# Humber Gateway Offshore Windfarm *Sabellaria* Report

Report to Environmental Resources Management Ltd

Institute of Estuarine and Coastal Studies
University of Hull

May 2006

Institute of Estuarine & Coastal Studies (IECS)
The University of Hull
Cottingham Road
Hull
HU6 7RX
UK

Tel: +44 (0)1482 465667 or 465661
Fax/Tel: +44 (0)1482 465001

E-mail:
iecs@hull.ac.uk

Web site:
http://www.hull.ac.uk/iecs

**Author(s): J.H. Allen, F. Burlinson & D. Burdon**

**Report: ZBB673-F-2006**

Client: Environmental
Resources Management Ltd

Report title: **Humber Gateway Offshore Windfarm *Sabellaria* Report**

May 2006

Reference No: ZBB673-F-2006

For and on behalf of the Institute of Estuarine and Coastal Studies

Approved by: ______________________

Signed: ______________________

Position: ______________________

Date: ______________________

This report has been prepared by the Institute of Estuarine and Coastal Studies, with all reasonable care, skill and attention to detail as set within the terms of the Contract with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This is a confidential report to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such parties rely on the report at their own risk.

## TABLE OF CONTENTS

# 1. INTRODUCTION

## 1.1 General

This report provides an assessment of the biogenic reefs present within the subtidal areas of the Holderness coast, directly within and adjacent to the proposed development of an offshore windfarm, 8km from Easington. The proposed development will comprise up to 80 turbines, sited within a development area of 35km$^2$ (Figure 1).

The Institute of Estuarine and Coastal Studies (IECS) were commissioned by Environmental Resources Management (ERM), on behalf of the developer (E.ON UK Renewables), to carry out an evaluation of the marine ecology within the area, and as part of this study, two species of reef forming polychaete (*Sabellaria spinulosa* and *S. alveolata*) were identified at locations in and adjacent to the proposed windfarm site.

These species can form reef like structures on the seabed and consequently are of conservation interest and protected under the EC Habitats Directive. Furthermore, *S. alveolata* has not been reliably recorded on the east coast of the UK. Consequently, further survey work has been carried out to clarify the status of these species in the area. This report provides further information on the distribution and status of the *Sabellaria* populations and highlights any potential impacts related to the windfarm development.

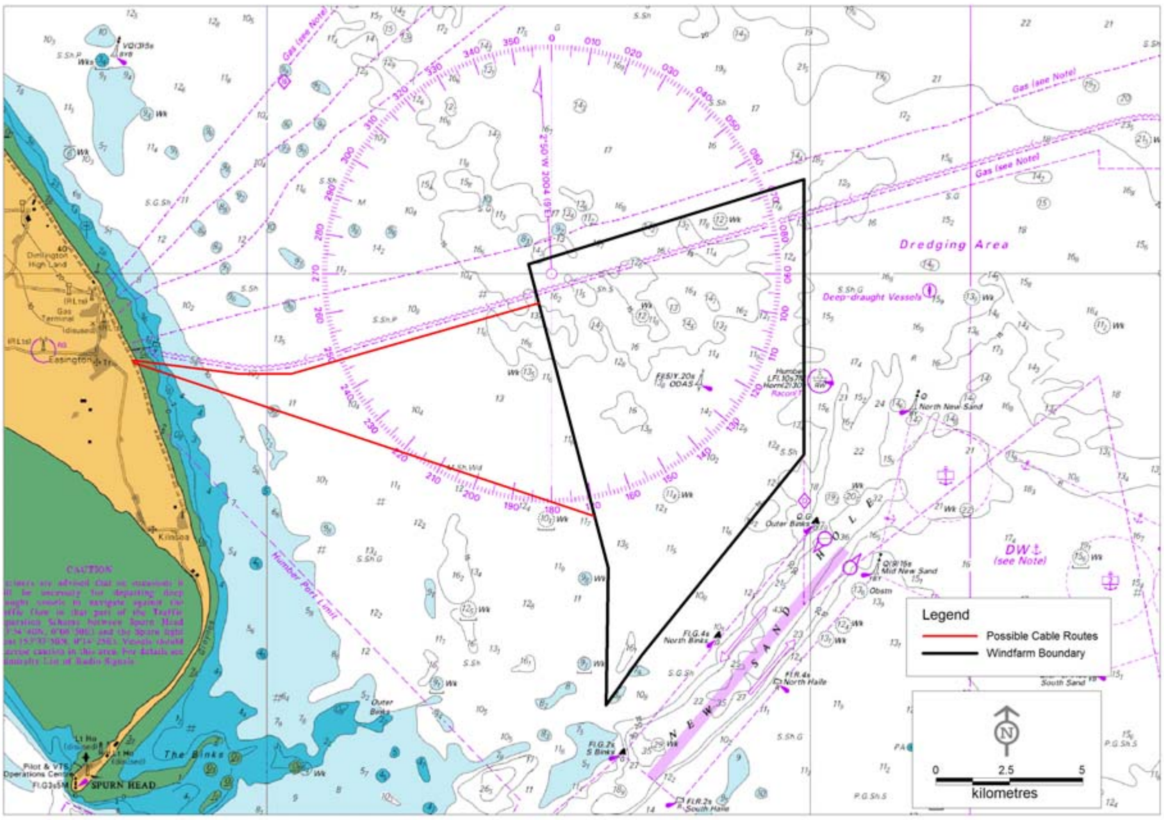



**Figure 1. Location of proposed windfarm.**

## 1.2 Biogenic Reefs

Reefs are one of the UK marine habitats defined under Annex 1 of the EC Habitats Directive and may be broadly divided into reefs which comprise of animals and plants growing on rock protruding from the seabed, and those where the reef structure is created by the species themselves (biogenic reefs). In the UK, the most important biogenic reefs in inshore waters are those comprised of *Sabellaria alveolata*, *S. spinulosa*, *Mytilus edulis*, *Modiolus modiolus* and *Serpula vermicularis.* Statutory protection in the UK for intertidal examples of *S. alveolata* may be achieved through SSSI designation and both species of Sabellaria may occur as sub-features of non-reef Annex 1 habitats (e.g. 'intertidal mudflats and sandflats' or 'Sandbanks which are slightly covered by seawater all the time'). Biodiversity Action Plans (BAPs) have also been defined for both *Sabellaria alveolata* and *S. spinulosa*.

The two species of *Sabellaria* vary somewhat both in terms of distribution and reef morphology. For example, *S. alveolata* is predominantly an intertidal species although it may extend into the shallow sublittoral. The UK represents the northern extremity of this species and consequently it is primarily found on the south and west coast of the UK (between Lyme Regis and the Solway) with few reliable records further east or north. This species may form extensive reef structures up to 1m high in which the tubes of the worms form tightly packed concretions on cobble, pebble or bedrock with a characteristic honeycomb appearance. *Sabellaria spinulosa* has a somewhat wider distribution and is primarily found in the shallow sublittoral. This species tends not to form extensive reef formations but instead is either solitary or found in low-lying aggregations of tubes in mixed sediment or sometimes encrusting cobbles and pebbles. However in some areas (e.g. the Wash) this species may form more extensive reef structures which cover large areas of seabed. Examples of the two species are given in Figure 2 and 3.

**Figure 2. Example of encrusting *Sabellaria spinulosa* (Image: JNCC - published on the *MarLIN* Web site).**

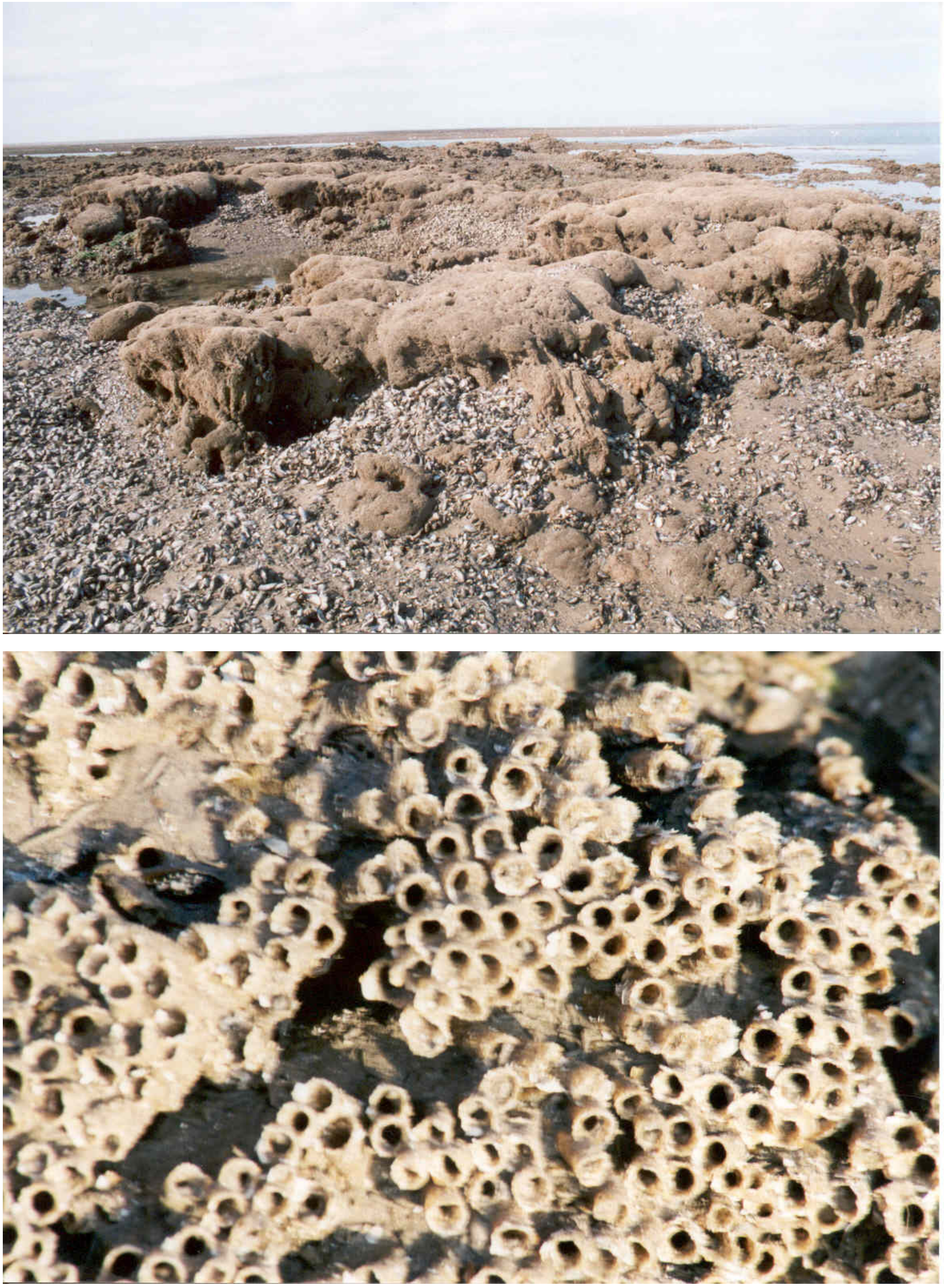


**Figure 3. Typical examples of intertidal *Sabellaria alveolata* reef (Image: JH Allen/IECS).**

## 2. SURVEY METHODOLOGY

Prior to this study, a number of baseline surveys within and adjacent to the proposed windfarm site were carried out as part of the scoping process. The methodologies for the baseline benthic surveys followed DEFRA Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements (Version 2 – June 2004) and all methodologies were agreed with CEFAS prior to initiation. These have been reported elsewhere but are summarised here:

- Geophysical Survey: Sidescan Sonar (105 kHz & 309 kHz), Sub-bottom profiler, magnetometer and echosounder (bathymetric) survey of windfarm site and proposed cable routes (area surveyed up 500m around the proposed site/cable routes)
- Baseline benthic survey: 54 stations sampled by Hamon grab
- Baseline Epibenthic survey: 27 stations sampled by 2m beam trawl

As the presence of two species of *Sabellaria* was determined from the baseline surveys described above, it was decided to carry out further survey work to assess the nature and extent of the *Sabellaria* populations. The aim of this survey was to provide a rapid assessment of *Sabellaria* within and adjacent to the proposed windfarm site using drop down video at selected sites which would provide enough information to give a preliminary assessment of the status of the species but not to map in detail the overall distribution of the species which would require a much more intensive survey. The survey methodology used here was agreed in advance with English Nature and as broad scale acoustic/geophysical data (beyond 500m outside the development site) was not available a wider scale survey of *Sabellaria* distribution were not undertaken in the current study but focused on those areas where the species was previously recorded.

Based on the subtidal benthic (grab survey) positions at which *S. alveolata* and *S. spinulosa* were recorded, a predetermined transect was established, with the benthic sampling station set as the mid point of the transect. Upon arrival at the transect start point and using the DGPS (Differential Global Positioning System) to fix the co-ordinates recorded for the grab position, a drop down video camera (SeaViewer Seadrop 650) was lowered over the side. The survey vessel then either maintained a position over the sampling site or drifted with the tide (dependant on tide/wind) in order to get the optimum coverage and video footage. The video camera was kept as close to the seabed as possible to allow for a clear representation of the bed and faunal type to be recorded. A maximum period of 5 minutes was allowed for each video-recording dependant on the strength of tidal currents/water clarity and subsequent movement of the vessel before the video camera was retrieved. For each site, the start and end time of the video display was noted along with start and end positions, and any other relevant features regarding substratum and epifauna/flora. This procedure was repeated 100-200m east and west from each sampling station.

The optimal time for video surveying in the marine environment is usually related to prolonged calm conditions; however, seasonal algal blooms can very quickly deteriorate the best of conditions. Historically, the best water clarity is observed as either early spring or mid-summer, and conditions can be improved further by surveying over neap tides. Further difficulties in terms of water clarity are caused by the Humber plume which severely reduces visibility over much of the tidal cycle (particularly on ebb tides). Therefore, conditions dictated the precise period of video sampling, although all attempts were made to ensure that any deployment coincided with the optimal environmental state. Surveys were carried out on the 9-10$^{th}$ August, 13/14$^{th}$ September and 5$^{th}$ October during which a combination of neap tides and calm weather gave the best chance of good water clarity.

In addition to the drop-down video, a 200 kHz RoxAnn Groundmaster single beam AGDS (Acoustic Ground Discrimination System) was deployed whilst running the transects in order to provide supplementary information on seabed sedimentary characteristics and depth profile at the areas where *Sabellaria* had been recorded.

# 3. RESULTS

## 3.1. Geophysical Survey

Full results of the geophysical survey are given in a separate report, but of relevance to this study is the description seabed features derived from the side-scan survey (Figure 4). Over the majority of the windfarm site and the proposed cable routes the seabed comprises of a veneer of sandy gravel and gravelly sand with pebbles, cobbles and boulders. This veneer derives from erosion products of the underlying Pleistocene Bolders Bank Formation comprised of boulder clay. The coarser material has also been formed into localised ridges of gravel and cobbles which run NW-SE across the area. To the south-eastern edge of the windfarm and at the nearshore end of the cable route, the seabed comprises of sand sometimes forming patches or ribbons.


**Figure 4. Seabed Features of proposed windfarm site from geophysical survey.**

## 3.2. Benthic Surveys

### 3.2.1. DISTRIBUTION OF *SABELLARIA ALVEOLATA*

The subtidal benthic survey identified areas within the cable route and south western edge of the turbine box that contained varying abundance of the Honeycomb worm *Sabellaria alvelolata*. In total, 12 of the 54 benthic stations contained *Sabellaria alveolata* ranging in abundance from 1 to 467 individuals per single 0.1m$^2$ grab and average abundances at each station (based on between 1 to 3 x 0.1m$^2$ grab per station) are given in Figure 5.

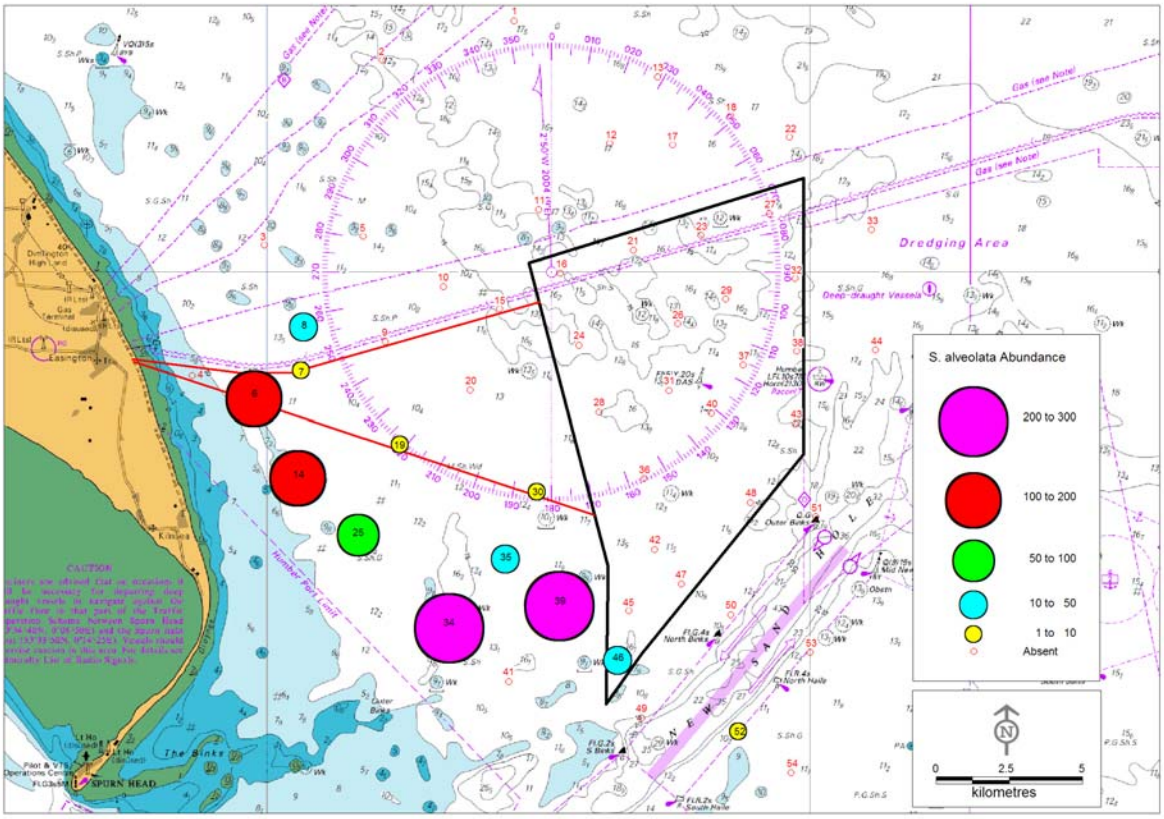



**Figure 5. Distribution of *Sabellaria alveolata* (average abundance per 0.1m$^2$) from benthic survey (numbers indicate station code).**

### 3.2.2. DISTRIBUTION OF *SABELLARIA SPINULOSA*

In addition to the presence of *Sabellaria alveolata*, the benthic survey also identified sampling stations which contained variable densities of the similar species *Sabellaria spinulosa*, a species commonly recorded along the eastern coastline of England. In total 37 stations contained *Sabellaria spinulosa* in varying densities ranging between 1 to 32 individuals per single 0.1m$^2$ grab. Average abundances at each station are given in Figure 6.

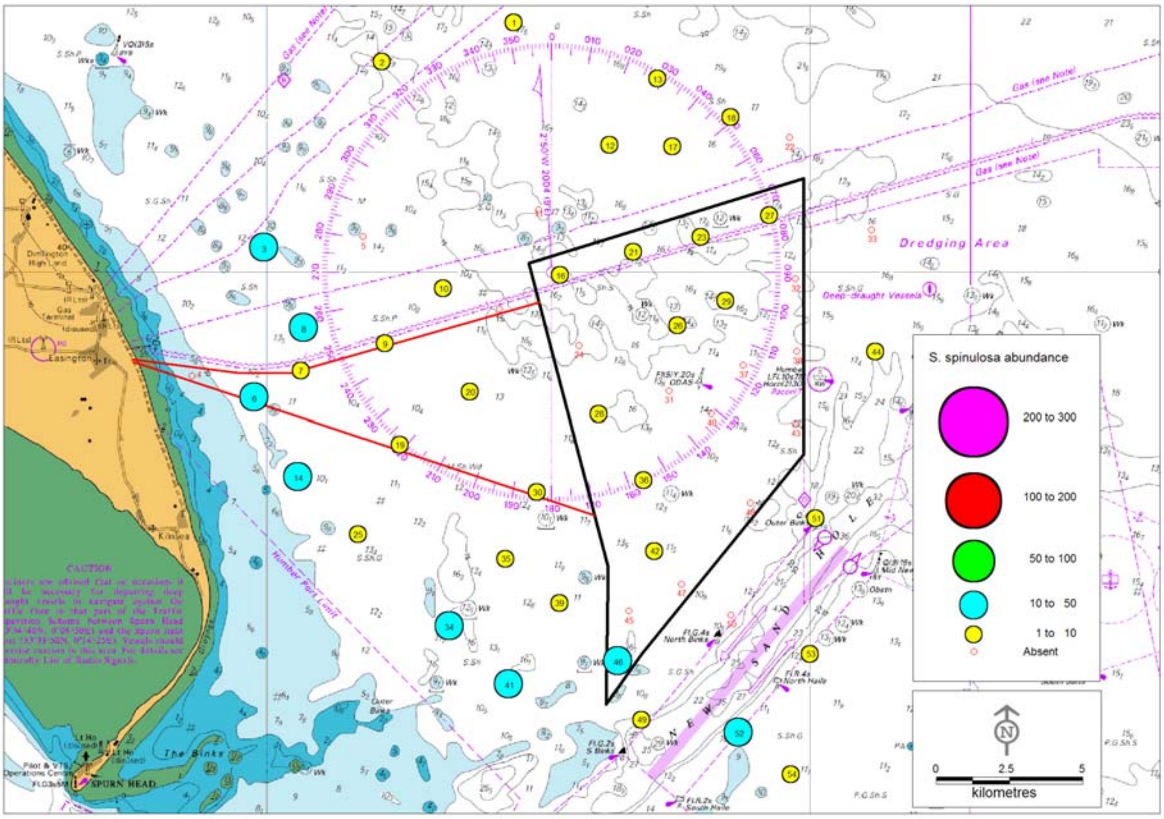



**Figure 6. Distribution of *Sabellaria spinulosa* (average abundance per 0.1m$^2$) from benthic survey (numbers indicate station code).**

## 3.3. Epibenthic/Fish Trawl Surveys

No quantitative data for *Sabellaria* was obtained from the epibenthic and fish trawls. However, at some sites occasional small pieces of 'old' *Sabellaria* structures were found in the trawls. Of the 27 beams trawls and 17 otter trawls only four contained some evidence of *Sabellaria*, although not in any significant quantity.

## 3.4. AGDS Survey

The Roxann Groundmaster AGDS outputs two echo signals (E1 & E2) which equate to roughness and hardness of the seabed respectively and these have been plotted along with the distribution of *Sabellaria* in Figures 7 and 8. The area of seabed covered by the echo returns from a single beam AGDS is largely related to water depth and transducer beam width. The system used here is a 205 kHz system with a transducer beam width of 10 degrees. The ability of the system to detect biogenic reef features will depend on the size of the features under investigation. A large reef structure of for example 5m to 10m across which covers the area of seabed coved by the transducer beam may give a unique echo return which, with careful ground-truthing, can be used to identify areas of reef directly. However, patchy low lying clumps of reef encrusting boulders/cobbles will not give a distinct echo signal based on the reef but will be based on the entire area of seabed coved by the beam. Therefore, in mixed sediments the system will give an 'average' value of roughness or hardness for an area and in such cases the system may not directly identify areas of biogenic reef but instead will indicate areas of suitable habitat.

The results derived from the AGDS and benthic studies indicate that *S. alveolata* is more prevalent in shallower inshore waters whilst *S. spinulosa* extends further offshore into slightly deeper waters although the highest abundances of both species are inshore of the proposed windfarm. In terms of seabed type, the results of the AGDS (and groundtruthed by video) indicate much of the area is moderately rough/hard (i.e. primarily coarser sediments such as pebbles and cobbles) on sand and gravel whilst the softer sediments (sand) are found closer to the shore. These results broadly correlate with the results of the side-scan survey. Values of E1 (seabed roughness) and E2 (seabed hardness) appear to increase somewhat offshore and there is some indication that *S. alveolata* is found in slightly less coarse sediment whilst *S. spinulosa* is also found in slightly rougher ground offshore.

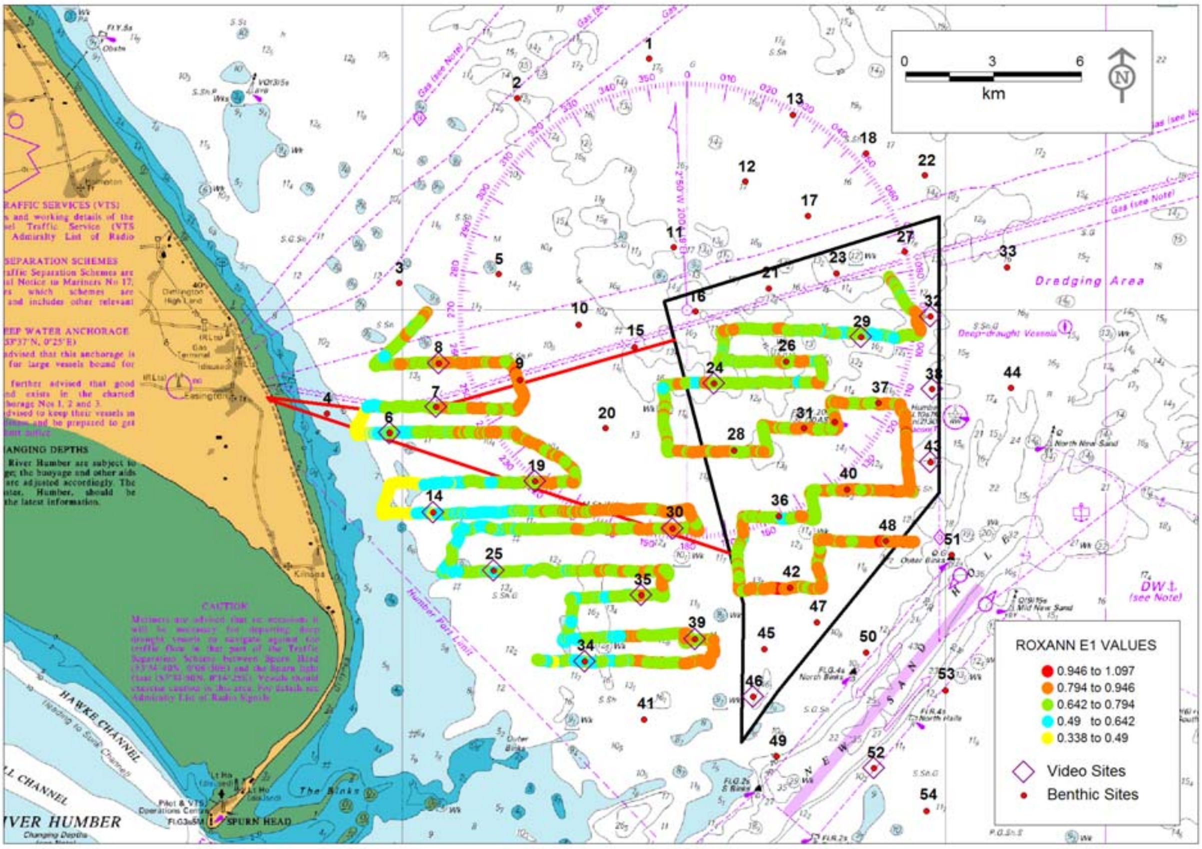



**Figure 7. E1 values (roughness) from acoustic survey.**

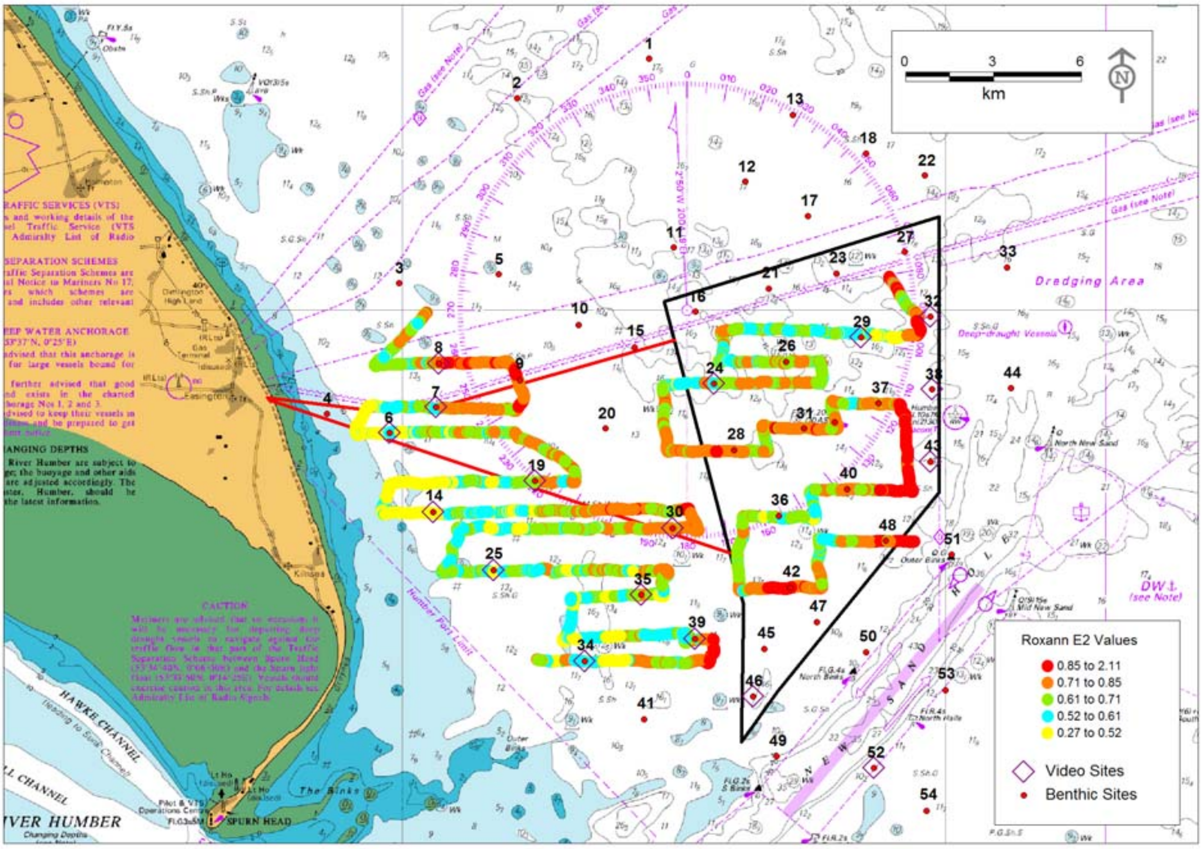



**Figure 8. E2 values (hardness) from acoustic survey.**

## 3.5. Video Survey

Video surveys were attempted on 9/08/05, 10/08/05, 13/09/05, 14/09/05 and 05/10/05. Due to the much higher abundance of *Sabellaria alveolata,* it was considered that drop-down video may have a higher chance of detecting reefs in these areas so sites benthic sites at which *S. alveolata* was present were targeted first (although *S. spinulosa* was also present at a number of these). Benthic sites within the windfarm were also targeted but given the relatively low abundance of *Sabellaria* within the windfarm site it was uncertain if drop down video would provide useful information on the extent of *Sabellaria* and it was also considered useful to attempt to take video at sites where *Sabellaria* was not found in the benthic grabs in order to see if wider changes in habitat could be detected. Poor weather disputed the video surveys on two days and whilst the remaining survey was carried out during optimum tides, a combination of presence of static gear (crab pots), poor water clarity (primarily due to the Humber plume) and strong tidal currents (even during neap tides), meant that over much of the survey visibility was quite poor as might be expected in a highly dynamic nearshore area. Whilst it was generally possible to assess the main habitat characteristics, identification of discrete areas of low lying *Sabellaria* communities, was often impossible with any certainty. On some days, good quality footage was only realistically feasible for an hour either side of slack high water. The sites at which video drops were attempted are shown in Figure 9 and Table 1.

The results of the video work have been summarised below and snapshots from some of the videos which show the general seabed character and any areas of potential *Sabellaria* growth have been given in Appendix 1. The results of the video survey confirmed results of the geophysical survey and the results from the AGDS survey. The majority of the seabed within and adjacent to the proposed windfarm site is characterised by relatively rough ground comprising of a mixture of pebbles, cobble, shell (usually mussel shell) and occasional boulders on sand and gravel. In general, the sediment is more mixed inshore and larger patches of sand/gravel were evident between the cobbles/pebbles in some of the more inshore sites (e.g. site 14 and site 52 adjacent to New Sand Hole). The sites outside the windfarm and closer to the shore also had a higher degree of siltation, presumably due to the Humber plume. Further offshore, within the windfarm site, seabed sediments were somewhat cleaner and the overlying veneer of stones and cobbles often formed a more solid 'pavement' with areas of larger boulders mixed within it.

A wide variety of biota was evident on the seabed bed including numerous species of crab (e.g. *Liocarcinus* sp., *Necora* sp.), echinoderms (e.g. *Crossaster papposus*, *Asteria rubens*), mussels, anemones (e.g. *Urticina* sp and *Sagartia* sp.) along with a variety of hydroids (e.g. *Nemertesia* sp. and *Sertularia* sp.), bryozoans (particularly *Flustra foliaca*), soft corals such as *Alcyonium digitatum*, sponges such as *Suberites* sp. and a variety of algae. In terms of *Sabellaria*, as noted previously, given the low lying encrusting nature of the populations evident within the area, it was often difficult to identify any areas of reef. This was particularly the case in the windfarm site in which the video survey was hampered by strong currents and poor visibility. In addition, relatively few sites within the windfarm footprint were able to be videoed although given the low abundance of *Sabellaria* in this area (as identified from the grab survey) any difficulty in identifying the species is perhaps unsurprising. Outside the windfarm site (where the highest abundances of *Sabellaria* were recorded in the grab survey) a higher number of sites were surveyed and whilst the Humber plume hampered the survey for much of the time, a combination of calm weather conditions and a flood tide did allow some relatively good footage to be obtained.

As evident from the video snapshots of the seabed, areas of *Sabellaria* appeared to be largely restricted to low lying encrusting forms with relatively low tube density on and in between cobbles. The majority of sites outside the windfarm showed some indication of this form of *Sabellaria* and in some areas the encrusting *Sabellaria* often formed a matrix between stones which whilst patchy was quite extensive. In terms of video footage, examples of the species were visible at sites 6, 7, 14, 25, 52 and possibly also at site 34 and 35. However, other sites with poorer visibility may also have contained populations of the species which were not visible. Where the species was recorded it was uncertain from the video footage which species of *Sabellaria* is present in these areas although the low lying and patchy nature of the species is typical of *S. spinulosa* (although may also include early colonies of *S. alveolata*). It is assumed that given the low abundance of *Sabellaria* recorded within the windfarm (possibly due to the somewhat cleaner sediments and lower sediment load offshore) that the low lying, patchy, encrusting forms of *Sabellaria spinulosa* described above will be type likely to be encountered where the species does occur. At some sites some larger formations of *Sabellaria* were evident, typically present as small clumps or hummocks on cobbles. The largest examples were found at site 14. *Sabellaria* tube densities appeared higher in these areas although the seabed was also quite heavily silted. Whilst the growth of *Sabellaria* in these areas was not particularly extensive, it appeared to be better developed than elsewhere. Given the presence of these larger structures (in terms of elevation above the seabed) at these sites, it is possible that the communities are examples of *S. alveolata* although the video footage is not conclusive.

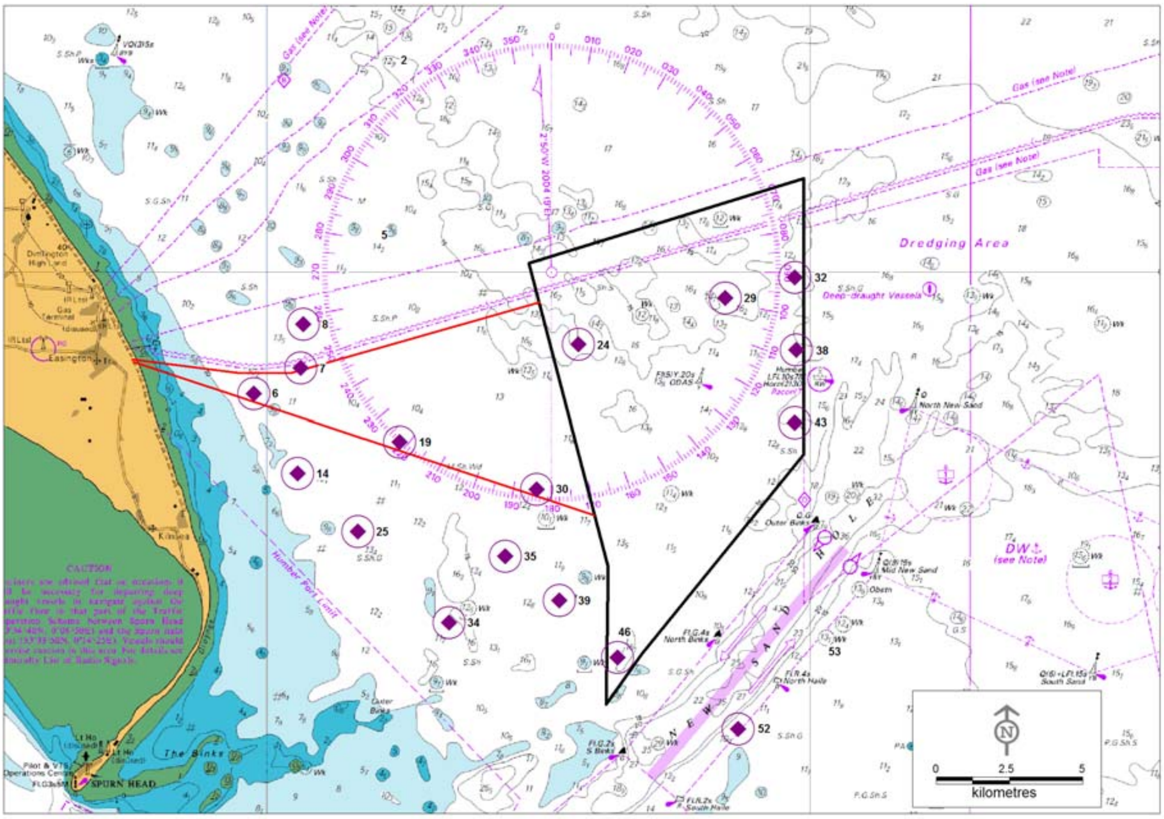



**Figure 9. Location of video drop sites.**

**Table 1. Positions of video drop sites.**

| **Site** | Latitude Degrees | Minutes | | Longitude Degrees | Minutes | |
|---|---|---|---|---|---|---|
| 6 | 53 | 38.667 | N | 0 | 09.760 | E |
| 7 | 53 | 38.945 | N | 0 | 10.619 | E |
| 8 | 53 | 39.426 | N | 0 | 10.672 | E |
| 14 | 53 | 37.798 | N | 0 | 10.567 | E |
| 19 | 53 | 38.139 | N | 0 | 12.443 | E |
| 25 | 53 | 37.161 | N | 0 | 11.676 | E |
| 30 | 53 | 37.621 | N | 0 | 14.972 | E |
| 34 | 53 | 36.162 | N | 0 | 13.353 | E |
| 35 | 53 | 36.889 | N | 0 | 14.393 | E |
| 39 | 53 | 36.406 | N | 0 | 15.385 | E |
| 46 | 53 | 35.779 | N | 0 | 16.454 | E |
| 52 | 53 | 34.990 | N | 0 | 18.680 | E |

## 4. ASSESSMENT OF REEFS & POTENTIAL IMPACTS

Well developed reefs are generally found in highly turbid areas, with a good supply of sand, usually subtidally to depths of approximately 40 m (for *S. spinulosa*) or in the intertidal or shallow subtidal (for *S. alveolata*). The species requires a firm substratum to attach itself to and is best developed in areas of mixed sediment with a sandy/gravel substratum containing some cobble / pebble. (Northern Ireland Habitat Action Plan, 2005). Dense aggregations of this species can stabilise mobile cobble, pebble and gravel substrata, providing a consolidated habitat for epibenthic species. *S. spinulosa* reefs such as those off the North Norfolk Coast and *S. alveloata* reefs on the western coast of the UK, are of particular conservation interest as they allow a range of epibenthic species together with specialised ‘crevice infauna’ to become established. Such species would otherwise be absent from the area and *S. spinulosa* is therefore classed as a biogenic reef forming species which can considerably increase species the diversity of an area (UK Biodiversity Group, 1999).

However, there is currently no clear consensus on what constitute a biogenic reef in terms of *Sabellaria* species and ongoing projects are currently attempting to derive better definitions which will assist classification of the species. The UK marine SACs Biogenic Reef report (Holt *et al.* 1998) uses the following criteria in defining biogenic reefs:

- the unit should be substantial in size (generally of the order of a metre or two across as a minimum, and somewhat raised, mainly in order to disqualify nodule like aggregations such as may be formed by *S. spinulosa* and scattered small aggregations such as occurs with many of the species under consideration);

- and should create a substratum which is reasonably discrete and substantially different to the underlying or surrounding substratum, usually with much more available hard surfaces and crevices on and in which other flora and fauna can grow.

They further classify biogenic reefs as follows:

"*Solid, massive structures which are created by accumulations of organisms, usually rising from the seabed, or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef building organism and its tubes or shells, or it may to some degree be composed of sediments, stones and shells bound together by the organisms.*"

However, due to the variable nature of its distribution and growth form (and despite the ecological importance of the species) the precise definition of a *Sabellaria* reef is unclear. For *S. spinulosa* it has been suggested that areas where more than 500 individuals / 0.1 $m^2$ are recorded with extensive coverage and structures up to 30cm above the bed would be of sufficient quality to constitute a reef (Foster-Smith and White, 2001). More recent studies have given abundances of over 375 individuals / 0.1 $m^2$ to distinguish reefs which are sufficiently distinct from other biotopes (Foster-Smith and Hendrick, 2003).

The results of the various surveys as given above indicate that whilst *Sabellaria* is relatively widespread through the area (as is common for such habitats), its distribution is patchy and generally restricted to the low lying ‘encrusting’ form in most areas. Given the abundances of *Sabellaria* shown from the grab surveys, it would appear that in many areas and particularly in the windfarm site, the populations of *Sabellaria* are of moderately low 'quality' (in terms of abundance and lifeform). However, some areas of better developed *Sabellaria* were encountered (albeit outside the windfarm development) where abundances above 300 individuals/0.1 $m^2$ were recorded and video footage revealed more extensive sheets of encrusting *Sabellaria* which occasionally formed elevated hummocks. In addition, the presence of *S. alveolata* is also of note given its distribution in the UK. The habitat is also considered a good example of low-lying agglomerations of *Sabellaria* which in some areas binds the cobbles and sediments to produce a biogenically enhanced matrix (Ian Reach – English Nature, pers. comm.).

In terms of potential impacts to the species, a number of studies have attempted to address the sensitivity of *Sabellaria* to natural and anthopogenic change (Cunningham, 1984; Holt *et al*. 1998; Jackson, 2005; Marshall, 2006). Both species of *Sabellaria* exhibit a degree of tolerance to most physical changes to its environment and has a relatively high potential for recovery (Holt *et al*. 1998). A more recent review of the sensitivity of *Sabellaria spinulosa* (carried out by *MarLIN* in 2006) assessed intolerance as intermediate for increased turbidity, smothering, changes to the hydrodynamic regime, abrasion and temperature change and contamination with respect to synthetic organics (Marshall, 2006). Thin crusts of *Sabellaria spinulosa* can act as a fast growing annual and may be a relatively resilient phenomenon (Holt *et al*. 1998) which may suggest that certain forms of this species would be relatively insensitive to some forms of disturbance. However, the species has been described as highly intolerant to substratum loss and whilst recoverability to factors such as smothering or physical disturbances/abrasion may be relatively high (Marshall, 2006) recoverability and re-establishment of true reef forms may be much slower. In the case of repeated/continual disturbance the species is unlikely to form significant aggregations (i.e. would no longer be defined as a reef) as the tubes would lose their ability to significantly stabilise the sediment and subsequently would lead to a reduction in 'hard substratum' communities.

However, the species is highly sensitive to larger scale disruption to the sediment in terms of substratum loss which may be associated with aggregate extraction, trawling and some offshore construction work. Severe storm events may also cause such substratum loss either by tearing up areas of reef and associated cobbles/pebble or by deposition of large volumes of sand on top of the reefs. In the Solway Firth, large areas of intertidal and subtidal reef have disappeared due to large scale movements of sandbanks (Allen *et al.*, 2002) and *S. alveolata* is also known to be sensitive to temperature changes (e.g. exceptionally cold winters) although this is primarily an issue in the intertidal zone (Holt *et al*. 1998). Whilst recovery from small scale impacts might be high (Northern Ireland Habitat Action Plan, 2005), English Nature (1999a) stated that, following extensive disturbance or removal of the substratum, recovery of a *S. spinulosa* reef is considered unlikely within ten years and regeneration of this biogenic habitat is considered to be difficult. Furthermore the recruitment of *S. alveolata* is highly variable although the reasons for this are unclear possibly due to reduced temperature/food supply or decreased larval supply from adjacent reefs or due to fluctuations in water movements (Holt *et al*. 1998). Along the Cumbrian and Lancashire coast, there has been much temporal fluctuation in distribution of *S. alveolata* reefs (Allen e*t al*., 2002).

Given the naturally high suspended sediment load in the area, construction impacts due to sediment disturbance are not considered an issue and in the context of the current project it would seem that the main potential impact to the species would be from direct loss of the habitat during construction. Within the windfarm footprint, given the relatively low abundances and patchy distribution, this is not considered likely to be a major problem and any potential areas of well developed reef could be avoided through micrositing of the turbine locations. It is considered that the main issue in terms of development of the site with regard to *Sabellaria* is the direct loss of habitat due to the placement, trenching and installation of the cables to the windfarm as they would traverse the inshore area where somewhat higher abundances of *Sabellaria* (including *S. alveolata*) were recorded. Details on the cable installation methodologies are given in Appendix 3. However, in this region the distribution of *Sabellaria* is also very patchy and microrouteing of the cable route trenching should mitigate against significant disturbance to any extensive areas of reef.

In addition, some areas of the proposed construction site may also comprise of subtidal cobble habitats which are currently not explicitly defined under the Habitats Directive but will be considered an important component of future offshore SACs. Whilst few studies have examined such habitats in detail (and they are at present poorly defined in conservation terms) they may require further consideration prior to construction. Consequently, the more diverse examples of cobble reef habitats may also require further study in future, although the major impacts to these areas are likely to be related to direct habitat loss (as described above for *Sabellaria*). Consequently, any mitigation measures are likely to be similar to those required for areas of biogenic reef e.g. micro-routeing for cables routes.

## 5. PROPOSED SURVEY WORK

Whilst the current survey gives some indication of the distribution and status of *Sabellaria* reefs within and adjacent to the proposed windfarm site, it is well known that the distribution and recruitment of *Sabellaria* may vary considerably over time. Consequently, there would be a need for further work, particularly in the region of the proposed cable route prior to any construction. A number of methods may be used to determine the distribution of *Sabellaria* and a number of other projects are currently looking into appropriate methodologies (including an EN part funded PhD investigating *Sabellaria spinulosa* ecology and best practice for field survey and a joint JNCC / Envision ALSF project to determine best practice for the aggregation industry to determine biogenic reef). Such studies will give guidance for the monitoring *Sabellaria* reefs. In terms of assessing the potential size and distribution of any reefs prior to instatement of the cable route or individual turbines, the following techniques could be applied:

- High resolution (>500 kHz) sidescan
- Swathe Bathymetry
- AGDS (Acoustic Ground Discrimination System)
- ROV/Towed Video
- Diver operated video

Given the nature of the substrate and size of *Sabellaria* populations present in the proposed construction area, it is uncertain if high resolution sidescan or other acoustic techniques could accurately map the boundaries of the patchy and discrete communities described in this study. Multibeam sonar or multibeam AGDS systems (such as the Sonavision ROXSWATH system) may prove useful in delineating areas of suitable habitat although they may not directly record areas of small scale/patchy *Sabellaria*. At this stage, until further guidance is forthcoming, it is anticipated that given the type of habitat in the area the most appropriate technique for providing a detailed assessment of *Sabellaria* along the proposed cable route would be by further video survey (possibly diver operated, if tidal conditions precluded the use of drop-down or towed video) and English Nature consider a combination of high resolution sidescan and video to be best practice for monitoring biogenic reefs at present. Such work could also be accompanied by other acoustic techniques (e.g. AGDS) if necessary.

# 6. CONCLUSIONS

- A combination of geophysical, grab, trawl, AGDS and video surveys have been carried out in the area to assess seabed characteristics, associated biota and distribution of *Sabellaria* communities.

- Seabed generally characterised by rough ground with a mixture of cobbles/pebbles and boulders on sand/gravel.

- *Sabellaria* species quite widely distributed although generally of low to moderate abundance.

- Presence of *S. alveolata* (a south/west coast species) also recorded inshore from the proposed windfarm.

- Difficulties in recording *Sabellaria* by video/acoustic methods due to strong tides, poor water visibility and nature of seabed. High abundance of static gear also hampers towed video and sidescan surveys.

- Video survey identified that *Sabellaria* in the area is generally patchy, low lying and encrusting, although some more extensive/better developed areas are present outside the windfarm.

- Major potential impact to the species is considered to be habitat loss due to construction, particularly along the cable route.

- Cable route indicates some conflict with ‘potential’ reef locations and micro-routeing of the cable will possibly be required as a mitigation procedure.

- Further work required prior to construction to mitigate against damage to any well established communities.

- Given the nature of the *Sabellaria* in the area, it is considered that following further survey work and successful microrouteing/micrositing of the cables/turbines, any significant direct impact to *Sabellaria* communities should be negligible.

## 7. REFERENCES

Allen, JH. Billings, I, Cutts, N. & Elliott, M., 2002. Mapping, condition and conservation assessment of honeycomb worm *Sabellaria alveolata* reefs on the Eastern Irish Sea coast.

Cunningham, P.N., Hawkins, S.J., Jones, H.D. & Burrows, M.T. 1984. The biogeography and ecology of Sabellaria alveolata. Nature Conservancy Council CSD report, No 535.

Foster-Smith, R.L. & White W.H. 2001. *Sabellaria spinulosa reef in The Wash and North Norfolk Coast cSAC and its approaches: Part I, mapping techniques and ecological assessment*. A report for the Eastern Sea Fisheries Joint Committee and English Nature.

Foster-Smith, R.L. & Hendrick, V.J. (2003). *Sabellaria spinulosa in the Wash and Norfolk cSAC and its approaches: Part III, Summary of knowledge, recommended monitoring strategies and outstanding research requirements*. A report for the Eastern Sea Fisheries Joint Committee and English Nature. 51pp.

Holt, T.J., Rees, E.I., Hawkins, S.J. & Seed, R. (1998). Volume IX. *Biogenic reefs: an overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project).

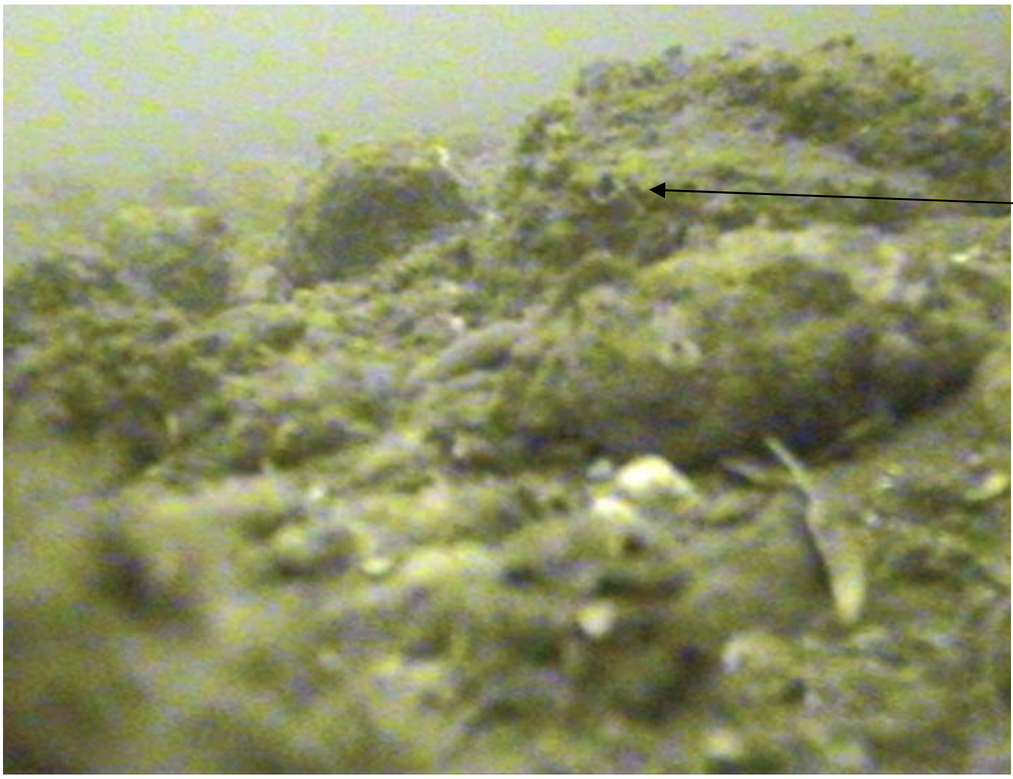
Jackson, A., 2005. *Sabellaria alveolata*. Honeycomb worm. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme* [on-line]. Plymouth: Marine Biological Association of the United Kingdom.

Marshall, C.E., 2006. *Sabellaria spinulosa* on stable circalittoral mixed sediment. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme* [on-line]. Plymouth: Marine Biological Association of the United Kingdom.

Northern Ireland Habitat Action Plan. *Sabellaria spinulosa* reefs. March 2005. http://www.ehsni.gov.uk/pubs/publications/Sabellariaspinulosareefs.pdf

UK Biodiversity Group Tranche 2 Action Plans - Volume V: Maritime species and habitats. October 1999, Tranche 2, Vol V.

## APPENDIX 1. SEABED SNAPSHOTS




Site 6

Site 7

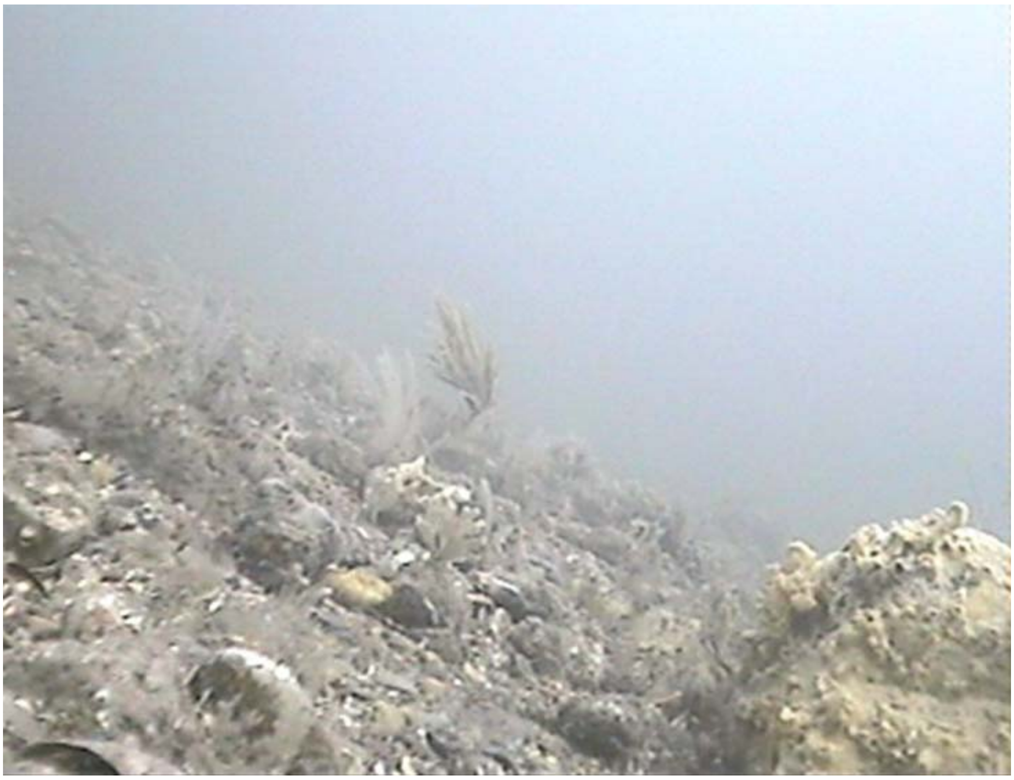
Possible encrusting *Sabellaria*

Site 7

Site 8

Site 8

Site 8

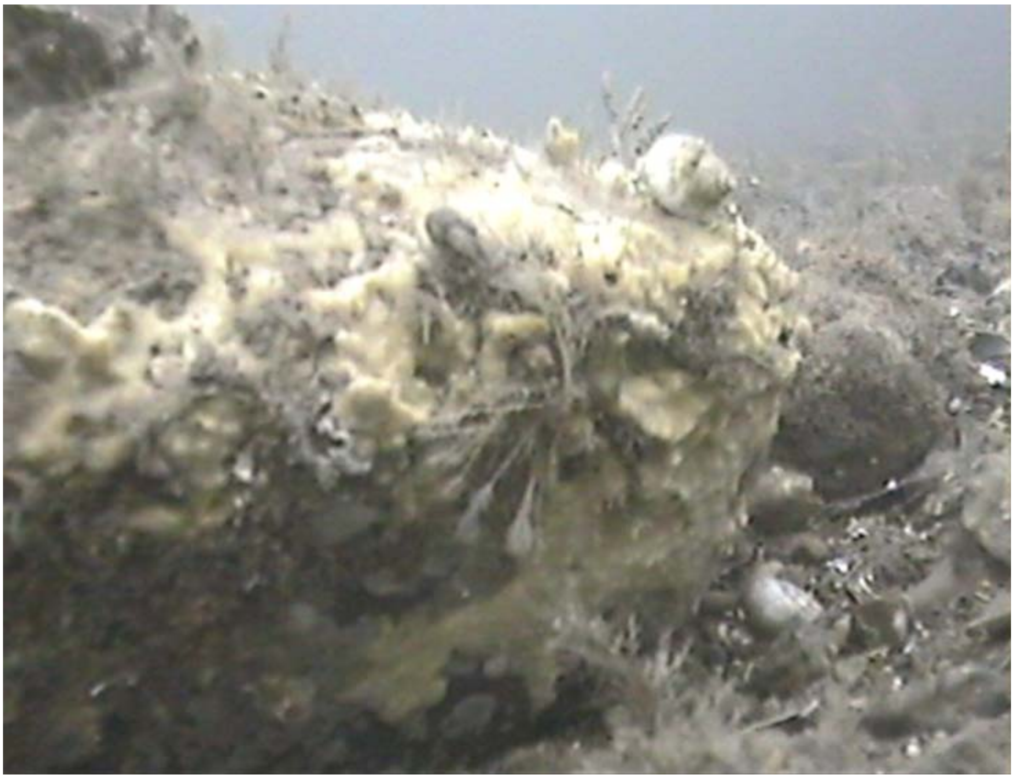


Site 8

Site 8

Site 8

Site 19



Site 19

Site 19

*Sabellaria* Tubes

Site 25

Encrusting *Sabellaria* tubes on cobbles

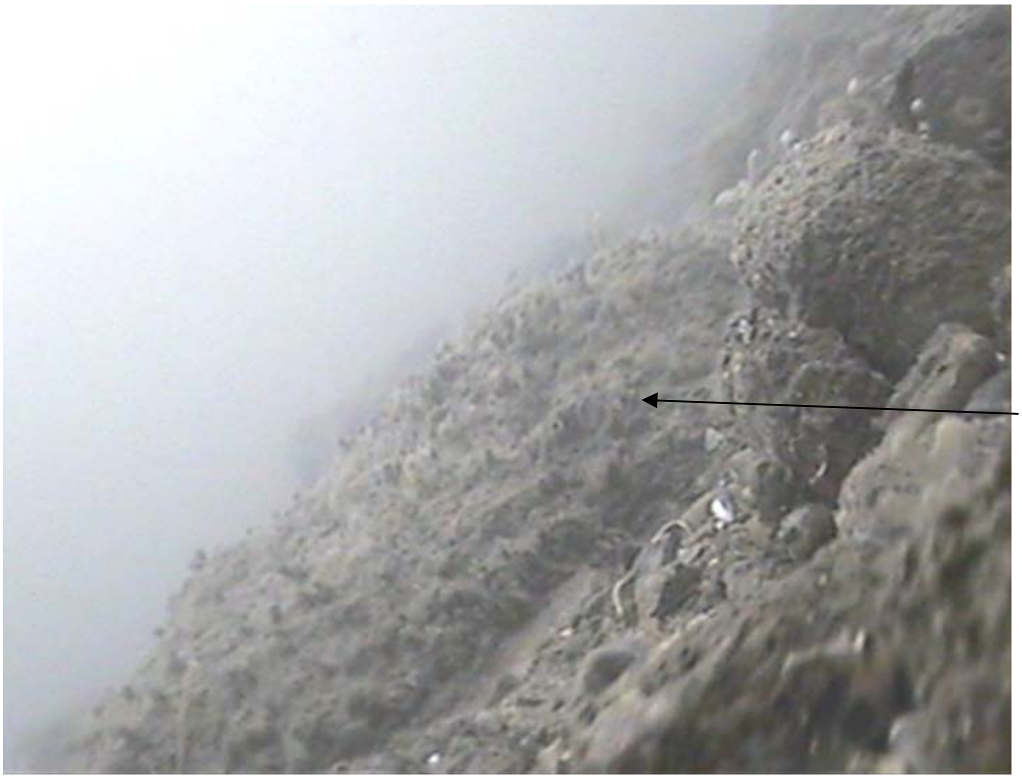
Site 25

Site 25


Site 25

Site 34

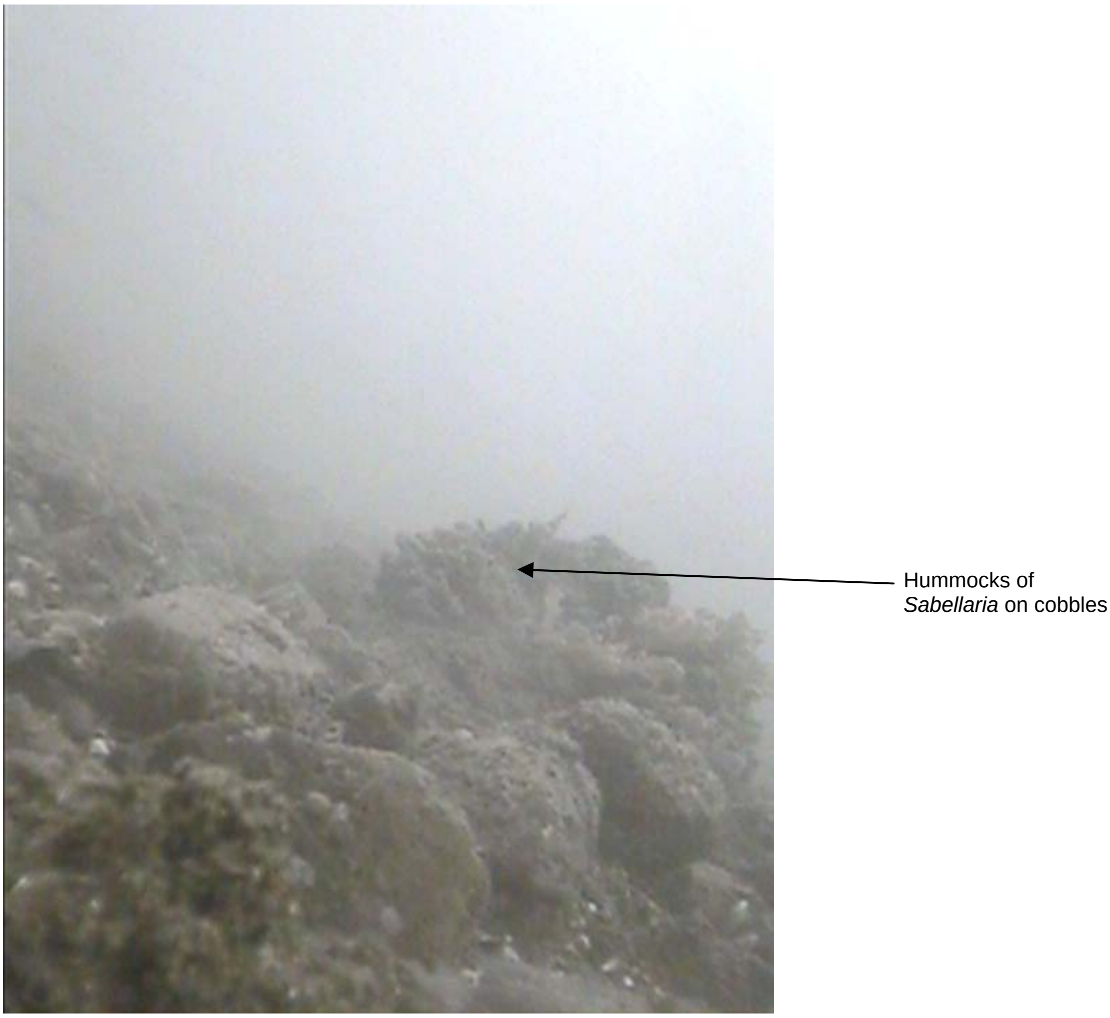
Site 35



Hummocks of
*Sabellaria* on cobbles

Site 14

Site 14




Site 14

Encrusting *Sabellaria* tubes

Site 14

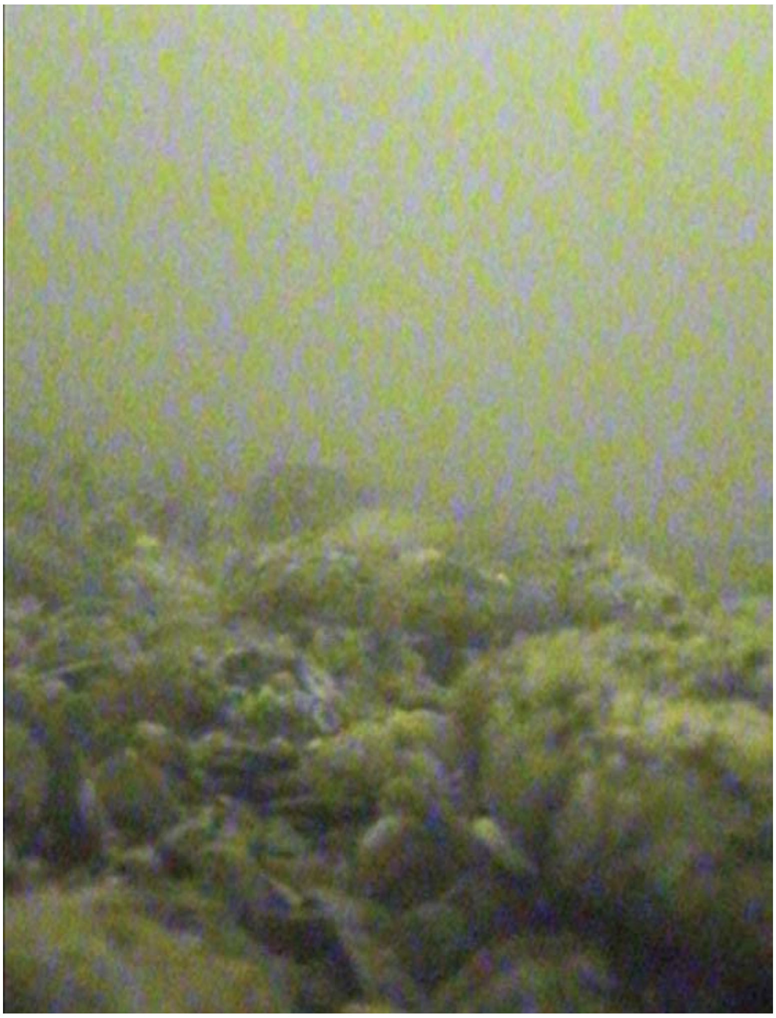
Hummocks of *Sabellaria* on cobbles

Site 14

Site 24

Site 24


Site 24



Site 29

Site 39

Site 39

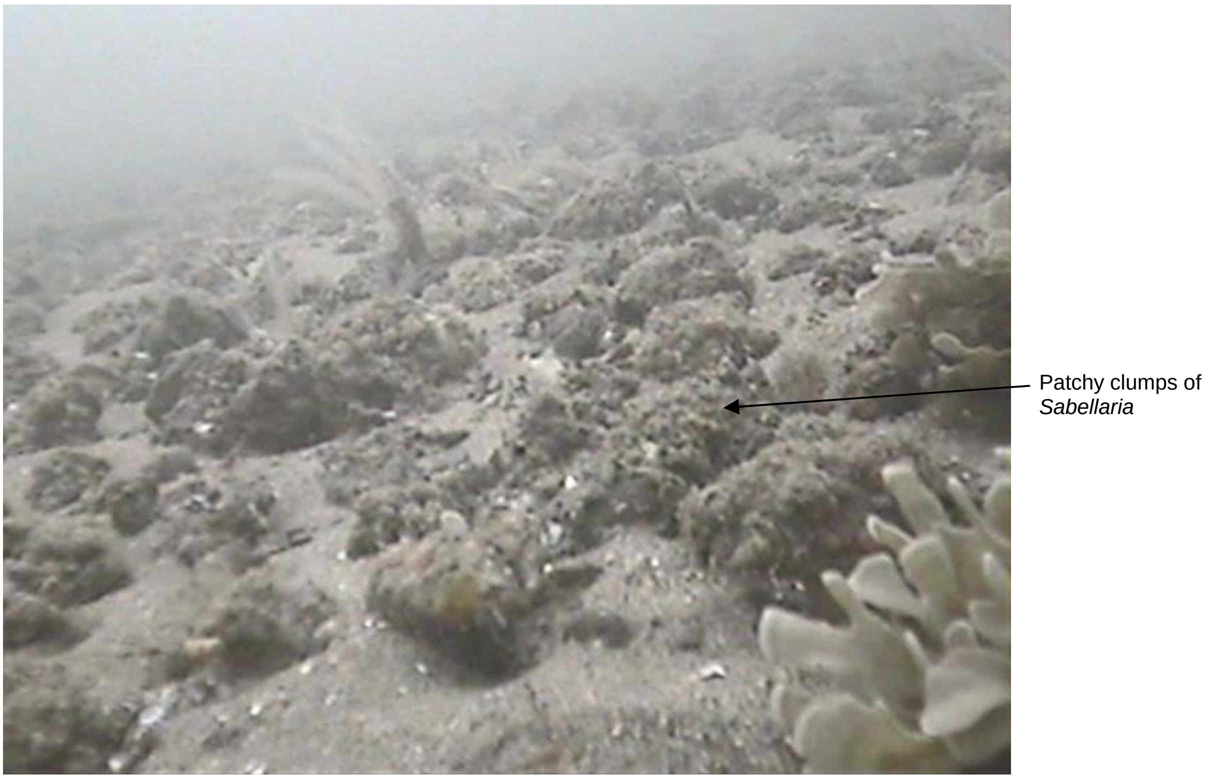
Site 52


Site 52


Site 52


Site 52

Site 52




Site 52

# APPENDIX 2

## *Sabellaria* abundances at each site

| Station | Replicate | Sabellaria alveolata | Sabellaria spinulosa |
|---|---|---|---|
| 1 | A | | 9 |
| 1 | B | | 4 |
| 1 | C | | |
| 2 | A | | 1 |
| 2 | B | | 1 |
| 2 | C | | |
| 3 | A | | 14 |
| 3 | B | | 22 |
| 3 | C | | 1 |
| 4 | | | |
| 5 | | | |
| 6 | A | 105 | 20 |
| 6 | B | 121 | 6 |
| 6 | C | 94 | 14 |
| 7 | | 2 | 4 |
| 8 | | 30 | 30 |
| 9 | A | | 1 |
| 9 | B | | |
| 9 | C | | 2 |
| 10 | A | | 2 |
| 10 | B | | 7 |
| 10 | C | | |
| 11 | | | |
| 12 | | | 4 |
| 13 | A | | 2 |
| 13 | B | | |
| 13 | C | | 15 |
| 14 | | 111 | 11 |
| 15 | | | |
| 16 | | | 1 |
| 17 | A | | 2 |
| 17 | B | | 2 |
| 17 | C | | 6 |
| 18 | | | 7 |
| 19 | | 4 | 8 |
| 20 | | | 1 |
| 21 | A | | 6 |
| 21 | B | | 4 |
| 21 | C | | 8 |
| 22 | | | |
| 23 | | | 1 |
| 24 | | | |
| 25 | A | 97 | 10 |
| 25 | B | 49 | 6 |
| 25 | C | 38 | 9 |
| 26 | | | 1 |
| 27 | | | 4 |
| 28 | A | | 3 |
| 28 | B | | |
| 28 | C | | |
| 29 | A | | 5 |
| 29 | B | | |
| 29 | C | | |
| 30 | A | | 4 |
| 30 | B | 1 | 1 |
| 30 | C | | |
| 31 | | | |
| 32 | | | |
| 33 | A | | |
| 33 | B | | |
| 33 | C | | |
| 34 | A | 467 | 32 |
| 34 | B | 8 | |
| 34 | C | 420 | 9 |
| 35 | | 45 | 4 |
| 36 | | | 5 |

## ***Sabellaria*** **abundances at each site (cont.)**

| Station | Replicate | *Sabellaria alveolata* | *Sabellaria spinulosa* |
|---|---|---|---|
| 37 | | | |
| 38 | A | | |
| 38 | B | | |
| 38 | C | | |
| 39 | | 265 | 4 |
| 40 | | | |
| 41 | | | 13 |
| 42 | A | | 1 |
| 42 | B | | |
| 42 | C | | 3 |
| 43 | | | |
| 44 | A | | 1 |
| 44 | B | | 1 |
| 44 | C | | 11 |
| 45 | | | |
| 46 | A | 56 | 19 |
| 46 | B | 5 | 3 |
| 46 | C | 69 | 14 |
| 47 | A | | |
| 47 | B | | |
| 47 | C | | |
| 48 | A | | |
| 48 | B | | |
| 48 | C | | |
| 49 | | | 3 |
| 50 | A | | |
| 50 | B | | |
| 50 | C | | |
| 51 | | | 1 |
| 52 | | 2 | 17 |
| 53 | | | 3 |
| 54 | A | | 17 |
| 54 | B | | 6 |
| 54 | C | | 2 |

## APPENDIX 3

### Cable Installation Methodology

The purpose of this section of the report is to provide:

- background to the likely array and transmission cables (e.g. size, voltage etc), and;

- a summary of the three possible cable installation methods: ploughing, trenching and jetting.

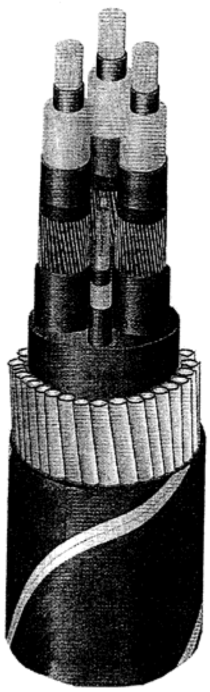
The final choice of technology is not currently known, but will be taken once all the known constraints are fully understood. These include cost, geotechnical issues, water depths, installation requirements and potential environmental impacts.

### Potential Environmental Impacts

The methodologies discussed here, and their potential environmental impacts will be fully presented in the Environmental Statement. However, the reader is also referred to the paper by Cooper and Beiboer (2002) in which the potential environmental effects of marine cable installation are reported.

### Array Cables

The array cables will use a voltage of 33 to 72 kV. The cable type will most likely be a sea-armoured 3 core copper XLPE cable. A drawing of such a typical cable is shown below.



**33 kV 3 core copper XLPE cable**

| Item | Unit | Approximate sizes |
|---|---|---|
| **Conductor cross section** | **$mm^2$** | **70-800** |
| **Diameter** | **mm** | **120-150** |
| **Weight in air** | **kg/m** | **70** |

**Example of 33 kV cable sizes**

## Transmission Cables

The transmission cables are likely to be 3 core copper XLPE cables, in the range of 132 to 220 kV.

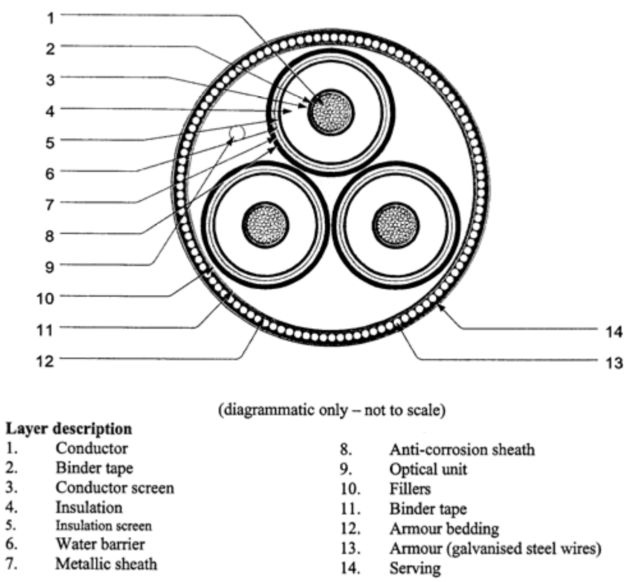



**Diagram of 132 kV 3 core copper XLPE cable**

| Item | Unit | Approximate sizes |
|---|---|---|
| **Conductor cross section** | **$mm^2$** | **3*800** |
| **Diameter** | **mm** | **200** |
| **Weight in air** | **kg/m** | **80** |
| **Weight in sea water** | **kg/m** | **50** |

**Example of 132 kV cable dimensions**

## Cable Depths

Cables will be buried between 0.5m and 3m for the majority of the route. The final depth will be decided when a detailed study has been carried out to assess the relevant factors at each part of the route.

## Installation Methods

The array cables and the cables from the offshore substation to land may be installed using one of the three methods; ploughing, trenching or jetting.

### PLOUGHING

This method involves a blade, which cuts through the seabed and the cable is laid behind. Ploughs are generally pulled directly by a surface vessel or, they can be mounted onto a self propelled caterpillar tracked vehicle which runs along the seabed. Pull forces to move the plough through the seabed can be significant (e.g. of the order of 200 tonnes) and the need for a suitably powerful towing vessel often precludes their use in shallow water. Cable ploughs are usually deployed in simultaneous lay and trench mode and use cable depressors to push the cable into position at the base of the cut trench. As the plough proceeds, the trench is back-filled to provide immediate burial. In general, ploughs are not suited to harder substrates such as boulder clay. Some ploughs are fitted with jet assist options and/or hydraulic chain cutters to work through patches of harder soils.

Ploughing is usually a one-off process and cannot be repeated to re-bury an exposed cable.

Examples of plough application include the export cable for North Hoyle, Kentish Flats and all cables for Scroby Sands. In the case of Scroby Sands the plough was able to be pulled close to the mono-piles but the final short section of cable laying was delivered by jetting methods, as the plough could not be brought completely up to the mono-pile. Sea Stallion 4 was the plough device used at both Scroby and North Hoyle for the export cables. This device is approximately 4m wide, and defines the main footprint of any impact on the seabed, as shown below.

**Sea Stallion deployment at North Hoyle**

### JETTING

This method involves directing water jets towards the seabed to fluidise and displace the seabed sediment.  This forms a typically rectangular trench into which the cable generally settles under its own weight.  The water jets are usually deployed on jetting arms beneath an ROV based system that can be free-swimming or based on passive skids or active tracks. It should also be noted that towed jetting skids are also available. During the formation of the trench the displaced sediment is forced into suspension and settles out at a rate determined by the sediment particle size, density and ambient flow conditions.  The jetting process is not intended to displace sediment to an extent that it is totally removed out of the trench, moreover, it requires that the fluidised sediment is available to fall back into the trench for immediate burial through settling. It is only the finer fractions of sediments that are likely to be held in suspension long enough to become prone to dispersal away from the trench as a plume.

For reference, jetting tools have been used successfully at North Hoyle, Arklow Bank, Nysted and Horns Rev, amongst others, and also at Scroby Sands to complete the last sections of inter-turbine cables.  A key benefit of a jetting tool is that it is able to operate close to structures, and it is also possible to use jetting tools for remedial burial, if required.

2 methods of water jetting are typically available;

Method 1 (Fluidising the seabed)

The cable is laid on the seabed first and afterwards a jetting sledge is positioned above the cable. Jets on the sledge flush water beneath the cable fluidizing the sand whereby the cable by its own weight is sinking to the depth set by the operator.

Method 2 (Forward jetting a trench)

In this method water jets are used to jet out a trench ahead of cable lay. The cable can typically be laid into the trench behind the jetting lance.

**Typical Jetting Equipment**

**TRENCHING**

Trenching involves the excavation of a trench whilst temporarily placing the excavated sediment adjacent to the trench. The cable would then be laid and the displaced sediment used to back-fill the trench, covering the cable. This is most commonly used where the cable has to be installed through an area of rock or seabed composed of a more resistant material. Such trenching operations were used for Nysted (where sediment hardness >75Pa), where a cable lay rate of up to 411m/day was achieved, excluding back-filling operations.

Trenching is a difficult, long and expensive method to use compared to other methods.