located in ana rea of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6338 (sss)	-
7020	Magnetic	389686	5685873	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6337 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7021	Dark Reflector	389658	5685681	A2	4.6	1.4	0.3	-	Indistinct dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6336(sss)	-
7022	Rope / Chain	389892	5685888	A2	42.8	1.1	0.0	13	long linear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6335 (sss and mag)	-
7023	Magnetic	389953	5685752	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6334 (mag)	-
7024	Wreck	389786	5685532	A1	31.4	4.8	0.8	66	Previously unrecorded wreck identified by all geophysical equipment. Structure is relatively small and appears to be mostly buried, though still retains some structure and height. Medium magnetic anomaly indicates it is at least partly ferrous in nature. 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.	6332 (sss and mag)	-
7025	Magnetic	390809	5685336	A2	-	-	-	53	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6331 (mag)	-
7026	Magnetic	390940	5685330	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6330 (mag)	-
7027	Debris	391279	5685143	A1	21.9	17.6	0.0	59	Area of dark reflectors with shadows associated with a medium magnetic anomaly. Located in an area of sand ripples and probably partially buried ferrous debris or the remains of a badly degraded structure.	6329(sss and mag)	-
7028	Magnetic	391380	5685057	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6328 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7029	Debris	391445	5685053	A2	8.1	0.7	0.0	-	Short linear dark refletcor with no shadow or associated magnetic anomaly. Located in an area of sand ripples and could be a piece of linear non-ferrous debris.	6327 (sss)	-
7030	Debris	391390	5685113	A2	0.9	1.8	0.0	-	Two adjacent angular dark reflectors, possibly with shadows but uncertain. No associated magnetic anomaly. Located in an area of sand ripples and could be pieces of partially buried non-ferrous debris.	6326 (sss)	-
7031	Debris	391669	5684906	A2	9.4	0.1	0.2	-	Linear alignment of numerous dark reflectors with large shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6325 (sss)	-
7032	Magnetic	392015	5684828	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6324 (mag)	-
7033	Magnetic	391836	5685008	A2	-	-	-	36	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6323 (mag)	-
7034	Debris	392435	5684935	A2	16.5	2.2	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Located on the edge of a sand wave and possibly an area of partially buried non-ferrous debris.	6322 (sss)	-
7035	Debris	392573	5685151	A2	22.8	1.1	0.5	-	Linear alignment of numerous dark reflectors with large shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6321 (sss)	-
7036	Magnetic	392916	5685167	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6320 (mag)	-
7037	Dark Reflector	392912	5685102	A2	1.7	0.3	0.3	-	Elongate dark reflector with a shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6319 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7038	Debris	393045	5685032	A2	10.7	3.1	0.0	52	Small area of disturbed seabed associated with a medium magnetic anomaly. Possible area of ferrous debris.	6318 (sss and mag)	-
7039	Magnetic	393180	5685073	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6317 (mag)	-
7040	Magnetic	393315	5684950	A2	-	-	-	51	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6316 (mag)	-
7041	Debris	393445	5685057	A2	3.3	0.2	0.6	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Possible piece of linear non-ferrous debris.	6315 (sss)	-
7042	Dark Reflector	393368	5685144	A2	0.9	0.4	0.7	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6314 (sss)	-
7043	Debris	393925	5685063	A2	18.1	2.3	0.0	-	A linear alignment of three closely spaced dark reflectors with shadows but without an associated magnetic anomaly. Possible area of non-ferrous debris.	6312 (sss)	-
7044	Debris	394215	5685254	A2	7.0	0.1	0.1	-	Short linear dark reflector with small shadow but without an associated magnetic anomaly. Possible piece of non-ferrous linear debris.	6311 (sss)	-
7045	Debris	394416	5685134	A2	15.5	4.0	0.0	-	A small area of angular dark and bright reflectors but no associated magnetic anomaly. Possible area of non-ferrous debris.	6310 (sss)	-
7046	Magnetic	394591	5685135	A2	-	-	-	37	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6309 (mag)	-
7047	Debris	394777	5685245	A1	22.2	10.7	0.0	43	Area of angular bright reflectors associated with a medium magnetic anomaly. Probably an area of ferrous debris, or the remains of a highly degraded structure.	6308 (sss and mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7048	Magnetic	395169	5685372	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6307 (mag)	-
7049	Debris [Live Obstruction]	395957	5685445	A1	7.2	6.5	0.9	6	Large, elongate dark reflector (or collection of reflectors) with large shadow and associated with a small magnetometer contact. Identified on multibeam 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).	6305 (sss and mag), 2017	75358 (UKHO)
7050	Dark Reflector	396102	5685521	A2	1.1	0.4	0.4	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6304 (sss)	-
7051	Debris	396271	5685652	A2	5.3	0.3	0.4	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Possibly a piece of non-ferrous debris.	6303 (sss)	-
7052	Rope / Chain	396359	5685603	A2	150.0	0.5	0.2	-	Very long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Possible length of rope or chain. Dark reflector with shadow at one end is possibly an anchor, indicating it is still probably attached to the sea bed. Length is approximate.	6302 (sss)	-
7053	Rope / Chain	396516	5685581	A2	65.0	0.5	0.3	-	Long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Possible length of rope or chain.	6301 (sss)	-
7054	Rope / Chain	396645	5685518	A2	46.5	0.2	0.2	-	Long curvilinear dark reflector with small shadow but without an associated magnetic anomaly. Reflector curves back on itself, and is probably length of rope or chain.	6300 (sss)	-
7055	Dark Reflector	396527	5685687	A2	2.2	0.6	0.5	-	Isolated dark reflector with shadow but without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6299 (sss)	-

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7056	Bright Reflector	396486	5685711	A2	2.4	1.9	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6298 (sss)	-
7057	Debris	396470	5685781	A2	4.5	0.1	0.2	-	Short linear dark reflector with a small shadow but without an associated magnetic anomaly. Possible piece of non-ferrous debris.	6297 (sss)	-
7058	Rope / Chain	396612	5685727	A2	26.0	0.2	0.2	-	Curvilinear dark reflector with a small shadow but no associated magnetic anomaly. Possible length of rope or chain.	6296 (sss)	-
7059	Debris	396655	5685646	A2	31.9	2.0	0.6	-	Linear alignment of a number of dark reflectors with shadows but no associated magnetic anomaly. Possible area of non-ferrous debris.	6295 (sss)	-
7060	Dark Reflector	396739	5685615	A2	3.1	0.4	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly, one larger than the other. Could be natural or non-ferrous debris.	6294 (sss)	-
7061	Debris	396822	5685599	A2	6.9	4.7	0.0	-	Small area of indistinct dark reflectors with small shadows, possibly attached to a linear dark reflector. No associated magnetic anomaly, but possibly an area of non-magnetic debris.	6293 (sss)	-
7062	Magnetic	396873	5685981	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6292 (mag)	-
7063	Dark Reflector	397255	5685875	A2	3.8	3.8	0.0	-	Poorly defined dark reflector without a shadow or associated magnetic anomaly. Could be natural or a piece of non-ferrous debris. Poor data quality makes definitive identification difficult.	6291 (sss)	-
7064	Dark Reflector	397455	5686059	A2	0.8	0.1	0.6	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6290 (sss)	-

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7065	Magnetic	397745	5686029	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6289 (mag)	-
7066	Rope / Chain	399165	5686341	A2	15.7	0.5	0.2	8	Curvilinear dark reflector with a small shadow and possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6285 (sss and mag)	-
7067	Debris	399344	5686534	A2	6.9	0.6	0.3	-	Short, linear alignment of dark reflectors with shadows but no associated magnetic anomaly. Possible piece of partially buried non-ferrous debris.	6284 (sss)	-
7068	Magnetic	400885	5686280	A2	-	-	-	27	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6282 (mag)	-
7069	Magnetic	400723	5686583	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6281 (mag)	-
7070	Bright Reflector	401708	5686249	A2	3.7	2.1	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6280 (sss)	-
7071	Magnetic	404638	5686808	A2	-	-	-	22	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6275 (mag)	-
7072	Magnetic	404373	5686770	A2	-	-	-	43	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6274 (mag)	-
7073	Dark Reflector	406312	5687241	A2	1.4	0.2	0.8	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6269 (sss)	-

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7074	Debris	406615	5687129	A2	10.7	9.9	0.6	-	Area of dark reflectors with shadows but no associated magnetic anomaly. Possibly an area of non-ferrous debris.	6268 (sss)	-
7075	Debris	406749	5687159	A2	2.3	0.2	1.3	73	Short linear dark reflector with a large shadow and associated with a medium magnetic anomaly. Probably a piece of ferrous debris.	6267 (sss and mag)	-
7076	Magnetic	406995	5686963	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6266 (mag)	-
7077	Dark Reflector	407402	5687204	A2	0.9	0.5	0.6	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6262 (sss)	-
7078	Magnetic	408188	5687115	A2	-	-	-	24	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6261 (mag)	-
7079	Debris	408332	5687243	A2	1.1	0.6	0.7	8	Dark reflector with shadow and possibly associated with a small magnetic anomaly. Located in an area of sand ripples and could be a partially buried piece of ferrous debris.	6260 (sss and mag)	-
7080	Debris	408730	5686800	A2	24.0	23.0	2.0	-	Large, irregular dark reflector with large shadow but no associated magnetic anomaly. Identified on multibeam bathymetry data as an isolated seabed mound. Possibly an area of non-ferrous debris or small structure, but no recorded wreck or obstruction is known in the vicinity.	6259 (sss)	-
7081	Magnetic	408940	5687020	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6258 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7082	Magnetic	408545	5687020	A2	-	-	-	53	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6257 (mag)	-
7083	Magnetic	408963	5687178	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6256 (mag)	-
7084	Magnetic	408805	5687250	A2	-	-	-	50	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6255 (mag)	-
7085	Dark Reflector	409160	5687350	A2	2.1	1.0	0.8	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6254 (sss)	-
7086	Dark Reflector	409556	5687204	A2	1.4	1.1	1.3	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6252 (sss)	-
7087	Dark Reflector	410579	5686862	A2	3.7	1.0	1.4	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6251 (sss)	-
7088	Debris	410623	5687218	A2	3.5	2.5	1.5	22	Large, irregular dark reflector with large shadow and an associated small magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried ferrous debris.	6250 (sss and mag)	-
7089	Rope / Chain	411082	5686753	A2	64.4	0.2	0.0	-	Long, curvilinear dark reflector without a shadow or an associated magnetic anomaly. Possible length of rope or chain.	6247 (sss)	-
7090	Dark Reflector	411329	5686921	A2	2.7	0.5	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Could be natural or non-ferrous debris.	6246 (sss)	-

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7091	Debris	411657	5686985	A2	2.8	0.6	0.8	8	Dark reflector with shadow and possibly associated with a small magnetic anomaly. Located in an area of sand ripples and could be a partially buried piece of ferrous debris.	6244 (sss and mag)	-
7092	Rope / Chain	412342	5686875	A2	218.2	0.3	0.0	11	Long, curvilinear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6243 (sss and mag)	-
7093	Magnetic	412548	5687140	A2	-	-	-	22	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6242 (mag)	-
7094	Magnetic	414243	5686620	A2	-	-	-	80	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6241 (mag)	-
7095	Magnetic	413768	5686708	A2	-	-	-	57	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6240 (mag)	-
7096	Magnetic	413545	5687065	A2	-	-	-	40	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6239 (mag)	-
7097	Magnetic	413853	5687190	A2	-	-	-	28	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous large anomalies (over the south falls bank) and could be natural, but could also indicate the presence of buried ferrous debris.	6238 (mag)	-

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7098	Debris	416527	5686440	A1	9.3	9.4	0.6	16	Two poorly defined, short, parallel linear dark reflectors with shadows possibly associated with a small magnetic anomaly. Possible partially buried ferrous debris.	6237 (sss and mag)	-
7099	Magnetic	417010	5687098	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6236 (mag)	-
7100	Dark Reflector	419566	5686703	A2	4.5	1.4	0.5	-	Isolated dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6232 (sss)	-
7101	Magnetic	419615	5686950	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6231 (mag)	-
7102	Debris	419829	5686989	A2	4.2	0.5	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Possible non-ferrous debris.	6230 (sss)	-
7103	Magnetic	420240	5686780	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6229 (mag)	-
7104	Magnetic	420162	5687000	A2	-	-	-	15	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6228 (mag)	-
7105	Magnetic	421212	5686530	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6227 (mag)	-
7106	Magnetic	420832	5686618	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6226 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7107	Magnetic	421335	5686898	A2	-	-	-	41	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6225 (mag)	-
7108	Dark Reflector	421784	5686542	A2	2.4	0.7	0.5	-	Dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6224 (sss)	-
7109	Debris	421877	5686734	A2	7.2	0.2	0.3	-	Small linear dark reflector, or linear alignment of dark reflectors, with shadow but no associated magnetic anomaly. Possible piece of partially buried non-ferrous debris.	6223 (sss)	-
7110	Magnetic	420240	5686780	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6222 (mag)	-
7111	Magnetic	422115	5686878	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6221 (mag)	-
7112	Magnetic	422675	5686565	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6220 (mag)	-
7113	Magnetic	423322	5686700	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6219 (mag)	-
7114	Magnetic	426255	5686465	A2	-	-	-	5	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6218 (mag)	-

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7115	Magnetic	425015	5686495	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6217 (mag)	-
7116	Debris	427338	5686310	A2	2.2	0.5	0.3	-	Elongate dark reflector with small shadow but no associated magnetic anomaly. Possible piece of debris.	6216 (sss)	-
7117	Magnetic	427157	5686328	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6215 (mag)	-
7118	Magnetic	427542	5686575	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6214 (mag)	-
7119	Magnetic	427227	5686650	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6213 (mag)	-
7120	Dark Reflector	428537	5686309	A2	2.0	0.7	0.4	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6212 (sss)	-
7121	Magnetic	428312	5686640	A2	-	-	-	5	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6211 (mag)	-
7122	Magnetic	429115	5686330	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6210 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7123	Magnetic	428047	5686323	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6209 (mag)	-
7124	Magnetic	428565	5686575	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6208 (mag)	-
7125	Magnetic	430585	5686625	A2	-	-	-	74	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6206 (mag)	-
7126	Magnetic	429655	5686630	A2	-	-	-	49	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6205 (mag)	-
7127	Dark Reflector	430665	5686454	A2	5.6	0.7	0.4	-	Two adjacent dark reflectors with shadows but no associated magnetic anomaly. Located in an area of sand waves and could be natural or partially buried non-ferrous debris.	6204(sss)	-
7128	Magnetic	431548	5686467	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6203 (mag)	-
7270	Recorded Wreck [Live]	386196	5685927	A3					Outside geophysical survey area. Wreck of the *Harvest Moon*.	2001	HER MKE13504
7271	Recorded Wreck [Live]	386609	5685964	A3					Outside geophysical survey area, abandoned four wheel drive vehicle.	2002	70367 (UKHO)
7272	Recorded Wreck [Live]	386928	5685054	A3					Outside geophysical survey area.	2003	13834 (UKHO), NMR 900604

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7273	Recorded Wreck [Live]	388921	5686408	A3					Outside geophysical survey area, steel tank.	2004	13844 (UKHO)
7274	Recorded Wreck [Live]	389454	5685030	A3					Outside geophysical survey area. Wreck of *LCP 586*	2006	13835 (UKHO)
7275	Recorded Wreck [Live]	396314	5685228	A3					Outside geophysical survey area.	2007	NMR 904884
7276	Recorded Wreck [Live]	396458	5686183	A3					Outside geophysical survey area. Wreck of the *Rydal Force*.	2008	13843 (UKHO), NMR 900887
7277	Recorded Wreck [Live]	404300	5687128	A3					Outside geophysical survey area.	2009	13850 (UKHO), NMR 904893
7278	Recorded Obstruction [Live]	386999	5687322	A3					Outside geophysical survey area.	2010	59030 (UKHO)
7279	Recorded Obstruction [Live]	387015	5685955	A3					Outside geophysical survey area.	2011	70374 (UKHO)
7280	Recorded Obstruction [Live]	387205	5686978	A3					Outside geophysical survey area.	2012	59034 (UKHO)
7281	Recorded Obstruction [Live]	387423	5687284	A3					Outside geophysical survey area.	2013	59031 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc'tion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7282	Recorded Obstruction [Live]	387519	5687243	A3					Outside geophysical survey area.	2014	59032 (UKHO)
7283	Recorded Obstruction [Live]	387685	5686971	A3					Outside geophysical survey area.	2015	59033 (UKHO)
7284	Recorded Obstruction [Live]	389348	5686330	A3					Outside geophysical survey area.	2016	15015 (UKHO)
7285	Recorded Obstruction [Live]	403019	5685997	A3					Outside geophysical survey area.	2018	13842 (UKHO)
7286	Recorded Wreck [Lift]	386798	5686089	A3					Outside geophysical survey area, abandoned Suzuki Jeep.	2019	70366 (UKHO)
7287	Recorded Wreck [Lift]	389816	5686073	A3					Outside geophysical survey area, wreck lost 1986.	2020	58820 (UKHO)
7288	Recorded Obstruction [Dead]	403493	5686941	A3					Outside geophysical survey area.	2021	58893 (UKHO)

APPENDIX VI – ENGLISH WATERS – RECORDED LOSSES

This appendix includes a list and description of the data for Recorded Losses supplied by the NMR. Recorded Losses provide information about the archaeological potential of an area, as they indicate ships that are known to have wrecked in the area, but whose remains have generally not been located on the seabed. When considering Recorded Losses it is important to note that the descriptions regarding the location of a wrecking incident are often vague. Consequently, the positions of recorded losses are often inaccurate, and therefore they have not been illustrated on any of the Figures. In addition to this, the temporal distribution of these Recorded Losses should not be regarded as representative of the density of shipping activity within the given periods. The number of documented losses is dependant on the reporting of the loss and the survival of the record of that loss. Note: There is no equivalent table for Belgian Recorded Losses as the information was not readily available.

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1201		55BC	Wreck of unknown number of Roman transport vessels lost during a sudden storm during Caesar's first invasion of Britain in 55 BC from Gaul, most likely in the vicinity of Kent which has traditionally been regarded as the site of the Roman landings.	387177	5684490	1508031
1202		55BC	Wreck of unknown number of Roman warships wrecked on the strand at the landing site during a sudden storm during Caesar's first invasion of Britain in 55 BC from Gaul.	387177	5684490	1508029
1203	*Nicholas*	1318	Wreck of English cargo vessel (wooden sailing ship) which foundered after being scuttled off Sandwich by Flemish pirates. Her cargo included wine, flour, whalebone, nut oil, vinegar, saffron, and pepper, suggesting that she was homeward-bound to London.	387177	5684490	1445015
1204	*La Seyne Anton*	1359	Wreck of Spanish cargo vessel (wooden sailing ship) which was wrecked near Sandwich, laden with cloth.	387177	5684490	1445835
1205	*La Seinte Marie de Burgh*	1364	Wreck of French cargo vessel (wooden sailing ship) which stranded at Sandwich en route from Sluis to Spain with cloth, silver plate and gold and silver coins.	387177	5684490	1247201
1206		Tudor	Wreck of wooden sailing ship that stranded at Sandwich.	387177	5684490	1444029
1207		1542	Wreck of French cargo vessel which stranded at Sandwich. Constructed of wood, she was a sailing vessel.	387177	5684490	1444027
1208		1653	Wreck of Dutch East Indiaman (wooden sailing ship) which stranded near Sandwich with her general cargo.	387177	5684490	1247841

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1209	*Biscay Merchant*	1682	English wooden sailing ship carrying cargo that was driven out of Margate Roads and stranded near Sandwich Bay. Reported to have broken up.	387177	5684490	1247917
1210		1690	Wreck of a wooden sailing vessel, nationality unknown, which stranded near Sandwich after being "forced out of the Downs" by a gale. The vessel had been captured as a prize by some Ostend privateers.	387177	5684490	1449037
1211	*Falklands Prize*	1705	Wreck of British wooden warship variously described as a Fourth Rate or Fifth Rate ship of the line, which was beached at Sandwich after being driven from her moorings in the Downs. The wreck was later broken up and sold. The vessel may have been the French warship *La Seine* of the 'flute' type captured the previous year.	387177	5684490	1248521
1212	*Race Horse Galley*	1711	Wreck of British "galley" (wooden sailing vessel) which capsized on her maiden voyage from Deptford to the Straits of Gibraltar, thought to be in the vicinity of Sandwich Flats. Possibly a privateer.	387177	5684490	1370384
1213	*Dolphin*	1735	Wooden sailing ship wrecked on Sandwich flats during a storm	387177	5684490	1368560
1214	*Industry*	1735	Wooden sailing ship lost on Sandwich flats after storm	387177	5684490	1368561
1215		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248661
1216		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane"..	387223	5686340	1248643
1217		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248648
1218		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248641
1219		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248646
1220		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248647
1221		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248663
1222		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248601
1223		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248644

WA_ID	NAME	Date of Loss	Description	UTM31N Easting	UTM31N Northing	NMR
1224		1752	Wreck of French fishing vessel (wooden sailing ship) which stranded in Pegwell Bay during a "hurricane".	387223	5686340	1248621
1225		1768	A brigantine (wooden sailing ship) collier was driven on shore on Sandwich Flats.	387177	5684490	1249021
1226	*Rose Hall*	1771	Wreck of British wooden sailing ship which stranded on Sandwich Flats en route from Jamaica to London.	387177	5684490	1249026
1227	*Kingston*	1809	A British cargo vessel, bound from London to Jamaica was driven on shore on Sandwich Flats during a violent gale.	387177	5684490	1250185
1228		1815	A foreign fir-built galliot laden with timber and deals wrecked near Shellness during a gale. The cargo drifted ashore but the crew were feared lost.	387177	5684490	1344395
1229	*Ann and Elizabeth*	1815	British cargo vessel wrecked at Shell Ness during the same gale as the galliot (**WA 1228**).	387177	5684490	1344393
1230	*Fame*	1815	British cargo vessel wrecked at Shell Ness during the same gale as the galliot (**WA1228**) and the *Ann and Elizabeth* (**WA1229**).	387177	5684490	1344392
1231	*Hussaren*	1828	Cargo vessel from the Cape of Good Hope, stranded on shore on Sandwich Flats full of water, after losing both anchors and cables in the Downs. The wreck went to pieces and the wreck and part of her cargo was strewed along the shore.	387177	5684490	1356671
1232	*Hannah*	1829	British craft, stranded in Sandwich Harbour.	387177	5684490	1250301
1233		1854	Fir-built vessel of about 120 tons, stranded on Sandwich Flats	387177	5684490	1316421
1234	*Fawn*	1911	A British craft sank following a collision with an unnamed 'blow boat'. The vessel was screw driven with a 3 cylinder triple expansion engine and a single boiler.	387177	5684490	1252783
1235	*Spitfire MK IIA P7386*	1940	The *Supermarine Spitfire Mk 11A* was a standard single-seat fighter, one of a batch of 1000 delivered between June 1940 and July 1941 to Contract No. 981687/39. The Spitfire was damaged by Bf 109s near Dover and abandoned over Sandwich Bay on 14 November 1940. The Spitfire had been built by Castle Bromwich Aircraft Factory and was part of Squadron 74.	387177	5684490	1322076

APPENDIX VII – FRENCH WATERS – GAZETTEER OF SITES RECORDED BY SHOM AND GEOPHYSICAL ANOMALIES (FIGURE 13, 14 AND 15)

This appendix includes a list and description of the data for the French waters produced by the SHOM and MMT (see **Figure 13**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7129	Dark Reflector	434211	5686388	A2	2.0	1.1	0.7	-	Dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6200 (sss)	-
7130	Dark Reflector	434319	5686352	A2	2.3	0.5	1.0	-	Dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6199 (sss)	-
7131	Magnetic	434418	5686434	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6197 (mag)	-
7132	Magnetic	434263	5686561	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6196 (mag)	-
7133	Magnetic	434408	5686596	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6195 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7134	Dark Reflector	434625	5686416	A2	3.5	0.4	1.2	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6194 (sss)	-
7135	Magnetic	436124	5686516	A2	-	-	-	7	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6192 (mag)	-
7136	Magnetic	436427	5686583	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6190 (mag)	-
7137	Magnetic	436850	5686510	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6189 (mag)	-
7138	Magnetic	437339	5686310	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6188 (mag)	-
7139	Magnetic	437032	5686304	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6187 (mag)	-
7140	Magnetic	437330	5686432	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6186 (mag)	-
7141	Wreck [Live]	438175	5686526	A1	-	-	-	149	A large magnetic anomaly observed as the site of the possible wreck of the HMS *Westella*. Not observed by sidescan sonar or multibeam bathymetry, but a large sand wave approximately 5m high has been observed at the site indicating the wreck is probably completely buried.	6183 (mag), 2023	15475 (UKHO) 21612019 (SHOM)

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7142	Magnetic	440106	5686330	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6179 (mag)	-
7143	Debris	441100	5686592	A2	17.7	0.3	0.1	-	Curvilinear dark reflector with a small shadow but no associated magnetic anomaly. Partially buried by a sand ripples, and possibly a piece of non-ferrous debris.	6178 (sss)	-
7144	Magnetic	441185	5686258	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6177 (mag)	-
7145	Magnetic	442050	5686241	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6174 (mag)	-
7146	Magnetic	442845	5686352	A2	-	-	-	54	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6172 (mag)	-
7147	Magnetic	445301	5685840	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6171 (mag)	-
7148	Recorded Obstruction [Live Obstruction]	445705	5685829	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. It could be the location of an ephemeral feature that no longer exists, or be covered by recent sand waves at the site.	6170 (db, 2025	15784 (UKHO) 21612272 (SHOM)
7149	Dark Reflector	445759	5685531	A2	1.1	0.5	0.8	-	Dark reflector with large shadow but without an associated magnetic anomaly. Located in an area of sand waves and could be natural or a piece of partially buried non-ferrous debris.	6168 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7150	Dark Reflector	446214	5685390	A2	5.5	0.8	1.0	-	Large, well-defined dark reflector with shadow but without an associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of partially buried non-ferrous debris.	6167 (sss)	-
7151	Wreck [Live Wreck]	446702	5685213	A1	95.0	31.0	6.0	13	Large seabed mound identified on the multibeam bathymetry data and associated with a small magnetic anomaly. Probably the known wreck UKHO 15469, though was identified approximately 100m NNW of the given position. Located just outside of the area covered by sidescan sonar, so condition unknown. Only partially imaged by multibeam bathymetry, so dimensions are a minimum, though appears to be orientated approx. ESE - WNW with a large NE - SW trending scour measuring 74m x 40m x 2m on the north side.	6165 (sss and mag), 2024	15469 (UKHO) 21612022 (SHOM)
7152	Magnetic	447633	5685434	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6163 (mag)	-
7153	Magnetic	448381	5685284	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6160 (mag)	-
7154	Debris	448669	5684966	A2	3.8	1.0	0.7	-	Elongate dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of partially buried non-ferrous debris.	6159 (sss)	-
7155	Dark Reflector	448995	5684915	A2	2.0	0.4	0.8	-	Dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and could be natural or a piece of non-ferrous debris.	6157 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7156	Debris	449246	5684879	A2	2.7	0.4	0.4	-	Short linear dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of non-ferrous debris. Located close to other possible debris 7157.	6154 (sss)	-
7157	Debris	449258	5684856	A2	2.5	0.3	0.3	-	Angular dark reflector with shadow but no associated magnetic anomaly. Located in an area of sand ripples and possibly a piece of non-ferrous debris. Located close to other possible debris 7156.	6153 (sss)	-
7158	Magnetic	449249	5685119	A2	-	-	-	36	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6152 (mag)	-
7159	Rope / Chain	449395	5685250	A2	65.2	0.1	0.1	18	A linear alignment of short linear reflectors with small shadows with a possible associated magnetic anomaly. Probably a partially buried length of rope or chain, periodically exposed between sand ripples	6148 (sss and mag)	-
7160	Magnetic	449586	5685021	A2	-	-	-	45	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6147 (mag)	-
7161	Magnetic	449649	5685286	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6146 (mag)	-
7162	Recorded Obstruction/ Probable Wreck [Live]	450638	5685464	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. A large sand wave currently exists at the site, which could be potentially covering the feature. The UKHO record indicates that this has been described as a 'probable wreck'.	6145 (db), 2026	15471 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Discr't ion	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7289	Recorded Wreck [Live]	437854	5685881	A3					Outside geophysical survey area. Wreck of the HMS *Blackburn-Rovers*.	2022 (mag)	15472 (UKHO)
7290	Recorded Obstruction [Dead]	432654	5687059	A3					Outside geophysical survey area.	2027	69714 (UKHO)
7291	Recorded Obstruction [Dead]	437707	5686934	A3					Outside geophysical survey area.	2028	15477 (UKHO)

APPENDIX VIII – BELGIAN WATERS – GAZETTEER OF SITES RECORDED BY VIOE AND GEOPHYSICAL ANOMALIES (FIGURE 17 AND 18)

This appendix includes a list and description of the data for the Belgian waters produced by the VIOE and MMT (see **Figure 17** & **18**). In the source column, the abbreviations in brackets indicate how the feature was visible/identified: with (sss) for side scan sonar, (sbp) for sub bottom profiler, (mag) for magnetometer and (db) for desk-based assessment. Sites visible in several datasets are indicated with each applicable abbreviation, as the compilation of the datasets is part of the archaeological assessment. Images of key features have been illustrated in the Figures as appropriate, however images of the remaining features are held in the project archives for future reference. For more details about the source / interpretation – see **Volume I: Methodology: Archaeological Interpretation of Geophysical Data.**

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7163	Debris	452273	5686101	A2	7.4	1.3	0.0	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of partially buried non-ferrous debris.	6144 (sss)	-
7164	Debris	452259	5686177	A2	4.9	0.2	0.4	-	Elongate dark reflector with shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of partially buried non-ferrous debris.	6143 (sss)	-
7165	Dark Reflector	452515	5686435	A2	2.7	0.4	0.8	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6139 (sss)	-
7166	Dark Reflector	452707	5686348	A2	4.5	0.6	1.4	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be natural or a piece of partially buried debris.	6138 (sss)	-
7167	Magnetic	453179	5686655	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6137 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7168	Dark Reflector	453618	5686701	A2	2.3	0.9	0.8	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6135 (sss)	-
7169	Dark Reflector	453687	5686888	A2	1.4	0.8	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6134(sss)	-
7170	Dark Reflector	453888	5686986	A2	1.3	0.8	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6133 (sss)	-
7171	Dark Reflector	454084	5686919	A2	1.6	1.0	1.0	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6132 (sss)	-
7172	Dark Reflector	455057	5687493	A2	1.5	1.0	1.0	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6130 (sss)	-
7173	Dark Reflector	455269	5687224	A2	3.6	0.7	0.8	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6128 (sss)	-
7174	Dark Reflector	455749	5687468	A2	2.2	1.0	1.1	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6124 (sss)	-
7175	Dark Reflector	455878	5687467	A2	1.5	0.4	0.5	-	Two adjacent dark reflectors with shadows but no associated magnetic anomalies. Could be natural or non-ferrous debris.	6123 (sss)	-
7176	Dark Reflector	455835	5687524	A2	1.9	0.5	0.7	-	Large dark reflector with large shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6122 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7177	Debris	456017	5687657	A2	3.1	0.7	0.8		Dark reflector with shadow and scour identified in an area of sand ripples, though no associated magnetic anomaly. Surround by an area of possible disturbed seabed, and could be a piece of partially buried non-ferrous debris.	6121 (sss)	-
7178	Dark Reflector	456166	5687790	A2	5.5	0.5	1.3	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6120 (sss)	-
7179	Magnetic	456315	5687665	A2	-	-	-	47	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6119 (mag)	-
7180	Dark Reflector	456393	5687630	A2	3.2	0.4	0.6	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6118 (sss)	-
7181	Dark Reflector	456686	5687803	A2	2.6	2.1	0.9	-	Large dark reflector with large shadow but no associated magnetic anomaly. Located in an area of sand ripples, and could be natural or a piece of partially buried non-ferrous debris.	6117 (sss)	-
7182	Debris	456654	5687924	A2	3.6	0.3	0.0	-	Short, curvilinear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear, non-ferrous debris.	6116 (sss)	-
7183	Debris	456566	5687968	A2	1.5	0.4	0.7	-	Elongate dark reflector with shadow but no associated magnetic anomaly, located in an area of sand ripples. Could be natural or a piece of non-ferrous debris	6115 (sss)	-
7184	Magnetic	456935	5687833	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6114 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7185	Magnetic	456738	5687753	A2	-	-	-	38	Medium well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6113 (mag)	-
7186	Dark Reflector	456893	5687924	A2	1.0	0.5	0.5	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6112 (sss)	-
7187	Magnetic	456980	5687928	A2	-	-	-	17	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6110 (mag)	-
7188	Debris	457351	5688358	A2	3.5	1.7	0.0	-	A small, tight cluster of dark reflectors with possible small shadows though without an associated magnetic anomaly. Located on the edge of a sand wave, and possibly a piece of non-ferrous debris.	6109 (sss)	-
7189	Recorded Obstruction [Dead]	457784	5688212	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere. A large sand wave currently exists at the site, which could be potentially covering an older feature.	6108 (db), 2044	15494 (UKHO)
7190	Magnetic	457638	5688438	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6107 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7191	Debris	458053	5688634	A2	13.3	5.1	0.0	-	Area of dark reflectors located on the edge of a sand wave. No associated magnetic anomaly, but could be partially buried non-ferrous debris.	6106 (sss)	-
7192	Magnetic	458173	5688643	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6105 (mag)	-
7193	Dark Reflector	458551	5688577	A2	2.5	1.2	0.6	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6104 (sss)	-
7194	Magnetic	458425	5688745	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6103 (mag)	-
7195	Debris	458626	5688694	A2	4.3	0.7	0.7	17	Two dark reflectors with large shadows, located on the edge of a sand wave. Possibly associated with a magnetic anomaly, but this is uncertain. Possible piece of partially buried ferrous debris..	6101, 6102 (sss and mag)	-
7196	Dark Reflector	459008	5688663	A2	2.2	0.9	1.1	-	Dark reflector with large shadow but no associated magnetic anomaly. Located on the edge of a sand wave, and could be a natural feature or a partially buried piece of non-ferrous debris.	6100 (sss)	-
7197	Magnetic	459388	5689123	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6099 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7198	Magnetic	460200	5689358	A2	-	-	-	16	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6098 (mag)	-
7199	Dark Reflector	460457	5689409	A2	3.0	0.5	0.6	-	Elongate dark reflector with shadow but no associated magnetic anomaly, located in an area of sand ripples. Could be natural or a piece of non-ferrous debris. Located next to a similar, smaller contact and could be related (not tagged).	6097 (sss)	-
7200	Wreck [Live]	460851	5689298	A1	90.7	32.1	4.4	64	Location of the known wreck *Tringa*, identified by all of the geophysical equipment. The wreck appears badly broken up, though still exhibits some structure and significant height. Medium magnetic anomaly suggests at least part of the structure is ferrous in nature. No scour or large debris field identified, just one piece of discrete debris some distance from the wreck. Orientated NE - SW.	6095, 6096 (sss, mag and db), 2029	15506 (UKHO) 121/226 (VIOE)
7201	Magnetic	461040	5689458	A2	-	-	-	48	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, possibly from nearby wreck 7200.	6094 (mag)	-
7202	Dark Reflector	461406	5689561	A2	2.3	0.6	0.7	-	Large dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6092 (sss)	-
7203	Dark Reflector	461482	5689613	A2	2.3	0.8	0.9	-	Large dark reflector with shadow but no associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6091 (sss)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7204	Magnetic	463391	5690163	A2	-	-	-	27	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6088 (mag)	-
7205	Magnetic	464335	5690448	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6087	-
7206	Recorded Obstruction [Dead]	465231	5690719	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere.	6086 (db), 2045	15520 (UKHO) (VIOE)
7207	Recorded Obstruction [Dead]	466392	5690773	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Recorded as dead by UKHO and may have been an ephemeral feature that no longer exists, or be located elsewhere. A large sand wave currently exists at the site, which could be potentially covering an older feature.	6084 (db), 2046	15522 (UKHO)
7208	Magnetic	467863	5690633	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6082 (mag)	-
7209	Magnetic	467558	5690863	A2	-	-	-	31	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6081 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7210	Magnetic	467125	5691028	A2	-	-	-	74	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6080 (mag)	-
7211	Magnetic	467398	5691028	A2	-	-	-	52	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6079 (mag)	-
7212	Magnetic	466225	5690788	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6078 (mag)	-
7213	Magnetic	466545	5690940	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6077 (mag)	-
7214	Magnetic	466373	5690935	A2	-	-	-	47	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6076 (mag)	-
7215	Magnetic	465953	5690870	A2	-	-	-	50	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris, though could be caused by the large sand waves in the area.	6075 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7216	Magnetic	471268	5688860	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6074 (mag)	-
7217	Magnetic	469655	5689035	A2	-	-	-	13	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6073 (mag)	-
7218	Magnetic	470430	5688920	A2	-	-	-	11	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6072 (mag)	-
7219	Magnetic	470325	5688710	A2	-	-	-	29	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6071 (mag)	-
7220	Magnetic	468740	5689445	A2	-	-	-	18	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6070 (mag)	-
7221	Magnetic	468543	5689598	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6069 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7222	Magnetic	474883	5688625	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6068 (mag)	-
7223	Magnetic	474233	5688825	A2	-	-	-	14	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6067 (mag)	-
7224	Magnetic	473320	5688805	A2	-	-	-	48	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6063 (mag)	-
7225	Debris	479141	5688334	A2	4.7	2.8	2.5	-	Large dark reflector with large shadow, located on the edge of a sand wave. Possibly associated with an 80nT magnetic anomaly, though this is more likely to have been created by the large sand waves in the area. Possible piece of debris, or a partially buried structure.	6062 (sss)	-
7226	Magnetic	482608	5688465	A2	-	-	-	109	Large, broad magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contacts. Located along a line of noisy data, so could be noise, but is large so could also indicate a large piece of buried ferrous debris.	6061 (mag)	-
7227	Magnetic	483513	5688693	A2	-	-	-	25	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6060 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7228	Debris	483705	5688678	A2	3.1	1.3	1.1	-	Large dark reflector with large shadow but no associated magnetic anomaly. Shown by multibeam bathymetry data to be located within a large depression, approx. 25m x 25m x 0.5m. Possibly a piece of non-ferrous debris.	6059 (sss)	-
7229	Magnetic	484086	5689088	A2	-	-	-	93	Large magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Located along a single noisy line, and could be caused by turning a corner in the route during survey, though is a large anomaly and so could also indicate a large piece of buried ferrous debris.	6057 (mag)	-
7230	Rope / Chain	484661	5688954	A2	108.0	0.3	0.2	-	A linear alignment of short linear reflectors with small shadows but no associated magnetic anomaly. Probably a partially buried length of rope or chain, periodically exposed between small sand waves.	6056 (sss)	-
7231	Magnetic	485783	5689115	A2	-	-	-	28	Small magnetic anomaly without any associated sidescan sonar or multibeam bathymetry contact. Located in an area of numerous anomalies and is similar in nature. Could be created by a natural feature, or be indicative of a piece of buried ferrous debris.	6054 (mag)	-
7232	Bright Reflector	485792	5689328	A2	6.4	0.8	0.0	-	Elongate bright reflector without an associated magnetic anomaly. Could be natural or a piece of non-ferrous debris.	6053 (sss)	-
7233	Magnetic	485946	5689453	A2	-	-	-	63	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Probably indicative of a piece of buried ferrous debris.	6052 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7234	Debris	486591	5689324	A2	2.5	0.3	0.8	45	Well defined dark reflector with shadow and possibly associated with a medium magnetic anomaly. Possible piece of ferrous debris.	6051 (sss and mag)	-
7235	Magnetic	487777	5689755	A2	-	-	-	63	Two medium magnetic anomalies without any associated sidescan sonar or multibeam bathymetry contacts. Located in fairly close proximity, and could be indicative of the same piece of buried ferrous debris.	6049 (mag)	-
7236	Magnetic	488886	5689318	A2	-	-	-	12	Two adjacent, small but well-defined magnetic anomalies without any associated sidescan sonar or multibeam bathymetry contacts. Could be natural or indicative of a piece of buried ferrous debris.	6048 (mag)	-
7237	Debris	488954	5689528	A2	7.9	6.0	0.0	37	Area of seafloor disturbance containing at least one, possibly two, curvilinear dark reflectors. Associated with a medium magnetic anomaly, and probably an area of ferrous debris.	6047 (sss and mag)	-
7238	Magnetic	489976	5688985	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6046 (mag)	-
7239	Magnetic	490396	5688960	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6045 (mag)	-
7240	Magnetic	492101	5688780	A2	-	-	-	64	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Possibly indicative of a piece of buried ferrous debris.	6043 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7241	Magnetic	492406	5688573	A2	-	-	-	26	Linear alignment of four small magnetic anomalies without an apparent sidescan sonar or multibeam bathymetry contact, trending NNE - SSW across the proposed cable route. Could be indicative of a buried cable or a piece of long, linear debris.	6041 (mag)	-
7242	Recorded Obstruction [Dead]	494196	5688380	A3	-	-	-	-	Location of a recorded obstruction, not identified by any of the geophysical equipment. Located right at the edge of the geophysical survey area, and could be an ephemeral natural feature or located elsewhere.	6040 (db), 2049	69611 (UKHO)
7243	Magnetic	494006	5688088	A2	-	-	-	109	Large magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact. Located in an area with numerous small anomalies, but is probably indicative of a piece of buried ferrous debris.	6039 (mag)	-
7244	Magnetic	494186	5687993	A2	-	-	-	83	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, but is probably indicative of a piece of buried ferrous debris.	6038 (mag)	-
7245	Magnetic	495223	5687898	A2	-	-	-	43	Medium, well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6037 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7246	Magnetic	494791	5688000	A2	-	-	-	10	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6036 (mag)	-
7247	Rope / Chain	498781	5687785	A2	46.6	0.2	0.0	11	Linear dark reflector without a shadow, but possibly associated with a linear alignment of three small magnetic anomalies. Possible length of rope or chain.	6033 (sss and mag)	-
7248	Rope / Chain	499489	5687643	A2	118.1	0.2	0.0	8	Long, curvilinear dark reflector without a shadow but possibly associated with a small magnetic anomaly. Possible length of rope or chain.	6030 (sss and mag)	-
7249	Magnetic	500226	5687710	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6026 (mag)	-
7250	Magnetic	507760	5687153	A2	-	-	-	19	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6025 (mag)	-
7251	Magnetic	500301	5687820	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6024 (mag)	-
7252	Magnetic	500806	5687655	A2	-	-	-	8	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6023 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7253	Magnetic	501011	5687443	A2	-	-	-	6	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6022 (mag)	-
7254	Magnetic	503618	5687320	A2	-	-	-	9	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6021 (mag)	-
7255	Magnetic	504243	5687528	A2	-	-	-	24	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6020 (mag)	-
7256	Debris	505219	5687483	A2	18.7	5.1	0.0	-	Two indistinct dark reflectors in close proximity without shadows or an associated magnetic anomaly. Possible an area of non-ferrous debris, or two parts of a partly buried structure.	6019 (sss)	-
7257	Seafloor Disturbance	505890	5687131	A2	5.2	2.2	0.0	-	Small area of possible seafloor disturbance, no associated magnetic anomaly. Could be natural or anthropogenic in origin.	6018 (sss)	-
7258	Debris	505947	5687220	A2	3.1	2.9	0.0	-	Strong, angular dark reflector without a shadow or associated magnetic anomaly. Possible piece of non-ferrous debris.	6017 (sss)	-
7259	Recorded Wreck [Live]	506371	5686959	A3	-	-	-	-	Recorded location of the remains of a fishing vessel, not observed by any of the geophysical equipment. Located right at the edge of the geophysical survey area and could actually lie just outside this area.	6016 (db), 2035	27313 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7260	Magnetic	506543	5687043	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6013 (mag)	-
7261	Magnetic	506610	5687190	A2	-	-	-	12	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6012 (mag)	-
7262	Magnetic	506723	5687295	A2	-	-	-	26	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6011 (mag)	-
7263	Debris	506807	5687158	A2	4.8	0.1	0.0	-	Short, curvilinear dark reflector without a shadow or associated magnetic anomaly. Possible piece of linear, non-ferrous debris.	6010 (sss)	-
7264	Rope / Chain	506972	5686999	A2	37.5	0.2	0.0	33	Curvilinear dark reflector without a shadow but associated with a magnetic anomaly. Probably a length of chain.	6008 (sss and mag)	-
7265	Debris	507341	5687281	A2	7.8	2.7	0.0	-	Small area of dark reflectors with shadows but no associated magnetometer contacts. Possible small debris field.	6007 (sss)	-
7266	Dark Reflector	507408	5687122	A2	2.1	1.1	0.5	-	Dark reflector with shadow but no associated magnetic anomaly. In an area of variable seabed reflectivity, and could be natural or a piece of non-ferrous debris.	6005 (sss)	-
7267	Magnetic	507738	5687015	A2	-	-	-	20	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Could be natural or indicative of a piece of buried ferrous debris.	6004 (mag)	-

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7268	Dark Reflector	508877	5687144	A2	2.1	1.1	0.5	-	Small dark reflector with shadow. No associated magnetic anomaly but possibly with a small area of disturbed seabed. Could be natural or debris.	6002 (sss)	-
7269	Magnetic	510050	5686783	A2	-	-	-	23	Small but well-defined magnetic anomaly without any associated sidescan sonar or multibeam bathymetry anomaly. Located in an area with numerous small anomalies, and could be natural or indicative of a piece of buried ferrous debris.	6000 (mag)	-
7292	Recorded Wreck [Live]	464678	5691157	A3					Outside geophysical survey area. Wreck of the *Mariner* (possibly), lost 1979.	2030	15528 (UKHO)
7293	Recorded Wreck [Live]	483250	5688250	A3					Outside geophysical survey area. Wreck of the *A-15* (possibly)	2031	15773 (UKHO) 120/245 (VIOE)
7294	Recorded Wreck [Live]	488866	5689873	A3					Outside geophysical survey area. Wreck of the *Empire Path.*	2032	15514 (UKHO)
7295	Recorded Wreck [Live]	488905	5689964	A3					Outside geophysical survey area.	2033	76861 (UKHO)
7296	Recorded Wreck [Live]	493001	5688721	A3					Outside geophysical survey area. Wreck of the *Gold Shell*.	2034	15502 (UKHO) 121/254 (VIOE)
7297	Recorded Obstruction [Live]	463146	5690550	A3					Outside geophysical survey area.	2036	15842 (UKHO)

WA ID	Name / Classification	Easting	Northing	Arch Disc	L (m)	W (m)	H (m)	Mag Amp (nT)	Description	Source	External Refs
7298	Recorded Obstruction [Live]	495110	5688842	A3					Outside geophysical survey area.	2037	15504 (UKHO)
7299	Recorded Wreck [Dead]	465186	5689793	A3					Outside geophysical survey area. Wrecks of the SS *Kilmare* and *West Hinder* LTV.	2038	15510 (UKHO)
7300	Recorded Wreck [Dead]	476787	5688800	A3					Outside geophysical survey area. Wreck of *FL5*	2039	69607 (UKHO)
7301	Recorded Wreck [Dead]	479108	5688790	A3					Outside geophysical survey area. Wreck of *FL8*	2040	69498 (UKHO)
7302	Recorded Wreck [Dead]	489266	5689685	A3					Outside geophysical survey area. Wreck of *Boscobel*.	2041	15512 (UKHO)
7303	Recorded Wreck [Dead]	508791	5685728	A3					Outside geophysical survey area, wreck marked with buoy 1974.	2042	27305 (UKHO)
7304	Recorded Obstruction [Dead]	467411	5689778	A3					Outside geophysical survey area.	2047	15511 (UKHO)
7305	Recorded Obstruction [Dead]	484116	5687969	A3					Outside geophysical survey area.	2048	69710 (UKHO)
7306	Recorded Wreck [Dead]	454723	5687712	A3					Outside geophysical survey area. Wreck of the *St Patrice*.	2043	15489 (UKHO)
7307	Recorded Obstruction [Dead]	492108	5689124	A3					Outside geophysical survey area.	2050	69494 (UKHO)

APPENDIX IX – BELGIAN LANDFALL – TERRESTRIAL SITES GAZETTEER

This appendix includes a list and description of the data for the Belgian terrestrial sites produced by the VIOE (see **Figure 19**)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1301	Roman	Harendjke (UK8)	Dating between the first and third centuries AD. Wooden building floor with baked tiles; as well as Pottery concentration contemporary of Camping Esmeralda	61781	222340	507231	5683653	75182 (De Haan)
1302	Roman	Port 1	Fire place probably from the second century AD	62842	222969	508280	5684301	75183 (Blankenberge)
1303	Medieval	Breeweg (U/171)	Medieval pottery concentration including Verhaeghe Group A.	65405	222882	510843	5684261	71847 (Blankenberge)
1304	Medieval	I molenstraat	Waste well	63591	223425	509020	5684770	76487 (Blankenberge)
1305	Medieval	Vogelghem	Farm	65034	223319	510464	5684691	72324 (Blankenberge)
1306	Medieval	Farm Raas Walle (U/51)	Site with moat of the type A1C (typology Verhaeghe) firstly mentioned in 1209. Medieval Pottery and Faience. Roof tile and metal fragments from undetermined period.	65635	223288	511066	5684671	71858 (Blankenberge)
1307	Late Medieval	Blankenberge Vaart 1	Abandoned site with moat. Yet clearly visible traces of micro-topographic (earthen embankment, surrounded by a wide moat, to 10m wide).	62477	221641	507940	5682967	70052 (Blankenberge)
1308	Late Medieval	Neptune Avenue I	Site with moat.	62089	221684	507551	5683003	70136 (Blankenberge)
1309	Late Medieval	Neptune Avenue (BE28)	Site with moat.	61729	222470	507177	5683781	70138 (De Haan)
1310	Late Medieval	Poseidon Avenue (BE29)	Site with moat.	62147	221923	507605	5683243	70139 (De Haan)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1311	Late Medieval	A vestige B 2	Dyke	64853	222888	510291	5684257	71833 (Blankenberge)
1312	Late Medieval	Uitkerke 2	Dyke	63797	222900	509236	5684249	71834 (Blankenberge)
1313	Late Medieval	Blankenberge Dijk	Dyke	64160	222294	509610	5683650	71835 (Blankenberge)
1314	Late Medieval	Zeebrugge Avenue (U/181)	Farm, no evidence of moat	65190	223015	510626	5684390	71860
1315	Late Medieval	Loge Voorde	Farm	63318	222596	508763	5683937	72279 (Blankenberge)
1316	Late Medieval	Blankenberge Vaart 2	Remains of a tannery craft place composed of 3 round structure with oil substance.	62583	221748	508044	5683076	72282 (Blankenberge)
1317	Late Medieval	Lenebrug	A footbridge with handrails on Zwin Bommel, Just South of the mill Uitkerke.	64089	222321	509538	5683676	72286 (Blankenberge)
1318	Late Medieval	Mill Uitkerke	Mill. The lord of Uitkerke only had the mill right in the Craft Uitkerke. In the early 19th century, Corneille Pollet owner. Because his mill fell, he built a new 200 m east, the later Tytens' mill.	64066	222431	509513	5683786	72319 (Blankenberge)
1319	Post Medieval	Stake Bed	The various entries outline their function well: 1. a repository of the material for the seawall, which consist of stakes, brushwood and stone blocks 2. was an unloading bay for boats, 3. a house for the strandopziener.	65134	224200	510548	5685573	72326 (Blankenberge)
1320	Post Medieval	Stationsstraat/King Albert I-laan/Prinsenlaan	A flattened mound	64103	223394	509533	5684749	72322 (Blankenberge)
1321	Post Medieval	Hofstede Oostpoort	Homestead	64135	223669	509559	5685024	72323 (Blankenberge)
1322	Post Medieval	Telgerie	Brick and tile works (brickyard)	62792	222328	508242	5683659	72280 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1323	Post Medieval	The Sloop	Non-walled farm site mentioned during the 17thy century as a homestead or a manor	63335	222291	508785	5683632	72285 (Blankenberge)
1324	Post Medieval	Ovenkotstuk	Farm land from the 16th century	66319	223558	511744	5684953	72315 (Blankenberge)
1325	Roman, Early Medieval, and Post Medieval	By Haagstraat (U/8)	Roman Pottery (Clip terra sigillata, central Gaul). Early Medieval Pottery (Verhaeghe group A). Post Medieval undetermined occupation showed on the Map of Pourbus (1562-1571).	66707	223633	512131	5685036	71837 (Blankenberge)
1326	Roman and Medieval	Breeweg (U/17, U/95)	Roman pottery concentration over large area including Terra-sigillata. Early Medieval pottery concentration such as Badorf and Gegladde. Late Medieval pottery concentration including Verhaeghe Group A. An also some organic material from undetermined period.	65725	222979	511161	5684364	71845 (Blankenberge)
1327	Roman and Medieval	Meeuwenlaan (U/104)	Roman sherds. Late Medieval pottery concentration including Verhaeghe Group A, and Badorf. Organic and metal material from undetermined period.	65132	222738	510573	5684112	71848 (Blankenberge)
1328	Medieval and Post Medieval	Castle Prince Gog or Castle of Uitkerke	Fortress associated with farm (bailey) and double circular moat. Destroyed by Dutch after an 80 years war (1568-1648), and destroyed again by the locals in 1849. There is also an 18th century Mansion in rococo style in place. And finally a Motte Castrale dating probably at least of 1270.	64547	222431	509994	5683794	71817 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1329	Medieval and Post Medieval	Groendijk (U15, U/16, U/138)	Several type of Early Medieval Pottery (such as Verhaeghe Group A). Other pottery of various type from the Late Medieval period (including Verhaeghe Group A), but without any apparent with the earlier period. Pottery and faience from the possibly from the 16th century. Organic material, bricks and glass fragment from undetermined period.	66247	223357	511676	5684751	71844 (Blankenberge)
1330	Medieval and Post Medieval	Farm Oosthof (U/169)	Residential occupation of a site with moat during the Medieval and Post Medieval period.	66261	223648	511685	5685042	71857 (Blankenberge)
1331	Medieval and Post Medieval	Zeebrugge Avenue (U/9)	Farm occupation from Medieval period. Medieval pottery sherds, and post medieval stoneware including Raeren Majolica. Bone fragments of undetermined period.	65402	223051	510837	5684430	71859 (Blankenberge)
1332	Medieval and Post Medieval	Molenstraat II	Occupation site from the Medieval period to the 18th century with fragments of pots and dishes, barrels, pottery, faience plate, key and shoe clips.	63660	223512	509088	5684858	72234 (Blankenberge)
1333	Medieval and Post Medieval	Tiendehof	Farm and barn demolished and transformed in cropland	64341	222294	509791	5683654	72318 (Blankenberge)

WA Number	Period	Name	Description	Lambert 72 Easting	Lambert 72 Northing	UTM31N Easting	UTM31N Northing	VIOE Location
1334	Medieval and Post Medieval	Oudengemse Sluis	Lock. The lock just west west of oudengem with the arranged drainage of the Church Corner of Reed. The water south of A vestige B flowed through three openings to the Eiesluis. Because the risk of breakthrough from the beachfront for a long time was present, remained until about 1500 with three openings of doors. The three locks, which could shut A vestige were Oudengemse Sluis, Sluis and the Boudin Meitin Koppe Luis.	65028	223015	510464	5684387	72325 (Blankenberge)
1335	Undeterm-ined	Brick Kiln	Brick and tile works (brickyard)	63765	222719	509207	5684068	72278 (Blankenberge)
1336	Undeterm-ined	Spoon Exhibit	Water place	62891	222180	508344	5683513	72281 (Blankenberge)
1337	Undeterm-ined	Bekegem	Occupation site of a Farmhouse	65463	222940	510900	5684320	72314 (Blankenberge)

APPENDIX X – COORDINATES SYSTEM INFORMATION

WGS84 UTM31

Datum:	WGS84
Ellipsoid:	WGS84
Semi Major:	6378137.00
Semi Minor:	6356752.31
Inverse Flattening:	298.2572236
Projection:	Universal Transverse Mercator
Projection Type:	Universal Transverse Mercator
Zone:	UTM-31N
False Easting:	500000.00000000
False Northing:	0.00000000
Latitude of Origin:	0.00000000
Longitude of Central Meridian:	3.00000000
Scale Factor at the CM:	0.99960000
Survey Units:	International metre

British National Grid (OSGB36)

Datum:	OSGB36
Ellipsoid:	Airy 1830
Semi Major:	6377563.40
Semi Minor:	6356256.91
Inverse Flattening:	299.3249646
Projection:	UK and Ireland
Projection Type:	Transverse Mercator (Gauss Kruger)
Zone:	OSGB36
False Easting:	400000.00000000
False Northing:	-100000.00000000
Latitude of Origin:	49.00000000
Longitude of Central Meridian:	-2.00000000
Scale Factor at the CM:	0.99960127
Survey Units:	International metre

Belgium National Grid (Belge Lambert 72 datum)

Datum:	Belge 1972
Ellipsoid:	Int'l 1924
Semi Major:	6378388.00
Semi Minor:	6356911.95
Inverse Flattening:	297.0000000
Projection:	Belgium
Projection Type:	Lambert Conic (2SP Belgium)
Zone:	Belge Lambert 72
False Eastings:	150000.01256000
False Northings:	5400088.43780000
Latitude of the Origin of Projection:	90.00000000
Longitude of the Centre of Projection:	4.35693972
Latitude of Northern Parallel:	51.16666667
Latitude of Southern Parallel:	49.83333333
Survey Units:	International metre

French National Grid (RGF 1993 Lambert 93)

Datum:	RGF93
Ellipsoid:	GRS80
Semi Major:	6378137.00
Semi Minor:	6356752.31
Inverse Flattening:	298.2572221
Projection:	France
Projection Type:	Lambert Conic (2SP)
Zone:	Lambert-93
False Easting:	700000.00000000
False Northing:	6600000.00000000
Latitude of the Origin of Projection:	46.50000000
Longitude of the Centre of Projection:	3.00000000
Latitude of Northern Parallel:	49.00000000
Latitude of Southern Parallel:	44.00000000
Survey Units:	International metre

OSGB36 to WGS84 datum

Conversion carried out using OSTN 2 conversion

Belge Lambert 72 datum to WGS84 datum

Datum:	Belge 1972
Ellipsoid:	Int'l 1924
Semi Major:	6378388.00
Semi Minor:	6356911.95
Inverse Flattening:	297.0000000
Datum Shifts to WGS84:	
Delta X(m):	-99.100
Delta Y(m):	53.300
Delta Z(m):	-112.500
Rotation X(sec):	0.4190
Rotation Y(sec):	-0.8300
Rotation Z(sec):	1.8850
Scale(ppm):	-1.0000000

Appendix 13: French Offshore Non-Technical Summary

Projet Nemo – Câble d'énergie entre le Royaume Uni et la Belgique *Partie française*

Pièce technique : Description du projet

Préparé pour le compte de
Elia Asset NV

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Rapport 109375-R P2 v2.2

Table des Matières

1. Situation, consistance et superficie de l'emprise du projet 1

1.1. Nature du projet 1
1.2. Route du câble 2
1.3. Superficie de l'emprise du projet dans les eaux françaises 7
1.4. Calendrier de réalisation 8
1.4.1. Echelonnement des travaux 8
1.4.2. Date de mise en service 9

2. Caractéristiques techniques du projet 10

2.1. Caractéristiques du câble 10
2.2. Installation offshore du câble 11
2.2.1. Préparation de la route du câble (Pre-lay) 11
2.2.2. Pose du câble (Laying) 16
2.2.3. Ensouillage du câble (Burial) 16
2.2.4. Raccordement du câble en offshore 18
2.2.5. Croisement des câbles 18
2.2.6. Post ensouillage du câble (Post-burial) 18
2.3. Exploitation du câble 20
2.3.1. Maintenance 20
2.3.2. Relevage du câble en fin de vie 23
2.4. Moyens nautiques mis en œuvre 24
2.4.1. Pose 24
2.4.2. Maintenance 26
2.4.3. Relevage en fin de vie 26

3. Dispositions propres à assurer la sécurité de la navigation maritime et la prévention des accidents maritimes 27

3.1. Signalisation et sécurisation du chantier itinérant 27
3.1.1. Zone de sécurité temporaire mobile 27
3.1.2. Navires de garde 27
3.1.3. Signalisation 27
3.2. Coopération avec les services de surveillance du trafic en Manche 28
3.3. Diffusion d'un avis aux navigateurs 28
3.4. Plan de mesures d'urgence (ERCoP) 29
3.5. Protection du câble 29
3.6. Risque lié à l'exposition du câble 29
3.7. Interférence géomagnétiques 29
3.8. Découverte de munitions et d'explosifs 29

Liste des figures

Figure 1.1.1 *Aperçu schématique de la liaison à courant continu entre la Belgique et la Grande-Bretagne*
Figure 1.2.1 *Tracé du câble*
Figure 1.2.2 *Tracé du projet de câble NEMO dans les eaux françaises*
Figure 1.4.1 *Programme d'installation pour les aspects maritimes du projet*
Figure 2.1.1 *Description du câble*
Figure 2.2.1 *Grappin de récupération de câble*
Figure 2.2.2 *Drague aspiratrice en marche (DAM)*
Figure 2.2.3 *Zones identifiées pour d'éventuelles opérations de pre-sweeping*
Figure 2.2.4 *Pose du câble*
Figure 2.2.5 *Exemples de charrue d'ensouillage : a- charrue à grappin ; b- charrue à jets*
Figure 2.2.6 *Structure de protection de type semi ensouillé / surensouillé pour le croisement de câbles*
Figure 2.4.1 *Pose et ensouillage assurés par deux navires en convoi*

Liste des Tableaux

Tableau 1.2.1 *Points tournants (A/C) sur la route du câble dans les eaux françaises*
Tableau 1.2.2 *Route du câble dans les eaux françaises*
Tableau 1.2.3 *Couloir de 500 m autour de la route du câble dans les eaux françaises*
Tableau 1.3.1 *Emprise du projet*
Tableau 2.2.1 *Zones identifiées pour d'éventuelles opérations de pre-sweeping*
Tableau 2.3.1 *Forces des champs électrique et magnétique à proximité du câble d'énergie BritNed*

Abréviations

MN	Mille nautique
PK	Point kilométrique
ZEE	Zone Economique Exclusive
A/C	Alter Course = point tournant de la route du câble
DAM	Drague aspiratrice en marche
CM	Cote marine
OMI	Organisation Maritime Internationale
MCA	Maritime and Coastguard Agency
CROSS	Centre Régional opérationnel de surveillance et de sauvetage
CNIS	Channel Navigation Information Service
RIPAM	Règlement international pour prévenir les abordages en mer
ColReg	Collision Regulation
HSE	Hygiène-Sécurité Environnement
ERCoP	Emergency Response Cooperation Plan
MARPOL	Maritime Pollution
SHOM	Service Hydrographique et Océanographique de la marine
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency / Très Haute Fréquence

1. Situation, consistance et superficie de l'emprise du projet

1.1. Nature du projet

Le projet NEMO, porté par National Grid Nemo Link Ltd et Elia Asset S.A, consiste à mettre en place un **câble d'énergie sous-marin**, traversant la mer du Nord entre la Grande Bretagne et la Belgique ; cette liaison est destinée à connecter leurs réseaux afin d'augmenter la liquidité des marchés et de soutenir la sécurité d'approvisionnement tant en Grande-Bretagne qu'en Belgique.

La capacité de la liaison se situera entre 700 et 1 300 MW. La liaison à courant continu est composée de deux câbles séparés (l'un avec une tension positive, l'autre avec une tension négative), exploités comme un tout unique. L'utilisation de la Haute Tension en Courant Continu (HVDC) est le moyen le plus efficace pour le transport de l'électricité sur cette distance.

La liaison sera constituée de deux grandes parties : une partie sous-marine « offshore » et une partie sur la terre ferme « onshore » ou atterrage (**Figure 1.1.1**). Les deux extrémités sont raccordées à un poste à haute tension, station de conversion, pour la conversion courant continu / courant alternatif (AC / DC) et le raccordement au réseau 380 kV. La conversion est réalisée par des composants semi-conducteurs d'électronique de puissance.

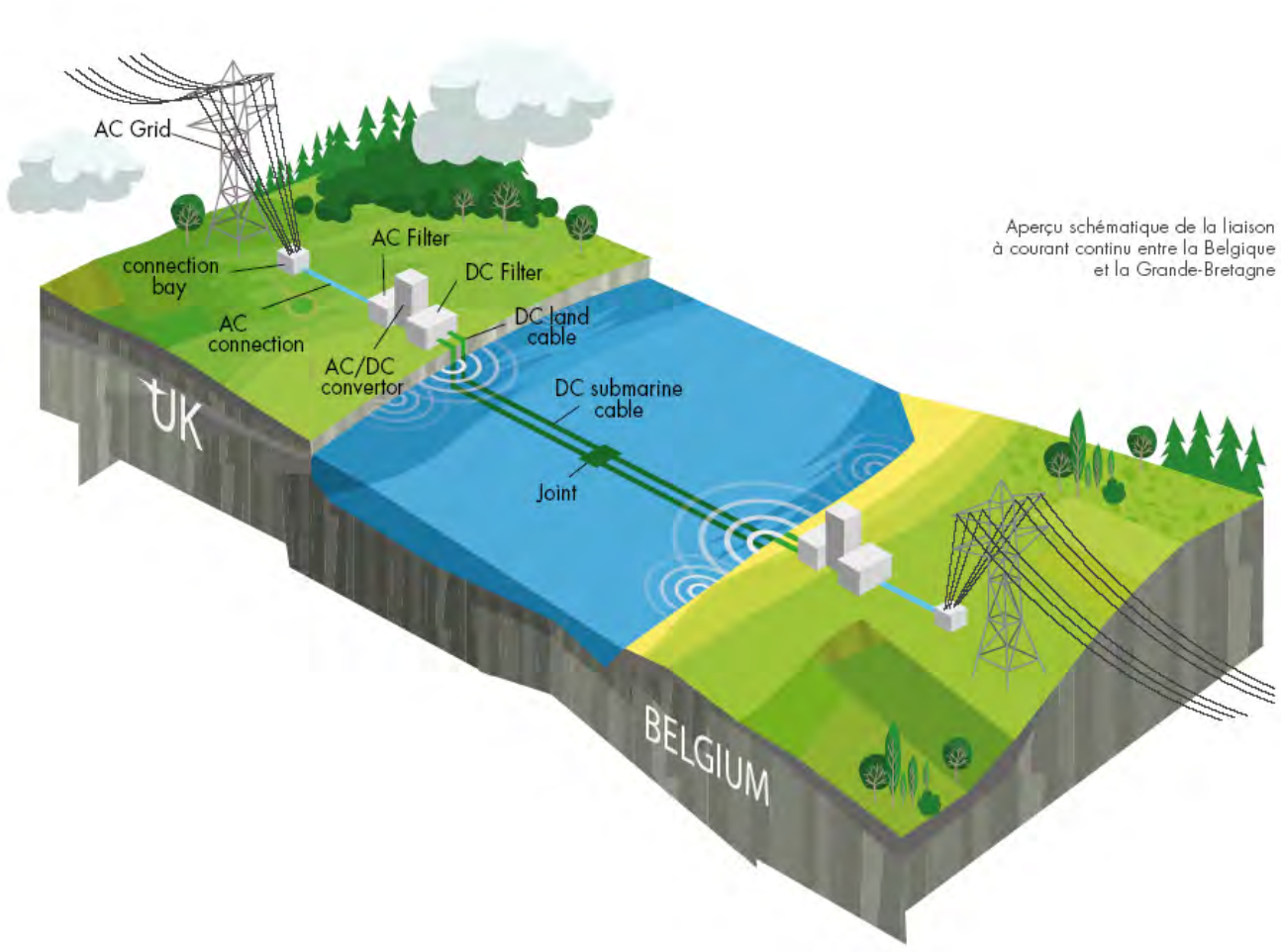


Figure 1.1.1 : Aperçu schématique de la liaison à courant continu entre la Belgique et la Grande-Bretagne

1.2. Route du câble

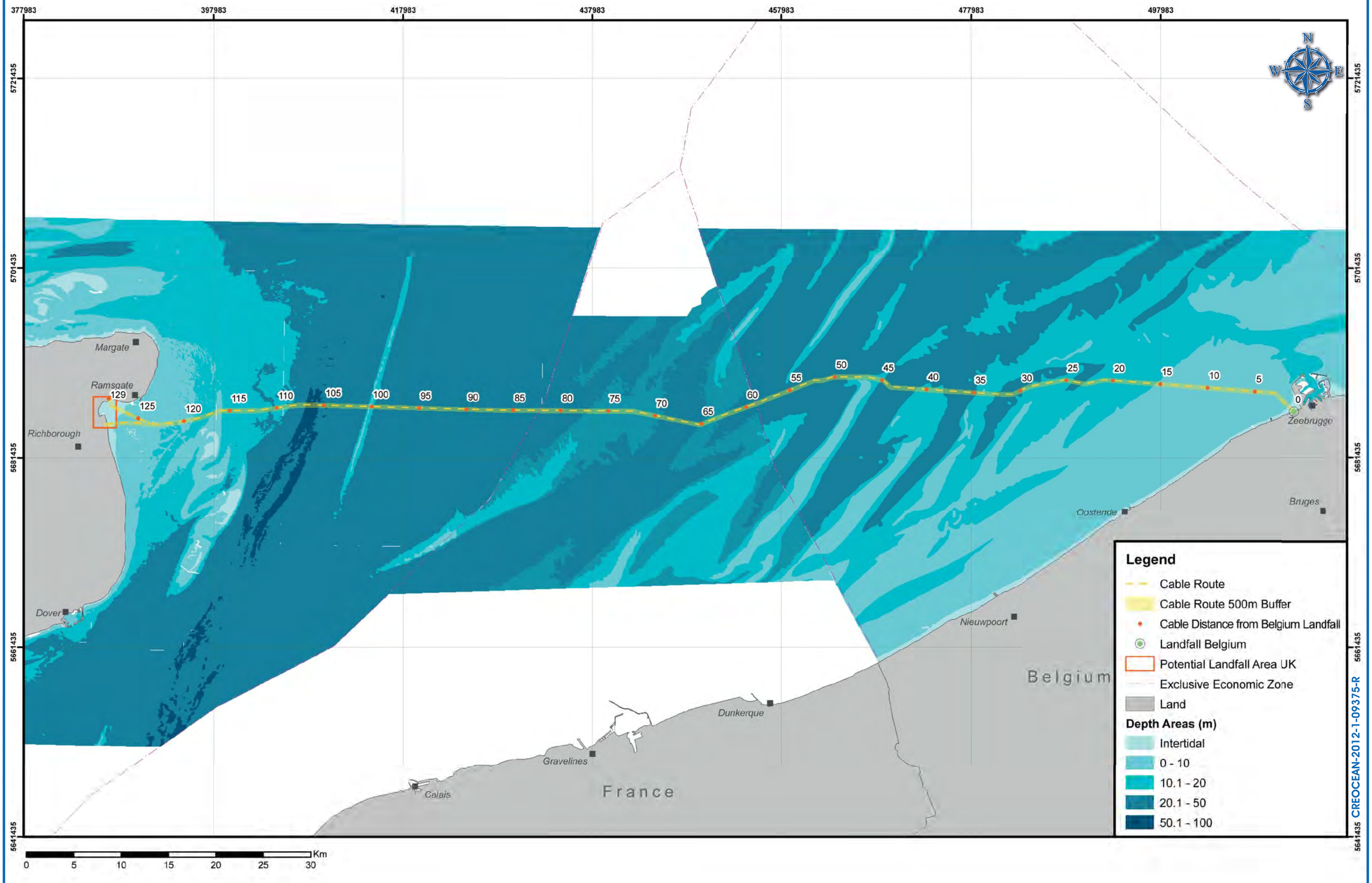
L'ensemble de la route du câble issue du tracé préliminaire et des investigations de terrain est présentée sur la **Figure 1.2.1** et la liste des points du tracé est donnée dans le **Tableau 1.2.1** :

Point tournant	KP	Long WGS 84	Lat WGS 84	Easting UTM31N	Northing UTM31N	Prof. (m CM)	Cap	Raison du changement de direction sur la route
West Zeebrugge	0	3.1670	51.3258	511641	5686073			Atterrage Belgique
ALTERCOURSE	1.6	3.1469	51.3335	510232	5686924	-6.0	273°	
ALTERCOURSE	4.5	3.1060	51.3353	507385	5687119	-8.0	273°	Eviter une épave
ALTERCOURSE	12.1	3.0581	51.3379	504047	5687405	-10.6	272°	Eviter une épave
ALTERCOURSE	17.7	2.9976	51.3416	499833	5687813	-15.2	271°	Eviter zone minée / épaves
ALTERCOURSE	19.5	2.9165	51.3444	494188	5688127	-16.6	278°	Epave répertoriée
ALTERCOURSE	24.3	2.8920	51.3480	492478	5688535	-21.7	278°	Croisement câble C-POWER
ALTERCOURSE	28.1	2.8253	51.3580	487839	5689651	-25.1	263°	Croisement câble Hermes South
ALTERCOURSE	30.1	2.7718	51.3516	484105	5688952	-25.7	255°	
ALTERCOURSE	32.5	2.7449	51.3442	482234	5688135	-21.5	271°	Maintien à 250 m des câbles Pan European Crossing et Hermes 2
ALTERCOURSE	32.8	2.7107	51.3449	479849	5688216	-16.8	274°	
ALTERCOURSE	42.8	2.7064	51.3451	479549	5688248	-32.0	272°	Maintien à 250 m du câble PEC
ALTERCOURSE	43.4	2.5634	51.3505	469593	5688899	-30.7	284°	
ALTERCOURSE	45.1	2.5557	51.3524	469060	5689111	-28.9	312°	Croisement câble Tangerine
ALTERCOURSE	46.0	2.5411	51.3653	468054	5690553	-29.5	286°	
ALTERCOURSE	48.0	2.5364	51.3667	467728	5690702	-33.6	286°	Croisement pipe FRANPIPE et câbles Tangerine et Rioja 2
ALTERCOURSE	48.0	2.4600	51.3570	462402	5689659	-32.1	270°	
ALTERCOURSE	50.0	2.4405	51.3571	461041	5689684	-33.3	256°	
ALTERCOURSE	51.1	2.4367	51.3562	460780	5689583	-35.4	232°	Eviter une épave répertoriée et croisement FRANPIPE
ALTERCOURSE	52.5	2.4322	51.3526	460459	5689193	-35.1	256°	
ALTERCOURSE	52.8	2.2863	51.3152	450262	5685120	-35.4	264°	Maintien à 250 m de Tangerine
ALTERCOURSE	53.3	2.2714	51.3137	449222	5684962	-26.8	277°	Croisement des câbles TAT14 et UK-Belgium 3
ALTERCOURSE	64.2	2.2226	51.3196	445828	5685657	-33.8	277°	
ALTERCOURSE	65.3	2.1721	51.3259	442316	5686390	-37.1	270°	Maintien à 250 m de Tangerine
ALTERCOURSE	68.8	2.0111	51.3253	431094	5686470	-29.8	270°	
ALTERCOURSE	72.4	1.9596	51.3252	427506	5686501	-37.1	271°	Croisement câble UK-Belgium 5
ALTERCOURSE	94.1	1.8600	51.3276	420570	5686870	-40.3	269°	
ALTERCOURSE	96.8	1.8216	51.3272	417893	5686869	-40.3	270°	Croisement câble AC1
ALTERCOURSE	103.5	1.7255	51.3269	411202	5686950	-46.3	273°	
ALTERCOURSE	107.3	1.6712	51.3301	407423	5687369	-36.2	262°	Eviter une crête abrupte
ALTERCOURSE	107.6	1.6665	51.3295	407098	5687306	-29.1	248°	Eviter récif à *Sabelleria*
ALTERCOURSE	108.2	1.6600	51.3268	406634	5687018	-26.4	264°	
ALTERCOURSE	112.3	1.6016	51.3209	402558	5686435	-21.0	269°	
ALTERCOURSE	116.2	1.5453	51.3201	398629	5686430	-8.6	257°	Eviter un banc
ALTERCOURSE	118.7	1.5111	51.3122	396231	5685592	-13.8	263°	
ALTERCOURSE	121.2	1.4766	51.3078	393814	5685152	-12.9	266°	
ALTERCOURSE	123.0	1.4509	51.3059	392021	5684987	-8.8	275°	Eviter une zone endommagée
ALTERCOURSE	123.7	1.4404	51.3064	391290	5685050	-9.5	285°	
ALTERCOURSE	127.3	1.3937	51.3187	388066	5686486	-2.1	283°	
ALTERCOURSE	128.2	1.3814	51.3216	387212	5686831	-0.5	279°	Maintien à 250 m des câbles ferme éolienne Thanet
ALTERCOURSE	129.2	1.3651	51.3248	386089	5687211		297°	
Richborough	129.4	1.3647	51.3249	386059	5687234			Atterrage Royaume Uni

ROUTE PRÉVISIONNELLE RETENUE AVANT SURVEY EN MER

D'après PPMS,2011

Figure 1.2.1



CREOCEAN-2012-1-09375-R

La partie offshore compte environ 130 km dont **23 km dans les eaux françaises, exclusivement en zone marine,** c'est-à-dire sans atterrage sur le territoire français.

La partie française est située grossièrement entre les PK59 et PK83 (comptés à partir de Zeebrugge, Belgique - **cf. Figure 1.2.2**).

Sur la base des reconnaissances de terrain, la route du câble définie après les reconnaissances de terrain et sur laquelle peuvent être étudiés les impacts, est la suivante :

Tableau 1.2.2 : Route du câble dans les eaux françaises

PK	Latitude N	Longitude E	X	Y	Profondeur (m)
60	2,343°	51,330°	454207	5686696	-38,1
61	2,329°	51,326°	453279	5686325	-36,8
62	2,316°	51,323°	452350	5685954	-35,9
63	2,303°	51,319°	451421	5685583	-35,3
64	2,290°	51,316°	450493	5685212	-29,3
65	2,276°	51,314°	449519	5685007	-34,0
66	2,262°	51,315°	448537	5685103	-35,9
67	2,247°	51,317°	447557	5685303	-36,4
68	2,233°	51,318°	446577	5685503	-37,2
69	2,219°	51,320°	445598	5685705	-36,9
70	2,205°	51,322°	444619	5685909	-34,7
71	2,191°	51,324°	443640	5686114	-31,5
72	2,177°	51,325°	442661	5686318	-30,1
73	2,163°	51,326°	441668	5686395	-30,2
74	2,148°	51,326°	440668	5686402	-31,8
75	2,134°	51,326°	439668	5686409	-35,0
76	2,120°	51,326°	438668	5686416	-33,8
77	2,105°	51,326°	437668	5686423	-28,9
78	2,091°	51,326°	436668	5686430	-39,1
79	2,077°	51,326°	435668	5686437	-38,3
80	2,062°	51,326°	434669	5686444	-37,2
81	2,048°	51,325°	433669	5686451	-38,4
82	2,034°	51,325°	432669	5686459	-39,2
83	2,019°	51,325°	431669	5686466	-31,2

Cette route n'est pas totalement figée : en effet, les porteurs du projet souhaitent maintenir la possibilité de poser le câble dans le couloir de 500 m défini plutôt que sur le tracé central car la morphologie des fonds est susceptible d'évoluer au niveau des zones mobiles comme les vagues de sable, au moment où le câble sera installé.

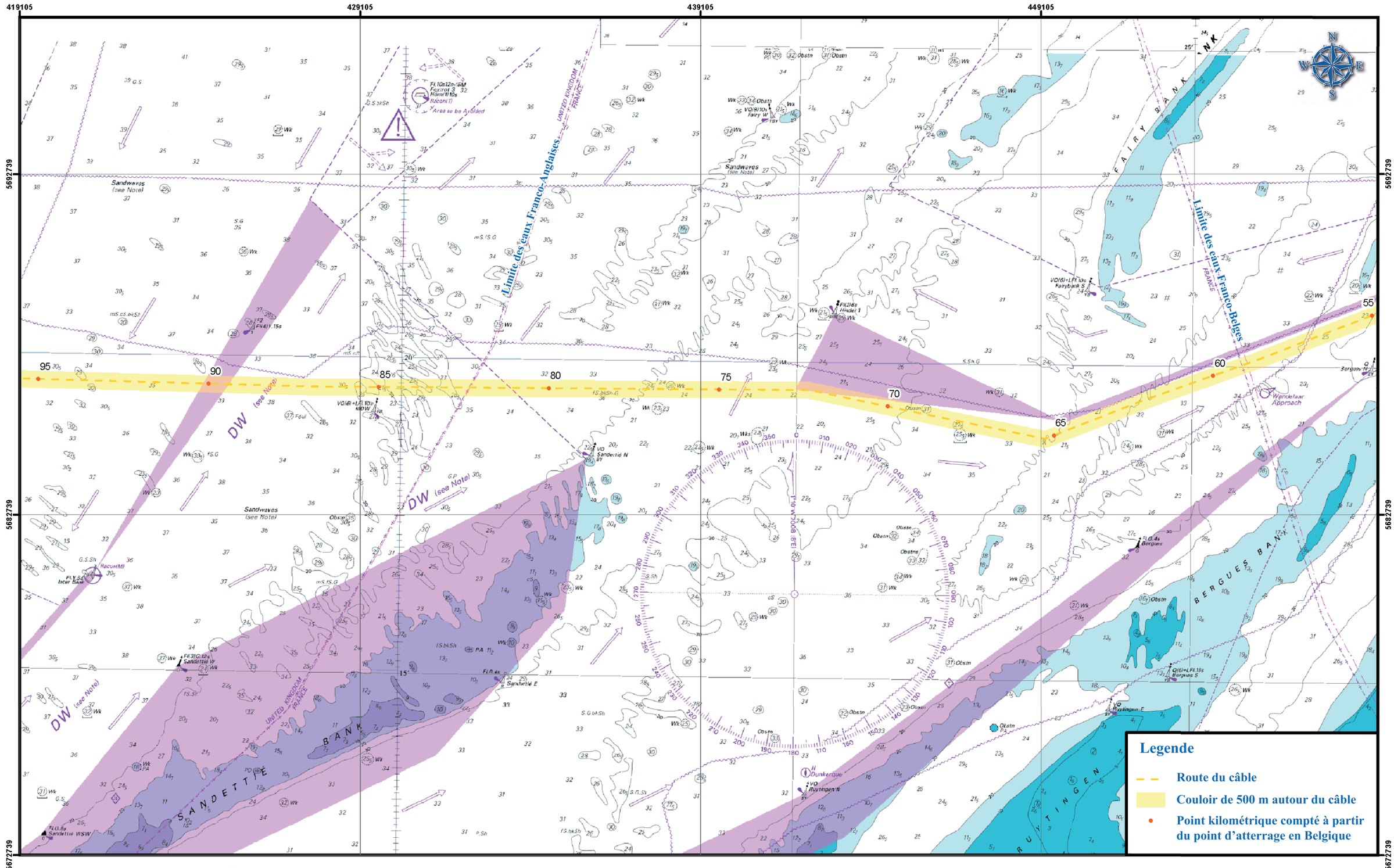
Tableau 1.2.3 : Couloir de 500 m autour de la route du câble dans les eaux françaises

ID	Longitude Est Lon_DD	Latitude Nord Lat_DD	X_UTM31(m)	Y_UTM31(m)
141	2,277669	51,312801	449656	5684850
142	2,276809	51,3125	449596	5684820
143	2,27195	51,3115	449256	5684720
144	2,27091	51,3115	449183	5684720
145	2,24639	51,314498	447478	5685060
146	2,17331	51,323398	442396	5686120
147	2,17158	51,3236	442276	5686140
148	2,06252	51,323398	434676	5686200
149	2,05448	51,323398	434116	5686210
150	2,04501	51,3232	433456	5686200
151	2,044719	51,323398	433436	5686220
152	2,02672	51,3232	432181	5686210
153	2,030649	51,327701	432462	5686710
154	2,172349	51,328098	442335	5686640
155	2,27148	51,316001	449229	5685220
156	2,274189	51,316699	449418	5685300
157	2,29355	51,321399	450772	5685810
158	2,35471	51,337001	455050	5687500
159	2,35553	51,335399	455105	5687320
160	2,35698	51,332599	455203	5687010

TRACÉ DU PROJET DE CÂBLE NEMO DANS LES EAUX FRANÇAISES

Figure 1.2.2

D'après PPMS,2011



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1.3. Superficie de l'emprise du projet dans les eaux françaises

Le projet dans son ensemble comprend plusieurs phases :

- la phase **d'installation** de l'ouvrage (travaux de pose du câble),
- la phase **d'exploitation** et de **maintenance** (surveillance de l'ensouillage du câble, interventions pour réparation…),
- et en fin de vie du câble, l'opération de **démantèlement** et de remise en état du site.

Ces phases avec les techniques utilisées et les moyens mis en œuvre sont décrites dans le paragraphe 3 suivant.

La superficie totale impliquée dans les travaux offshore sur la portion française est de :

Tableau 1.3.1 : Emprise du projet

Phase du projet	Emprise
Préparation de la route du câble	Le couloir à nettoyer des obstructions, afin de faciliter le passage de l'engin d'ensouillage, est de 100 m de part et d'autre du tracé retenu au niveau des zones reconnues au préalable. L'emprise maximale du grappin ou du ROV sur le fond est de 10 m. En surface, l'emprise des navires sur le plan d'eau est de 500 m de rayon.
Pose du câble	Sur le fond marin : • Le câble sera ensouillé à une profondeur de 2 à 3 m. En se basant sur les techniques les plus courantes d'ensouillage, l'emprise maximale de l'engin d'ensouillage est de 10 m et l'emprise de la tranchée est 1 à 5 m. • La largeur de la zone nivelée (pre-sweeping) varie en fonction de la forme et la taille de chaque structure sédimentaire mais peut être généralement considérée de 10 m à 20 m. Sur le plan d'eau (en surface) : • en général, un grand câblier de grande taille (150 m de long) en marche travaille dans un secteur sécurisé de 500 m de rayon ; si l'engin d'ensouillage est tracté par un navire en convoi avec le câblier principal, la zone de sécurité est augmentée de 500 m sur 1000 m, • si le câblier doit travailler en statique avec ancrages, le rayon de la zone de sécurité est porté jusqu'à 2000 m.
Maintenance	La zone de sécurité du navire câblier effectuant une réparation, en station, est de 2000 m.
Démantèlement	Comme pour l'opération de pose, la zone de sécurité autour du navire est de 500 m sur 1000 m.

1.4. Calendrier de réalisation

1.4.1. Echelonnement des travaux

Le calendrier d'installation du câble dépend d'un certain nombre de facteurs tels que la livraison du câble, la disponibilité du câblier et les autres engagements de l'installateur.

Le tracé du projet est relativement simple, avec environ 20 km en petits-fonds (<10 m CM) côté Royaume-Uni, une section d'environ 100 km (traversant les eaux anglaises, françaises et belges) en eau profonde (> 10 m CM) et une section d'environ 10 km en petits-fonds côté belge.

La **Figure 1.4.1** suivante donne une indication du programme d'installation pour les aspects maritimes du projet, avec la séparation des travaux sur les petits et les grands fonds, ainsi que l'échelonnement des travaux dans les eaux anglaises et françaises-belges.

		Mois				
Phase	**Description**	**1**	**2**	**3**	**4**	**5**
C1a installation petits-fonds Royaume Uni	*Nettoyage de la route, pose and post ensouillage du câble*					
C1b installation petits-fonds Belgique	*Nettoyage de la route, pose and post ensouillage du câble*					
C2 installation offshore Royaume Uni	*Préparation des fonds (nivelage des crêtes des vagues de sable et éclaircissement de la route du câble, raccordement du câble, pose et ensouillage simultané du câble*					
C3 installation offshore France et Belgique	**Préparation des fonds (nivelage des crêtes des vagues de sable et éclaircissement de la route du câble, raccordement du câble, pose et ensouillage simultané du câble**					

Figure 1.4.1 : Programme d'installation pour les aspects maritimes du projet

Le programme et la date pour le début des travaux d'installation ne sont pas encore arrêtés mais il est estimé que l'installation pourra commencer en 2016 au plus tôt.
En général, les installations dans les eaux européennes ont lieu pendant la saison estivale (entre Avril et Octobre) : ces opérations sont principalement tributaires des conditions météorologiques et d'agitation du plan d'eau. Le calendrier sera également tributaire de facteurs tels que la mise en œuvre des mesures d'atténuation des impacts sur les compartiments écologiques les plus fragiles, ainsi que de la disponibilité des navires.

Les travaux d'installation dans les zones intertidales au Royaume-Uni et la Belgique devraient prendre moins d'une semaine.

Il est prévu qu'au moins cinq points de raccordement de câbles marins soient nécessaires sur l'ensemble du système et chaque opération de raccordement prend environ cinq jours.

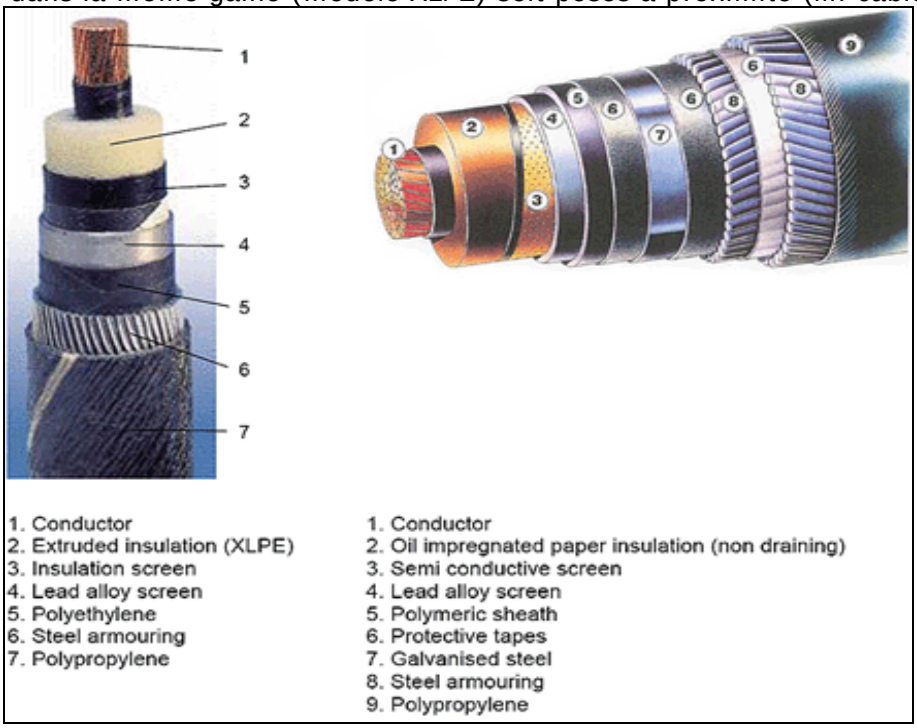
1.4.2. Date de mise en service

Les travaux d'installation sont prévus s'achever en 2018. La date de mise en service n'est pas encore arrêtée.

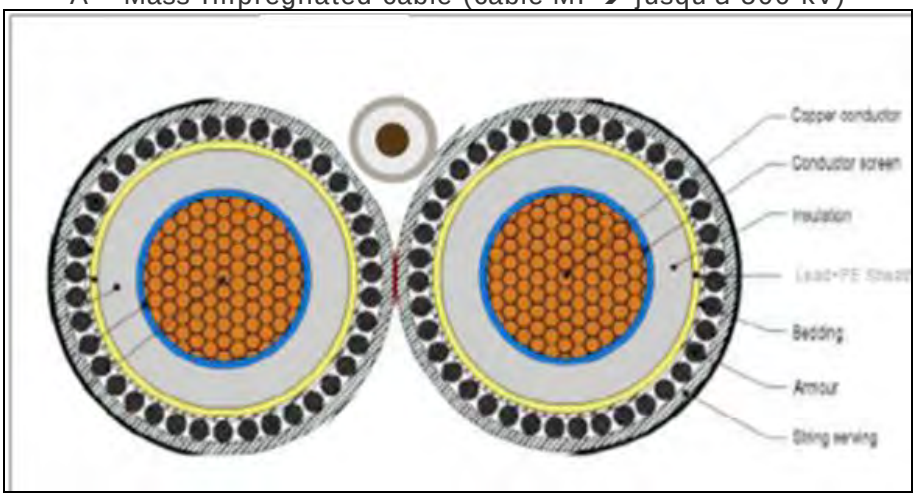
2. Caractéristiques techniques du projet

2.1. Caractéristiques du câble

Le système retenu en priorité est bipolaire haute tension en mode continu (HVDC) avec un voltage de 300 kV ou 500 kV, selon le modèle choisi. La taille d'un câble est d'environ 12 cm.
Pour assurer la liaison bidirectionnelle, deux câbles sont nécessaires (l'un positif, l'autre négatif) : ils seront soit reliés dans la même gaine (modèle XLPE) soit posés à proximité (MI cables).



A – Mass Impregnated cable (câble MI ➔ jusqu'à 500 kV)



B – câble XLPE (jusqu'à 300 kV)

Figure 2.1.1 : Description du câble

- La technologie des **câbles XLPE** est une isolation par Polyéthylène réticulé extrudée sur un conducteur en cuivre ou en aluminium, recouverte d'une gaine étanche de plomb sans soudure et d'une gaine de protection en plastique. Le câble sous-marin destiné au projet Nemo sera doté d'une armure en acier galvanisé, qui lui permettra de mieux résister aux contraintes de l'installation sous-marine : l'armure simple est composée d'une couche de fils enroulés en hélice autour du câble, recouverte d'une gaine de bitume imprégné de polypropylène pour empêcher la corrosion.
  Dans les zones rocheuses ou d'intenses activités humaines, l'armure peut être double.

- Le **câble MI**, dont l'efficacité de cette technologie a été testée sur plusieurs interconnecteurs sous-marins, est constitué d'un faisceau de brins de câble à âme en cuivre, immobilisé et isolé par une couche de papier imprégné d'huile minérale de haute viscosité. Ce type câble n'est ainsi pas pressurisé et il n'y a pas d'huile qui puisse s'écouler en cas de rupture de la gaine du câble. L'armure est composée d'une ou deux couches de fils en acier galvanisé en hélice, sous une couche de fils de jute bitumé et une couche intermédiaire de fils de polypropylène, pour améliorer la maniabilité.

➔Ces deux technologies certifient qu'aucune huile ne puisse être rejetée dans le milieu marin, en cas de rupture du câble.

Pour le projet Nemo d'interconnexion1000 MW, la configuration «de base» du câble la plus probable est **un système bipolaire HVDC, avec deux câbles MI regroupés dans la même tranchée**. Toutefois, en fonction de la technologie d'installation disponible, il y a une faible probabilité que les câbles puissent être installés dans des tranchées distinctes.
Le câble doté d'une armure simple ou double sera ensouillé à une profondeur moyenne de 2 à 3 m sur l'ensemble du trajet, lorsque ce sera possible.

2.2. Installation offshore du câble

Le trajet sur la partie française n'ayant aucun atterrage, seules des techniques offshore adaptées au milieu naturel sont utilisées.

2.2.1. Préparation de la route du câble (Pre-lay)

Trois activités préliminaires à la pose sont nécessaires pour faciliter le passage de l'engin d'ensouillage :

- le nettoyage du tracé du câble des obstructions et des câbles de télécommunications hors service, au moyen d'un grappin,
- la préparation des fonds pour assurer le meilleur ensouillage du câble dans les structures mobiles,
- la préparation des fonds pour le croisement avec les autres ouvrages en service et la mise en place du système de protection.

2.2.1.1. Nettoyage des obstructions (Clearance)

Les débris des fonds marins tels que les filins qui peuvent avoir été largués par les navires sur le fond marin, les câbles de communication abandonnés et d'autres débris peuvent être préjudiciables à la progression et au travail de l'engin d'ensouillage tracté derrière le câblier.

Avant le début des opérations de pose du câble, le parcours du câble doit être nettoyé des obstructions identifiées au cours des précédentes missions de reconnaissance des fonds et au cours de la mission d'essais d'ensouillage (Pre-Lay Grapnel Run ou PLGR).
L'installation du câble peut nécessite plusieurs campagnes, en fonction de la capacité de transport du navire câblier. L'opération PLGR peut être réalisée progressivement afin d'assurer que la route sera bien dégagée des débris récemment rejetés avant chaque campagne de pose.

Les câbles de télécommunications hors service qui croisent le tracé de NEMO sont recherchés et relevés au moyen d'un grapin désensouilleur et coupés sur une longueur de 100 m autour du tracé du projet de câble.

Figure 2.2.1 : grappin de récupération de câble



Le navire tracte le grappin le long du tracé du câble. Le treuil de remorquage est muni d'une jauge de contrainte qui détecte une augmentation de la tension si un objet est accroché. La plupart des câbles anciens et les filins se trouvent normalement en surface sur le fond marin ; le grappin peut pénétrer le fond marin jusqu'à une profondeur d'environ 1 m pour récupérer les câbles hors service ensouillés.

Les débris rencontrés seront ainsi récupérés à bord du navire pour une élimination à terre appropriée. Dans le cas de découverte des munitions non explosées au cours de cette mission, un spécialiste habilité pour l'élimination des munitions et explosifs sera disponible à bord afin d'identifier les éléments suspects et de fournir les conseils sur la marche à suivre.

Les câbles de communication hors service seront coupés sur une distance de 100 m de part et d'autre du tracé du projet. Le tronçon coupé sera remonté à bord et les épissures de deux extrémités coupées du câble seront lestées avant d'être remis à l'eau.

2.2.1.2. Préparation des fonds (nivelage – tranchée)

Après les essais géotechniques, les fonds sont considérés comme meubles sur le tracé français : il ne sera pas nécessaire de préparer une tranchée préalablement à la pose (ensouillage pendant la pose).
Les zones sableuse modelées en vagues de sables représentent des zones instables rendant l'ensouillage du câble difficile et surtout le maintien de la profondeur d'ensouillage au cours du temps. Pour cette raison, il existe une technique dite de Pre-Sweeping qui consiste à niveler les fonds dans le double but de réduire la hauteur des vagues de sables (pour assurer une profondeur

d'ensouillage constante) et d'aplanir la surface pour faciliter le passage de la charrue lors de l'ensouillage du câble. Cette opération est généralement réalisée juste quelques jours avant les opérations de pose du câble au moyen d'une drague aspiratrice en marche, qui rejette les sables à proximité. Cette méthode a été utilisée pour la pose du câble d'énergie BritNed, entre la Grande-Bretagne et les Pays-Bas.

Cette opération peut être réalisée par une Drague Aspiratrice en Marche (DAM). Les volumes dragués sont similaires à ceux des opérations de dragage d'entretien de chenal portuaire et restent donc relativement faibles. Les volumes extraits sont déposés sur le fond marin au voisinage immédiat de l'opération : il n'y a pas d'extraction définitive du milieu marin.

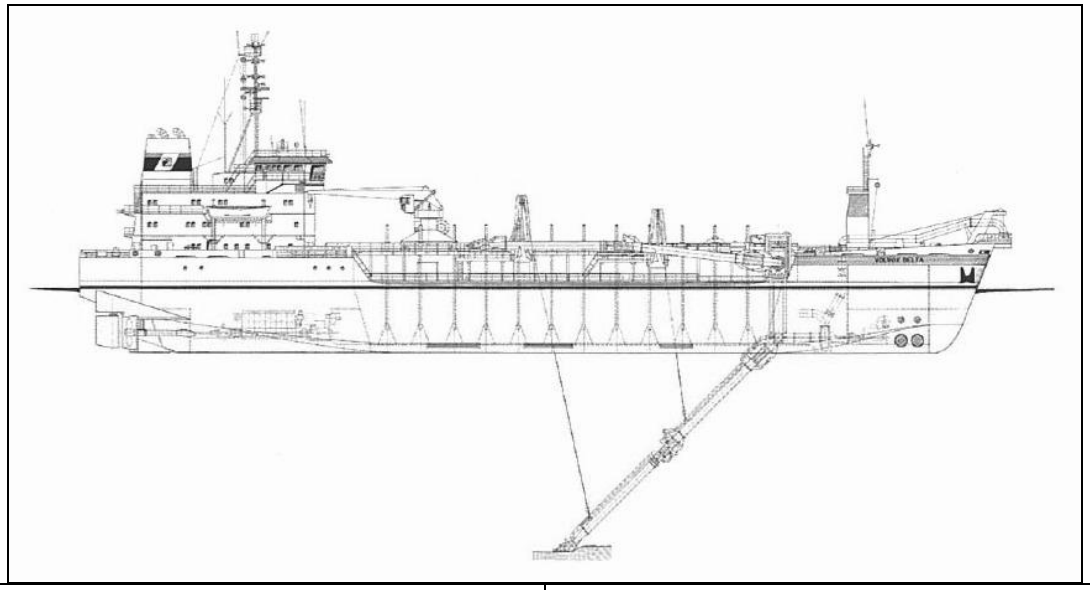


Figure 2.2.2 : Drague aspiratrice en marche (DAM)

La largeur de la tranchée à réaliser à l'élinde dépend de la forme et de la taille de la structure sableuse à traverser : la tranchée la plus large envisagée est de 20 m à la base pour une profondeur de 2 m, avec des pentes latérales de 10 m de largeur de part et d'autre de la tranchée.
Afin de réduire les coûts de transport (par rapport à un site commun de dépôt) et de favoriser la remise en état naturelle du site (sans enlever définitivement les sables) , il est préférable que la drague dépose les sables à environ 1,5 km, en amont des courants et que l'opération n'ait lieu que quelques jours avant la pose du câble (afin d'éviter que la tranchée se referme).

Les secteurs susceptibles d'être ainsi nivelés par dragage (pre-sweeping) ont été identifiés à la suite de la campagne de reconnaissance bathymétrique et un exercice a été réalisé pour calculer les volumes à draguer correspondants. Ceci ne concerne que les crêtes des bancs sableux et des vagues de sables le long de la route du câble.

Sur la partie française, plusieurs secteurs de vagues de sable ont été reconnus (**Figure 2.2.3**). Les pentes mesurées n'ont pas imposé de déviation du tracé du câble mais 4 secteurs convenant aux opérations de pre-sweeping ont été identifiés: ils sont situés à la traversée nord du banc Sandettié et au sud du Banc Fairy.

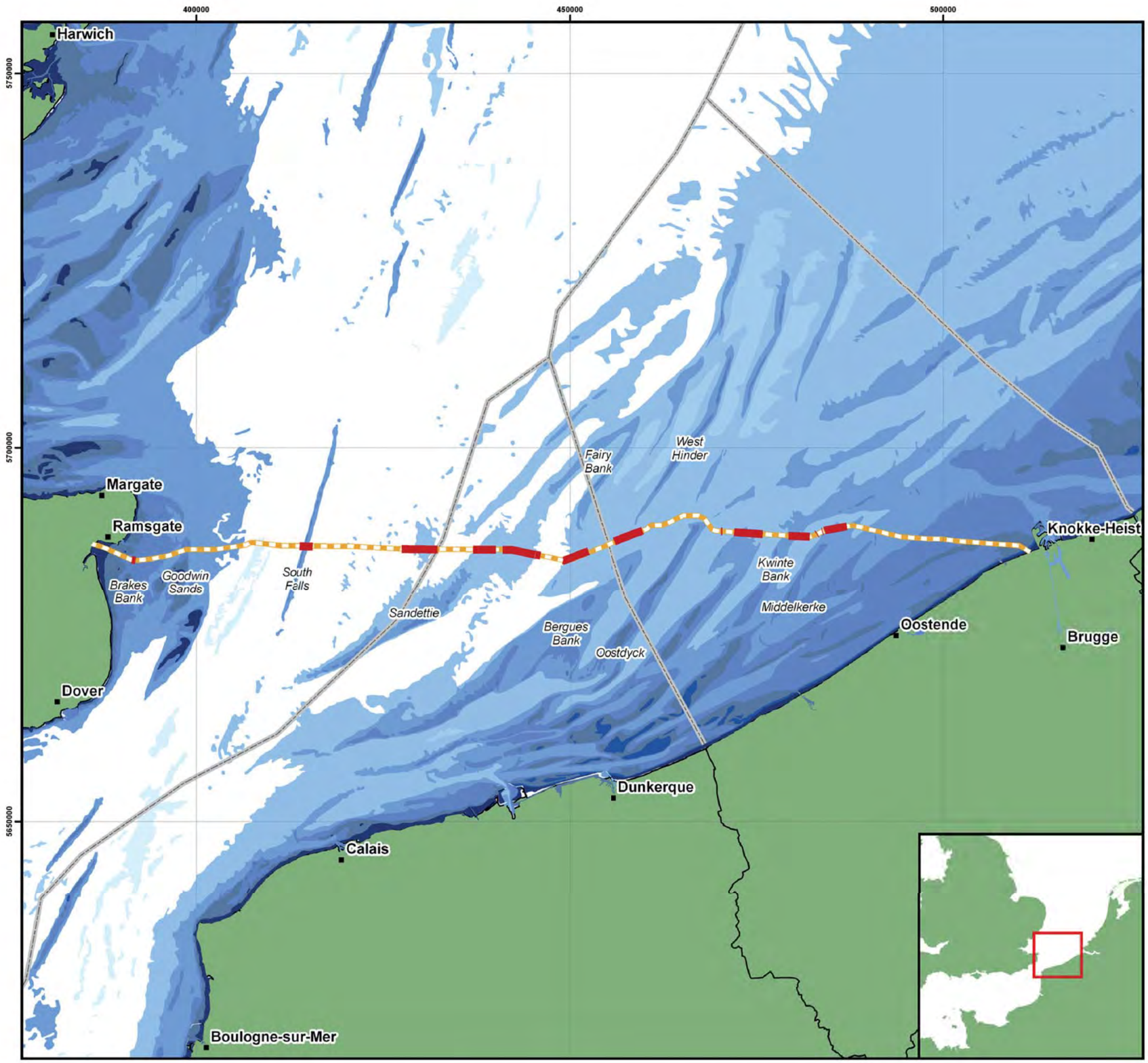
Tableau 2.2.1 : Zones identifiées pour d'éventuelles opérations de pre-sweeping

PK	Latitude N	Longitude E	X	Y	Volume (m^3)	But recherché
63-65.4	51.31693	2.28503	450 174	5 685 316	21 330	Protéger le câble vis-à-vis de la mobilité des vagues de sable
69.2- 73.6	51.32437	2.18433	443 165	5 686 213	60 249	
74.5 – 77.5	51.32572	2.11854	438 583	5 686 417	32 614	
82.3 - 87	51.32529	1.99369	429 883	5 686 480	24 470	

ZONES IDENTIFIÉES POUR D'ÉVENTUELLES OPÉRATIONS DE PRE-SWEEPING

D'après PPMS,2011

Figure 2.2.3



NEMO

Proposed Dredge Locations

- Zones à draguer
- Frontières maritimes
- Route du câble

Bathymétrie (mCD)

- 0
- 2
- 5
- 10
- 20
- 30
- 40
- 50
- 60

Figure No. DDR4633/13	**Date** 26/05/2011	**Revision** 002
Author dde	**Check** rjsw	**Scale @A3** 1:500,139
Data Source MUMM	**Projection System** UTM Zone 31N	
Spheroid WGS84	**Datum** WGS84	

0 6 12 18 24 km
0 3 6 9 12 nm

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2.2.2. Pose du câble (Laying)

Le navire câblier assure le transport et la pose du câble en le déroulant au fur et à mesure. En fonction de la capacité de transport du câblier et de la longueur totale de l'ouvrage (100 km de câble offshore), plusieurs campagnes successives de pose seront nécessaires. Il est en effet prévu que le tracé du câble nécessite 5 raccordements dont les localisations ne sont pas encore déterminées.

Il existe trois alternatives pour la pose du câble, selon le modèle de câble choisi (deux câbles réunis dans la même gaine ou deux câbles séparés), nécessitant la création d'une ou deux tranchées (cf. **Figure 2.2.4**).

2.2.3. Ensouillage du câble (Burial)

L'ensouillage dans les matériaux sableux peut être réalisé au moyen d'une charrue tractée à partir du navire câblier ou d'une machine à jets tractée ou autonome. Les charrues sont des machines remorquées généralement utilisées pour les opérations simultanées de pose et d'ensouillage, contrôlées à partir du câblier (vitesse, tension et profondeur d'ensouillage).

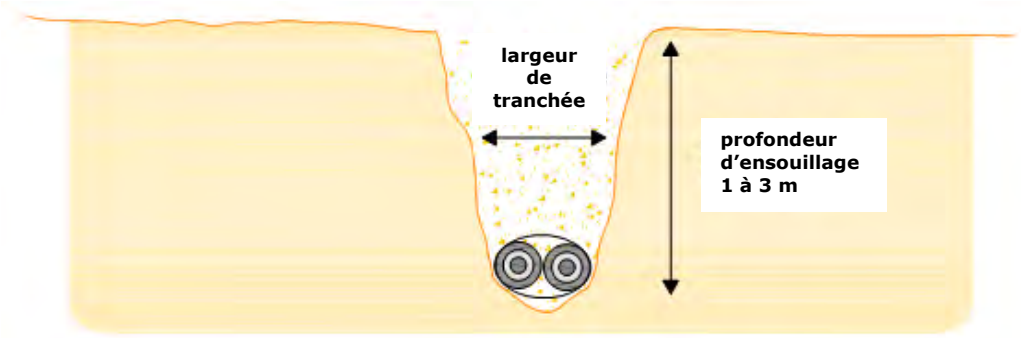
Dans les matériaux sableux, la charrue ouvre le sillon où le câble est déposé et le sillon se referme par gravité ou nivellement par la charrue, quasi simultanément. Une autre technique d'ensouillage sans déplacement de sédiment est utilisée : la charrue à injection d'eau (jetting), qui injecte de l'eau à haute pression pour déstabiliser la couche sédimentaire et permettre l'ensouillage naturel du câble par gravité, la couche de sédiments se redéposant et se recompactant naturellement ensuite. Cette méthode est efficace dans les bancs sableux car elle requière moins de tension sur le câble qu'une charrue classique pour une même profondeur d'ensouillage. Cependant, le jetting génère plus de turbidité qu'un sillon d'ensouillage et la largeur de la zone déstabilisée dépend de la profondeur d'ensouillage recherchée.

Les photos suivantes illustrent les deux types de charrues utilisables dans le secteur français :

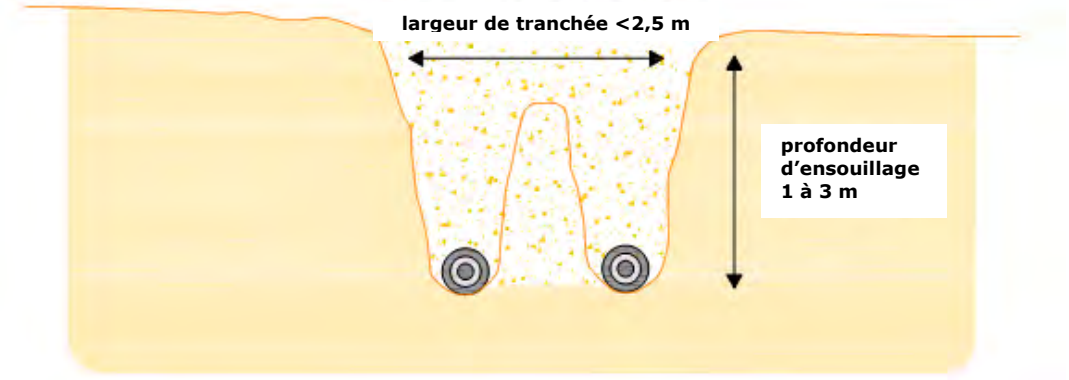


Figure 2.2.5 : Exemples de charrue d'ensouillage : a- charrue à grappin ; b- charrue à jets

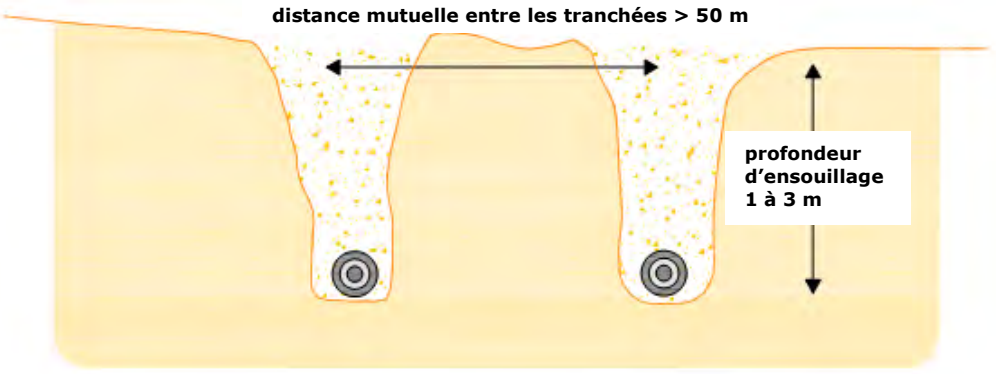
Figure 2.2.4 : Pose du câble (d'après ARCADIS, 2011)



A – Pose du câble double dans une seule tranchée (<1 m de large)



B- Pose des deux câbles dans deux tranchées proches (écart maximal de 2,5 m)



C- Pose des deux câbles dans deux tranchées séparées au maximum de 50 m

2.2.4. Raccordement du câble en offshore

Comme le câblier ne peut transporter l'ensemble du câble en un seul voyage, il est nécessaire de travailler par segments avec raccordement des deux extrémités de câble ; cette opération est effectuée à bord du câblier et peut prendre 1 semaine, le navire étant ancré. Une fois le câble raccordé, la pose peut reprendre normalement.
Il est prévu 5 opérations raccordements pour l'ensemble du câble NEMO sur la partie offshore.

2.2.5. Croisement des câbles

Le croisement avec d'autres ouvrages nécessite l'obtention d'un agrément de croisement avec le propriétaire de l'ouvrage, qui décrit le mode de protection à mettre en place, conformément aux pratiques recommandées par l'International Cable Protection Comitee (ICPC). L'agrément détaillera la protection mise en place et les droits et responsabilités de différentes parties pour assurer l'intégrité des ouvrages et de l'activité.

La figure suivante illustre un exemple de protection au croisement de deux ouvrages. L'emprise du croisement concerne une surface de 100 m (enrochements ou matelas le long de l'ouvrage NEMO) sur 30 m (largeur du pont sur le câble existant).

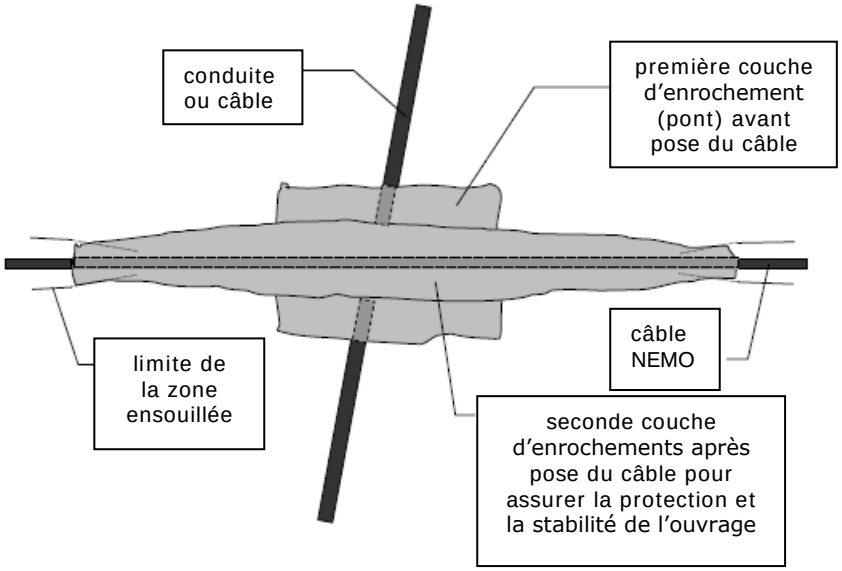
N.B. : si la mise en place d'enrochements s'avère nécessaire pour protéger le câble, un dossier d'autorisation spécifique devra être déposé, comprenant une étude d'impact.

Sur le tracé français, le câble NEMO ne croisera aucun câble ou conduite en service et donc ne nécessitera **pas de** mettre en œuvre la **procédure particulière de croisement d'ouvrage.**

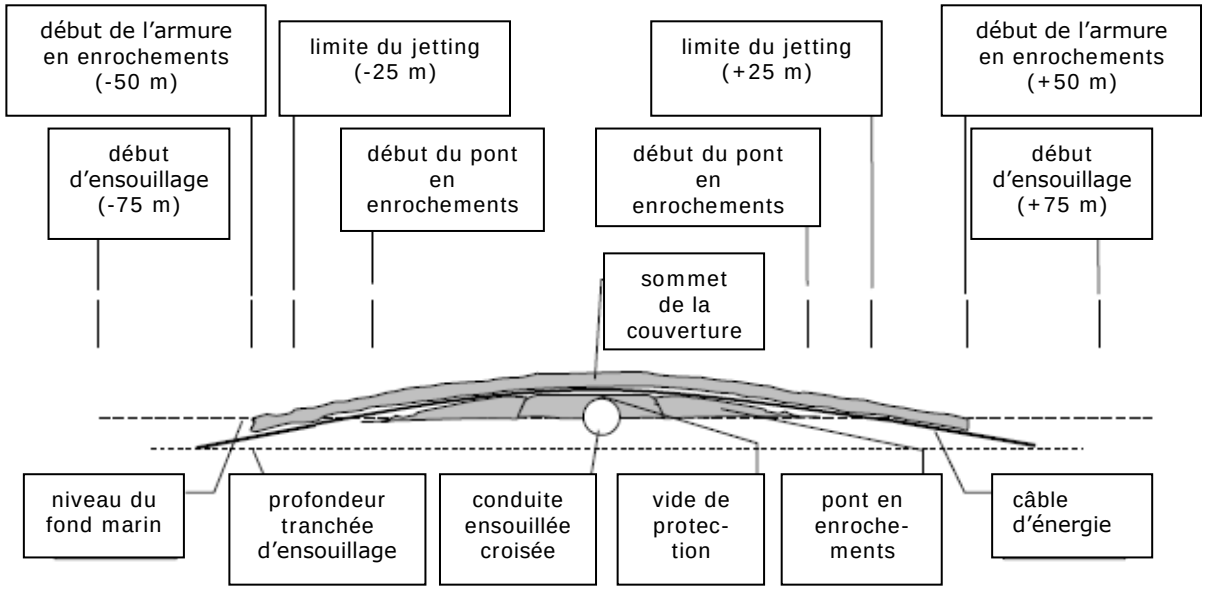
2.2.6. Post ensouillage du câble (Post-burial)

Dans les zones particulières où le câble n'est pas ensouillé au moment de la pose (croisement de câble ou zone de raccordement par exemple), un ensouillage du câble posé ou de la boucle excédentaire de câble peut être nécessaire, dans le prolongement du chantier de pose ou quelques jours après.
Aucun croisement de câble n'est prévu sur le tracé dans les eaux françaises et la position des points de raccordement n'est pas encore connue.

Figure 2.2.6 : Structure de protection de type semi ensouillé / surensouillé pour le croisement de câbles- (PMSS, 2011 d'après METOC, 2004)



Vue en plan



Vue en coupe

2.3. Exploitation du câble

2.3.1. Maintenance

Après l'installation, il n'est pas prévu de travaux d'entretien de routine. Toutefois, certains travaux peuvent être nécessaires pour maintenir l'ensouillage du câble pour le protéger des interactions indésirables avec d'autres usagers de la mer et les processus naturels marins qui pourraient l'endommager. Le câble et son installation sont conçus pour limiter les besoins d'entretien.

2.3.1.1. Surveillance de l'ensouillage du câble

Le câble est ensouillé pour réduire les opérations de maintenance. Cependant, certains secteurs réclament une surveillance régulière telles les zones de croisement des câbles ou ouvrages ainsi que les zones de forte mobilité comme les bordures des bancs sableux de la zone offshore ou les zones d'intenses activités maritimes.
Des campagnes de surveillance au moyen d'un sonar à balayage latéral ou d'un ROV avec caméra vidéo embarquée peuvent être régulièrement programmées pour vérifier d'éventuels secteurs où le câble serait exposé et la tenue des protections dans les zones de croisement d'ouvrages.

2.3.1.2. Intervention sur le câble pour réparation

Bien qu'il soit ensouillé sur la totalité du tracé, des accidents externes (liés aux ancres des navires commerciaux ou aux chaluts) peuvent endommager le câble et nécessiter une réparation.

Le déroulement typique d'une opération de réparation est :

- chargement du segment de secours (à partir du stock de maintenance laissé dans un port à proximité ou provenant du constructeur) ; la longueur de câble nécessaire correspond au minimum à 3 fois la hauteur d'eau où a été détectée la panne (et plus si le câble a été endommagé sur une distance),
- localisation précise possible de la panne,
- désensouillage du câble au moyen d'un grappin
- recouvrement du câble en surface et réparation (jonction avec le segment de câble apporté)
- relargage du câble et réensouillage : la longueur supplémentaire de câble pour la réparation signifie que le câble réparé ne pourra pas être réensouillé et aligné exactement au même endroit ; l'excès de câble forme alors une boucle sur le fond qui sera réensouillée par jetting par exemple.

Selon l'ampleur des dommages, l'opération de réparation du câble peut durer plusieurs semaines voire mois.
Les détails de l'opération (date, cause de la panne, longueur de câble rajoutée, position de la boucle de réparation, navire utilisé…) seront consignés dans le registre de maintenance.

2.3.1.3. Emissions du câble

Il existe un certain nombre d'émissions qui peuvent survenir à des degrés divers lors de l'installation ou de l'exploitation du câble : champs électromagnétiques, chaleur, bruit, courants parasites, élévation du potentiel de terre…

Champs électromagnétiques

Le champ géomagnétique terrestre forme le bruit de fond sur lequel les champs électromagnétiques artificiels interfèrent. Dans l'étude bibliographique réalisée pour l'interconnexion BritNed, on estime que le champ électromagnétique au voisinage du câble sous-marin à environ 48 µT (Swedpower, 2003a), que l'on peut appliquer au câble NEMO.

Le champ géomagnétique joue un rôle dans les déplacements de la faune marine (migrations, chasse) et est également utilisé par l'homme pour naviguer : les compas de marine sont ajustés pour compenser la déclinaison avec le nord magnétique. Des champs électriques sont induits dans l'eau de mer lors de son passage à travers le champ géomagnétique : la force de ces champs dépend de l'intensité du champ géomagnétique et des caractéristiques de l'eau de mer (salinité, viscosité, vitesse d'écoulement et direction par rapport aux lignes de flux magnétique). Les champs électriques naturels pour la mer du Nord ont été mesurées à 35 mV / cm (Pals et al, 1982). En 1974, Kalmijn a estimé que le champ électrique en Manche atteint 25µV/cm deux fois par jour, avec les marées mais il reste essentiellement un champ statique.

Champs magnétiques associés aux câbles sous-marins

Les câbles produisent un champ magnétique statique avec un champ magnétique variable superposé de faible niveau. Le système NEMO produit un champ magnétique statique d'une grandeur sensiblement identique au champ géomagnétique. En théorie, un type de câble appelé Conducteur de Retour Intégré (CRI) créera une forte diminution, voire l'absence, le champ magnétique si les deux conducteurs sont centrées sur le même axe du câble ; ce type de câble, considéré comme idéal pour sa signature magnétique, a été utilisé pour une liaison double HVDC entre l'Ecosse et d'Irlande du Nord. Cependant, il n'est pas actuellement de câble de type CRI capable de transporter le niveau de puissance proposé pour NEMO. Ainsi, le système qui sera mis en œuvre est un système bipolaire avec deux câbles de polarité électrique opposée, en configuration groupée (séparation de 0,2 m). Les champs magnétiques qui en résultent seront très faibles en raison de l'annulation mutuelle des pôles positif et négatif, et la composante variable a été calculée pour être négligeable.

Champs électriques associés aux câbles sous-marins

La haute tension en courant continu (HDVC) du système NEMO produit un champ électrique statique. Le milieu marin est protégé de ce champ électrique par la gaine métallique externe des câbles, qui sont reliés à la terre, ce qui rendra négligeable les champs électriques induits.

Les champs électriques variables produits par induction dans l'eau de mer autour des câbles et les très petits champs électriques variables résultant du « bruit » électrique des câbles ne sont pas considérés comme significatifs.

Le champ électrique produit dans le champ magnétique du câble sera influencé par le champ électrique naturel induit par le champ magnétique terrestre dans l'eau au même endroit. Il n'est pas possible de décrire avec précision l'intensité du champ électrique à un endroit donné sans une réelle compréhension des conditions environnementales locales. Une étude (SwedPower, Décembre 2003) visant à évaluer les champs électriques produits par le système de câbles BritNed (système similaire à NEMO) a été basée sur un débit d'eau maximal parallèle à un câble posé sur le fond marin, qui produit la plus grande induction et ne tient pas compte des interactions avec les champs naturels. La force du champ magnétique sur le fond marin est moins forte pour les câbles ensouillés.

Ainsi, la configuration du système NEMO réduit les champs électromagnétiques vers le milieu marin, comme le montrent les résultats des simulations pour BritiNed (SwedPower, December 2003) :

Configuration	Champ électrique (µV/m)		Champ magnétique (µT)	
	à 1 m du câble	à 5 m du câble	à 1 m du câble	à 5 m du câble
assemblé (0.2 m séparation)	61	1.9	72	2.2
séparés (2 m séparation)	260	18	310	21

Tableau 2.3.1 : Champs électrique et magnétique calculé pour le projet BritNed.
Source: Swepower, December 2003

Remarque: Les valeurs ci-dessus sont calculées pour être le maximum possible des champs électriques et magnétiques qui seront produits par BritNed. Les calculs sont basés sur une vitesse de l'eau de mer actuelle de 0,85 m / s, et un courant câble électrique de 1.320 A.

Ces résultats montrent que les champs électriques et magnétiques sont sensiblement réduits en regroupant les câbles ensemble : l'intensité de champ magnétique diminue à 0,5 µT à 8 m des câbles, ce qui représente seulement 1% de l'intensité du champ magnétique terrestre.
➔ce sera le "scénario de base" du projet NEMO.

2.3.1.4. Chaleur

Pour le transport d'énergie électrique en courant continu, les pertes se produisent en raison de la résistance interne dans le conducteur, proportionnelle à la longueur des câbles et inversement proportionnelle à la surface du conducteur (l'âme en cuivre du câble). L'énergie qui est perdue est convertie principalement en chaleur.
Sur la base des données de résistivité thermique recueillies au cours de la mission géotechnique, le calcul des effets de la présence du câble (2 faisceaux avec un conducteur section transversale de 1440mm², ensouillé à 2,5 m) sur la température des fonds marins (17° C en été et 5° C en hiver) indique que :

- à 30 cm de profondeur, l'élévation de température est de 1,2° C à l'aplomb du câble,
- à 10 cm de profondeur, l'élévation de température est de 0,7° C à l'aplomb du câble.

Ainsi, l'ensouillage à 2,5 m conduit à une augmentation maximum locale de la température des fonds à 18,2° C en été et 6,2° C en hiver dans les 30 premiers centimètres des fonds marins. Cet échauffement ne se produit qu'à proximité immédiate du câble tandis qu'en surface des fonds marins, la température de l'eau de mer n'est pas modifiée.

2.3.1.5. Bruit

Le bruit lors de la période d'installation offshore est lié à la présence des navires, en chantier itinérant (câblier et navire tractant l'engin d'ensouillage). Le convoi se déplace à faible allure (300 m de câble posé à l'heure, sur une base de travail 24/24h) : le bruit occasionné est temporaire. Dans le cas où les navires travaillent en stationnaire, la durée du chantier par zone est de 1 et 2 semaines.

Une étude sur le bruit émis lors de l'installation des câbles d'alimentation pour le parc éolien offshore North Hoyle a été réalisée par Cowrie en 2003, avec des mesures des niveaux de bruit engendrés par les tranchées de câbles dans le fond marin. Les niveaux sonores, enregistrés à une distance de 160 m de la tranchée par un hydrophone situé à 2 m de profondeur, étaient de 123 dB re 1 mPa : le niveau sonore pour les tranchées se situe dans une large bande sonore, intégrant le bruit de fond des machines et des bruits transitoires associés aux bris de roche. L'intensité sonore dépend de la nature des fonds et du type de roche tranché. L'analyse des données indique que si une perte de transmission de 22 log (R) est pris en charge, le bruit résiduel est de

178 dB re 1 mPa /m. La modélisation montre alors que, sur un rayon de 5 km de la source, toutes les mesures sont <70 dBht ➔ les impacts du bruit de la pose de câbles ne sera pas significatif.

Elévation du potentiel de terre
Une élévation de potentiel de terre (EPT) se produit quand un courant électrique de forte intensité s'écoule à la terre. Le potentiel électrique est plus élevé au point où le courant pénètre dans le sol, et diminue avec l'éloignement de ce point. L'EPT est généralement provoquée par des courants de défaut qui peuvent se produire au niveau des postes de distribution électrique, des centrales électriques, ou des lignes à haute tension : un courant de défaut circule à travers la structure des installations jusqu'au point de mise à la terre ; comme la résistance de la terre est finie, le courant injecté au niveau du point de mise à la terre produit une élévation de potentiel par rapport à un point de référence distant.

Lorsque l'isolation autour du conducteur HT fait défaut, pour des raisons externes, la majeure partie du flux de courant engendré retourne au convertisseur de la station terrestre, par le biais de l'armure métallique du câble. Le débit restant circule dans l'eau ou le sol au niveau du défaut sur le câble, où les fonds marins jouent le rôle de masse. Les calculs montrent que l'élévation temporaire du potentiel de la station convertisseur terrestre peut atteindre 800 V (SwedPower, 2003b), ce qui est dangereux pour le public, mais sur les fonds marins, l'ensouillage des câbles évitent cette EPT transitoire. Si la zone de'EPT atteint des infrastructures adjacentes, telles que les pipelines, des tensions jusqu'à 230 V peuvent être transférées à l'infrastructure ; cependant, les potentiels de contact ne s'avèrent pas nocifs si la séparation minimale entre le câble et le pipeline est maintenue à plus de 1,7 m (KEMA, 2003).

2.3.2. Relevage du câble en fin de vie

En fin de vie, le câble ensouillé peut soit être laissé sur place soit retiré selon le protocole industriel en vigueur. Le porteur de projet reconnait l'importance de prendre en compte dès à présent le processus de démantèlement de l'ouvrage ; ainsi, en fin de vie du câble, les différentes options pour le déclassement du câble seront évaluées. Dans certaines situations, l'option la moins dommageable pour l'environnement pourrait être de laisser le câble en place mais cette option soulève la question de la responsabilité de toute réclamation de pêcheurs ou d'autres tiers qui entreraient en contact avec les câbles. Cette question sera abordée dans le stade de la planification du déclassement du câble.

Les objectifs du porteur de projet durant le processus de déclassement sera de minimiser les effets à court et à long terme sur l'environnement tout en rendant le plan d'eau et les fonds sans danger pour les autres usagers de la mer. Sur la base de la réglementation en vigueur et de la technologie disponible, National Grid / Elia propose de retirer le câble lorsque c'est nécessaire ou de le laisser ensouillé, et de laisser en place les protections mises en place (matelas ou enrochements).

En cas de retrait du câble, l'opération de démantèlement correspond à l'inverse d'une opération de pose. Le câble est désensouillé sur toute sa longueur (directement au moyen d'un grappin ou exposé avec d'une machine à jets et repris par un grappin) puis remonté à bord (ré-enroulé dans la cuve du câble ou découpé en tronçons et stocké en containers).
De retour au port, le navire câblier ou de recouvrement du câble dépose les segments ou tronçons à quai pour reprise ultérieure (dont recyclage).
Une campagne de reconnaissance en fin de pose permettra de s'assurer que tout le câble est relevé.

2.4. Moyens nautiques mis en œuvre

2.4.1. Pose

Sur la partie offshore (environ 100 km par des fonds >10 m de profondeur d'eau), le bateau utilisé sera un **câblier** (cable lay vessel) pouvant travailler par des profondeurs d'eau minimale de 10 m, d'une taille de 150 m de longueur. Le câblier travaille à vitesse réduite (1 à 2 nœuds) et déploie des équipements reliés par ombilics : le rayon de sécurité autour de ce navire à capacité de manœuvre restreinte (déroulement du câble et ensouillage) est de 500 m et peut être porté jusqu'à 2 km si le câblier doit ancrer.
La capacité de transport du câblier limite la longueur du câble à poser au cours d'une seule campagne. Plusieurs campagnes sont nécessaires pour poser la totalité du système mais, a priori, la pose dans les eaux françaises se déroulera sur la même journée, s'il n'y a pas de raccordement à faire sur la partie française.
La période de pose préférentielle dans les eaux européennes est l'été mais peut s'étendre d'avril à octobre : cette période assure les meilleures conditions de navigabilité pour poser le câble (état de la mer en particulier).

Dans les zones de fort trafic, les autres navires seront avertis au préalable des opérations de pose par un avis à la navigation (AVURNAV) et message radio VHF. Sur zone, des **navires d'accompagnement** (dits chiens de garde) seront déployés pour protéger le chantier et assurer la liaison linguistique avec les autres bateaux navigant ou opérant à proximité (trafic transmanche, DST du Pas de Calais et pêcheurs français / anglais / belges).

2.4.1.1. Ensouillage

La charrue classique ou à jets est remorquée par le navire câblier (généralement dans la distance de sécurité autour du navire) ou par un autre navire de petite taille suivant le câblier.

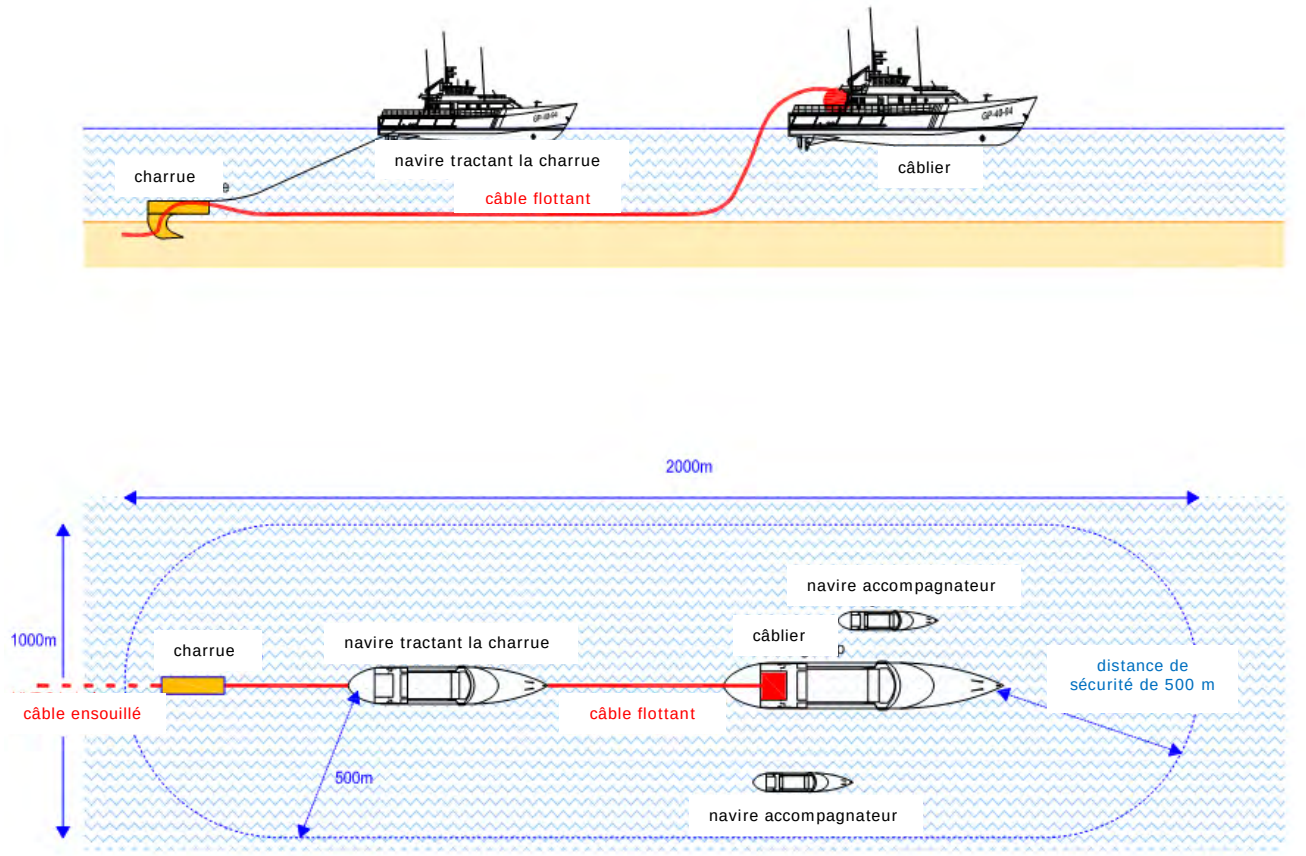


Figure 2.4.1 : Pose et ensouillage assurés par deux navires en convoi (d'après ARCADIS, 2011)

Le rayon de sécurité autour des navires reste de 500 m en latéral de chaque côté du navire mais est porté à 2 km en longitudinal (2 navires en convoi et la charrue). Les navires d'accompagnement évoluent dans le périmètre de sécurité des navires de pose.

2.4.1.2. Raccordement du câble en offshore

Le raccordement de deux segments de câble est réalisé à bord du câblier et peut prendre 1 semaine, le navire étant ancré.
Selon que l'un des 5 raccordements prévus sur l'ensemble du trajet se situe au niveau des 23 km dans les eaux françaises, la durée de l'opération de pose du câble peut être rallongée, le navire étant à l'arrêt (zone de sécurité de 2 km).

2.4.1.3. Post ensouillage

Dans les zones particulières où le câble n'est pas ensouillé au moment de la pose, l'ensouillage après pose est réalisé par un navire de post ensouillage qui peut suivre à une certaine distance le câblier de pose ou intervenir quelques jours après. Ce sont donc deux opérations distinctes dans le temps et l'espace.
A priori, ce ne sera pas nécessaire sur la partie française sauf s'il faut post-ensouiller la boucle excédentaire au niveau d'un raccordement offshore.

2.4.2. Maintenance

Surveillance de l'ensouillage du câble
Les campagnes de suivi de l'ensouillage du câble peuvent être mises en œuvre à partir de petits navires spécialisés ou non, capables de travailler par ces profondeurs d'eau. Il n'est pas nécessaire d'utiliser les moyens lourds mis en œuvre lors des reconnaissances géotechniques et géophysiques.

Intervention sur le câble pour réparation
Une opération de réparation ne nécessite généralement la mise en œuvre que d'un seul navire. Dans les eaux offshores, un câblier ou une barge à positionnement dynamique est mobilisé. Ces navires sont à capacité de manœuvre restreinte car ils doivent travailler à l'arrêt.
Le post-ensouillage du câble en excès et des nouveaux joints de raccordement se fait typiquement au jetting au moyen de machines déployées à partir du navire câblier ou d'un navire spécialisé supplémentaire.

2.4.3. Relevage en fin de vie

Le programme de démantèlement implique la mise en œuvre du même type de navire (câblier relevant et stockant le câble à bord, navire accompagnateur) et le même calendrier que pour une opération de pose (plusieurs campagnes à envisager selon la capacité de transport du câblier). La mise en œuvre du grappin pour récupérer le câble peut se faire directement à partir du câblier.

La campagne de vérification en fin de relevage du câble peut être réalisée par le même type de navire que pour les opérations de surveillance de l'ensouillage de l'ouvrage.

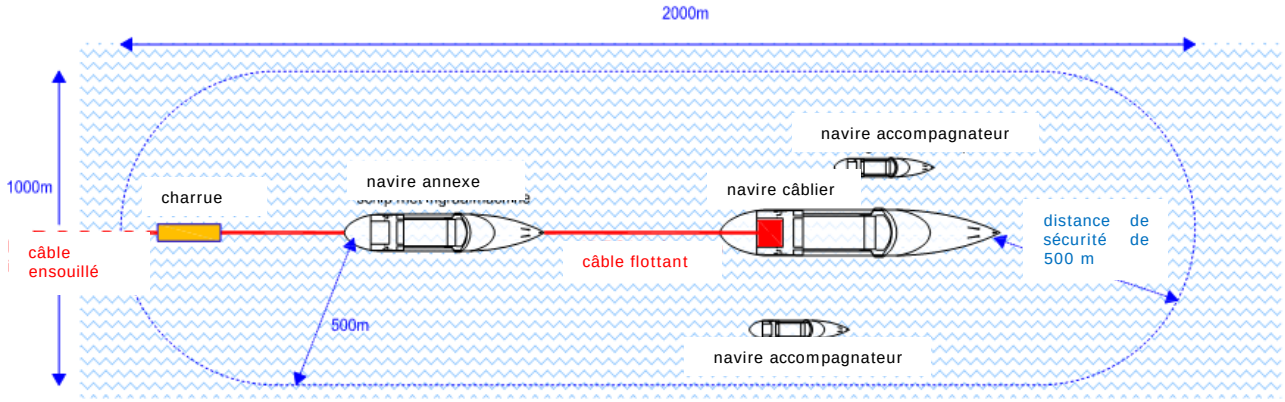
3. Dispositions propres à assurer la sécurité de la navigation maritime et la prévention des accidents maritimes

Des mesures de réduction d'impact ont été définies pour réduire les impacts de l'installation du câble sur la navigation maritime.

3.1. Signalisation et sécurisation du chantier itinérant

3.1.1. Zone de sécurité temporaire mobile

En raison de la vitesse d'évolution et la taille des navires travaillant dans une zone de fort trafic maritime, une zone de sécurité interdite aux autres navires sera établie autour du chantier mobile d'installation du câble.



3.1.2. Navires de garde

La présence de navires accompagnateur (« chiens de garde » sur lequel se trouve un personnel bilingue) permet d'assurer l'information sur le plan d'eau et d'éviter les conflits sur le plan d'eau.
Deux navires de la garde seront assignés au chantier d'installation : un navire en protection rapprochée du câblier et un navire secondaire pour la liaison et la gestion des conflits avec les autres navires.

Ces navires seront choisis en fonction de la vitesse, des équipements maritimes et de la tenue sur la plan d'eau. Ainsi, la protection du chantier peut être assurée par des pêcheurs locaux, qui connaissent bien le secteur et les autres utilisateurs du plan d'eau.

3.1.3. Signalisation

Les navires d'installation de câbles montreront les feux et marques réglementaires, tels que requis par le Règlement international pour prévenir les abordages en mer (RIPAM ou ColReg).

3.2. Coopération avec les services de surveillance du trafic en Manche

L'objectif des services de surveillance du trafic (CNIS - Channel Navigation Information Service ,côté anglais, et CROSS − Centre Régional opérationnel de surveillance et de sauvetage, côté français) est d'assurer la sécurité de la navigation dans le détroit du Pas de Calais, en exhortant les navires à se conformer aux procédures de l'Organisation Maritime Internationale (OMI) pour les bateaux naviguant dans un dispositif de séparation du trafic (TSS) et de fournir les dernières informations à la navigation sur les activités, les conditions et les irrégularités de navigation qui peuvent influer sur la sécurité de la navigation.

La procédure obligatoire d'identification des navires dans le détroit du Pas de Calais (CALDOVREP), et la couverture de la zone radar permettent une réduction des risques non négligeables pendant l'installation du câble. Il est en effet indispensable de communiquer le plan des opérations son opération avec la notification préalable et des rapports quotidiens à destination des services de surveillance du trafic maritime (Station de Dover Coastguard au Royaume-Uni et CROSS Gris-Nez[1] en France). Un plan régulier de communication, indiquant la position des navires et les activités quotidiennes, sera établi avec le CNIS Dover et le CROSS Gris-Nez pour s'assurer des échanges d'informations.

Dans le cas peu probable de navires «voyous» navigant dans le détroit sans communiquer avec le CNIS ou le CROSS en dépit de la réglementation CALDOVREP, les plans d'intervention des navires de garde du chantier maritime incluront une procédure de tractation avec ces navires hors-la-loi.

3.3. Diffusion d'un avis aux navigateurs

Les informations nécessaires à la sécurité pour la navigation seront annoncées conformément aux directives des services de surveillance du trafic maritime, qui diffusent en bade marine VHF un avis aux navigateurs présentant une description de l'opération, l'identification des navires en opération et précisant la zone d'opération. Cet avis est régulièrement mis à jour. Un avis urgent aux navigateurs (AVURNAV) sera émis en cas d'incident ou opération spécifique (raccordement de câble nécessitant un chantier stationnaire…).

Le Service d'information Kingfisher, qui fournit des informations précises sur la position des navires sur le plan d'eau au large des côtes et sur les dangers sous-marins, sera également avisé afin de publier les détails des travaux et le tracé final du câble dans leurs bulletins.

Par ailleurs, le nouvel ouvrage sera indiqué sur les cartes marines et les instructions nautiques diffusées par le SHOM et son équivalent britannique (UKHO).

Une information directe sera donnée aux organisations locales de pêche et de plaisance, via un officier de liaison avec les Pêcheurs (FLO) côté britannique et via les Comités Régionaux de pêche, incluant l'ensemble des flottilles concernées (Basse-Normandie, Haute-Normandie et Nord-Pas de Calais) côté français.

[1] Le CROSS Gris-Nez est un point de contact international SAR (Recherche et Sauvetage maritimes) pour la France, chargé de la surveillance du détroit du Pas de Calais et de la Manche / Mer du Nord, de la frontière belge au Cap d'Antifer, ainsi que des opérations de sauvetage internationales si un navire français est concerné.

3.4. Plan de mesures d'urgence (ERCoP)

Les représentants HSE (Hygiène-Sécurité Environnement) de l'opérateur en offshore fourniront un plan de coordination des mesures d'urgence (Emergency Response Cooperation Plan – ERCoP) couvrant toutes les phases du projet. Ce plan, qui devra être approuvé par le CROSS et le MCA, décrira en détails la coopération avec les services de surveillance du trafic maritime, avec les ressources d'intervention d'urgence, les ports les plus proches et les pilotes.

3.5. Protection du câble

Pour limiter au maximum les risques d'accrochage et de détérioration du câble, notamment en cas de mise à l'ancre d'urgence à proximité du câble, le câble équipé d'une armure métallique est ensouillé à profondeur définie sur la base de pénétration des ancres et des engins de pêche ainsi que sur la jurisprudence dans le détroit du Pas de Calais (à savoir un strict absolu de 0,5 m sur toute la longueur de la route).

3.6. Risque lié à l'exposition du câble

Tout incident entrainant la mise à l'affleurement du câble, devenant sensible aux croches par les navires fréquentant le site (engin de pêche notamment) sera signalé à la surface du plan d'eau par la mise en place de bouée lumineuse et/ou la présence d'un navire de garde (selon la densité du trafic et la zone de l'incident) jusqu'à résolution du problème (réensouillage).

3.7. Interférence géomagnétiques

Les risques liés au champ électromagnétique émis par le câble d'énergie fonctionnel sur la réception des instruments de navigation concernent la navigation dans le DST du détroit du Pas de Calais, notamment en cas de faible visibilité.
L'étude réalisée dans le cadre du projet de câble d'énergie BritNed (2004), dans un configuration similaire à celle du projet de câble NEMO, a montré que la déviation maximale du compas induite par le câble était inférieure à 5 degrés (SwedPower, Octobre 2003), ce qui reste à un niveau acceptable pour les autorités gérant la circulation dans le DST.
L'ensouillage du câble NEMO à des profondeurs similaires rend ces conclusions applicables au projet.

3.8. Découverte de munitions et d'explosifs

Le Maître d'Ouvrage s'engage à signaler, dans les délais réglementaires (48h), aux autorités compétentes (Préfecture Maritime et DDTM) toute découverte d'engin suspect et à respecter ses consignes. Il s'engage également à fournir, en fin de mission de reconnaissance, la liste complète des épaves et obstructions observées dans le couloir d'investigation.

Appendix 14: Belgian Offshore Non-Technical Summary

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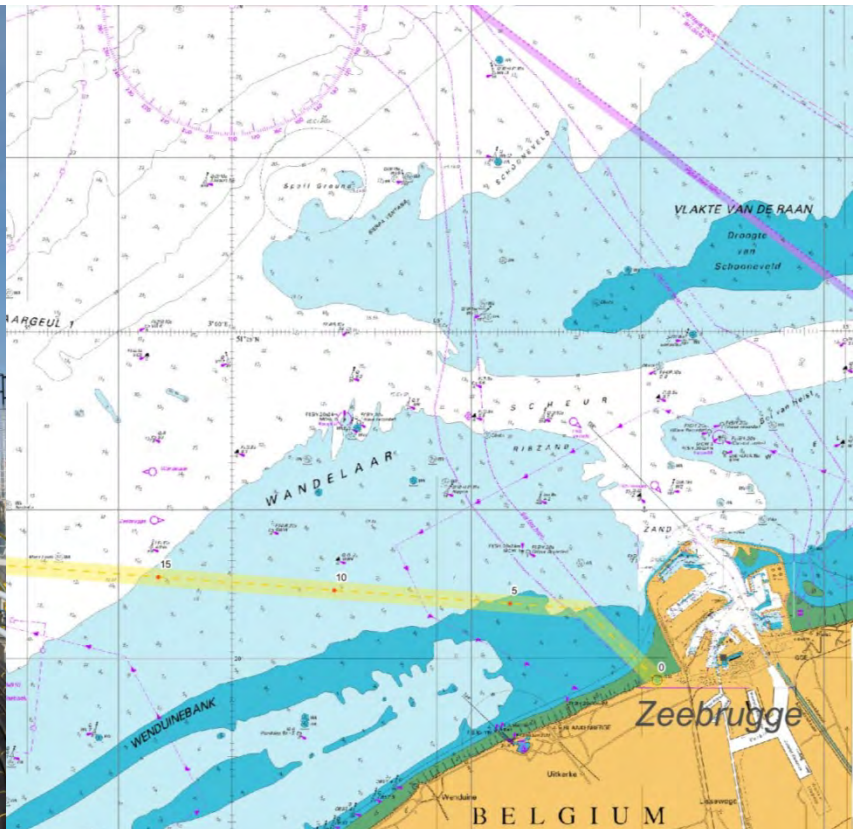
ENVIRONMENTAL IMPACT REPORT – The NEMO LINK

NON-TECHNICAL SUMMARY

Elia Asset SA

Project n° 11/005405 | 21-12-2012





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Non-technical summary – The Nemo Link

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NON-TECHNICAL SUMMARY

The Nemo Link

December 2012

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Table of Contents

1 PURPOSE AND PROPOSED ACTIVITY 9
2 PROJECT DESCRIPTION 9
2.1 General description of the activity 9
2.2 Location of the cable route 10
2.3 Description of the cable system 11
3 ALTERNATIVES 14
3.1 To location of the route 14
3.2 To cable type 14
3.3 To cable configuration 14
3.4 To offshore installation procedure 15
3.5 To burial technique 15
3.6 To landfall technique 15
4 IMPACT DESCRIPTION AND ASSESSMENT 16
4.1 SOIL 16
4.2 WATER 18
4.3 CLIMATE & ATMOSPHERE 20
4.4 NOISE 22
4.5 FAUNA, FLORA & BIODIVERSITY 23
4.6 SEA SCAPE & CULTURAL HERITAGE 28
4.7 HUMAN ACTIVITY 30
4.8 SAFETY ASPECTS 34
5 CUMULATIVE EFFECTS 36
5.1 SOIL 37
5.2 WATER 38
5.3 CLIMATE & ATMOSPHERE 38
5.4 NOISE 38
5.5 FAUNA & FLORA 39
5.6 SEA SCAPE & CULTURAL HERITAGE 39
5.7 HUMAN ACTIVITY 39
5.8 SAFETY ASPECTS 40
6 MONITORING 40
7 CROSS-BORDER EFFECTS 40
8 SUMMARY AND CONCLUSIONS 41

1 PURPOSE AND PROPOSED ACTIVITY

National Grid Nemo Link Limited and Elia Asset SA intend to connect the high voltage grid systems of the United Kingdom and Belgium through an electrical interconnector with an approximate capacity of 1,000 MW, the Nemo Link-project. The power would be able to flow in either direction at different times, depending on the supply and demand in each country. This system provides a rapid response to changes in electrical power production, where the power flows can be adjusted in a short time.

Initiators of the entire Nemo Link-project are National Grid Nemo Link Limited and Elia Asset SA. The applicant for the permits for the section of the route of the HVDC interconnector located in the Belgian part of the North Sea, is Elia Asset SA.

In order for the environmental interests to be taken fully into account in the license granting, an environmental impact report (EIR) has been drafted. This EIR will be used to underpin the consents process and describes the construction, exploitation and dismantling of the HVDC interconnector for the Belgian Part of the North Sea (BPNS). For those parts located in British and French waters, the environmental impacts are described in separate reports. The coastal zone, inland from the MLLWS (mean low low water spring line), is under regional (Flemish) authority, including environmental protection. This has the consequence that the scope of this EIR is limited to the marine areas (i.e. from the mean low low water spring line).

2 PROJECT DESCRIPTION

2.1 General description of the activity

Overall, the activities of the project are defined as follows:

- The study phase (2006 → 2014):
  - Realization of a feasibility study to identify all potentially suitable routes between the United Kingdom and Belgium (2007);
  - Route-engineering study using a desktop study and a marine survey;
  - Engineering of the interconnector;
  - Consult with licensees of crossing cables and pipelines to obtain ‘letters of no objection';
  - Drawing up the EIR and permit applications;
  - Completion and signing of 'crossing agreements’ with licensees of crossing cables and pipelines;

- The construction phase (2014 → 2017):
  - The installation of the cable system is preceded by some preparatory work:
    - Potential local removal of out-of-service telecommunications cables that cross the cable route;
    - Deposit of protective measures, bridging and separation structures at crossings of the interconnector with present cables and pipelines;
    - Local leveling or ‘pre-sweeping' of the route, with local removal of sand waves;
    - Clearance of the seabed, to expose and remove undetected obstacles before the cable is unrolled.

- Offshore installation of the interconnector, consisting of two operations: unrolling & laying the cables and burying the cables. These two operations are performed simultaneously or not;
- Offshore connection between the cable sections;
- Landfall installation.

The start of the work depends on several factors including the delivery of the cables and the availability of ships. In general, installations in European waters are typically 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 duration of the offshore construction works of the interconnector in Belgium is estimated at approximately 2 months.

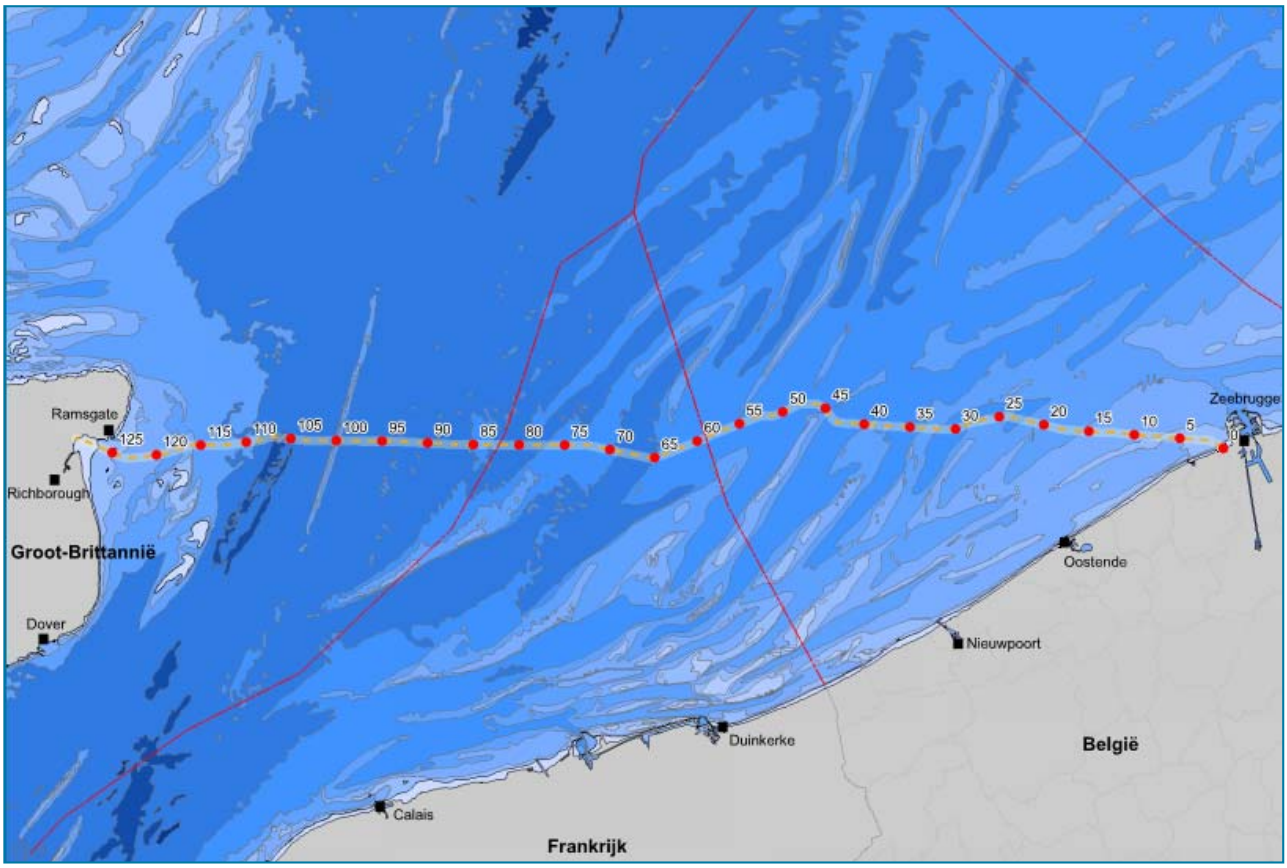
- The operational phase (2017 → 2036):
  - During the operational phase, electrical power flows from the Belgian high voltage grid system to the British high voltage grid system, or vice versa;
  - Regular preventative maintenance and inspection will be performed in order to keep the installation in optimum condition and to avoid interferences;
  - If necessary repair work will be performed;
  - After the operating period, which is set at 20 years, a renewal of the permits will be requested. Otherwise, the cables will be taken out of use (decommissioning phase).

- The decommissioning phase:
  - Currently it is not yet certain whether the interconnector, after it has been taken out of use, will remain in situ or will be removed.

2.2 Location of the cable route

The location of the HVDC interconnector between the United Kingdom and Belgium (shortly: Nemo Link) is shown in the figure below. The cable runs from Richborough (UK) to Zeebrugge. A French section of the North Sea is also being crossed.

The cable route was initially established on the basis of a feasibility study, at which the route between Richborough (Kent) and Zeebrugge West was identified as the most suitable route between the United Kingdom and Belgium, mainly because of availability of land (including for the construction of a new converter station), length of the cable route and licensing and permit issues. Subsequently, a preliminary route engineering study was carried out to identify the most suitable offshore cable route between Richborough and Zeebrugge. The route engineering study consisted of a desktop study, at which existing data and knowledge of the proposed cable route were studied and analyzed, and a marine survey, in which certain aspects on site were verified (mainly geophysical, geotechnical and limited benthic features). Where necessary, adjustments to the route were carried out to mitigate potential impacts or risks in order to minimize both cable and installation costs and disruption of the marine ecosystem and its users. In the present EIR, the cable route resulting from the route engineering study is considered.



2.3 Description of the cable system

2.3.1 System: bipolar direct current connection

For the interconnector between UK and Belgium the HVDC (High Voltage Direct Current) technology will be used. The portion situated in the Belgian Part of the North Sea, is about 59 km long. The base case of the interconnector between UK and Belgium is a bipolar HVDC system, with an approximate capacity of 1,000 MW. Bipolar systems transmit power through two high voltage conductors of opposite polarity (e.g. +500 kV and -500 kV). These cables each have a diameter of approximately 150 mm and a conductive copper or aluminum core surrounded by electrical insulation and protective coating. In the base case of the interconnector between UK and Belgium the two cables are bundled together and installed in the same trench. Other configurations are not excluded (see 'Alternatives').

The cable system is buried up to a depth of 1 to 3 m, depending on local soil properties. Burying too shallow can over time lead to exposure of the cables, while burying too deep can impede heat dissipation. The soil conditions also affect the burial depth in another way: a stable soil (e.g. clay) requires less burial depth than for example a sandy soil to maintain protection of the cable. Moreover, for the determination of the buried depth, the guidelines developed by Maritime Access (Department of Transport and Public Works) and other competent authorities shall also be taken into account. In case suitable burial depth can't be reached, it may be necessary to provide additional protection from anchors and fishing activities.

The subsea cable system is jointed to its corresponding land cable in a joint pit located above mean high water mark. To connect the interconnector, that uses direct current, and the high voltage grid systems of National Grid and Elia, that both use alternating current, HVDC needs to be converted to HVAC in a converter station, both in Belgium and the UK. On the Belgian side, a new converter station will be built in Zeebrugge.

2.3.2 Cable type

Several types of electrical insulation for the cables exist. In the base case of the interconnector between the UK and Belgium the mass-impregnated (MI) cable is used. The MI cable has one copper or aluminum core surrounded by layers of paper that serve as electrical insulation. The paper layers are impregnated with high viscosity mineral oil. 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. Such cables have a diameter of approximately 150 mm.

2.3.3 Electromagnetic fields, induction phenomena and heat

Electromagnetic fields, induction phenomena and heat generation are some energetic aspects specific to submarine HVDC connections that will be discussed briefly in following paragraphs. Potential effects due to these specific energetic aspects are discussed in Chapter 4 (‘Description and evaluation of the environmental impact per discipline’) as well as non-specific environmental aspect related to the construction, operation and decommissioning of submarine HVDC connections (increased shipping, increased turbidity, etc.).

2.3.3.1 Electromagnetic fields and induction phenomena

An important characteristic of high voltage cables in operation is the production of electromagnetic fields. When an object is subject to high-voltage, such as a conductor, an electric field around that object will be created. Field strength increases with increasing voltage. A magnetic field is created when current flows through a conductor. The strength of this field is determined by the current.

The electric field of the interconnector is almost completely shielded by the lead sheath and other external metallic components of the cables. Magnetic fields on the other hand are able to pass through most materials.

The magnetic fields around the individual cables can be largely neutralized by installing the two cables of the bipolar system close together. By the opposite flow direction of both individual cables, both magnetic fields will also be opposed so that they cancel each other largely. The smaller the distance between both cables, the smaller the resulting magnetic field.

Burying the cable does not fully mitigate the magnetic field, but it can be assumed that exposure of organisms susceptible to magnetic fields will be greatly reduced by the creation of a physical barrier. Moreover, the field strength rapidly decreases with distance from the cables.

Because seawater flows through the magnetic field of the cable, induced electric fields arise. However these induced electric fields are very small. Especially when magnetic fields are largely neutralized by bundling of the cables and with a buried depth of 1-3 m, the induced voltages in the seawater will be negligible.

2.3.3.2 Heat generation

In transporting electrical energy, losses occur as a consequence of the internal resistance in the conductor. The energy that is lost is converted primarily into heat. The amount of heat that is released is small and is determined by the cable system (DC or AC, mono-or bipolar, bundled or not, insulation type, thickness and material of the conductor, depth at which the cable is laid), the voltage and the characteristics of the environment (thermal conductivity and resistivity) (OSPAR, 2009a).

3 ALTERNATIVES

3.1 To location of the route

The cable route was initially established on the basis of a feasibility study in which a detailed comparison and assessment of the possible routes and landing points was performed, and which showed that the route between Richborough (Kent) and Zeebrugge West offers significant advantages. In a subsequent route-engineering study, the selected route was further optimized, in which the physical and biological aspects and aspects related to human activity were studied in more detail. It was attempted to outline the route so that both cable and installation costs and distortion of the marine ecosystem and it's users are minimized. Given the already very advanced optimization, no alternatives to the location of the route will be studied in the present EIR, and the one remaining route will be considered as the most suitable route.

3.2 To cable type

In the base case of the interconnector between UK and Belgium, the MI (mass-impregnated) cable type is used. Alternatively the XLPE type of cable can be applied. This type is made with extruded and cross linked polyethylene (XLPE) as insulation. XLPE cables are essentially structured similarly to MI cables, but XLPE serves as insulation instead of oil-impregnated paper.

XLPE HVDC cables are more robust compared with MI HVDC cables and can therefore better withstand the stresses of submarine installation. A disadvantage of XLPE cables is that there is no technology available yet for use at very high voltages such as +/- 500 kV DC. XLPE has already been applied up to 200 kV DC. New developments go in the direction of 320 kV DC.

3.3 To cable configuration

The base case consists of two cables that are bound together (bundled). The bundled cables are placed and buried together in one trench. This configuration can be considered as the technically and financially most feasible alternative.

An alternative cable configuration consists of an unbundled system, with a small installation distance of 0.5 to 2 meters between both cables. The cables are laid in one single operation and are buried simultaneously with one excavator in two narrow trenches (i.e. in one large, wide trench in which a partition between both cables is created).

If both cables are installed at more than 2 meters apart, two separate lay and burial operations will be required. The cables are then installed in two separate trenches. According to the safety regulations set out in annex of the Royal Decree of 12 March 2002, the distance between the two cables has to be at least 50 m in this case.

3.4 To offshore installation procedure

Installing the interconnector implies a combination of two operations: the unrolling and laying of the cables on the one hand and burying the cables on the other. Following alternatives to the offshore installation procedure are possible:

Burying the cable	Number of ships to deploy	Alternative
Simultaneously with unrolling and laying → one operation	1 ➔ the cable laying vessel is provided with burial equipment	Alternative 1
	2 ➔ cable laying vessel + separate vessel with burial equipment	Alternative 2
Non-simultaneously with unrolling and laying → two operations	2 ➔ cable laying vessel + separate vessel with burial equipment	Alternative 3

The procedure ultimately used will depend on the contractor that shall carry out the installation of the Nemo Link, and the availability of vessels at this contractor.

3.5 To burial technique

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. A combination of techniques is also an option. Most generic types of equipment for installing cables into the seabed are ploughs and jetting machines:

- Ploughing: with a plough a large trench is created in the seabed in which the cable can sink
- Jetting: jetting implies fluidization of the seabed to the appropriate burial depth with water jets. In this way, a trench is created in which the cable can sink.

3.6 To landfall technique

The landfall installation of the cable can be carried out with basically two techniques that optionally can be used in combination:

- Open cut trenching, with the use of mechanical excavators. This technique is applicable mostly above the high water line. When combined with a cofferdam, the technique can be used beyond the low water line;
- Horizontal directional drilling (HDD) implies drilling an underground borehole from the dry to a point in the direction of the sea. Then the cables are pulled through the borehole.

4 IMPACT DESCRIPTION AND ASSESSMENT

In this paragraph most important results of the impact assessment are summarized per discipline.

Given the difficulties to quantitatively describe certain effects, a semi-quantitative approach has been chosen. The effects are described as a relation between their size, their range (dimension) and their temporary or permanent character. The described effects are presented as a plus-minus assessment.

The following definitions have been applied:

Symbol	Definition	Description	Assessment environment/ organisms
++	Significant positive effect	Measurable positive effect, large range (BPNS[1]), temporarily or permanent character	Very positive
+	Moderate positive effect	Measurable positive effect, limited range (project area), temporarily or permanent character	Positive
0/+	Small positive effect	Measurable small positive effect, limited range (project area), always temporarily character	Neutral
0	(almost) no effect	Non-measurable effect or not relevant	No
0/-	Small negative effect	Measurable small negative effect, limited range (project area), always temporarily character	Negligible
-	Moderate negative effect	Measurable negative effect, limited range (project area), temporarily or permanent character	Acceptable
--	Significant negative effect	Measurable negative effect, large range (BPNS), temporarily or permanent character	Not acceptable

In the impact assessment distinction has been made between effects during construction, exploitation and potential decommissioning. Knowledge gaps and possible mitigating (effect reducing) measures have also been indicated. Attention has been given to both the negative and possible positive environmental effects.

In Chapter 3 several alternatives are described (for cable type, cable configuration, burial method...). In many cases these alternatives are not distinctive for their effects. Therefore, the various alternatives will only be discussed when a difference is expected in the relevant effects.

4.1 SOIL

4.1.1 Reference situation and autonomous development

The Nemo Link runs from Richborough (UK) to Zeebrugge. A French section of the North Sea is also being crossed. The interconnector enters the Belgian Part of the North Sea southwest of the 'Westhinder' sandbanks. Then the interconnector runs eastward, almost completely parallel to the northern boundary of the 'Vlaamse Banken' (KP[2] 15-58), and passes from west to east the 'Oostdijck', 'Buitenratel', 'Kwintebank',

[1] Belgian Part of the North Sea
[2] KP = kilometer point

'Middelkerkebank' and 'Oostendebank'. The eastern part of the route (KP 0-15) crosses the area of the 'Kustbanken' near the 'Wenduinebank'.

At several locations along the route various sand waves are located, rising up to 6 m above the surrounding seafloor. The sand waves are usually covered with smaller ripples.

The shallow geology (Quaternary and/or partially Tertiary) along the cable route is composed of sand with a thickness of 0 to 6 meters, on top of clay. Occasionally, a thin gravel layer was found on the sea floor (up to 37 cm).

The 'Vlaamse Banken' appear to be quite stable. For the autonomous development in the project area it can be assumed that it would undergo only few changes over the next few decades.

Due to climate change, changes will occur in the flow characteristics and the morphology of the Belgian Part of the North Sea (BPNS). Even within the period of operation changes will already be noticeable. Besides changes in the overall average values of sea level, temperature, etc., an increase in extreme climatic events is expected.

4.1.2 Impact description and assessment

4.1.2.1 Construction phase

Pre-sweeping involves local dredging of (tops) of sand waves and thin layers of sand, followed by the dumping of the dredged sand in the vicinity of the works or at the designated disposal sites for dredged material in the BPNS. It is estimated that an amount of approximately 100,000 m^3 of sand shall have to be moved. This will include an increased turbidity and sedimentation in the vicinity of the works. Because of the limited volume of sand to be moved and because of the high mobility and dynamics that sand waves already naturally own, the impact of pre-sweeping on the soil is assessed as small negative (0/-).

At crossings with other cables and pipelines, protective measures and bridges are installed. In the Belgian Part of the North Sea five existing cables and one pipeline need to be crossed. In most cases, these protections are installed by placing special mattresses that are subsequently covered with rock armour to stabilize. The protective measures disturb the original geological structure. However, given the very limited size of the protective measures, this effect is very limited (0).

The thickness of the Quaternary cover along the route of the Nemo Link varies between less than 0.5 m and 17 m, so that the cables will be buried partially in Quaternary and Tertiary sediments. The degree of increase in turbidity and sedimentation here depends on the burial method. The effect of burial of the cables to the overall sediment transport, sedimentology and morphology of the seabed and the original geological structure is assessed as small negative (0/-). The nature and significance of the impact on geology are completely similar (not significant) for the various configuration options and burial techniques.

No effect (0) is expected on soil quality due to accidental discharges from ships and machinery during construction or due to loss of pollutants from the cables or from crossing infrastructures.

4.1.2.2 Operational phase

The HVDC interconnector between the UK and Belgium will be installed in such a way that the coverage of the cables will be guaranteed for the longest possible period. In addition, periodic inspection along the cable route is provided so that insufficient coverage of the interconnector can be noticed in time. The chance that the cables will become exposed is thus quite low. A possible effect due to local erosion at which the cables appear as obstruction on the seabed, is therefore assessed as small negative (0/-).

The scour protection applied at the crossings with other cables and pipelines minimizes the creation of extensive scour holes around the crossing infrastructure. The erosion shall move to the border area between the seabed and scour protection (secondary erosion). The effect of erosion near the crossing infrastructure is assessed as small negative (0/-).

As with the construction phase it is not expected that the operation will lead to contamination of the soil (no effect, 0).

It can be assumed that the increased temperature in the seabed decreases rapidly with the distance from the cables. On the basis of a study in the context of the Nemo Link-project it was calculated that at a cable depth of 3 m the warming-up at the surface would be less than one degree. Using a cable depth of 1 m, this could increase to a heating of the surface by 2 to 3° C. Given the limited volume of the seabed that therefore may be affected by the warming of the cables, the effect is considered negligible (0 / -), irrespective of the type of cable and the configuration alternatives.

4.1.2.3 Decommissioning phase

If the cables are removed, non-significant effects may occur, similar to the effects that will occur during the construction phase (0/-). If the cables are not removed, no effects occur (0). When removing protective measures and associated scour protection at the crossings with other cables and pipelines, the original geological structure and morphodynamics will be restored. In both cases, the impact on the soil is considered as very limited (0).

4.1.3 Mitigating measures

As no significant adverse effects are expected, no mitigating measures are required.

4.2 WATER

4.2.1 Reference situation and autonomous development

The project area, from the landfall in Zeebrugge to about KP 15, is determined by average water depths of 0 to approximately 10 m. At the rest of the route in the BPNS the average water depth is 20 to 30 m. The water level in the project area will vary by the tide (low tide, high tide) and under the influence of wave action and wind.

The currents of the North Sea water in Belgium mainly come from SW to WSW, driven by the tides and prevailing winds.

The turbidity or clarity of the seawater is determined by the amount of suspended (particulate) matter in the water. Satellite images that measure the amount of particulate matter in the upper water column, show a clear spatial variation in concentrations with a decrease from the Belgian coast into the sea. There is always a lower concentration at the sandbanks than near the coast (e.g. Zeebrugge, where the highest concentrations occur) because of the sandy sediment.

The mean water temperature in the BPNS is about 11 °C. Seasonal variations occur with a magnitude of 8 to 9 °C above the mean temperature.

For the project area it can be assumed that the natural concentrations of heavy metals in the water are relatively low. The main organotin compound is tributyltin (TBT). The 'Quality Status Report 2010' by OSPAR demonstrates that concentrations of certain hazardous substances in the seawater have decreased, although problems remain in many coastal areas. With regard to eutrophication, large areas of the North Sea coasts remain problem areas.

Due to climate change, changes will occur in the flow characteristics and chemical properties of the seawater. Even within the operation period changes will already be noticeable. Besides changes in overall mean values of sea level, temperature, etc., an increase in the occurrence of extreme climatic events is expected.

It can further be expected that the anthropogenic impact on water quality in the marine environment will continue to drop. For example, the concentrations of TBT, heavy metals, nutrient supply via rivers, etc., should show a positive downward trend in the future.

4.2.2 Impact description and assessment

4.2.2.1 Construction phase

During the construction phase an impact is possible on water quality resulting from pre-sweeping operations and from burying the cables, by release of heavy metals and organic pollutants from 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 can be regarded as a negligible (0/-). As the burial activities for the present project are very local, temporary and progressive in nature, this effect of burial of the cables is also assessed as negligible (0/-) (OSPAR, 2008).

During the construction phase, a local increase in turbidity will occur, primarily due to pre-sweeping operations and to a lesser extent due to the burying of the cables. Normally all works will be carried out in quiet (low flow) weather conditions, so when the natural turbidity is low. This also means that the sedimentation of the churned sediment will occur relatively quickly and within a small radius around the activities. It is expected that the concentrations of suspended material during construction activities shall occur in the same order of magnitude as the natural levels in stormy weather (Royal Haskoning, 2005; BMM, 2006a; OSPAR, 2008). The preparatory work and actual laying of the Nemo Link will have a local and temporary increase in turbidity with only a small negative effect (0/-), regardless of the burial method and the applied configuration alternative, especially compared to turbidity levels that naturally occur during storms and compared with dredging and commercial sand and gravel extraction operations that are already present in the BPNS (OSPAR, 2008). No long-term effect is expected.

4.2.2.2 Operational phase

No effect on water quality is expected (0) due to accidental discharge during inspection or repair work or due to the release of substances present in or around the cables.

The electric fields generated in the seawater are negligible (0/-), as the strength of the electric field caused by the cables decreases rapidly with distance from the cables and the cables are buried to a depth of 1-3 m, and especially when the magnetic fields are largely neutralized by bundling the cables.

No measurable increase in temperature of the seawater is expected (effect 0) due to heating of the cables.

Only if the cables over time would become exposed at a particular place, a local and temporary increase in turbidity can occur when re-burying the cables. This effect is negligible (0/-).

4.2.2.3 Decommissioning phase

The effects that may occur during the decommissioning phase shall be similar to those in the construction phase (slightly negative, 0/-, to nonexistent, 0).

4.2.3 Mitigating measures

As part of the overall safety system, there will be a clear procedure available which describes how and by whom actions are taken when an emergency should arises that could adversely affect water quality (e.g. oil spill) during the installation, operation or decommissioning.

4.3 CLIMATE & ATMOSPHERE

4.3.1 Reference situation and autonomous development

4.3.1.1 Climatic factors

Belgium generally has a temperate maritime climate. The maritime climate is characterized by relatively high rainfall and wind and small temperature variations between seasons. It has a cool summer and mild winter. The climate characteristics that prevail on land also largely prevail for the climate at sea. At sea however there is generally a more constant wind climate and a higher wind speed. At 10 km from the coast, the wind speed at sea can be 25 % higher than at the coast.

Following future climate changes are expected on a global scale (IPCC, 2007):

- During the next two decades a warming of 0.2 °C per decade is forecasted for many of the scenarios;
- The expectations of the average global warming by 2100 are highly dependent on the emission scenario considered; compared to the period 1980-1999, the expected warming is estimated at 1.8 [1.1 to 2.9] °C to 4.0 [2.4 to 6.4] °C (depending on the scenario);
- The average global warming 'in balance' expected at a doubling of CO_2 concentrations probably lies between 2 and 4.5 °C, with a best estimate of 3 °C. It is highly unlikely that the temperature rise will be below 1.5 ° C. A temperature rise far above 4.5 °C is not excluded.

- A sea level rise between 0.18 and 0.80 m (depending on the scenario) is expected by 2100 relative to the period 1980-1999.

4.3.1.2 Atmosphere

With respect to air quality following parameters are relevant: CO, NO_x, SO_2 and PM_{10} (dust). The air quality near the Belgian coast amply meets the quality objectives for these parameters.

For the autonomous development of the atmosphere it can be stated that the emissions that result from the construction, operation and eventual removal of the cable system will not occur. Therefore, there will be no temporary influence on the local air quality.

4.3.2 Impact description and assessment

4.3.2.1 Climatic factors

During the installation of the Nemo Link the global climate won't encounter relevant impacts (0). During the operation, the local temperature climate in the vicinity of the cable can be influenced by heating of the cables. It can be assumed that the heating of the cables will only cause a limited and very local warming of the sea floor, that is assessed as non-significant (0/-).

During the decommissioning phase, the global climate will encounter no relevant effects, whether the cable is removed or not (0).

4.3.2.2 Atmosphere

The installation of the cable system is associated with only a limited number of vessel movements, spread over a relatively long period. The channel between the UK and the mainland is one of the busiest shipping routes so it is expected that the emissions from vessels used during the construction phase of the Nemo Link only will have a negligible impact on local air quality (0/-).

During the operational phase limited emissions will occur due to inspection and maintenance and potential repair work. It is not expected that these limited emissions will have a noticeable impact on local air quality (0).

The impact on air quality resulting from emissions of vessels that would be used in the potential removal of the interconnector is similar as in the construction phase (negligible, 0/-).

4.3.3 Mitigating measures

Since relevant effects are expected neither the discipline atmosphere, nor for the discipline climatic factors, mitigation measures related to these disciplines are not applicable.

4.4 NOISE

4.4.1 Reference situation and autonomous development

The natural underwater background noise level lies between 90 and 100 dB (re 1 µPa) at frequencies ranging from 100 Hz to a few kHz. The noise of ship engines is one of the major noise sources of human origin. The noise and vibrations from the engine, propeller noise and noise from the currents cause an increase in ambient noise underwater. The channel between the UK and the mainland is in literature considered as a ‘hot spot’ for underwater noise, caused by the high density of shipping. Dredging, seismic investigation of the soil and piling in the construction of wind turbines are also major anthropogenic sources.

Above water, at sea level, the background noise level is estimated to be 35 + 5 dB(A).

Wind and waves dominate the noise level at the beach. According to data found in literature, it seems that near the shore the background noise level lies between 50 and 65 dB(A) at 25 m from the shoreline.

As far as noise is concerned, no significant change is to be expected in the autonomous development of the area from a global point of view. Though an increase of shipping on the route towards the ports of Zeebrugge and Oostende may cause an increase in the underwater and above water noise.

4.4.2 Impact description and assessment

4.4.2.1 Construction phase

The relevant noise sources that will occur during the construction phase, include vessels and machinery with their own characteristics and capabilities depending on the task for which they are used: specialized vessel for the installation of protective measures on existing cables and pipelines, rock dumping vessel, dredger, cable laying ship (equipped with an excavator), support ships.

Effects on the underwater sound

It is not expected that the activities during the construction phase, and the deployed ships and machinery, will produce sounds a high noise level, as is the case with for example seismic investigation or the 'impulsive' noise produced by piling monopile foundations for wind turbines. Noise produced during the construction phase of the Nemo Link will however often be similar to other already existing underwater noise of anthropogenic origin, such as dredging, sand extraction, etc. (OSPAR, 2008). Moreover, the channel between the UK and the mainland is considered as a ‘hot spot’ for underwater noise, caused by the high density of shipping. Therefore it is expected that the limited number of additional shipping movements and the activities for preparation work and installation of the Nemo Link (which are all temporary and progressive in nature), will cause no significant noise disturbance, regardless of the equipment used (small negative impact, 0/-).

Effects on the sound above water

Given the limited number of vessels to be deployed during the construction phase and as the installation works are progressive in nature, the increased noise above water is considered to be generally negligible compared to the normal shipping traffic (0/-), regardless of the equipment or type of cable laying ship used.

4.4.2.2 Operational phase

The presence of the Nemo Link will not result in noise production.

As can be assumed that the inspections and repairs to be carried out during the operational phase will occur rather sporadic and very locally, and as the noise from such works (worst case) will be similar as during the construction phase, the effect of noise disturbance during the operational phase both above and under water is assessed as negligible (0/-).

4.4.3 Mitigating measures

From the aspect of noise, no mitigating measures are considered necessary, as no significant noise disturbance due to the project is expected.

4.5 FAUNA, FLORA & BIODIVERSITY

The discipline Fauna and Flora deals with four different groups of organisms, namely the benthos (macro- and epibenthos), the fish, the birds (avifauna) and the sea mammals.

4.5.1 Reference situation and autonomous development

4.5.1.1 Benthos and fish

Marine organisms that live in or on the seabed, or benthos, are an important part of the food chain (dominant prey for demersal fish) and the ecosystem. They contribute to the biodiversity and the productivity of the sea. In this study we focus exclusively on the epibenthos (> 1 mm; on the seabed) and the macrobenthos (> 1 mm; in the seabed). Due to its limited mobility the presence of macrobenthos is an important indicator for the ‘health’ of marine systems. As regards the fish we focus only on fish living on or near the seabed (demersal fish) as they are the ones that will probably be affected most by the planned activities.

Four general occurring macrobenthic communities can be distinguished in the subtidal mobile substrates of the Belgian part of the North Sea, named after the most dominant species in the community. In between, another 6 transition-communities are identified. These are characterized by typical species, diversity and density and each are observed within a specific and well-defined environment.

Generally it can be assumed that the coastal zone is characterized by the *Macoma* and *Abra* community (De Backer *et al.*, 2010). The offshore samples are usually only characterized by *Nephtys* and *Ophelia* communities (De Backer *et al*., 2010). In addition, the samples in the coastal zone are generally characterized by a smaller grain size and a higher silt concentration than the offshore samples.

In the epibenthic communities significantly different density and biomass were observed between the coastal and the offshore zone, with significantly higher density and biomass in the coastal zone. With regard to species diversity, there are no significant differences between coastal and offshore.

Analogous to the epibenthos, the coastal zone is clearly richer in demersal fish (in biomass and density) than the more distant areas. Regarding species diversity, there is an overall increase from the coast further offshore, with the highest value at the 'Vlaamse Banken'. The main groups of demersal fish at the BPNS are the Perciformes (e.g. lesser weever, gobies…), the Pleuronectiformes (e.g. dab, plaice, sole…).

As regards the autonomous development it can be said that the benthic communities and the demersal fish fauna would not really change if the HVDC interconnector between the UK and Belgium would not be installed and operated. Other activities such as fishing, aggregate extraction, dumping, etc., can have a certain impact on the benthos and fish communities. Further it can be expected that the benthic and fish communities will undergo changes due to climate change (changes in flow characteristics, chemical properties of the sea water, temperature, storm frequency, etc.). At present there is still much uncertainty about the quantification of the impacts of climate change on the marine environment, especially on the scale of the BPNS. Moreover, the effects induced by climate change cannot always be separated from effects due to other human influences.

4.5.1.2 Birds

At the BPNS the highest densities of seabirds are reached in winter (average density of approximately 11.5 birds/km²) (Vanermen & Stienen, 2009). The species of seabirds occurring at the BPNS, can be divided into species that occur in the coastal zone and species that occur further offshore. Further from the shore the water is clearer, which for some seabirds is a condition to be able to catch prey, such as Common Guillemots, Auks and Northern Gannets. These species besides Red-throated Diver, Little Gull and Black-legged Kittiwakes appreciate the presence of sandbanks, because the concentration of food is apparently high. There are also true offshore species that rarely or never can be observed at the coast; these are Northern Fulmar and Great Skua. As regards the terns, Common Tern and Sandwich Tern forage near the coats mainly during breeding season, and especially around the ports of Zeebrugge, Oostende and Nieuwpoort.

The densities of Common Tern, Sandwich Tern and Little Gull are generally lower at the western part of the cable route than at the eastern part of the route. The highest densities are observed during the breeding season around the ports of Oostende, Zeebrugge and Heist, with highest densities located around the breeding colony of terns in the port of Zeebrugge.

If the Nemo Link is not installed, it can be assumed that the populations occurring on the Belgian part of the North Sea won't be affected in any way and consequently the ornithological value will remain the same.

4.5.1.3 Marine mammals

Until 2003 sea mammals were only sporadically observed during seabird counting in the BPNS. Since spring 2003, sea mammals are however increasingly found in the Belgian and Dutch part of the North Sea, whereby Harbour porpoises and White-beaked dolphins are the main species. This is probably not an actual increase

in numbers, but a shift of the foraging areas of sea mammals from more northerly areas, although other reasons cannot be excluded (Courtens *et al*., 2006; Depestele *et al.*, 2008; Haelters & Camphuysen, 2009).

Due to the mobility of sea mammals, the large area in which populations occur and the unpredictable nature of their occurrence, it is currently very difficult to determine migration corridors or areas that are more or less important for sea mammals (Di Marcantonio *et al.*, 2007; Degraer *et al.*, 2009b).

Four sea mammal species are considered as indigenous in Belgium; the Common seal, Grey seal, Harbour porpoise and Bottlenose dolphin (Haelters, 2009; 2010). As the Harbour porpoise occurs in much larger numbers than the other sea mammal species in the BPNS and as the Harbour porpoise turns out to be very sensitive to disturbance, the focus for the impact assessment is set on the Harbour porpoise.

During migration a large part of the Harbour porpoise population of the North Sea uses the Belgian part of the North Sea. Therefore the Belgian part of the North Sea is considered as seasonal important for the Harbour porpoise within Europe, namely at late winter and early spring (February to late April), with densities between 2000-4000 animals throughout the BPNS (Haelters, 2009; Haelters & Camphuysen, 2009; Degraer *et al.*, 2010b; Haelters *et al*., 2011; Rumes *et al*., 2011).

If the Nemo Link is not installed, it can be assumed that the value of the route of the HVDC interconnector between UK and Belgium will remain the same. Apart from existing (semi)-natural fluctuations in marine mammals stocks (for example by changes in food availability, or by shifts in the wintering areas) there are no indications that significant changes occur in the area. The main threats to marine mammals are overfishing, incidental catch, pollution (including noise and waste), climate change and collision with ships.

4.5.2 Impact description and assessment

4.5.2.1 Benthos and fish

Construction phase

Both during the preparatory work and during the laying of the cables, temporary and local habitat disturbance will occur. Permanent habitat loss doesn't occur during both the construction and operation phase as the cables are laid completely into the soil at a minimum depth of 1 m and the benthic communities mainly occur in the first 20 cm of the soil. As the disturbance may be regarded as limited in size in comparison to the entire surface of the BPNS (i.e. 0.005 % to 0.034 % of the BPNS) and the work is temporary in nature, the effect of habitat disturbance on benthos is assessed as negligible, regardless of the applied burial method or cable configuration. It is assumed that after the work a natural recovery of the benthic community will occur. Moreover fish are mobile organisms, so the effect of habitat disturbance during the construction phase will be even less pronounced.

During some preparation work (leveling or pre-sweeping, clearance of the seabed) and during the laying of the cables increased turbidity and sedimentation will locally occur. As the present life community is well adapted to a sandy surface that is naturally in motion, given the high mobility of fish and given the limited size of the impact zone with increased turbidity and sedimentation (both in time and space), the impact is assessed as negligible, regardless of the applied burial method or cable configuration.

Also on the specific habitat type 'gravel beds' no significant impact is expected, as the ‘Hinderbanken’, where the most important gravel beds and valuable refugia are situated, are not crossed, since there is not an indication of the occurrence of valuable gravel beds along the route in the BPNS on the basis of the marine survey, and since there will be no removal of sediment in areas where gravel fields may be present. The exact location of the (valuable) gravel beds in the BPNS is nevertheless an important gap in knowledge.

During the installation of the cable, underwater noise disturbance will occur. Because of the temporary nature and the type of work (with no impulsive noise with a high sound level being produced), the effect of noise disturbance on epibenthos and fish fauna is assessed as slightly negative (0/-).

Operational phase

During the operational phase, a magnetic and induced electric field will be generated around the HVDC interconnector. The impact of electromagnetic fields on benthos is expected to be minimal as the electromagnetic fields created by the Nemo Link cable will be within the natural range of the North Sea. There is no doubt that the electromagnetic fields generated by the HVDC interconnector between the UK and Belgium can be detected by some fish. The sensitivity to electromagnetic radiation appears to be species-specific and likely even individual-specific (Gill *et al*., 2010). The occurrence of effects and the significance of these potential impacts at individual and population level is very uncertain, so that more fieldwork is required. All recent literature (Boehlert & Gill, 2010; Gill *et al*., 2009; Tasker *et al*., 2010; Wilhelmsson *et al*., 2010) indicate the impact of electromagnetic radiation on marine organisms as a gap in knowledge. Given the very local nature of the generated electromagnetic fields, as the field strength decreases rapidly with distance from the cables and as the exposure of organisms that are susceptible to electromagnetic fields is greatly reduced by burying the cables (which creates a physical barrier of some thickness), the potential negative effects are assessed as small negative (0/-).

When transmitting electrical energy, the cables itself and the surrounding seabed shall warm up. As most benthic organisms occur in the upper layer of the seabed (about 20 cm from the surface) and the temperature rise in the upper 20 cm is rather low, and as the potential effects will occur very locally, the effect of warming of the seabed on macrobenthos is assessed as small negative (0/-), regardless the chosen cable configuration (bundled or not) or the selected type of cable (XLPE or MI). Based on the fact that the temperature of the seabed at the surface remains unchanged by the rapid removal of heat due to the moving sea water, it can be concluded that there will be no effect (0) on epibenthos and fish.

As part of the operational phase regular inspection of the Nemo Link will take place. If damage is found or parts of the cable are exposed, they will be repaired and/or buried again. This work may cause a potential habitat disturbance and disturbance from sedimentation, but are temporary and limited in size, so the effects on benthos and fish as a result of this work can be regarded as negligible.

Decommissioning phase

If it is chosen to remove the cables, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase (small negative, 0/-). If the cables stay in the seabed, no effects on benthos and fish fauna shall occur (0).

4.5.2.2 Birds

Construction phase

During the preparatory work and actual laying of the Nemo Link, a local increase in water turbidity and an increased sedimentation may occur. Seabirds occurring at the BPNS are however accustomed to foraging in turbid water, and most species feed in the upper meters of the surface. Therefore, the effects of increased turbidity and sedimentation on avifauna are assessed as small negative (0/-).

Furthermore, the increased presence of vessels and machinery can cause a temporary disturbance of avifauna, especially at the landfall. Because of the proximity of the port of Zeebrugge, however, busy shipping is already present in the landfall area of the Nemo Link. This disturbance effect is therefore also assessed as negligible (0/-).

Operational phase

During the operational phase (repair or inspection work), no direct effects is expected on the avifauna present at the BPNS (0).

Decommissioning phase

If a dismantling is chosen at which the cables are re-excavated, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase (small negative, 0/-). If the cables stay in the seabed, no effects on the avifauna shall occur (0).

4.5.2.3 Marine mammals

Construction phase

Installation and preparation work can cause to disturbance of marine mammals by underwater movements, the presence of vessels (busy shipping traffic) and machinery, a change in water turbidity, noise, etc. Given the limited number of additional shipping movements compared to the current number of shipments already present in the BPNS (mainly near the shipping lanes), given the local and non-permanent effect of the installation and given the high mobility of marine mammals, no significant and long-term adverse effects in the form of disturbance (including noise) are expected due the installation of the HVDC interconnector between the UK and Belgium (BERR, 2008; OSPAR, 2008). It is expected that the noise will not affect the echolocation capabilities of marine mammals (DIFRES, 2000). Marine mammals shall probably temporary avoid the area of the construction activities and its surroundings. Given the preceding and very local nature of the cable installation activities, no impact on the migration movements of marine mammals is expected. Disturbance and other potential impacts resulting from construction work is assessed as small negative to negligible (0/- to 0).

Operational phase

The magnetic field generated by the Nemo Link could potentially interfere with the orientation mechanisms of sea mammals (BERR, 2008; OSPAR, 2008; Tasker *et al*., 2010). The strength of the electromagnetic fields

generated decreases rapidly with increasing distance from the cables. As the cables are additionally buried up to a minimum depth of 1 m and as marine mammals do not have the habit to swim close to the seabed surface, it is very unlikely that marine mammals will be exposed to the electromagnetic fields generated by the cables. Therefore it seems unlikely that the electromagnetic fields generated by the Nemo Link cable will affect marine mammals (0).

When transmitting electrical energy, the cables itself and the surrounding seabed shall warm up. The temperature of the sea floor at the surface, however, will remain equal to the temperature of the seawater by the rapid removal of heat due to the moving sea water. Therefore, marine mammals won't be affected by the heating of the cables (0).

Inspections, maintenance or repair during the operational phase can disturb marine mammals. The effect of disturbance is considered as small negative (0/-) given its temporary nature, given the limited area on the Belgian part of the North Sea that will be affected and given the limited additional ship movements compared to the existing traffic in the Belgian part of the North Sea.

Decommissioning phase

If it is chosen to remove the cables when they are out of use, the effects during the decommissioning phase are expected to be of the same kind as those during the construction phase: there will be a slight, temporary and local disturbance of marine mammals (small negative impact, 0/-). If the cables are left in situ, there will be no effect at all (0).

4.5.3 Mitigating measures

Uncertainty remains about the exact location of (valuable) gravel beds in the Belgian part of the North Sea. A marine survey conducted in the summer of 2010 in the context of the Nemo Link-project along the proposed route of the Nemo Link, gives however no indication of the presence of valuable gravel beds and their associated fauna. This is in contrast to the British territory where this habitat type was found. Mitigating measures are therefore only proposed in the British part of the North Sea with respect to the gravel beds and their sensitive species (such as herring).

4.6 SEA SCAPE & CULTURAL HERITAGE

4.6.1 Reference situation and autonomous development

The sea and the beach are regarded as positive by the population. In Belgium the coast is an important tourist attraction, for day trippers as well as holiday makers. In contrast to the sea view, the coastal view in the inland direction is characterized by a range of high-rise buildings. Movement in the landscape by freighters, fishing boats, pleasure boats, surfers, etc., are part of the perception of the landscape for people on the dikes. Especially near the seaports there is a continuous coming and going of ships. A development that shall change the seascape in the future is the (further) construction of the currently permitted wind farms.

Along the coast there are many heritage sites, either protected or not. The most important ones are a number of dune areas and polders, piers, lighthouses, the fort of Napoleon, etc. At sea the cultural heritage consists mainly of wrecked ships. Several wrecks are located along the cable route.

4.6.2 Impact description and assessment

4.6.2.1 Construction phase

During the preparation work and the actual installation of the Nemo Link there will be a temporary visual change of the seascape due to passage of several vessels. The landscape at the landfall could also be altered temporarily. The perception of these activities can be assessed as negative (disturbance) or positive (touristic attraction). Because of the very temporary nature of the works the impact of the construction of the HVDC inter connector on the sea sight is assessed as negligible (0/-).

When setting out the cable route for the Nemo Link, avoidance of shipwrecks was used as a basic principle. For this purpose, the existing data of the location of shipwrecks was studied and taken into consideration. Then the position of the known wrecks along the proposed route has been verified using a Side Scan Sonar at the marine survey. With the Side Scan Sonar it was also possible to capture the location of yet unknown wrecks. So as avoidance of shipwrecks is pursued maximally, the effect on the maritime cultural heritage is limited to a minimum (0).

The construction of the HVDC has no direct or indirect impact on the cultural heritage along the coast from Knokke-Oostende (0).

4.6.2.2 Operational phase

Inspections along the cable route and possible cable repairs shall only slightly increase the shipping movements at sea and are of short duration. Therefore, the impact of the activities during the operational phase on the sea sight are assessed as practically nonexistent (0).

The operation of the Nemo Link will have no direct or indirect effects on the (maritime) cultural heritage (0).

4.6.2.3 Decommissioning phase

If the HVDC inter-connector is removed after the period of exploitation, the effects on the sea sight will be similar to those during the installation phase (negligible, 0/-). If it is chosen to leave the interconnector in situ, there are no effects at all on the sea sight (0).

In the preliminary investigation and during the installation of the Nemo Link, the location of all (possibly hitherto unknown) shipwrecks is identified. Therefore, possible removal of the cables will have no impact on the maritime cultural heritage (0). If it is chosen to leave the interconnector in situ after it has been taken out of use, there will also be no effects at all on the maritime cultural heritage (0). The cultural heritage along the coastline is not expected to be affected as well (0).

4.6.3 Mitigating measures

With regard to the sea scape it can be appropriate to inform the general public in advance, for example trough information panels at the dike, especially during the work in the intertidal zone and at the beach. In this way the acceptance of the temporary change in the landscape are strongly encouraged.

A general rule for the cultural heritage when constructing the interconnector is preferable avoidance of shipwrecks. If during the installation of the Nemo Link a wreck should still be 'discovered', the competent authorities must be informed as soon as possible, and avoidance of this wreck should be pursued as far as possible.

4.7 HUMAN ACTIVITY

4.7.1 Reference situation and autonomous development

4.7.1.1 Fishery

Most important species supplied are shrimps and demersale fish species, mainly sole, ray and flounder (Tessens & Velghe, 2010; Dienst Marien Milieu, 2009; Vanderperren & Polet, 2009). The intensity of the fishery (namely trawling) is carried out predominantly in the gullies between the sandbanks. Shrimp fishers on the other hand will look for their catch on the sand banks, mostly nearer the coast. On an international and national scale the fishing sector is faced with socio-economic problems by a steady decline of the existing biomass in the higher trophic levels in the North Atlantic since 1950 and increased fishing intensity during the 1950-1975 period. Researchers have found that the current fish exploitation cannot carry on and that the higher trophic level of fish in the North Atlantic will disappear completely in the next few decennia in view of present trends (Christensen *et al*., 2002). This is also evident from the fact that the stocks of nearly all species are specified as being ‘outside safe biological limits’.

Developments in the European Fisheries policy lead us to believe that further quota restrictions and accompanying measures (such as technical measures and restricting the days at sea) will mean that the trends described above will only grow stronger in the short and medium term.

4.7.1.2 Shipping

The reference situation of the professional shipping is described in the chapter ‘Safety aspects’.

4.7.1.3 Sand and gravel extraction

The exploration and exploitation of sand and gravel now takes place in three ‘control zones’ and one ‘exploration zone’. The Nemo Link runs north of the control zones 2c and 2a, but stays outside of these designated areas. Control zone 2c is located outside ‘Buiten Ratel’ and ‘Oostdyck’ and is open for exploitation throughout the year. Division 2a is located on the ‘Kwintebank’ and is open for exploitation for a period of 3 years alternatingly with sector 2b (rotation system).

4.7.1.4 Military activities

The Nemo Link crosses any of the areas designated for military activities on the BPNS, but passes nearby two military zones:

- A relatively small military zone where war munitions and training mines are detonated. These activities occur ≤ 10 days a year on average.
- A zone in which shooting exercises are performed from the beach of Nieuwpoort - Lombardsijde towards the sea. The number of shooting days in this area is ≤ 9 per year.

4.7.1.5 Cables and pipelines

The HVDC interconnector between the UK and Belgium shall cross a total of six communication cables, one electric power cable and a pipeline in the BPNS. One of the communication cables is yet no longer in use; the Hermes South.

4.7.1.6 Tourism and recreation

Along almost the entire Belgian coast, associated with the dikes and dunes, recreation and tourism plays an important role. The landfall of the Nemo Link is provided west of the western breakwater of the port of Zeebrugge. The beach of Zeebrugge west of the western breakwater is a very wide beach. The dike of Zeebrugge is relatively short (approx. 850 m). The eastern section runs into the dune area 'De Fonteintjes', which is designated as a Special Protection Area. At the most easterly point of the dike, the Animal surf club is located. A swimming area and a (kite)surf zone are situated in front of the surf club.

4.7.1.7 Biodiversity and nature conservation areas

Based on observed biodiversity patterns, different types of protected areas are identified in Belgian marine waters, mainly focusing on the west coast. The cable route of the Nemo Link passes through the special protection area SPA3 'Zeebrugge' and runs in close proximity to the special protection area SPA2 ‘Oostende’. In addition, the cable route crosses the recently approved special area of conservation (SAC) ‘Vlaamse Banken’ (RD 16/10/2012).

4.7.2 Impact description and assessment

In the following sections (socio-economic) impact of the construction and operation of the Nemo Link on relevant aspects is discussed. As a possible removal of the Nemo Link implies similar activities to be carried out and similar machinery to be used as during the construction phase, it is expected that similar effects will occur. The decommissioning phase is therefore not discussed separately.

4.7.2.1 Fishery

The expected impacts during installation of the Nemo Link are assessed as negligible. There is no loss of traditional fishing grounds and disturbance of fish by the work will only be very temporary and limited. During

the installation of the Nemo Link the construction area will nevertheless be temporarily inaccessible to fishing vessels. A security zone of maximum 2 x 1 km will be provided, where fishing is prohibited during the work.

The main potential impacts during the operational phase are the changes in the fish behavior caused by electromagnetic radiation emitted by the Nemo Link. For a discussion of these effects, see the chapter 'Fauna and Flora'.

If the Nemo Link would become exposed during the operational phase, fishing gear could get entangled with the cables. However, the interconnector is installed so that the coverage will be maximally guaranteed for the longest possible period. In addition, periodic inspections along the cable route are provided so that an insufficient coverage of the interconnector can be noticed in time. Therefore, the probability that the interconnector can be entangled in fishing gear is minimal.

4.7.2.2 Shipping

Safety aspects (risk of accidents, oil spills) of the professional shipping is discussed in the chapter 'Safety aspects'.

4.7.2.3 Sand and gravel extraction

The Nemo Link is installed in the vicinity of the control zones 2c and 2a, but stays completely out of these zones, so no conflicts are expected between the construction, operation and potential decommissioning of the interconnector on the one hand and the sand and gravel extraction on the other.

4.7.2.4 Military activities

Given the limited military activities (maximum 10 days per year per zone) at the military zones and the fact that the Nemo Link crosses none of these zones, no significant effects are expected due to the construction, operation and possible decommissioning of the Nemo Link. When approaching these military zones during the construction it remains advisable to maintain proper communication with the competent services of the Ministry of Defense, so they are aware of the activities in the vicinity of the military zones.

4.7.2.5 Cables and pipelines

At crossings with cables and pipelines, structures are made that form a safe bridge or separation between the Nemo Link and the existing cable or pipe. In most cases, these protections are created by placing special mattresses subsequently covered with armour rock to stabilize. In accordance with the provisions of the Royal Decree of 12 March 2002 (Art. 15, 8°), the initiators shall close a 'crossing agreement' with all licensees of the crossed cables or pipes individually, in which specific agreements are recorded with regard to the work to be performed and the manner of crossing with the relevant cable or pipeline. If all contractual agreements are respected, and every precaution is taken to avoid damaging the existing cables and pipelines, it can be assumed that there will be no impact on the existing cables and pipelines due to the construction, operation and possible decommissioning of the Nemo Link. The Nemo Link-project has initiated discussions on crossing agreements for all cables/ pipelines to be crossed.

4.7.2.6 Tourism and recreation

Outside the coastal zone no negative effects are anticipated for tourism and recreation due to the construction of the Nemo Link given the low number of ships to be used. In the shallow coastal zone a temporary disturbance is possible. By recreational boats, windsurfers, kite surfers, swimmers, etc., a safety zone may be used. Since the construction of the Nemo Link however is temporary and the prohibition of entering the safety zone will be monitored, the effect on tourism and recreation is assessed as small negative. Good communication with the Coast Guard during the execution of the work is necessary at this point.

During the operational phase no effects on tourism and recreation are expected at the marine part of the interconnector.

4.7.2.7 Biodiversity and nature conservation areas

Generally it can be stated that the construction will cause a certain disturbance by both the presence of vessels and the movement of the sediment. No significant impact is expected due to the construction work on the special protection areas SPA3 and SPA2 and the recently approved SAC 'Vlaamse Banken' (RD 16/10/2012). Given the temporary and local nature of the installation of the Nemo Link, also no significant adverse effects on the quality of the habitat of porpoises are expected, so the provided conservation objectives are not significantly affected. Exploitation and possible decommissioning of the Nemo Link are also expected to have no significant impact on the protected areas and species.

4.7.2.8 Other activities

Because of the large distance (at least 5 km) from areas where mariculture is allowed to the Nemo Link, no effects are expected on the mariculture activities that may develop in the future.

The entire route of the interconnector has no overlap with the designated area for the construction of wind farms. Consequently, no effects on the existing and planned wind farms are expected due to the construction, operation and possible decommissioning of Nemo Link.

4.7.3 Mitigating measures

Proper communication with the Ministry of Defense and the Coast Guard during the installation of the Nemo Link in the vicinity of the designated military areas is advisable. During the installation of the various crossing infrastructures, all necessary precautions need to be taken to avoid damage to existing cables and pipelines. If several initiatives in which cables are laid, including the future construction of wind farms, are permitted in a limited period of time, it should be attempted to align the different projects (grouped implantation). During the construction of the Nemo Link proper communication with the Coast Guard is required for ensuring the safety of recreational vessels and particularly in the coastal area where windsurfers, kite surfers, swimmers, etc., can be present. Since the work will take place mainly in the summer, this communication is of great importance.

4.8 SAFETY ASPECTS

4.8.1 Reference situation and autonomous development

4.8.1.1 Shipping

A total of approximately 150,000 vessels navigate through the Belgian marine areas, of which about 15 % tankers (oil, chemicals and gas tankers), and nearly half (approx. 50 %) container ships and RoRo's (roll- on roll-off vessels). Loads of oil and other harmful or (environmentally) hazardous substances are mainly transported on board of tankers, container ships and RoRo's. The project area is located near one of the busiest shipping routes in the world (FPS Health, Food Chain Safety and Environment, 2010).

4.8.1.2 Marine pollution

Since the project area is situated in the North Sea, it is covered under the regulations applicable to the MARPOL 'special zones', Appendix I. The discharge of oil containing liquids is thereby prohibited. A loss of oil from ships can have several causes: a collision between two ships, ships that collide with a stationary or floating obstacle, cracks in the hull, sinking, fire on board, severe negligence, intentional (criminal) discharge activity. Should an (accidental) discharge take place, it will spread and a potentially threat the marine ecosystem and coastal areas.

Despite the increase in maritime transport a clear downward trend in the annual number of detected oil pollutions in Belgian waters is being determined. The total volume of discharges also declines. The reason for the overall downward trend can be found in the stricter policy and legislative framework for safety and pollution on the one hand and by the deterrent nature of the current control means (FPS Health, Food Chain Safety and Environment, 2010).

4.8.2 Impact description and assessment

4.8.2.1 Shipping

Construction phase

During the preparatory work and during the actual construction of the cables collision with a cable laying vessel and the accompanying ships may occur. The cable laying vessel navigates at a slower speed than usual traffic (about 300 m per hour), and temporarily comes to a complete standstill when a joint between two interconnector sections is made. To prevent collision with the installation vessels, other vessels need to adjust their course or speed. The risk of collision is greatest near the locations where the cable route crosses the various shipping lanes. Given the very limited number of vessels to be deployed during the construction phase and as all the work is only temporary and local in nature, the chance of a collision is low. Moreover, different measures are provided to keep disturbance to shipping and risk of collision to a minimum. The risk of collision is considered to be negligible (0/-).

Operational phase

During inspections and possible repair work, potential collision with other vessels can occur. Given the very low frequency of these works, their temporary and local character and the very limited number of additional shipping movements in comparison to the total present shipping traffic in the BPNS, no significant increase in the risk for shipping safety is expected in relation the current situation (negligible impact, 0/-).

The magnetic field of the Nemo Link can locally cause compass deviation. The magnetic field around the interconnector is however very small and the field strength decreases rapidly with distance from the cables. The impact of the magnetic field of the HVDC interconnector to shipping and navigation is therefore considered to be negligible (0/-).

Decommissioning phase

If it is decided to remove the cables once they are out of use, the operations to be performed and the vessels to be deployed will be similar to those during the construction phase (negligible impact, 0/-).

4.8.2.2 Marine pollution

Given the very limited number of ships to be deployed during construction, operation and possible decommissioning of the HVDC interconnector between the UK and Belgium and as the work is only of short duration, the probability of the occurrence of oil pollution is small (negligible effect, 0/-).

The effect of loss of oil or other substances from the cables is zero (no effect, 0).

4.8.2.3 Radioactivity

Out of use telecommunication cables that cross the cable route are usually locally removed (cut) near the location where the interconnector crosses this cable. These cables can contain signal amplifiers with radioactive substances. It is therefore advisable to collect in advance all possible information on the signal amplifiers present in the cable that needs to be cut. If the section of the out of use telecommunication cable that should be removed effectively contains a signal amplifier with radioactive substances, the necessary security measures to protect humans and the environment must be provided.

4.8.2.4 Damage to the cables

The main threats to the Nemo Link are bottom fishing, with heavy weights to be pulled across the cable, and anchors of ships. This can cause damage to the cables, possibly resulting in short circuit between the cable core and the sheath. The current is then shortly returned through the sheath and/or the soil. This is recorded in the converter station, and within a few tenths of a second the voltage on the cable is disconnected. As a result damage or injury to infrastructure or persons is prevented.

Given the small risk of occurrence of damage to the cables, and as security mechanisms in the converter station almost immediately would stop the occurrence of possible effects, no safety risks due to the occurrence of damage to the cables are expected (0).

4.8.3 Mitigating measures

During the construction, operation and possible decommissioning work several safety measures should always maximally be used to minimize hindrance and risk of collision.

5 CUMULATIVE EFFECTS

The potential effects arising from the construction, operation and possible decommissioning of the HVDC interconnector between the UK and Belgium (shortly: Nemo Link) can lead to the accumulation of effects when it is combined with the construction, operation and decommissioning of other offshore power cables. The number of electric power cables in the North Sea does indeed increase rapidly (HVDC interconnectors, export cables from wind farms). At the time of the preparation of the present EIR, following planned or already in use electric power cables are known in the Belgian Part of the North Sea:

- The export cables from the C-Power wind farm are two 3-phase 150 kV AC submarine cables of XLPE type. These export cables run from the C-Power wind farm to Oostende and cross the planned route of the HVDC interconnector between the UK and Belgium near kilometer point 20 (KP 20).
  The export cables from the wind farms Belwind and Northwind (formerly Eldepasco) don't traverse the planned route of the Nemo Link, but all land on the beach of Zeebrugge. Only one of the two export cables from the Belwind wind farm is currently installed and in use, the second export cable will be constructed during the second construction phase of this wind farm (planned for launch during 2013). These export cables are all the same type as the export cable of C-Power. Based on the currently known planning of the various projects, there is a chance that the construction of the export cables of Belwind and Northwind will coincide (partially) with the construction of the HVDC interconnector between the UK and Belgium. Given the short duration and the progressive nature of construction work for electricity cables, this chance is however rather small.
- During the preparation of this EIA, a permit was also licensed to the North Sea Power wind farm (MD 01/18/2012). The export cables from the North Sea Power (250 MW to 470 MW) wind farm will be landing at Zeebrugge. These export cables are of the same type as the export cables C-Power, although the North Sea Power wind farm can also opt for a 220 kV AC cable. The export cables will cross the planned route of the Nemo Link near KP1. Again there is a chance that the construction of the North Sea Power wind farm partly overlaps with the construction of Nemo Link.
- For the planned wind farm Rentel was the licensing procedure for the construction and operation recently started. Recently domain concessions have also been granted for the projects Seastar and Mermaid in the designated area for wind farms. The location and characteristics of the export cables of all these future wind farms are not yet known.
- It is important to note that the situation described in previous sections, in which always one or more export cables depart from each separate wind farm to a power station on the coast, the situation is as it was common until now. Currently, however, a concept is developed to build an offshore meshed network

step by step, where the different wind farms are linked to each other at sea, in power stations on platforms that lie close to the various concessions. This network will then be connected to the grid on the mainland through a limited number of cables connected. Currently, this concept has not yet been worked out concretely enough to give an exact estimate of the number of high voltage cables (and their location and characteristics) that finally will be constructed between the designated area for wind farms and the mainland.

- The park cables of the various wind farms (33 kV cables interconnecting the wind turbines and offshore high-voltage stations) will not be considered in this impact assessment, as the occurrence of cumulative effects is ruled out by the large distance of these cables (all located within the designated area for wind farms) to the route of the Nemo Link.

Besides potential cumulative impacts resulting from construction, operation and decommissioning of several power cables, cumulative effects may also result from the construction, operation and decommissioning of the HVDC interconnector between the UK and Belgium in combination with other human activities at sea that (partly) cause similar effects (such as sand and gravel extraction). When relevant, this type of cumulative effects is also discussed.

Only those effects that have at least a small positive or small negative impact on a particular discipline, are discussed, since it is assumed that a certain aspect that has (almost) no effect on the environment for each power cable separately, will also cause no cumulative effect.

5.1 SOIL

Construction phase

The cumulative effect of the construction of several power cables on the soil is considered to be negligible, as the disruption is very limited compared to the size of the Belgian Part of the North Sea.

The route of the HVDC interconnector between the UK and Belgium runs along the northern edge of the sand and gravel extraction areas 2a and 2c. Pre-sweeping and burying the Nemo Link cause similar effects on the seabed as these extraction activities. The differences in scale of both activities are though so large that it can be expected that the construction of the Nemo Link won't reinforce the existing effects, and more likely will blend into the existing high sediment dynamics in this region.

Operational phase

The probability that the various power cables in the BPNS will become exposed simultaneously and for long periods is small given the performance of periodic inspections. Therefore, the cumulative effect on the overall morphodynamics and erosion is considered to be less than the sum of the effects of the individual cables.

The cumulative effect on the seabed of the warming of several cables scattered about the BPNS is negligible given the very limited volume of the seabed that will suffer from warming in comparison with the size of the total BPNS and taking into account the naturally occurring temperature variations.

Two power cables can come close enough together only at the crossings (separated only by crossing infrastructure) so that a further temperature increase of the seafloor (amplified effect) may occur. This effect is highly localized (only a few meters in length) and is therefore considered to be insignificant.

5.2 WATER

Construction phase

Even if multiple cables would be built simultaneously within the landfall zone, it is expected that the effects on the turbidity of the sea water will be completely disappeared after a few tidal cycles. The cumulative effect is at worst equal to the sum of the individual effects, and – compared to the naturally occurring turbidity levels during storms – still acceptable. On the other hand, if there is no overlap of the construction work of several cables, the cumulative effect is smaller than the sum of the effects of the individual cables.

Operational phase

During the operational phase electromagnetic fields occur around power lines. The magnetic fields generated by the Nemo Link are static and districts in this respect from the magnetic fields of export cables from wind farms, operating on alternating and hence changing ('pulsating') magnetic fields. Therefore, the combined magnetic and induced electric field of the HVDC interconnector and an export cable are considered to be complex and almost unpredictable. Interaction between two power cables will however only occur at the point of crossing of two cables, as in both AC and in DC the magnetic field strength decreases rapidly with increasing distance from the cable and because submarine power cables are obliged to be laid at a distance of at least 50 meters apart. In the Belgian Part of the North Sea, the Nemo Link crosses two pair of power lines, namely the export cables from the C-Power wind farm and the North Sea Power wind farm. At this crossing a magnetic and induced electric field in the seawater can thus be generated that is different from the fields generated in the vicinity of the individual cables. It is impossible to predict whether the cumulative effect will be larger (amplified) or smaller (weakened) than the sum of the individual effects. However, it is evident that the cumulative effect takes place to locally to be significant.

5.3 CLIMATE & ATMOSPHERE

During the construction, operation and possible decommissioning of several power cables, the air quality will be affected by emissions from shipping movements. The cumulative effect is negligible.

The impact on the local temperature climate in the seabed by warming of multiple cables in operation is also negligible (see § 5.2).

5.4 NOISE

Even if the construction of multiple cables would simultaneously take place, the cumulative impact on the sound climate (caused by ships, dredging, plowing and/or jetting...) will be negligible.

5.5 FAUNA & FLORA

No relevant cumulative effects on birds and marine mammals are expected.

A possible strengthening of the effects on benthos and (demersal) fish communities during the construction phase will only occur if the construction work of two cables will take place at the same time, and furthermore only in regions where cables will be installed close together, i.e. in the area near the coast to the west of the port of Zeebrugge (landfall area). In this hypothetical case, the cumulative effect equals the sum of the individual effects, and is still acceptable given the small size and duration of the effects. If there is no overlap of the construction work of several cables, the cumulative effect will be smaller than the sum of the effects of the individual cables.

During the operational phase, the electromagnetic fields of two power cables can cause a stronger or weaker combined electromagnetic field at the point of their crossing. Each impact is however localized and therefore no cumulative effect on the benthos community and the fish fauna is expected.

On the other hand, the presence of multiple power cables scattered in the BPNS can exert effects on sensitive species by the frequent and widespread presence of electromagnetic fields, which also differ from each other in orientation, strength and physical appearance (static or pulsing). This can have an impact on fish fauna, with some species using electromagnetic fields for orientation, migration or detection of their prey. Since the impact of the electromagnetic field of one separate power cable on the demersal fish fauna is already a gap in knowledge, the potential impact of multiple electromagnetic fields with different characteristics and scattered on the seabed is not known at all. Further research is therefore appropriate.

No cumulative effect is expected from the heating of the seabed by several cables.

5.6 SEA SCAPE & CULTURAL HERITAGE

No relevant cumulative impact on the sea sight and the (maritime) cultural heritage is expected.

5.7 HUMAN ACTIVITY

The effects on the fishery during the construction works are temporary and local. Given the small chance of simultaneous occurrence of the work of several cables, the cumulative effect is negligible. Potential cumulative effects on fishing during the operation phase are caused by the presence of electromagnetic fields. Currently there great uncertainty concerning the impact of these fields on fish. Further research is therefore appropriate.

Cumulative impacts on tourism and recreation in the coastal zone will only occur when the construction of several power cables in the landfall area will take place simultaneously. Even then, the disturbance is acceptable if a proper communication with the authorities is maintained during execution of the works and if the construction close to the beach takes place outside the tourist season (holidays).

5.8 SAFETY ASPECTS

If no overlap occurs in the construction of the various cables, the cumulative impact on shipping safety will be less than the sum of the individual effects. If there is an overlap of activities, the risk of collision will increase. The cumulative effect is acceptable given the short duration of the works and given the limited number of vessels to be deployed.

6 MONITORING

Given the large sediment dynamics at the BPNS, the cables can become exposed over time. Therefore, periodic inspection of cable burial will take place, including potential erosion around infrastructure at crossings with other cables and pipelines.

Since no significant impact on fauna and flora is expected, no project-specific monitoring is required. The gaps in knowledge are though important to note, where research on the effects of electromagnetic radiation on the marine ecosystem is appropriate. The necessary research on spawning and nursery areas for fish fauna should additionally be noticed.

7 CROSS-BORDER EFFECTS

As in the present EIR no significant negative environmental impacts for the Belgian Part of the North Sea were identified due to the Nemo Link-project, it is evident that there will also be no significant adverse transboundary environmental effects. Significant cumulative effects due to the Nemo Link-project in combination with projects abroad are also excluded because of the short duration and the local nature of most effects.

8 SUMMARY AND CONCLUSIONS

First, it should be noted that the route of the HVDC interconnector between the UK and Belgium has already been mitigated largely at the phase of the design, as various physical, biological and human aspects have already been taken into account maximally during the route engineering study of 2011 to determine the most appropriate offshore cable route between Richborough and Zeebrugge. Where necessary, adjustments to the route were already carried out to mitigate potential impacts or risks in order to minimize both cable and installation costs and disruption of the marine ecosystem and its users.

The impact assessment and discussion of the present EIR show that all effects that can occur during the construction phase are limited in size as all construction activities take place locally and preceding and are always of short duration. The potential impacts during the construction phase are therefore all assessed as small negative (0/-) to nonexistent (0).

For many potential impacts during the operational phase, only a (very) low frequency of occurrence is expected. Moreover, these effects are all temporary and limited in size. Other, more permanent effects (electromagnetic radiation, heating...) are always too limited in size to be significant. All potential impacts during the operational phase are therefore assessed as small negative (0/-) to nonexistent (0).

With regard to the cumulative effects, the probability of simultaneously occurring construction phases of multiple power cables in the BPNS is rather small, given the short duration and the progressive nature of such construction work. The probability of occurrence of cumulative effects during the construction phase is therefore also very small, given the very local and non-permanent nature of the potential impact of the individual cables. Even then, these cumulative effects are still negligible (0/-).

As during the operational phase for the separate power cables only a very low frequency of occurrence for the diverse effects is expected (inspections, repair work) and given the local and temporary nature of these effects, the possibility that the effects of these individual cables will coincide (resulting in potential cumulative effects) is very small. Even then, these cumulative effects are negligible (0/-). Other, more permanent effects during the operational phase (such as warming of the sea floor) take place too locally to cause significant cumulative effects (0/-). The cumulative impact of electromagnetic fields of several power cables in the BPNS on the fish fauna is a gap in knowledge.

Finally it is expected that the construction, operation and decommissioning of the Nemo Link between the UK and Belgium will have no significant impact on the Good Environmental Status and the environmental targets as defined under the Marine Strategy Framework Directive 2008/56/EC.

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Appendix 15: UK Onshore Non-Technical Summary

Nemo Link®

Environmental Statement

Non-Technical Summary

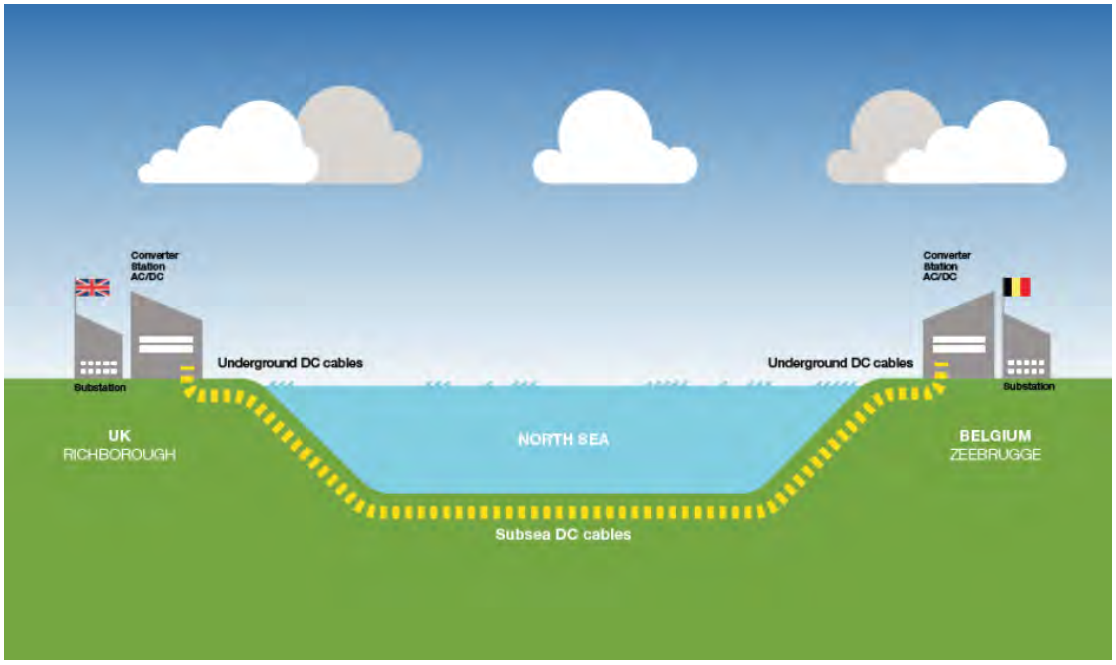
February 2013

Introduction

The Nemo Link (the Project) is a proposed high voltage direct current (HVDC) electrical interconnector with an approximate capacity of 1,000 megawatts (MW) which will allow the transfer of electrical power via subsea cables between the UK and Belgium. The power would be bi-directional, able to flow in either direction at different times, depending on the supply and demand in each country.

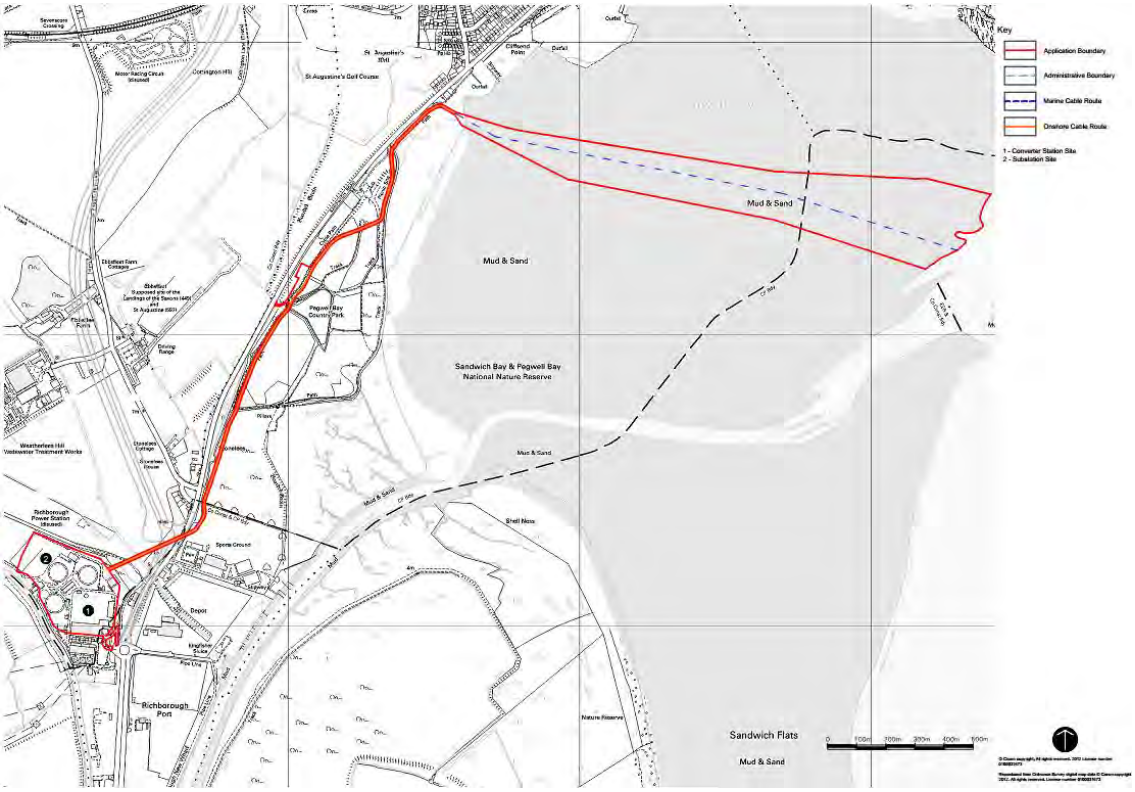
The proposed subsea cables would run from the converter station at the former Richborough power station site to Pegwell Bay at Richborough in Kent to Zeebrugge in Belgium passing through English, French and Belgian waters.

Figure 1 – The Nemo Link Graphical Representation



The UK onshore elements (the Proposed Development) of the Project for which planning permission is being sought (as part of this application) comprise a converter station and substation at the former Richborough power station site, and cables installed below the ground between the converter station and mean low water at Pegwell Bay. These will connect to the other parts of the interconnector (which are outside the planning jurisdiction of the local planning authorities), being the subsea cables from mean low water across the North Sea; onshore underground cables, a converter station and 400kV substation in Belgium. In the UK and Belgium, a connection to the corresponding electricity transmission networks will be required; these will be subject to a separate consenting process and will be promoted separately to this planning application.

Figure 2 – The Proposed Development Application Boundary



The Nemo Link is being developed jointly by National Grid Nemo Link Ltd (NGNLL), part of the National Grid group, and Elia Asset S.A. (Elia) which is part of the national electricity transmission company in Belgium. The proposed substation at Richborough would be owned and operated by National Grid Electricity Transmission (NGET).

This document provides a Non-Technical Summary (NTS) of the predicted effects on the environment of the Proposed Development. It also sets out a summary of the effects, including cumulative effects, of the other parts of the interconnector, together with the effects of the connection to the UK transmission network, which would be promoted by NGET separate to this planning application.

Full details of the effects of the Proposed Development are contained within the Environmental Statement (ES) that has been prepared to support the planning application. Separate Environmental Statements have been prepared to describe the effects of the subsea cables and the onshore elements in Belgium.

Need for the Project

It is European Union (EU) and UK 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 is to allow a more efficient energy market within the EU, to 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.

There is no existing connection between the UK and Belgian transmission systems. Belgium is particularly suitable for a new interconnector not only because of its geographical proximity to the UK, but also because its electricity transmission system is highly connected to Central Europe. A UK-Belgium interconnector will provide enhanced opportunities for the UK to trade with wider European power markets.

The Planning Process

Electrical interconnectors and the individual components for which consent is being sought are not listed in the Schedules which describe and define Environmental Impact Assessment (EIA) development.

However, NGNLL has decided to prepare and submit a voluntary ES to accompany the planning application to enable the anticipated environmental effects of the proposed works to be assessed and appropriate mitigation measures to be determined and implemented.

Detailed pre-application consultation was undertaken with statutory consultees, including the local Councils, local communities and the general public. Responses received during the formal consultation process have informed the EIA process, throughout which, informal consultation has also been undertaken with a range of stakeholders.

Content of the Environmental Statement

The ES contains the following information:

- A description of the Proposed Development;
- An outline of the alternatives considered;
- A description of the likely significant effects of the Proposed Development on the environment; and
- A description of measures envisaged to prevent, reduce or where possible off-set any significant adverse impacts on the environment.

Project Proposals

<u>Feasibility Studies</u>

Alternative converter station sites, underground cable routes, landfalls and subsea cable routes were considered as part of the development of the Nemo Link. This established that a converter station site at Richborough and an underground cables route to a landfall at Pegwell Bay was the preferred option as this best meets the project objective relating to technically feasibility, economic viability, deliverability and the least disturbance to the environment and people

Following selection of the preferred option, further detailed environmental and technical studies as well as consultation have been used to refine the preferred option and further reduce the potential environmental effects of the Nemo Link project including the substation which the convertor station is required to connect to. This included considering emerging results from environmental

assessments with initial technical designs and results of consultation with stakeholders, land owners and local communities.

Proposed Development

The Proposed Development will comprise a new converter station, substation and onshore underground cable route leading to the sub-sea cable connection.

Converter Station

The converter station will convert between direct current (DC), which is used for sending electrical power through the subsea cables, and alternating current (AC), which is used by each country's national electricity transmission system. The converter station will require a footprint of approximately 4.85 hectares (ha) and it is proposed that the main building will be constructed re-using the steel frame of the former Richborough Power Station's turbine hall.

The converter station will contain the equipment necessary for the conversion between DC and AC, transformers for switching to the correct voltage rating, filter banks and associated switch gear. The converter station requires 'valve halls' and other buildings to enclose the equipment. The main building will comprise 3 main parts and in total will be approximately 149 metres (m) long by 93m wide with a maximum height of approximately 30.3m. The roof and walls of the converter station will be formed by a steel frame clad with metal panels which will graduate in colour from dark green (lower levels) to white (roofline). AC connection gantries of approximately 15m in height will also be required.

The other equipment will be enclosed in two smaller buildings which comprise a service building and a storage building. These buildings will each be approximately 27.4m long, 13.6m wide and 14.5m high, and attached to the main building. The converter station will be designed for a 40 year lifespan.

Substation

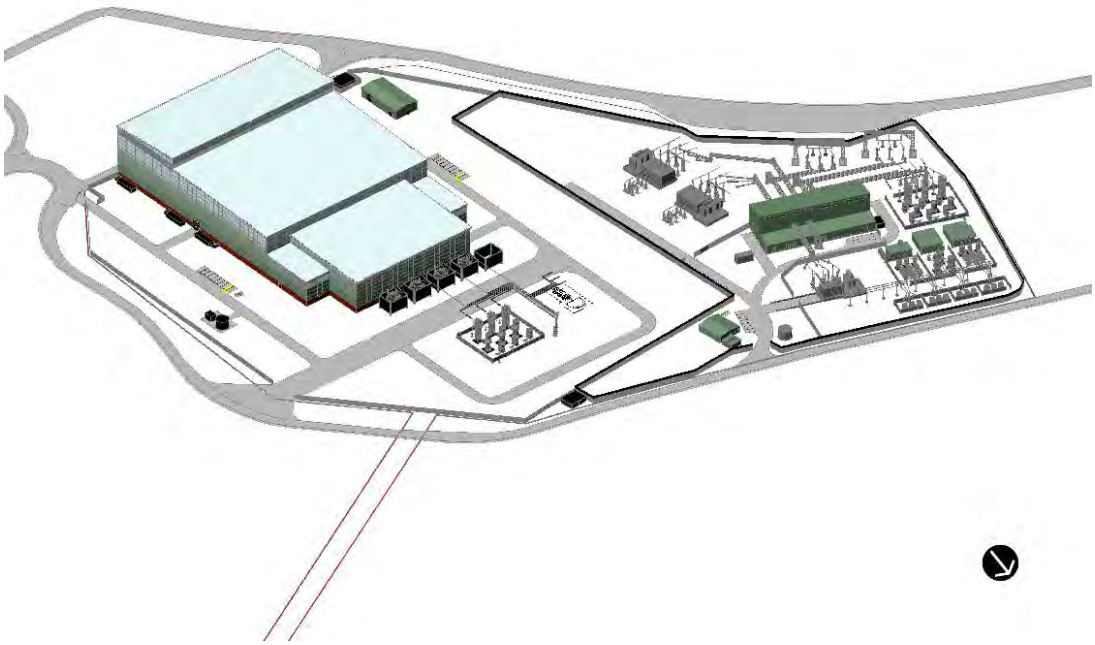
A new 400kV Gas Insulated Switchgear (GIS) substation is needed to connect the interconnector to the national electricity transmission system.

The substation will be within a separately fenced compound adjacent to the proposed converter station to the west. The proposed substation will occupy a footprint of approximately 2.65 ha and will contain a combination of indoor and outdoor electrical equipment.

The substation will include a GIS Hall containing switchgear outdoor gas insulated busbar (GIB), overhead line gantries, two Super Grid Transformers (SGTs), a Mechanically Switched Capacitor (MSC) and a Static Var Compensator (SVC) compound. The MSC and SVC are specific types of equipment used to regulate and stabilise transmission voltages.

The GIS Hall will be approximately 52.2m long, 21.5m wide and 15m high and clad in a similar manner to the converter station. The maximum height of the outdoor electrical equipment will be approximately 12.7m.

Figure 3 – Isometric Drawing of the Proposed Converter Station and Substation



Onshore Underground Cables and Subsea Cables Connection and Landfall

The Proposed Development will include two underground cables (each approximately 15 centimetres (cm) in diameter) which will be installed onshore in a trench approximately 1m wide and 1m deep and sub-sea between the mean low water mark and the landfall in a trench approximately 1-2m wide and 2-3m deep. Fibre optic cables will also be installed for control and communication along the link. An onshore underground cables route has been identified between the subsea cables' landfall at Pegwell Bay and the converter station taking account of the environmental constraints including designated sites of nature conservation, the presence of protected species, the quality of saltmarsh habitat, proximity to residential area, archaeology, highways, planning proposals, watercourses, risk of encountering contamination, utilities and services and land use. The route of the subsea cables to Pegwell Bay has been confirmed by geophysical and geotechnical survey.

The HVDC onshore underground cables will run from the landfall on the coastal side of the existing cycle track which runs parallel to the A256 Sandwich Road, through Pegwell Bay Country Park, then into Stonelees Nature Reserve and the BayPoint sports complex. From the Sports Ground, the cables will be routed by horizontal directional drilling (HDD) beneath the A256, Minster Stream, and a compartment of Hacklinge Marshes SSSI. The cables will terminate at the converter station. The overall length of the onshore cable route and sub-sea cable route from the mean low water mark is approximately 2.1km and 1.8km long respectively.

Upon completion of the cable installation works, land will be restored to its previous condition.

Construction Programme

The construction of the converter station and substation is intended to be undertaken over a period of 36-42 months between mid-2014 and mid-2018. Both the converter station and substation will be commissioned in October 2018.

Main construction activities will include:

- Preliminary works and preconstruction surveys;
- Site clearance and establishment;
- Civil engineering works including earthworks;
- Mechanical and electrical works;
- Commissioning and testing; and
- Site reinstatement and landscape works.

Operation

The converter station and substation will form an integral part of the national grid electricity transmission system. The substation would be an unmanned site and subject to periodic inspections and maintenance visits. The converter station is likely to operate with approximately 6 personnel per day divided between 3 shifts over a 24 hour period.

Summary of Environmental Impacts

The following section summarises the predicted effects of the construction and operation of the Proposed Development on the environment.

Land Use

The cable route and converter station and substation site have been carefully selected to minimise disruption to amenity and the future use of land.

The construction of the converter station and substation will result in the permanent loss of approximately 8 hectares of derelict brownfield land. There is no defined on-going land use; the site and the surrounding land is part of the Richborough Energy Park proposals. The Proposed Development would make a positive contribution as it would result in the re-use of derelict industrial land contributing to national and local sustainability objectives. There would be no adverse effects from the loss of the derelict land to the Proposed Development.

The onshore cables have been routed to avoid areas of existing and proposed developments and the cable route will not result in any permanent land take. Effects on 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.

A permanent 5m cable easement will be required; however this will not affect current land use although there will be some restrictions on planting above the cables route.

Ground Conditions and Contamination

Construction activities such as cables installation, drilling and piling have the potential to disturb areas of contamination and create pathways for the migration of contaminants into watercourses. Prior to construction, 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. Cable laying over the surface of the ground within Pegwell Bay Country Park will prevent potential contamination pathways being opened up and the migration of landfill gas and leachate.

There is a risk of ground and water contamination from spillages of fuel, oil and chemicals and from the importation of contaminated materials from off-site; however this can be managed by the implementation of best practice guidelines. A Construction Environmental Management Plan (CEMP) will be prepared to set out the minimum requirements which contractors will be required to undertake in order to prevent adverse impacts.

Appropriate mitigation techniques will ensure that potential adverse effects are prevented both during construction and operation.

Hydrology and Flood Risk

The Proposed Development has the potential to have adverse effects on the water environment through surface water run-off, ground contamination and disturbance to existing flows and the mobilisation of contaminants both during construction and operation. The River Stour is approximately 10m south of and Minster Stream is approximately 100m north east of the former Richborough power station site.

Best practice measures to prevent pollution of the water environment during construction will be implemented through a CEMP which as a minimum will be based on addressing the EA Pollution Prevention Guidance documents. The cables will be installed by HDD beneath the A256 and Minster Stream before connecting to the proposed converter station; this will avoid any disturbance to this watercourse.

The proposed substation and converter station site is within Flood Zone 1 (low probability of flooding). Ground levels will be raised to ensure the proposed substation and converter station compounds will operate safely in an extreme flood event without increasing flood risk elsewhere. Sustainable drainage measures will be integrated into the detailed drainage design to ensure that water quality is not adversely affected and water discharge rates into the River Stour are no higher than the current rate.

Ecology

A number of designated sites are located along the proposed cable route including Thanet Coast and Sandwich Bay Special Protection Area (SPA) and Ramsar site, Sandwich Bay Special Area of Conservation (SAC), Thanet Coast SAC and Sandwich Bay to Hacklinge Marshes Site of Special Scientific Interest (SSSI). The cable route crosses the designated areas at three locations along the route, passing through the north of Pegwell Bay, Stonelees Nature Reserve and land north of the Richborough Site. Mitigation measures will be developed in consultation with Kent Wildlife Trust to

minimise impacts on, and reinstate, the habitats within these sites. Further details of the likelihood of effects on these nature conservation areas and mitigation measures are detailed at Appendix 8.9 (information for Habitats Regulations Assessment).

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.

Protected species have been identified along the cable route and mitigation measures identified to ensure no adverse effects will result from the Proposed Development. Any disturbance of the local bird population will be avoided by carrying out construction works at the appropriate time of year in consultation with the statutory authorities.

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.

Overall a minor adverse to minor beneficial impact during construction is predicted. No impacts are envisaged during operation.

Archaeology and Cultural Heritage

A desk-based study and walkover survey were undertaken to assess the archaeological potential of the development site.

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. This included seven designated receptors of high importance (one Grade II* Listed building and six Grade II Listed buildings), and twenty-eight non-designated receptors of medium importance which largely comprise archaeological sites recorded as part of modern development control regimes. The remaining 126 sites are non-designated receptors of low and negligible importance.

No significant impacts on above ground or shallow archaeological deposits are predicted; however, a watching brief is proposed during cables installation to identify the presence of unknown archaeological deposits.

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 neutral.

Landscape and Views

The converter station and substation development would 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.

Measures have been incorporated into the development proposals to mitigate effects on landscape and views during construction and on completion of the Proposed Development. Mitigation of the long-term effects on landscape and views would be achieved by using colour graded cladding to the converter station building ranging from a muted green at the building's base to off-white at the roofline, and muted green cladding to the substation building to minimise landscape and visual effects. Native tree and shrub planting is proposed to the western site boundary adjacent the River Stour, to provide filtering and screening of the converter station and substation buildings and associated outdoor equipment particularly in views looking north, east and southwest towards the site from the Saxon Shore Way and River Stour.

The wider proposals for Richborough Energy Park include the implementation of new planting associated with a new estate road. The planting scheme will include tree planting along the eastern and north eastern site boundaries (partly mitigating trees removed to accommodate the new road), new native trees, shrubs and fruit trees near the site entrance, and new native tree planting amongst existing trees and shrubs on the northern site boundary.

The underground cable route would have no 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 chalk 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.

<u>Traffic and Transport</u>

Average Annual Daily Traffic (AADT) flows have been obtained for the key roads to be used during the construction of the Proposed Development including the A229 West Canterbury Road, the A256 Richborough Road, the A256 Dover Road and Sandwich Road. It is predicted that overall the long-term environmental impact of the Proposed Development on traffic and transport during the construction phase would be minor to negligible; a maximum increase of 0.9% in total traffic and 17% increase in HGV traffic is anticipated. A range of mitigation measures including traffic management during construction, appropriate signage in the local area and the preparation of a Transport Management Plan will ensure significant construction effects are avoided.

There are likely to be a number of minor environmental impacts that cannot be fully mitigated during the construction phase. These mainly include impacts relating to pedestrian and cyclist delay and 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 proposed converter station and substation.

Once operational, the converter station will generate a small number of vehicular trips as it is anticipated that six members of staff will be based at the site with two people working shifts over a 24 hour period. This would result in approximately 12 two-way trips per day. The substation will be

unmanned; however, it will on average generate approximately four staff trips a week made by car or Light Goods Vehicle (LGV). A small number of trips may be generated during maintenance of both the converter station and substation; however, this is anticipated to occur infrequently. Operation traffic effects are expected to be negligible.

Noise and Vibration

The general noise climate at sensitive receptors in the vicinity of the Proposed Development is primarily affected by road traffic noise, existing industrial noise, noise from agricultural activities and birdsong.

Best practice construction noise methods will be used to minimise noise associated with cables installation and construction of the substation and converter station and detailed in the CEMP. General construction noise is anticipated to be of minor to neutral significance and will be of a temporary nature. Construction noise during HDD will be of moderate significance; however HDD duration will be for a maximum of 2 days and 1 night for each cable (3 cables in total) and effects will be temporary in nature.

Without mitigation, there is potential for the operation of both the converter station and substation to give rise to complaints from neighbouring properties. Mitigation will be incorporated into the design of the converter station and substation to ensure that noise levels no higher than the background noise levels. Mitigation measures could include the use of noise shields, noise enclosures, low noise fans, and silencers or barriers on cooling fans. With mitigation measures included, the significance of operational noise would be minor as noise levels will be below background levels.

Air Quality

The Proposed Development will make no emissions to air during operation and has not been assessed. Potential construction effects on air quality can potentially arise from construction traffic (including the operation of motor vehicles and plant) and dust arising from construction works.

Background concentrations for 3 representative existing sensitive receptor locations have been obtained from the latest 2010 Defra Background Maps which provide an estimate for Particulate Matter (PM_{10}) concentrations of between 15.55 and 16.14µg/m^3 and concentrations of Nitrogen Dioxide (NO_2) of between 12.84 and 14.33µg/m^3. In the absence of monitoring data for dust deposition, it is assumed to be absent from the local environment (this is a very conservative assessment because dust deposition will be occurring naturally in the surrounding environment).

Exceedance of the annual mean objective concentrations for PM_{10} and NO_2 at the 3 representative receptor locations is not predicted to occur as a result of construction traffic. The significance of effects will be negligible.

A number of mitigation measures will be implemented during the construction works and detailed within the CEMP to minimise potential impacts from dust and air quality emissions. Measures include reducing vehicle speed limits, site management, maintenance of equipment, and 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.

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 to ensure the Thanet Coastal Trail and the Viking Coastal Trail remain open throughout the duration of the installation works. Access to the Country Park will be possible throughout the duration of the works although there will be some areas with limited access and there will be some temporary disruption to users of BayPoint sports complex.

The works to install the cables are similar to those carried out by any utility company in its day-to-day business and would be of short duration and limited in geographic effect. All land take associated with cables installation will be reinstated following completion of cable laying activities so will not adversely affect future recreational land use.

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 due to accommodation requirements and the purchase of materials, equipment and other services during the construction phase. This may have a small benefit through the creation of temporary and permanent jobs locally and nationally.

Electric and Magnetic Fields (EMF)

All equipment that generates, distributes or uses electricity produces EMFs. The NEMO Link uses both AC and DC technology therefore producing both static and alternating electric and magnetic fields.

The new converter station and substation will be designed to ensure that they are compliant with the relevant UK Government guidelines on EMF exposure using the Department for Energy and Climate Change (DECC) Code of Practice to assess the compliance.

An assessment has been carried out of the likely impact of the cable route, converter station and substation. The assessment 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.

Cumulative Impacts

Unrelated Projects

There is the potential for cumulative construction and operation effects to arise from the proposed UK onshore elements of the Nemo Link together with other projects in the surrounding area (unrelated to the Nemo Link) either currently under construction, soon to be subject to a planning application, pending planning decision, or recently granted planning permission. These projects

include: a peaking plant facility at the former Richborough power station site; the Richborough Energy Park estate road; the Pegwell Bay Flood Defence Scheme north of Pegwell Bay Service Station; waste related development on land west of Ramsgate Road; a 5MW solar farm on land west of the River Stour; glasshouses, water storage tanks and pack house at Ebbsfleet Lane; and an anaerobic digestion plant on Ramsgate Road.

An assessment has been undertaken to determine the likely significance of such cumulative effects. There are no predicted long-term cumulative effects resulting from this Proposed Development and other development proposals in the study area. Any potential effects are likely to be localised and temporary during construction and can be mitigated by the use of well-established and industry-standard techniques.

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 the 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 a minor adverse effect overall.

Other Elements of the Nemo Link Project

Applications for consent for the other elements of the Project (sub-sea cables between the UK and Belgium and onshore cables, converter station and substation in Belgium) are being submitted to the relevant national authorities and each element has been subject to environmental assessment to determine the potential for effects on the physical, biological and human environment. All other elements of the Nemo Link have been assessed as having no significant adverse effects on the environment.

There is the potential for cumulative construction and operation effects to arise from the proposed UK onshore elements of the Nemo Link (to which this application relates) together with other elements of the Project, namely the subsea cables in the UK, France and Belgium and the onshore infrastructure in Belgium. Cumulative effects will be limited to the interaction of the subsea cables close to the UK foreshore and the land cable installation in the foreshore and the surrounding area. There will be no cumulative effects as a result of the UK onshore components and the subsea cable works within French and Belgian waters, and with Belgian onshore components, due to distance between these developments during construction and operation.

No significant cumulative adverse effects resulting from any aspect of the UK onshore elements with any other aspect of the Nemo Link are anticipated to arise during the construction or operation phases as significant adverse effects can be avoided through cable micro-routeing and the adoption of best practice and industry-standard mitigation measures during construction.

Grid Connection

The construction and operation of the grid connection which is required for the operation of the Nemo Link, has the potential to result in direct environmental effects and cumulative effects when considered together with the construction and operation of the UK onshore elements of the Nemo

Link. The development of the grid connection is the responsibility of NGET and the route and technology options for the connection are still in early development. The grid connection does not form part of this planning application; an assessment of the likely effects of the connection is considered within the ES.

For the majority of the environmental topic areas, potential adverse effects will be temporary and localised. Adverse construction effects can also be avoided or reduced through the implementation of best practice industry standard mitigation and prevention measures. Careful route alignment would likely ensure that the potential for significant adverse effects on designated areas could be avoided or minimised as far as possible (subject to detailed routeing at a later date).

Appropriate mitigation measures can be implemented during the construction period to ensure that no significant cumulative effects occur. For construction effects with the potential to be longer lasting and/or permanent (e.g. ground conditions and hydrology), the implementation of best practice industry-standard mitigation and preventative measures will also ensure that significant cumulative effects can be avoided.

Potential cumulative effects during the operation period are largely minimal and localised and are not anticipated to be significant. There is potential for cumulative ecological effects on Thanet Coast and Sandwich Bay, Stodmarsh and The Swale Natura 2000 sites (disturbance to breeding and wintering birds using these sites and moving between them). Such effects could potentially be avoided or minimised through the development of the detailed design of the connection (careful route alignment) and identification of mitigation measures. Environmental assessment work will also be undertaken for the connection option to determine the significance of likely effects and appropriate mitigation. The cumulative operation effects on landscape and views (if an overhead line is proposed) 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.

At a time when the nature and extent of the grid connection is finalised, consent under the relevant legislation will be applied for by NGET separately to this planning application for the UK onshore elements of the Nemo Link. All potential relevant environmental effects and appropriate mitigation of the connection will be assessed and identified separately by NGET to provide sufficient information to the relevant authority to enable consents (if required) to be granted under the relevant legislation.

Summary and Conclusions

The Nemo Link is a proposed HVDC electrical interconnector which will allow the transfer of electrical power between the UK and Belgium. The power would be bi-directional, able to flow in either direction at different times, depending on the supply and demand in each country. The development of the Nemo Link will enable a more efficient energy market within the EU in accordance with EU policy.

NGNLL has decided to prepare and submit a voluntary ES to accompany the planning application to enable the anticipated environmental effects of the Proposed Development to be assessed and appropriate mitigation measures to be determined and implemented.

The construction and operation of the Proposed Development will not give rise to any significant long term effects, either in isolation or when considered in combination with other unrelated projects, other aspects of the Nemo Link and the grid connection. Any impacts identified as part of the assessment are considered to be localised and temporary and appropriate mitigation measures will be implemented to avoid, offset or reduce impacts.

The table below provides a summary of the residual (i.e. with mitigation in place) environmental effects of the proposed UK onshore elements of the Nemo Link to which this application relates.

SUMMARY OF EIA RESULTS		
Topic Area	Residual Effects*	
	Construction	Operation
Land Use	Minor Adverse	No Effect
Ground Conditions and Contamination	No Effect	No Effect
Hydrology and Flood Risk	Minor Adverse	Minor Adverse
Ecology	Minor Adverse-Minor Beneficial	Negligible
Archaeology and Cultural Heritage	Low/Negligible	No Effect
Landscape	Moderate Adverse	Minor Adverse
Views	Moderate/Minor Adverse	Moderate/Minor Adverse
Traffic and Transport	Minor Adverse	Negligible
Noise	Moderate	Minor
Air Quality	Negligible	No Effect
Coastal Tourism, Recreation and Socio-Economics	Minor Adverse-Minor Beneficial	No Effect
Electric and Magnetic Fields	No Effect	No Effect

* Summarises residual effects on the basis of the 'worst' or most significant effect identified.

Appendix 16: Belgian Onshore Non-Technical Summary

Voluntary environmental statement

NON-TECHNICAL SUMMARY

Onshore HVDC cables and converter station at Zeebrugge forming part of the Nemo Interconnector

Project n° BE0112000366 | version A | November 2012

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Table of Contents

1 Project goal 3
2 Project description 4
2.1 Project location 4
2.2 Detailed description of the proposed project 4
2.2.1 HVDC cable connection 4
2.2.2 Nemo converter station 5
2.2.3 Alternating Current (AC) cable connection between Nemo and Stevin 6
3 Alternatives 6
3.1 HVDC cable connection 6
3.2 Nemo converter station 7
4 Administrative context 8
4.1 Previous proceedings 8
5 Effect description and Assessment 9
5.1 Soil 9
5.1.1 Reference situation 9
5.1.2 Impact analysis 9
5.2 Water 10
5.2.1 Reference situation 10
5.2.2 Impact analysis 10
5.3 Audible noise 12
5.3.1 Reference situation 12
5.3.2 Impact analysis 12
5.4 EM fields 13
5.4.1 Reference situation 13
5.4.2 Impact analysis 13
5.5 Nature 14
5.5.1 Reference situation 14
5.5.2 Impact analysis 14
5.6 Landscape 16
5.6.1 Reference situation 16
5.6.2 Impact analysis 17
5.7 Human population 18
5.7.1 Reference situation 18
5.7.2 Impact analysis 18
6 Cumulative effects 21
6.1 Audible noise 21
6.2 EM fields 21
6.3 Landscape 21
6.4 Human population 21
7 Conclusion 23

1 Project background

The Nemo interconnector (the Project) is being jointly developed by Elia Asset NV and National Grid Nemo Link Limited. The interconnector will be a High Voltage Direct Current (HVDC) transmission cable system with a capacity of 1000 MW that will link the Belgian and UK electricity transmission networks. The Project will enable electricity to flow in either direction at different times depending on the level of supply and demand in each country. The system will allow a quick response to changes in the balance between supply and demand of electricity in Europe and the UK.

Elia Asset NV is the applicant for the permit for the section of the HVDC cables that will lie in the Belgian part of the North Sea.

The Belgian onshore elements of the Project comprise a converter station and underground HVDC cables in Flanders (the Proposed Development). These cables will connect to the subsea cables across the North Sea to a converter station in Richborough in the UK.

Because the distance of the cables inside a special area of conservation is limited, the Proposed Development does not come under annex I or annex II of the Decision of the Flemish government from 10 December 2004, BS 17.02.05. Also, underground high voltage cables are not listed in annex III. Thus, the Proposed Development does not fall under the jurisdiction of the circulation letter, and an environmental impact assessment (EIA) is not required for the Proposed Development. However, Elia is voluntarily supplying this environmental statement. The layout of this document follows the structure of a request for an exemption from the requirement for an EIA.

2 Description of Proposed Development

2.1 Location

The Proposed Development is located in the city of Brugge, west of the harbour of Zeebrugge. The proposed land connection comes ashore at the beach to the north of the nature reserve, De Fonteintjes. After an underground crossing of the nature reserve, the cable will head east south of the GraafJansader to the Baron de Maerelaan. The converter station is proposed inside the triangular area of land bordered by the railroad tracks to the east of the Baron de Maerelaan, the Kustlaan and the Veerbootstraat.

2.2 Detailed description of the Proposed Development

The primary function of the proposed converter station is the conversion of high voltage direct current (HVDC) to alternating current (used in Elia's AC high voltage network) or vice versa, depending on the direction of the energy flows. The new installation will be constructed in the eastern corner of the zone for community and public utilities (indicated according to the RUP 'Optimalisatie van het hoogspanningsnetwerk in Vlaanderen'; according to the old regional planning, this is a military area), along the Baron De Maerelaan in Zeebrugge.

The converter station will be connected to Elia's AC high voltage network at Stevin's substation, located on the other side of the Baron De Maerelaan. The connection between the two stations will be underground.

2.2.1 HVDC cable connection

Elia is proposing an underground HVDC cable connection, consisting of two separate HVDC cables, that connect to the Nemo converter station west of Zeebrugge's harbour.

The HVDC cables will cross the nature reserve 'De Fonteintjes' via horizontal directional drilling (HDD) over an approximate distance of 500 m. Two alternatives exist for the implementation. (see section 3.1).

An underground transition pit will be installed in order to connect the sea cables with the land cables. The transition joints will be installed in an inspection pit in order to allow for any future testing of the cables.

After the HDD, the cables will be installed in open trenches to the proposed Stevin substation west of the Baron de Maerelaan. Because of the route length in the open

trench, the underground HVDC cable will be installed in two sections. The two sections will be connected to each other via a connection joint in the middle of this part of the route east of the Fluxys station.

In order to avoid difficulties in restoring the existing terrain profile, horizontal directional drilling will be used to cross the GraafJansader and the polder grassland ditches. The Baron de Maerelaan will also be crossed in the same manner. Finally, the cables will be connected to the Nemo converter station.

When the cables are in service, they will produce heat. In order to guarantee the continued functioning of the cables, they may not exceed a certain maximum temperature. When placed in open trenches, the underground cables will be installed in a layer of dolomite to avoid this technical problem. Dolomite has a relatively high heat conductivity that quickly dissipates the heat and therefore prevents the cables from over-heating. The dolomite layer will be approximately 60 cm thick.

Before the installation of the cables in the open trench, any water in the trench will be drained to just under the trench depth. This water drainage will be limited to approximately 30 days. The jointing pit will be installed in such a fashion that the drainage time is as short as possible.

2.2.2 Nemo converter station

The Nemo converter station will be located in the public utility zone bordered by the railway tracks to the east of the Baron de Maerelaan, the Kustlaan and the Veerbootstraat.

The most important characteristics of the converter station are:

- Station area: +/- 30,000 m² (only the installation and buildings, not including any green bordering)
- Building area: +/- 7,000 m²;
- Building height: +/- 20 m;
- Access roads and paved area:+/- 9,000 m²;
- Building cellar depth: 0 m (no cellar);
- Foundation depth: +/- -1 m.

The HVDC cables on the converter station site will be open trenched.

An architectural and landscape study is currently being conducted to develop an optimal design to fit with the surrounding landscape.

2.2.3 AC cable connection between Nemo converter station and Stevin substation

The AC cable connection between the Nemo converter station and the Stevin substation will be located under the Baron de Maerelaan, south of the HVDC cables. This connection is likely to be achieved with three pipe jackings with a diameter of 800 mm.

3 Alternatives

3.1 Alternative locations

Multiple alternative locations were investigated during the “plan MER” procedure (see paragraph 4). The current location was selected from 4 alternatives, evaluating each location on the following parameters:

- Environment
- Landscape
- People: farming
- People: housing
- People: Industry

Full details are available in the EIA used for the “plan MER” procedure, ref. 04/006233, version i, 6th April 2011.

3.2 HVDC cable connection alternative work methods

There are two ways of carrying out the horizontal directional drilling. Either the drill rig will commence drilling at sea and drill towards the coast, or the drill rig will be located on land and drill towards the sea or the beach.

With the first option, the cables will hit land south of the nature reserve south of the GraafJansader. With the second option, the drilling machine will be located in the fields to the south of the GraafJansader, so that the cables with come out of the ground in the sea or on the beach. The drilling machine could also be installed on the beach.

In the event of a sea drilling, the installation of the pipe bundle on land must be completed before the sea drilling construction phase begins. If the drilling is from land, the pipe bundle with either float on the surface of the sea or they will lie on the beach. In each case, the pipe bundle will be laid out in the direction of the horizontal directional drilling.

3.3 Nemo converter station alternative work methods

There are no alternative work methods for the implementation of the converter station.

4 Administrative context

4.1 Previous proceedings

The procedure plan-MER (i.e. EIA), '380kV hoogspanning Zomergem-Zeebrugge', was carried out in the period 2008 – 2011 for the spatial implementation plan (RUP) 'Optimalisatie van het Hoogspanningsnetwerk in Vlaanderen'.

The identification of a region for community and public utilities in Zeebrugge, and the identification of a utility zone along a high-voltage cable route from the Nemo converter station to the coast, are part of this RUP.

The plan-MER, including the assessment, was approved by the MER service on 25th May 2011. The approved plan-MER was integrated in the development of the regional spatial implementation plan (GRUP), provisionally adopted by the Flemish government on 22nd July 2011. The public consultation on the provisionally adopted RUP ran from 13th September to 10 November 2011.The RUP was finally adopted on 13th July 2012.

5 Assessment and description of effects

5.1 Soil

5.1.1 Reference situation

In the area of the proposed development there are roughly two soil types: the polders between Brugge and Zeebrugge, and the artificial ground in Zeebrugge's harbour.

OVAM possesses two relevant soil investigation files where soil pollution was documented in the project area. OVAM stands for Openbare Afvalstoffenmaatschappij voor het Vlaams Gewest (Public Waste Agency of Flanders) and is responsible for waste management and soil remediation in Flanders. The contamination is located in the soil of both sites to the west and east of the Baron De Maerelaan. Both sites are currently owned by the Ministry of Defence and will be fully decontaminated before being sold to a new owner. By the time the proposed development is carried out, these sites will be decontaminated.

5.1.2 Impact analysis

5.1.2.1 Warming of the soil

The soils surrounding the underground cables may warm up because of heat dissipation. In order to guarantee the functioning of the cables, a maximum temperature of 90°C is allowed. To avoid this technical problem, a layer of dolomite is used. This is a standard practice used by Elia.

The thickness of the dolomite layer is such that a maximum soil area temperature will amount to 15°C when the cable is operating at maximum power levels. The underground high voltage cables will only cause the soil temperature to be higher than normal during the cold season, and even in times of maximal use, the increase in temperature will be limited to the normal temperature range.

5.1.2.2 Profile disruption and soil compaction

There will be no significant soil profile degradation in the area of the trenches. The clay soils profile is rather homogeneous and the anthropogenic soils are already disturbed. During construction, the top layer of soil will be removed and stored for later re-use. Once the trench is filled in, the top layer will be restored as close as possible to the original layering.

Inside the construction zones, steel planking will be used due to the sensitivity of the clay grounds to soil compaction.

No significant effects are expected at the converter station site. The site is, for the most part, already paved and, according to the soil investigations, the only soils present are of anthropogenic origin.

5.1.2.3 Soil pollution

The re-use of excess soil from the trenches will be recorded in a Technical Report to avoid the risk of spreading any soil that is subsequently identified as being polluted.

Any soils previously identified as being polluted will be decontaminated before the start of the project.

5.2 Water and flood risk

5.2.1 Reference situation

The HVDC cable will be constructed south of the GraafJansader.

According to the salinity map, the freshwater – saltwater border area lies in the area south of the dunes at 2 m below ground level. At the beach north of the dunes, there is a steep salinity gradient to 25 m below ground level at the coastline.

On the water assessment map, the polders are categorized as very sensitive for groundwater flow. In theory, the polders may be flooded from the sea. The zone for the proposed converter station is not located in an area indicated as sensitive to flooding. To the southwest of the proposed Stevin substation is a flood risk zone an area of which was recently flooded.

There is no groundwater extraction or protection zone in the surrounding area.

5.2.2 Impact analysis

5.2.2.1 Modified rain water drainage and infiltration

The site for the proposed converter station is mostly paved. The portion that is paved will be halved by this Proposed Development. Consequently, the Proposed Development will lead to an increase (restored pre-built situation) in infiltration (addition to the groundwater) and/or a decrease (restore pre-built situation) 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.

5.2.2.2 Disruption of the groundwater level and groundwater flow

5.2.2.2.1 Ground water drainage

Groundwater drainage is necessary while making open trenches and can have an effect on the groundwater level and groundwater flow.

The influence on pools and low-lying grounds is relatively small because of the low permeability. After 30 days of drainage, a reduction of the ground water level of 5 cm is expected at a distance of 100 m from the trench. The expected flow rate of the extracted groundwater for the entire trench is 350 m³/day(trench of 1500 m).

In the polder grounds (= creek deposits) the groundwater level reduction contour of 5 cm is located at a distance of 500 m from the trench. The expected flow rate of the extracted groundwater for the entire trench is 2000 m³/day and is almost six times higher than in the pool grounds, also for a trench length of 1500 m.

The proposed route of the cables lies in a zone with shallow salinized groundwater (0-2 m ground level). The duration and depth of the expected drainage are not of the nature that salinity will increase. A contribution to increased salinity can occur indirectly if freshwater is pulled from under the nature reserve, de Fonteintjes. Poor hydraulic contact between GraafJansader and the dunes to the north of the N34, could cause significant groundwater and surface water reduction in the nature reserve. Considering the natural characteristics of de Fonteintjes, this should be avoided and any necessary measures will be applied. An Appropriate Assessment will define further which measures will have to be taken at what location, in order to minimize effects.

5.2.2.2.2 Dolomite layer

The dolomite layer has a very high permeability, unlike the layers under and above. The dolomite layer could cause a decrease of the groundwater hydrostatic line, causing a draining effect in some connecting grounds and ditches. This draining effect could extend to the nature reserve, de Fonteintjes.

It is also possible that the water table will decrease permanently over the complete length of the trench. The groundwater hydraulic head in certain locations under the polder, clay and peat layers may become 20-30 cm lower than the water table. In the event of an entrenched dolomite bedding, these layers together may cause a hydraulic ‘short circuit’ and make the effect permanent.

Possible mitigation measures

The following mitigating measures are proposed to limit the effects on the groundwater level caused by the Proposed Development:

- Re-pumping of groundwater to the site;
- Limiting duration of groundwater pumping (i.e. by placing sheet piling with underwater concrete);
- Fragmentation of the dolomite bedding by means of ducts;
- The application of clay plugs to limit the hydraulic contact between the dolomite and the water-bearing Pleistocene sands.

The impact radius of the groundwater pumping can be limited, provided that these measures are taken during the installation of the underground HVDC cable. Groundwater fluctuations during the exploitation phase can be avoided by the use of dolomite fragmentation and the application of clay stops.,. Consequently, significant effects to the groundwater level and groundwater flow will be avoided.

Based on the assessment above, an additional groundwater effects study was ordered by Elia to identity the specific mitigation methods.

5.3 Audible noise

5.3.1 Reference situation

The current audible noise quality at the site of the proposed Nemo converter station is determined on the basis of data from a study by Vinçotte Environment. This study shows that during the day and in the evening the VLAREM guide values are exceeded at all points. The night values, however, are met.

5.3.2 Impact analysis

These studies were carried out for the designs of the Stevin and Nemo stations as they were at the time. Modifications to the stations have already been proposed on the basis of those findings. The final design of the Stevin substation will be elaborated in the project EIA for Stevin. The final design of the Nemo converter station will be further elaborated by the supplier of the installations. The final designs will take forward a vision which is currently being developed about the architectural and landscape integration of the stations.

This section therefore provides an assessment of the expected impact based on the current outline designs. The final designs will be determined only in the course of 2013-2014.

5.3.2.1 Nemo converter station

It can be concluded that the audible noise impact of the converter station (including the recommended mitigation measures) on the original ambient audible noise is negligible throughout the daytime and the evening. The calculated increase in ambient audible noise is not perceptible by the human ear.

During the night, an increase in ambient audible noise perceptible by the human ear may occur at one measuring point.

5.4 EM fields

5.4.1 Reference situation

For Belwind's wind turbine concession at Bligh Bank, an onshore underground 150 kV high voltage cable was installed. The cable lands at Londenstraat in Zeebrugge and then continues to Evendijk-West, continuing along it in an easterly direction, crossing the N31 road and railway lines, and eventually connecting to the Blondeellaan substation in the port.

The installation of an onshore 220 kV cable has been proposed by Northwind in the near future (2012/2013) in the framework of their wind farm concession.

Elia will examining the connection of the other offshore wind farm developments to the onshore high-voltage grid. The exact number of cables required, and their precise location, is not yet known. The number is estimated at seven cables, which will land east of the Nemo cable and then run south of the Nemo cable to the Stevin high-voltage station.

Moreover, west of the Baron de Maerelaan the Stevin substation will be built, and there are also plans for a 150 kV overhead line between the existing Blondeellaan substation and the proposed Stevin substation.

5.4.2 Impact analysis

5.4.2.1 HVDC link

The HVDC cables will generate electric and magnetic fields.

The electric field is almost completely screened off by the metal screens on the outside of the insulation around each conductor. Magnetic fields, however, are not blocked by these screens.

The magnetic fields surrounding the separate cables can be largely neutralised by laying the two cables close to one another. Because of the opposite flow direction of the two separate cables, the magnetic fields are also opposite and largely cancel out each other.

In this way, the field strengths remain of the same order of magnitude as the earth's natural magnetic field.

5.4.2.2 Converter station

The HVDC cables will be connected to the Nemo converter station. Inside the station, the direct current is converted to alternating current or alternating current to direct current, depending on the direction of the energy flows.

The main equipment is electrically and magnetically shielded by the converter building.

5.4.2.2.1 DC cables

The static electric and magnetic fields generated by the DC cables at the converter station are comparable with those of the HVDC cable.

5.4.2.2.2 AC cables

Magnetic and electric fields generated by alternating current have a very low frequency. Magnetic and electric fields may occur on the converter station site. However, perimeter fencing will be installed for safety purposes. At the site enclosure, the average magnetic and electric field is already strongly reduced.

5.5 Nature

5.5.1 Reference situation

The area for the Proposed Development is for the most part situated in the ‘Poldercomplex’ special bird protection area, partly in the ‘Duingebieden incl. IJzermonding en Zwin’ special habitat protection area, and partly in ‘de Fonteintjes’ and ‘Oudemaarspolder’ ecological network, of which the recognised ‘Fonteintjes’ nature reserve forms part. The ‘Polders’ special habitat protection area lies in close proximity to the area of the Proposed Development.

5.5.2 Impact analysis

5.5.2.1 Habitat loss

The Proposed Development will cause temporary habitat loss as a result of the temporary storage of the ducts bundle in the polder (for drilling from the sea), creation of the construction area, excavation of the trenches for the HVDC cables, and construction of the underground jointing pits.

When drilling from the land, the ducts bundle would not be temporarily stored onshore, but would prepared at sea or installed on the beach. This would therefore entail a more limited temporary loss of habitat.

The HVDC cable will be installed through directional drilling underneath the beach, the 'Duingebieden incl. IJzermonding en Zwin' (special habitat protection area), the recognised 'Fonteintjes' nature reserve and the 'De Fonteintjes' and 'Oudemaarspolder' ecological network. Directional drilling will therefore not cause a loss of habitat within these protected areas.

Because of the temporary nature of the loss of habitat, and the fact that the vegetation can be restored afterwards, the impact of construction of the trench, the work area and the connecting jointsin the 'Poldercomplex' special protection area, is considered acceptable.

Possible mitigation measures

In order to minimise possible damage to the biologically valuable habitats present in the polder area, it is proposed to install the larger part of the pipe bundle on the less biologically valuable arable plots. Care should be taken that the installation is executed with minimum damage to the vegetation currently under development there (polder meadows, salty lakes/creeks).

Permanent loss of habitat occurs only as a result of the construction of the underground jointing pits and the converter station.

Because of the minimal area of permanent biotope loss, the impact of the construction of the jointing pits is considered negligible. At the converter station, there is only permanent loss of the biologically less-valuable habitats. This is also considered acceptable.

5.5.2.2 Disturbance of birds

Noise emissions may disturb birds in the surrounding ornithologically valuable areas.

Noise generated during the construction phase is not considered significant to bird life because of the following findings:

- the noise during construction is temporary;
- the current ambient audible noise in the area is already quite high because of its position parallel to Kustlaan and the surrounding industry;
- the area is regarded as clearly acoustically disturbed for bird life and is therefore not susceptible to acoustic disturbance of bird life;
- the relatively limited number of (highly) disturbance-sensitive summer birds, water birds and waders;

- a study by Gabriels (1998) has shown that temporary audible noise levels do not have a significant lasting impact on animal life.

The operation of the Nemo converter station will lead to a permanent increase in audible noise level. The audible noise studies have shown that the disturbance contour of more than 45 dB(A) does not reach as far as the polder area. Consequently, no significant audible noise impact is expected in relation to flora and fauna.

5.5.2.3 Drying out

Lowering of the groundwater level during drainage may have a drying-out impact on the local groundwater-dependent vegetation and species habitats. Increased salinity of shallow ground water is also a possible effect to be taken into account. The establishment of a dolomite base may also have a draining, and therefore drying-out, effect. This effect might reach as far as into the De Fonteintjes nature reserve.

Possible mitigation measures that may be used to avert such effects have been mentioned in section 5.2.2.2. On the basis of the possible effects with regards to groundwater, it was decided to conduct additional investigations so that, by the time the application for the planning permit is submitted (which will have to include an Appropriate Assessment for the Natura 2000 areas), it will be clear which mitigation measures will be taken exactly where in order to prevent significant negative effects on the natural characteristics of these areas.

5.5.2.4 Soil heating

As a result of the heat emitted by the underground cables, the soil in the immediate vicinity of the cables may heat up. The warmer soil may speed up the growth of vegetation, but soil heating may also lead to the soil drying out. As the cables will be laid on a dolomite base, there will be a spatial spreading of the heat, reducing soil heating. Soil heating will therefore not give rise to a significant adverse impact on the natural features present.

5.6 Landscape

5.6.1 Reference situation

According to the Landscape Atlas, the area of the Proposed Development is for the most part situated in the valuable landscape areas (“relictzones”) ‘DuinenOostkust’ (north of GraafJansader) and ‘Oudemaarspolder’ and ‘Kreekrugpolder ten westen van het kanaal’ (situated south of GraafJansader). The Proposed Development is also situated in the very valuable landscape areas (“ankerplaatsen”) ‘Strand en DuinenFonteintjes’ and ‘Oudemaarspolder’

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.

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 nil.

5.6.2 Impact analysis

5.6.2.1 Impacts on archaeological potential

For the cables that are laid through directional drilling, the risk of impacts on archaeological heritage is deemed quite limited. Elia will have an archaeological investigation carried out for the part of the HVDC cable that will be installed in an open trench. The archaeological investigation will be conducted in consultation with the *Onroerend Erfgoed* (Heritage) agency.

As a result of the previous activities pursued at the site where the converter station is proposed, it is expected that the soil has already been quite disturbed, which further reduces the likelihood of an impact on archaeological potential. No archaeological investigation is deemed necessary here.

5.6.2.2 Visual disruption

The visual disruption in 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. However, the inspection pit will be visible. 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.

5.7 Human population

5.7.1 Reference situation

The cable route runs across the beach and dunes of Zeebrugge and the polder hinterland. Here, most of the land is used for farming, i.e. as meadows. There are no houses in this area.

The proposed converter station is situated in a highly industrialised environment characterised by harbour and transport activities. The proposed location of the converter station was in military use, but this use has recently been discontinued.

The audible noise study carried out by Vinçotte Environment shows that the ambient audible noise in the area covered by the Proposed Development is already quite high due to the presence of Kustlaan (and transport zone) which constitutes a significant audible noise source.

5.7.2 Impact analysis

5.7.2.1 Consumption of land

The trench itself and the construction area take up land. Moreover, the ducts bundle installed at the drilling exit point also temporarily occupies land (on land in the case of drilling from the sea and at sea or on the beach when drilling from land).

After the trench has been backfilled, farming activities can be resumed, for both grazing and crop cultivation. Farmers who are adversely affected by the land take on farmland will receive appropriate compensation in accordance with the protocol agreed between Elia and the agricultural organisations. Because of the temporary nature of this claim on land, this impact is considered limited.

The only land that is permanently taken up by the HVDC cable is occupied by the inspection pits. This is not regarded as significant because of the limited size of the pits.

The converter station will be built on a site that was formerly used for military purposes. The land permanently occupied by the station is therefore not relevant to functional loss for the human population.

5.7.2.2 Visual disruption

There will be temporary visual disruption during the construction stage of the HVDC cable and the converter station. The work may cause disruption for people spending their leisure time on the beach, cyclists using the coastal cycling route, people living along Evendijk West, and residents of Veerbootstraat. Because of its temporary nature, this impact is considered limited.

After the construction phase, only the inspection pits will be visible along the HVDC link. This is not considered significant because of the limited size of the pits.

The converter station will have a permanent visual effect. The proposed infrastructure may be higher than the existing structures and may also have a more industrial appearance. There will be visual impact for the residents of Veerbootstraat, Venetiëstraat, Kustlaan and Baron De Maerelaan. In order to limit the visual impact, Elia is incorporating an architectural and landscaping design in order to maximise natural integration of the converter station into the surrounding area. Multiple designs are being considered in order to maximise the options.

5.7.2.3 Audible noise

There are residential areas to the east and northwest of the proposed converter station. The noise exposure to humans during the construction phase is considered minor negative because of the following findings:

- the audible noise sources during the construction phase must at all times comply with the standards required by law;
- the noise produced during the construction phase is temporary;
- the current ambient audible noise in the area is already quite high;
- noise reduction measures can be taken.

There will be a permanent increase in audible noise while the Nemo converter station is operational. The audible noise study compiled by Vinçotte Environment shows that the disturbance contour of more than 45 dB(A) is not located within the residential zone. Consequently, it can be argued that the VLAREM guide values for the day, evening and night periods within the adjacent residential areas will be complied with.

5.7.2.4 Impact of electromagnetic fields

5.7.2.4.1 HVDC link

The cables that will be used in the Proposed Development are direct current cables. These generate static electric and static magnetic fields. The electric fields are blocked by the cable covering, which cannot however block magnetic fields.

The maximum magnetic field strength at ground level above the cables will be within the order of magnitude of the earth's magnetic field and be more than 10,000 times lower than the exposure limit to the general public proposed by the ICNIRP. It can therefore be concluded that there will be no impact on human health.

5.7.2.4.2 Converter station

The outdoor installation of the converter station will generate extremely low-frequency electric and magnetic fields (alternating current). However, the site will have a perimeter fence for safety reasons. At the enclosure of the site, the average magnetic field is already greatly reduced.

The houses in Veerbootstraat are located more than 50 m away from the converter station enclosure. At the houses, the magnetic and electric fields will be reduced to such an extent that there can be no impact on humans.

5.7.2.5 Impact as a result of additional surfacing

Since the design will be compliant with regional urban development regulations on rain water wells, infiltration facilities, buffer facilities and separate discharge of sewage and rain water and the decrease of surfacing, no negative impact is expected.

6 Cumulative effects

6.1 Audible noise

The future Stevin substation across the road from Baron de Maerelaan may cause an additional audible noise impact. For this reason, the audible noise impact was also determined for the operation of Nemo together with the Stevin substation.

It can be concluded that during the day and the evening the total audible noise impact of Nemo (including the recommended mitigation measures) and Stevin on the original ambient audible noise is negligible. The calculated increase in ambient audible noise is not perceptible to the human ear.

The final designs of the Stevin and Nemo stations will be elaborated later, including their architectural and landscape integration which is still under development. A new audible noise study will be compiled for the final design in connection with the environmental permit application.

6.2 EM fields

Magnetic and electric fields will also be generated at the proposed Stevin substation. Only AC is applied in this station. The average magnetic field is already greatly reduced at the site enclosure. Accordingly, no impact is expected as a result of the combination of the Nemo converter station and the Stevin substation.

6.3 Landscape

The Stevin substation is being proposed on the former military site west of Baron de Maerelaan. As this site borders the Oudemaarspolder, and the Nemo station is separated from the polder by railway and road infrastructure, it is expected that the Stevin substation will cause a potentially greater visual disruption on the Oudemaarspolder. It is expected that because of the presence of the Stevin substation the additional disturbance to Oudemaarspolder resulting from the construction of the Nemo converter station will be relatively limited.

6.4 Human population

Cumulative effects may result from the proposed Stevin substation which will already be operational when the converter station is built.

The cumulative audible noise impact is described in section 6.1. The disturbance contour of more 45 dB(A) will not be within the residential area. The cumulative effects within the

adjacent residential areas comply with the VLAREM guide values for the day, evening and night periods.

For an analysis of the cumulative impact of the EM fields, see section 6.2. No impact is expected as the result of the combination of the Nemo converter station and Stevin substation.

7 Conclusion

This environmental assessment has been drawn up for the underground HVDC cable system and converter station that Elia intends to build west of the port of Zeebrugge. This report examines which effects could be generated by the Proposed Development in both the construction and operational phase.

For the purposes of the application for the planning and environmental permit, the following investigations to further reduce the impact are still in progress:

- Inquiry into the groundwater system in the vicinity of the cable route.
- Development of an architectural and landscape concept for the station.
- Conducting new audible noise simulations (after the final design has been completed)

The measures taken ensure that the Proposed Development will not have any major negative impacts on the environment.

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