East Anglia Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

East Anglia THREE

Chapter 10

Benthic Ecology

Environmental Statement

Volume 1

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Table of Contents

10 Benthic Ecology 1

10.1 Introduction 1

10.2 Consultation 2

10.3 Scope 14

10.3.1 Study Area 14

10.3.2 Worst Case 15

10.3.3 Embedded Mitigation specific to Benthic Ecology 28

10.4 Assessment Methodology 29

10.4.1 Legislation, Policy and Guidance 29

10.4.2 Data sources 33

10.4.3 Impact Assessment Methodology 39

10.4.4 Cumulative Impact Assessment 42

10.4.5 Transboundary Impact Assessment 43

10.5 Existing Environment 43

10.5.1 Sea Bed Sediments 43

10.5.2 Infaunal Communities 44

10.5.3 Epifaunal Communities 58

10.5.4 Landfall and Intertidal Habitat 65

10.5.5 Protected Habitats and Species 66

10.5.6 Context and Summary 71

10.6 Potential Impacts 72

10.6.1 Potential Impacts During Construction 73

10.6.2 Potential Impacts During Operation: 92

10.6.3 Potential Impacts during Decommissioning 104

10.7 Cumulative Impacts 105

10.7.1 East Anglia THREE site 105

10.7.2 Export Cable Corridor 106

10.7.3 The Project as a Whole 109

10.8 Transboundary Impacts 109

10.9 Inter-relationships 109

10.10 Summary 110

10.11 References 116

Chapter 10 Benthic Ecology figures are presented in **Volume 2: Figures** and listed in the table below.

Figure number	Title
10.1	Benthic Ecology Study areas and Sample locations
10.2	Sediment Distribution
10.3	Infaunal Abundance
10.4	Infaunal Diversity
10.5	Infaunal Biomass
10.6	Infaunal Groups
10.7	Infaunal Targeted Samples
10.8	Epifaunal Abundance
10.9	Epifaunal Diversity
10.10	Epifaunal Groups
10.11	Infaunal Biotopes within East Anglia ONE
10.12	*Sabellaria spinulosa* Abundance
10.13	*Modiolus* and *Mytilus* Abundance
10.14	Predicted area of Cable Crossing and overlap with SPA

Chapter 10 Benthic Ecology appendices are presented in **Volume 3: Appendices** and listed in the table below.

Appendix number	Title
10.1	Benthic Ecology Evidence Plan
10.2	East Anglia Offshore Windfarm Zonal Environmental Appraisal: Benthic Biological Characterisation Report
10.3	East Anglia ONE Offshore Windfarm Cable Route: Benthic and Intertidal Characterisation Report.
10.4	East Anglia THREE and FOUR Cable Route Benthic Characterisation Report
10.5	Benthic and Epibenthic Survey Statistical Power Analysis
10.6	Multivariate Statistical Analysis of Combined Data

10 BENTHIC ECOLOGY

10.1 Introduction

1. This chapter of the Environmental Statement (ES) describes the ecology of the sea bed (benthic ecology) and the foreshore below the mean high water mark (intertidal), within the proposed East Anglia THREE project and the wider southern North Sea. Potential impacts are assessed and mitigation measures provided where appropriate.

2. Other aspects of marine ecology that are closely linked to benthic ecology are presented elsewhere in this ES. Chapter 11 Fish and Shellfish Ecology incorporates shellfish, and although certain commercially important benthic shellfish species are taken into account within this chapter, they are considered in greater detail in Chapter 11.

3. Other chapters that are linked with benthic ecology, or that cover impacts that may be related to those in this chapter include:

- Chapter 7 Marine Geology and Coastal Ecology;
- Chapter 8 Marine and Sediment Quality Chapter;
- Chapter 9 Underwater Noise, Vibration and Electromagnetic Fields;
- Chapter 11 Fish and Shellfish Ecology;
- Chapter 12 Marine Mammals;
- Chapter 13 Offshore Ornithology; and
- Chapter 14 Commercial Fisheries.

4. This section of the ES was written by Royal HaskoningDHV, and incorporates results and advice from other contributors including Fugro Emu Ltd and Marine Ecological Surveys Limited (MESL). Technical reports from MESL's Zone Environmental Appraisal (ZEA) and East Anglia ONE cable corridor survey, and Fugro Emu's East Anglia THREE and East Anglia FOUR Cable corridor survey (herein referred to as the East Anglia THREE / FOUR survey), are included in *Appendix 10.2*, *Appendix 10.3* and *Appendix 10.4* respectively in Volume 3. In addition, technical survey reports of MESL's East Anglia ONE site survey are available on the Planning Inspectorate

website[1]. All figures referred to in this Chapter can be found in Volume 2 as listed in the table above.

5. This chapter has taken account of primary relevant guidance provided in the National Policy Statement (NPS) for Renewable Energy Infrastructure (EN-3). The NPS guidance notes relevant to benthic ecology are described in detail in *Table 10.3*.

10.2 Consultation

6. *Table 10.1* summarises issues raised and advice provided during the consultation process surrounding the project. Consultation relevant to benthic ecology mainly occurred through five separate processes:

- Scoping opinion - which was sought from the relevant statutory consultees (The Planning Inspectorate 2012);
- Evidence Plan - consultation with key statutory consultees which was undertaken through the Evidence Plan process (for further detail on the Evidence Plan please refer to *Appendix 10.1* and Chapter 6 Environmental Impact Assessment Methodology);
- East Anglia ONE - Although not directed specifically at the proposed East Anglia THREE project, feedback from consultees on the East Anglia ONE examination process (which was conducted from June to December 2013) was taken into account where relevant to this project;
- Comments and advice received during the PEIR consultation period (May 2014 to July 2014) were also considered; and
- Comments and advice provided during the Phase III consultation period (June 2015 to July 2015).

7. *Table 10.1* indicates which section(s) of this or other chapters address the issues raised during consultation.

[1] http://infrastructure.planningportal.gov.uk/wp-content/ipc/uploads/projects/EN010025/2.%20Post-Submission/Application%20Documents/Environmental%20Statement/7.3.4b%20Volume%202%20Chapter%209%20Benthic%20and%20Epibenthic%20Environment%20(including%20Shellfish)%20Appendices%20(App%209.1%20-%209.2).pdf

Table 10.1.Consultation Responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
Scoping Opinion			
Joint Nature Conservation Committee (JNCC) and Natural England (NE)	November 2012	We note that the potential for *Sabellaria spinulosa* has been identified through the analysis of this data. With the project being submitted for examination by PINS in 2014, the data at this point will be over 4 years old. We advise that owing to the ephemeral nature of *S.spinulosa* the age of this data is likely to result in reduced confidence in conclusions relating to the presence or absence of Annex I reef in these areas. We advise that the requirement for further survey should be explored and we would be happy to discuss this further with EAOW.	East Anglia THREE Limited (EATL) have made a commitment to conduct pre construction survey(s) which will assess the presence of *S. spinulosa* reef within the proposed East Anglia THREE project. Section 10.3.3 and the In Principle Monitoring Plan (IPMP)
JNCC and Natural England	November 2012	We advise that the assessment of the potential for Annex I sandbank and any potential impacts should be explicitly presented within the ES.	No Annex I sandbanks have been identified within the proposed project boundaries. Section 10.5.5
JNCC and Natural England	November 2012	When designing surveys we advise that grab sample and video / still imagery sampling sites are located with reference to geophysical data. The use of previously collected remote sensing data makes for effective benthic ecology survey as it enables better direct sampling effort.	The design of the East Anglia THREE offshore cable corridor survey used the geophysical surveys to assign sampling sites (see *Appendix 10.4* for details)
JNCC and Natural England	November 2012	We also advise that geophysical data collected in areas of potential Annex I habitat is undertaken such that it enables a meaningful estimate of the coverage of the potential Annex I habitat in the area and to be effected as a result of development.	Geophysical surveys have been conducted across the entire zone as well as high-resolution site-specific surveys. The results of which have been used to identify areas that potentially support Annex I habitat (*Appendix 10.2 Appendix 10.3* and *Appendix 10.4*)
JNCC and Natural England	November 2012	If there is any scoping out of impacts to Annex 1 habitats it should be explicitly explained why.	Impacts are not scoped out

Consultee	Date /Document	Comment	Response / where addressed in the ES
Marine Management Organisation (MMO)	November 2012	Full details of scour quantity need to be assessed in the ES to ensure the footprint is accurate.	*Appendix 7.3* makes an assessment of scour protection which informs the assessment in section 10.6.1.
MMO	November 2012	Full details of cable protection measures need to provided and assessed in the ES to ensure the project footprint is accurate.	Chapter 5 Description of the Development describes the cable protection methods under consideration and the maximum amounts required which informs the assessment in section 10.6.1.
MMO	November 2012	A detailed monitoring and mitigation plan must be developed as the design and Environment Impact Assessment (EIA) process develops.	An IPMP has been developed for the Development Consent Order (DCO) application and will be finalised pre-construction with approval from the relevant statutory bodies.
MMO	November 2012	The MMO expects to see appropriate mitigation included in the ES for cable laying operations to minimise adverse impacts on *S. spinulosa* habitat.	EATL have produced an IPMP. This includes monitoring provisions such as a survey to detect the presence *S. spinulosa* reef. The final monitoring plan will be agreed with NE, MMO and Cefas prior to construction. Where the presence of *Sabellaria* reef is confirmed, measures would then be agreed with NE and MMO to avoid siting of infrastructure on such habitat, this will be reported in the final Design Plan as part of the final deemed Marine Licence (DML).

Consultee	Date /Document	Comment	Response / where addressed in the ES
MMO	November 2012	The proposed cable route also crosses a licensed marine disposal site; however, sampling for sediment-surface contaminants at this site has revealed no evidence of contamination. Therefore, it is proposed that further sediment quality sampling is not required to inform the EIA. The MMO concurs with this decision.	No action. Potential impacts from re-mobilisation of contaminants are considered in section 10.6.1
MMO	November 2012	The MMO recommend that the ES should not make the case that colonisation of the turbine foundations by benthic species is a positive, as no development should seek to change the natural environment.	The assessment (section 10.6 to 10.8) does not make this case.
Evidence Plan			
Cefas and Natural England	September 2013	Agree that the time for specific *Sabellaria* surveys would be the preconstruction stage and would not be required for the EIA. With any avoidance achieved within the project redline boundary through micrositing.	EATL have made a commitment to conduct preconstruction surveys (section 10.3.3).
Cefas and Natural England	September 2013	Cefas and Natural England agreed that sufficient benthic ecology survey data has been collected for the proposed East Anglia THREE project (*Appendix 10.1*).	Survey data are presented in section 10.5 and in *Appendix 10. 2, 10.3* and *10.4.*
Cefas and Natural England	September 2013	Cefas and Natural England agreed that the list of impacts proposed by EATL in the Evidence Plan method statement is comprehensive (*Appendix 10.1*).	Sections 10.6 to 10.8 assess all impacts agreed within the Evidence plan process as well as others that were identified outwith the Evidence plan.
Cefas and Natural England	September 2013	Cefas and Natural England agreed the proposed methodology for each impact (*Appendix 10.1*).	Each of the identified impacts (section 10.6) have been assessed using the methods agreed within the evidence plan (*Appendix 10.1*).
Cefas and Natural England	September 2013	Cefas and Natural England agreed the sensitivity and magnitude definitions are appropriate (*Appendix 10.1*).	Impacts have been assessed using the methods agreed in the Evidence plan. (section

Consultee	Date /Document	Comment	Response / where addressed in the ES
			10.4)
Cefas and Natural England	September 2013	Cefas and Natural England agreed that no site specific modelling of sediment dispersal will be required for assessing benthic ecology (Appendix 10.1).	The assessment for impacts associated with sediment dispersal has applied a more qualitative approach, using the modelling carried for East Anglia ONE as a proxy.
Cefas and Natural England	September 2013	If *Mytilus* reef is an issue the time to survey would be preconstruction. Avoidance of such reef could then be achieved within the project redline boundary through micrositing	No *Mytilus* reef has been identified in surveys (*Appendix 10.2, Appendix 10.3* and *Appendix10.4*) EATL has made a commitment to conduct pre-construction surveys to determine the presence of any Habitats of Principal Importance / Annex I habitat.
Cefas and Natural England	September 2013	Cefas and Natural England agreed that all cumulative impacts can be wrapped up in one section of the ES	Cumulative Impacts associated with the East Anglia THREE site are assessed in section 10.7 using the agreed method.
Consultation on PEIR (Phase IIa)			
MMO	July 2014	The PEIR does not include information regarding monitoring requirements. We would expect such detail to be included in the ES and we would welcome the opportunity to discuss such requirements prior to the submission of the EA3 application Vol. 1, Section 10.3.3 – Many of the mitigation measures are dependent on which techniques are eventually employed during the construction phase. These measures must be discussed and agreed in detail for inclusion within the ES and associated DCO/DML(s).	EATL have produced an IPMP which includes monitoring provisions.
MMO	July 2014	Special consideration should be given to potential impacts to *Sabellaria spinulosa*, *Mytilus edulis* and the section of the	Consideration of these features is provided in section 10.6.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		cable corridor which transits through the Outer Thames Special Protection Area (SPA). This should also be considered further with regards to the CIA.	Impacts to the Outer Thames SPA are considered in sections 10.6.1.5, 10.6.2.6 and 10.7.2.4
MMO	July 2014	Within the Potential Impacts section, the effects that construction and decommissioning may have on key species such as S. spinulosa should be considered. This will avoid biogenic reef being classified as 'benthic species and habitats' and therefore being given the same magnitude and significance score as a sand habitat/community.	Impacts to these species were addressed in the PEIR however further detail has been added in section 10.6.1 and 10.6.2.
MMO	July 2014	Vol. 1, Section 11.6 – Whilst the Marine Life Information Network (MarLIN) sensitivity assessment is a useful source of information the limitations of these assessments should be considered and made clear in the text.	The limitations of the MarLIN assessments have been recognised in this chapter in section 10.4.3
Rijkswaterstaat	July 2014	We would like to emphasize the necessity of a broad international coordination related to building activities in the North Sea, in order to be able to determine and minimize the effects on environment and marine life, and kindly suggest developer Vattenfall to play a role in this matter.	EAOW are contributing towards a number of international projects which will further the understanding of the ecology of the North Sea, including Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS).
Natural England	July 2014	Further clarification is required regarding survey data and mitigation for Annex I habitat, temporal aspects of impacts to benthic ecology, OSPAR and BAP species, cumulative impacts and impacts at the time of decommissioning.	Mitigation for Annex I / Habitats of Principal Importance is set out in the IPMP which will be agreed with Natural England, the MMO and Cefas and finalised pre construction. Further detail has been added on the temporal aspects of impacts in *Table 10.2* and these have been assessed in

Consultee	Date /Document	Comment	Response / where addressed in the ES
			section 10.6.1. OSPAR and Biodiversity Action Plan (BAP) species are considered in section 10.5.5, impacts at decommissioning are considered in section 10.6.3 and cumulative impacts are considered in section 10.7.
Natural England	July 2014	Having reviewed the submitted survey data, we have some reservations with leaving all mitigation to the pre-construction stage. Note that there are four distinct areas showing consistently high *Sabellaria* presence, with reef identified in Figure 21 and Figure 50. These areas appear to be established and therefore it is our view that a buffer may be required around these areas. Note that it states in Table 10.1 that 'in the event of Annex 1 habitats being present during pre-construction surveys, micro-siting would ensure impacts are minimised or avoided'. We would expect that, once the position of reef features have been fully established during pre-construction surveys, micro-siting should be able to avoid the impacts and where this is not possible the surveys data should be sufficiently robust to enable impacts to be minimised as much as possible and thus reducing the risk.	The presence of *Sabellaria* reef is highly variable, therefore, given that data to inform the Zonal Environmental Appraisal (ZEA) was collected in 2010 and that the earliest construction would start is 2020, EATL believes that the most appropriate time to establish the continued presence / distribution of *Sabellaria* reef is during preconstruction surveys. Further information on the preconstruction surveys is included in the IPMP and in section 10.3.3
Natural England	July 2014	We note that Appendix 7.3 includes an assessment of scour protection. However there is not an assessment of scour protection in relation to potential effects to benthic organisms within Chapter 10. We appreciate a full assessment is difficult when the details concerning the use of cable protection are not yet known, but expect more details to be submitted to us as they become available. We would also expect post construction monitoring to be included so that we will be able to determine the level of scour across the structures, most	Further detail on the amount and type of scour protection to be used has been provided in Chapter 5 Description of the Development sections 5.5.4 and 5.5.14., This detail has been incorporated into the impacts assessment within this chapter. See IPMP

Consultee	Date /Document	Comment	Response / where addressed in the ES
		notably the offshore cable corridor.	
Natural England	July 2014	Overall this [section 10.6.1 of the PEIR] is lacking in detail. More detail on the time that specific habitats would be disturbed and the habitats and species involved would be helpful. We appreciate the timing of works has been covered in an earlier chapter but it has not specifically been related to this chapter i.e. to benthic habitat disturbance.	Further clarity on these on the habitats that could be affected and the timings of works has been provided in this ES *Table 10.2* and in section 10.6.1
Natural England	July 2014	It is stated that 'where large numbers of similar sized fish and invertebrates were encountered, subsampling was carried out in an appropriate manner'. This requires more detail; what exactly is meant by 'an appropriate manner'?	The size of the subsample varied between species. The exact detail of how this was achieved is not available however, it would have involved taking between 10 and 20% of all organism of one species, measuring these and using these measurements to represent the dimensions recorded for all organisms in that species. As the analysis used in this chapter does not use individual size of organisms this does not affect the assessments.
Natural England	July 2014	The evidence suggests that brittlestars (ophiuroidea) represent a greater proportion of the East Anglia 3 site than on the East Anglia one site, with species found to be present at 21 of the EA3 sub sample stations and comprising 5% of the EA3 recorded data. It is not inferred in the text but note these species are listed on the OSPAR List of Threatened and/or Declining Species and Habitats (Region II North Sea and Region III – Celtic Sea). Natural England would like further discussions over these findings.	Section 10.5.5.5 and 10.5.2.2
Natural		NE considers it best practice to	

Consultee	Date /Document	Comment	Response / where addressed in the ES
England 03/07/14 workshop		implement a monitoring regime to investigate the impacts construction and operation of human activities have on brittlestar beds.	
Natural England	July 2014	UK BAP (Biodiversity Action Plan) habitats are now listed as habitats of principal importance' under section 41 of the 'Natural Environment and rural communities act (NERC) 2006. This should be reflected in the submitted report. Noted in workshop by EA3	This ES chapter has been updated and now refers to Habitats of Principal importance where relevant.
Natural England	July 2014	Note that [in Section 4.1.2.5 of Appendix 10.1 to the PEIR], if the placement of structures and cable protection results in a localised increase in biodiversity yet changes the species composition of the area in question, we would consider that to be a negative effect on the environment, the term 'beneficial' in this context is misleading.	The term beneficial was not used in Section 4.1.2.5 of *Appendix 10.1* And in section 10.6.2.4 it is made clear that such affects cannot be regarded as beneficial
Natural England	July 2014	It is stated that 'the methods used for assessing the impacts during decommissioning will be very similar to those used during the construction phase. The operation involved will be slightly different, however it is anticipated that the magnitude of impacts will be less'. The applicant needs to explain this in more detail. How will it differ from the methods used during the construction phase and why will the magnitude of impacts be less?	Further detail is provided in *Table 10.2*; however, it is not possible to define precisely how activities would be carried out during decommissioning, as it would depend on the wishes of the regulator at that time and the best available technology.
Natural England	July 2014	This section on cumulative impacts is lacking any explanation on the proposed method of assessment (which is included in all other sections). We would expect this to be included, particularly given potential impacts within the offshore cable corridor	The method for cumulative impact assessment, which has been agreed through the Evidence plan process (*Appendix 10.1*) is described in section 10.4.4
Natural England	July 2014	Paragraph 305 states that 'it is unlikely that installation of the cables would	The integrity of the Special Protection Area

Consultee	Date /Document	Comment	Response / where addressed in the ES
		change the population of crustaceans, molluscs and worms within the SPA to an extent that there would be a noticeable change in population of the red-throated divers and therefore the sensitivity of the receptor (the Outer Thames Estuary) is considered to be low'. It should not be forgotten that the integrity of the Outer Thames SPA needs to be taken into account here, not simply the interest features of the site (which have been covered in the birds section).	(SPA) and potential impacts upon it have now been considered within sections 10.6.1.5 and 10.6.2.6
Natural England	July 2014	It is stated that 'it is likely that communities are habituated to smothering from natural events and are tolerant to smothering'. Note that a recent study found an upper threshold to smothering tolerance which varies with species (Last et al, 2001) and therefore we do not agree with this statement. We also find this section lacking in detail. There is no explanation on the level of smothering or expected sediment loads in water in this chapter, for example.	The assessment of increased suspended sediment and deposition levels as described in section 7.6.1 of Chapter 7 Marine Geology, oceanography and Physical Processes are likely to be considerably less than those used in the MarLIN assessments which form the basis of the sensitivity assessments in section 10.6.1.2 and 10.6.2.3. This is explained further in those sections.
Natural England	July 2014	Impact 1: Physical disturbance and loss of sea bed habitat - total area of habitat loss during operation. It would be helpful to have all parameters listed, i.e. including the expected diameter of scour protection around each GBS foundation.	This detail is now provided in Chapter 5 Description of the Development section 5.5.4 and in *Table 10.2*
Natural England	July 2014	Impact 1: Physical disturbance and loss of sea bed habitat - Cable protection of export cable. Natural England questions if the assumption of 2.5% of cable length requiring protection is overly optimistic. Following discussions with Cefas it is confirmed that these quantities seem optimistic and it would be useful for the ES to provide evidence for assumption or present a realistic worse case.	The worst case calculations in *Table 10.2* now use a precautionary 10% cable protection assumption within the calculations, however EATL believe it would be possible limit the amount of cable protection to 2.5% of

Consultee	Date /Document	Comment	Response / where addressed in the ES
			the export cable within 15m water depth and have committed to trying to achieve this.
Suffolk Wildlife Trust	July 2014	We have concerns as to the potential cumulative impacts, in particular the moderate adverse significant impact of physical disturbance and habitat loss within the export cable corridor, due to a large number of cable crossings. We would urge East Anglia THREE Ltd to look further at mitigation options to reduce this impact.	This was an error in the summary table of the PEIR, the narrative around the impact in concluded an impact of Minor significance, this has been updated in this ES. Section 10.6.2.1.2 provides an assessment of this impact
Suffolk Wildlife Trust	July 2014	Although there is a commitment to following best practice in terms of vessel maintenance to reduce the potential for introduction of invasive non-native species, there is no mention of the potential for non-native species colonisation of the turbines or cable protection during operation. Given the potential for these artificial structures to act as stepping stones, we believe that there should be a requirement for monitoring of this during the lifespan of the development, with an agreed protocol in place for responding to any realised colonisation.	Section 10.6.2.5 assesses the impacts of non-native species colonising structures. EATL believe that the most appropriate active management is to abide by the International Convention for the Prevention of Pollution from Ships (MARPOL)
The Danish Nature Agency		The Danish Nature Agency does not have any objections to the proposed project "Offshore Wind Farm in North Sea East Anglia Zone".	No action required
Phase III consultation (Report)			
Natural England	July 2015	We do not have any detailed comment to make at this time but look forward to receiving the revised environmental assessment and the detail contained therein of how the changes to the project may affect the outcome of the receptor specific assessments.	The impact assessment takes into consideration all changes that have been made to the project, specifically sections 10.3.2 and 10.6.1 which both consider the Single Phase and the Two Phased approaches.
Informal consultation			

Consultee	Date /Document	Comment	Response / where addressed in the ES
Natural England	July 2015	Natural England advised that *Sabellaria spinulosa* reef outwith designated Annex 1 sites to be referred to as a Section 41 of the NERC act rather than Annex 1 habitat.	An explanation of the terminology used to describe Annex I habitat and Habitats of Principal Importance (the terminology used in the NERC act) is provided in section 10.5.5
Relevant consultation from East Anglia ONE Examination process.			
Fishermen	March 2013	Concerns regarding impacts to benthic ecology that will have a knock on impact to commercially important fish and shellfish species.	Sections 10.6 to 10.8 assess the impacts on relevant benthic species. This assessment is utilised in the inter-relationship section 10.9
MMO	March 2013	Could the applicant please clarify if the referenced literature relating to the ability of benthic species to survive burial and smothering is relevant, i.e. is the magnitude of effects expected during constructions (burial depth and duration) similar to those discussed within the literature? This is relevant to the sensitivity scores given for biotopes and species in relation to sea bed disturbance.	This is addressed in section 10.6.1 and 10.6.2
Natural England	March 2013	The potential requirement for maintenance works such as the deposition of protection or stabilisation material relating to cable exposure or malfunction has not been appropriately explored. We advise that an assessment outlining the potential for any maintenance works over the lifetime of the project, including works such as turbine or cabling requirements, is fully explored to ensure that any associated environmental impacts are fully considered within the Environmental Assessment. Without this assessment, we do not consider that the potential impacts of the development have been fully or robustly explored.	The potential impacts of maintenance works for the proposed East Anglia THREE project have been assessed in section 10.9.2.

10.3 Scope

10.3.1 Study Area

8. For the purposes of the benthic ecology assessment the proposed East Anglia THREE project has been divided up into two main study areas which are displayed in *Figure 10.1* and are defined as follows:

- The East Anglia THREE site: The 305km^2 area which would contain the wind turbines, offshore platforms, inter-array cables and platform link cables; and
- The offshore cable corridor, a 571km^2 area which is comprised of:
  - The export cable corridor, a 454km^2 area which would contain cables that export power to land; and
  - The interconnector cable corridor which would contain cables that connect the proposed East Anglia THREE project with the East Anglia ONE site.

9. The interconnector cable corridor and the export cable corridor overlap by approximately 120km^2 and are therefore considered one study area, defined as the offshore cable corridor.

10. As the proposed East Anglia THREE project was progressed following the consultation on the PEIR, the export cable corridor was refined and the interconnector cable corridor was established. Details of how this process was completed are provided in Chapter 4 Site Selection and Alternatives.

11. All data collection was completed before these changes were made and therefore some of the samples that targeted the offshore cable corridor are now outside of that study area, therefore when referring to the offshore cable corridor study area these sample stations are also included.

12. When assessing some impacts, the intertidal area at the landfall location is also treated as a separate study area.

13. The proposed East Anglia THREE project would have the same landfall location as East Anglia ONE and would utilise part of the East Anglia ONE export cable corridor. There are a number of options for the point at which the East Anglia THREE export cable would join this export cable corridor.

14. Within this chapter, the two main study areas are also placed within the context of the East Anglia Zone and the wider southern North Sea.

15. The East Anglia Zone and the proposed East Anglia THREE site and the East Anglia ONE site are displayed in *Figure 10.1*

10.3.2 Worst Case

16. In accordance with the requirements of the project design envelope (also known as the Rochdale envelope) approach to environmental impact assessment (EIA) (IPC 2011), realistic worst case assumptions in terms of potential impacts upon benthic ecology have been adopted.

17. The definitions of the worst case assumptions have been made from consideration of the Chapter 5 Description of the Development.

18. *Table 10.2* outlines the worst case scenarios for each identified impact. EATL are currently considering constructing the project in either a Single Phase or in a Two Phased approach. Under the Single Phase approach the project would be constructed in one single build period and under a Two Phased approach the project would be constructed in two phases each consisting of up to 600MW. There would be some differences between the worst cases for the construction impacts of the two approaches in terms of infrastructure installed (and the duration of construction) – this is covered in *Table 10.2*. For operational impacts, the worst case under either approach (Single or Two Phased) has been considered in the assessment and is presented in *Table 10.2*.

Table 10.2.Worst Case Assumptions (numbers are displayed to two decimal places therefore totals may not align exactly with individual elements)

Impact	Key design parameters forming the worst case scenario	Rationale
Construction		
Impact 1: Temporary physical disturbance	**Single Phase approach** Under the Single Phase approach the maximum area of disturbance across the East Anglia THREE site and offshore cable corridor has been quantified based on the following: 1. Sea bed disturbance for 60m gravity base foundations and scour protection calculated as 25,500m^2 per foundation (see Chapter 5 description of the Development *Table 5.10*). Therefore, for 100 foundations (see rationale column) the maximum area of disturbance would be 2.55km^2. 2. Sea bed disturbance for offshore electrical platform and accommodation platform foundations with associated scour protection would amount to 16,800m^2 each. Under a Single Phase approach there would be up to six such structures totalling 0.10km^2. 3. Sea bed disturbance for up to two meteorological masts and scour protection each 2,830m^2 totalling an area of 0.01km^2. 4. Jack up barge sea bed footprint for 180 foundations (based on a jack up barge footprint of 1,800m^2 and three movements per foundation) the maximum disturbance would be 0.65km^2 5. Installation of up to 550km inter-array cables and 195km of platform link cables (with worst case trench width of 17.3m and 15m spoil width either side of that) of 35.2km^2. 6. Installation of anchors for up to 12 buoys (LiDAR, wave recording and guard) 48m^2. The total maximum area of disturbance during construction within the East Anglia THREE site would be 38.87km^2 (12.74% of the East Anglia THREE site) and would occur over a 33 month period (See Chapter 5 Description of the Development	**Single Phase approach** The largest wind turbines (12MW) would be installed on 60m diameter gravity base foundations and therefore the worst case would be 100 wind turbine foundations with their associated scour protection (a larger number (172) of the smaller (40m diameter) gravity base foundations and associated scour protection results in a smaller area of disturbance). Under a Single Phase approach, up to five foundations for electrical platforms, and one foundation for the accommodation platform would be installed and scour protection may be required (Calculations for the affected area are provided within Chapter 5 description of the development, *Table 5.16*). Up to two meteorological masts would be installed using one of a number of different foundation types as provided in Chapter 5 Description of the Development, *Table 5.17*. The greatest area of disturbance would result from gravity base structures and their associated scour protection. If scour protection is applied it is likely to be in the form of rock, concrete mattresses, sand-filled geotextile bags, or similar. If jack up vessels are used to install the wind turbines, offshore platforms and meteorological masts the jack up legs will be placed on the sea bed causing disturbance. A conservative assumption estimates that the jack up vessel

Impact	Key design parameters forming the worst case scenario	Rationale
	Table 5.34). 7. Installation of up to 380km of interconnector cables (between the East Anglia THREE site and East Anglia ONE) within 190km of trench would create a maximum area of disturbance of 8.99km^2 (3.78% of the interconnector cable corridor). The disturbance would occur over a 13 month period (See Chapter 5 Description of the Development *Table 5.34*). 8. Installation of up to 664km of export cable would result in a maximum disturbed area of 31.41km^2 (6.92% of the offshore export cable corridor) and would occur over a 22 month period (See Chapter 5 Description of the Development, *Table 5.34*). The total maximum area of disturbance during construction within the East Anglia THREE offshore cable corridor would be 40.39km^2 (7.07% of the offshore cable corridor) and would take 41 months to complete with a 6 month hiatus between export cable and interconnector installation (See Chapter 5 Description of the Development *Table 5.34*). The total overall total footprint of disturbance of the East Anglia THREE site and offshore cable corridor combined under a Single Phase approach is 79.26km^2 (9.04% of the proposed East Anglia THREE project) occurring over a 41 month period. **Two Phased approach** Under the Two Phased approach, there would be one additional offshore platform (16,800m^2) and up to 3 extra platform link cables therefore maximum disturbance across the East Anglia THREE site would be 41.02km^2 (13.45% of the East Anglia THREE site) with works taking place over a 42 month period. Within the offshore cable corridor there would be up to two additional trenches required for 190km of interconnector cable installation therefore the maximum	would need to reposition three times for each installation. When installing cables the greatest area of disturbance to benthic habitat would be caused by excavating a trench large enough to bury the cables to up to 5m. To achieve this a trench would be required that would be 17.3m wide and would have 15m, of spoil either side (See chapter 5 Description of the Development section 5.5.14.1.7) LiDAR buoys, wave recording buoys and guard buoys would be anchored to the sea bed by anchors that would have a footprint of 4m^2 per buoy. Up to 12 buoys would be installed. Of the two methods being considered for installing the export cables at landfall, the short duct method is considered the worst case scenario (see Chapter 5 Description of the Development section 5.6.2) as disturbance would occur over a slightly greater area and closer to shore. **Two Phased approach** Under the Two Phased approach to construction the area of disturbance would be largely the same as with the Single Phase approach with the addition of 1 electrical platform, 3 platform links and two trenches in which interconnector cables would be laid. The construction periods would also be extended (see Chapter 5 Description of the Development section 5.5.16). Under either approach much of this calculated area would be

Impact	Key design parameters forming the worst case scenario	Rationale
	disturbance across the cable corridor would be 49.38km^2 (8.64% of the offshore cable corridor) and would take 39 month period (See Chapter 5 Description of the Development *Table 5.37*) The overall total footprint of disturbance of the proposed East Anglia THREE site and offshore cable corridor under a Two Phased approach is 90.40km^2 (10.32% of the proposed East Anglia THREE project) with impacts occurring over a 42 month period.	only temporarily disturbed (i.e. anything related to cable installation or Jack up vessels). It is anticipated that a small proportion of it (the physical footprint of the proposed project) would represent permanent habitat loss. Operation Impact 1 assesses the impact of permanent habitat loss. An overlap would occur where there is a temporary physical disturbance (for example with sea bed preparation) with an area which then suffers permanent habitat loss through infrastructure being placed on that location. By assessing the two impacts (Construction impact 1 and Operation impact 1) separately all possible impacts will be quantified although there would be a degree of "double counting". This is a precautionary approach but ensures a comprehensive assessment.
Impact 2: Smothering due to increased suspended sediment	**Single Phase approach** The worst case scenario for the Single Phase approach would involve the maximum amount of sediment disturbance including: 1. Sea bed preparation of 40m diameter gravity base foundations calculated as 17,500m^3 per foundation (see Chapter 5 Description of the Development *Table 5.9*). Therefore, for 172 foundations (see Rationale column) the maximum expected amount sediment released into the water column is 3,010,000m^3. 2. Sea bed preparation for installation of gravity base or jacket foundations for up to 2 meteorological masts. Therefore, the maximum possible amount of sediment released into the water column would be up to 20,750m^3. 3. Sea bed preparation to install Jacket foundations for up to six offshore platforms (see rationale) would result in a maximum sediment release into the water column of 439,350m^3.	In either the Single Phase or the Two Phased approach the worst case would be defined by either 172 of the smallest wind turbines (7MW) being installed on 40m diameter gravity base foundations requiring a maximum sediment excavation of 17,500m^3 of ground preparation, or100 of the largest turbines (12MW) being installed on a 60m diameter gravity base foundation requiring a maximum sediment excavation of 26,000m^3 (See Chapter 5 Description of the Development *Table 5.9*). Therefore, the worst case for sediment disturbance from wind turbine foundation installation would be 172 of the 40m diameter gravity base foundations. In either Single Phase or Two Phased approach the two meteorological masts would be installed on foundations which, in the worst case scenario for sediment disturbance, would be either gravity base or jacket, would require similar

Impact	Key design parameters forming the worst case scenario	Rationale
	Therefore the total maximum excavation requirement for foundations within the East Anglia site would be 3,470,100m^3 4. Sea bed preparation required for cable installation (see rationale column) within the East Anglia THREE site would be up to 136,000m^3. 5. Sea bed preparation required for cable installation within the offshore cable corridor would be up to 385,841m^3. Therefore the total maximum excavated sediment required for sea bed preparation for cable installation within the proposed East Anglia THREE project would be up to 521,841m^3 6. Installation of 550km inter-array, 195km of platform link, 190km of interconnector trenching and 664km of export cables (Total 1,599km) to a depth of 5m using the technique of jetting. The maximum realistic speed of cable installation if jetting is used is likely to be approximately 150-450 m/hr. The installation of cables would be spread across 26 months for the inter-array and platform link cables and across 13 months for the interconnector cables. (See Chapter 5 Description of the development Table 5.34). The installation of cables and foundations would be spread across 41 months (See Chapter 5 Description of the development *Table 5.34*) with a maximum of two sea bed preparations for foundations per day. **Two Phased approach** Under the Two Phased approach, sea bed preparation to install 1 extra Jacket foundation would result in a maximum sediment release into the water column of up to 3,543,325m^3. The installation of foundations would extend across two distinct 7 month periods (See Chapter 5 Description of the Development *Table 5.36* and *Table 5.37*). Under the Two Phased approach, three extra platform link cables, and two extra	sea bed preparation of 10,375 m^3 (See Chapter 5 Description of the Development, section 5.5.7). . Under the Single Phase approach, the worst case for sediment disturbance would be the installation of foundations for up to five converter and collector stations, and one accommodation platform. The greatest amount of sea bed preparation would occur if these offshore platforms were installed on jacket foundations, in which case up to 73,225m^3 could be excavated. Should the installation of monopiles or jackets using pin piles be required, drilling may also be undertaken which would release subsurface materials into the water column. It has been estimated that the maximum quantity of released material under this scenario would be 83,560m^3 (Chapter 5 Description of the development, Section 5.5.4.1.3. Sub-surface sediments have a different physical composition to near-surface sediments and may therefore be more widely dispersed by tidal currents. However the volumes involved are far smaller than sea bed preparation for gravity base foundations (Chapter 7 Marine Geology, Oceanography and physical processes *Table 7.5*) and therefore overall it is considered that installation of gravity base foundations are the worst case scenario for re-suspension of sediments. To allow efficient installation and protection of electrical cables there could be a requirement for sea bed excavation in areas where steep sided sand waves occur. A detailed explanation of how the calculations were made for the amount of material that may be excavated is provided in section 7.6.1.3 of Chapter 7 Marine Geology, Oceanography

Impact	Key design parameters forming the worst case scenario	Rationale
	trenches would be required for interconnector cables would be required, therefore the total length of installed cable would be 1,834km. The installation of cables and foundations would extend across 42 months (See Chapter 5 Description of the Development *Table 5.37*) with a maximum of two sea bed preparations for foundations per day.	and Physical Processes and these calculations are deemed relevant to both the Single Phase and the Two Phased approaches. The worst case scenario for the suspension of sediment during the cable installation process would be to install all electrical cables using jetting techniques. Other techniques are being considered (Chapter 5 Description of the Development, section 5.5.14) and in reality, jetting would only be used for a small proportion of the cable instillation. **Two Phased approach** Under the Two Phased approach, much of the worst case scenario would be identical to that of the Single Phase, with the addition of one offshore electrical platforms three platform link cables and two interconnector cable trenches and the construction period would be longer.
Impact 3: Re-mobilisation of contaminated sediments	As above	The worst case would involve the maximum amount of suspended sediment released into the water column. This is calculated in the row above.
Impact 4: Underwater noise and vibration	The maximum anticipated hammer energy for monopile Installation is 3,500KJ. **Single Phase approach** Under a Single Phase approach the installation of monopiles would occur over a 15 month period with one pile installed at a time or over an 8 month period where up to two monopiles could be installed concurrently. **Two Phased approach** Under a Two Phased approach, monopiles would not be installed concurrently and	The greatest impact to underwater noise, which may affect benthic species, would be from installation of monopile foundations. The greater the hammer energies used the greater the amount of underwater noise produced. *Tables 5.34* and *Table 5.37* in Chapter 5 Description of the Development illustrate indicative time periods for monopile installation under a Single Phase and Two Phased approach respectively.

Impact	Key design parameters forming the worst case scenario	Rationale
	installation would occur over two 8 month periods separated by 10 months.	
Impact 5 Potential impacts on Sites of Marine conservation interest	An area of the export cable corridor overlaps with the Outer Thames SPA. The overlap is 94.81km^2 and within this up to 104km (26km × 4) of export, cable would be installed. With a worst case trench width of 17.3m and 15m spoil width either side of that this would create an area of disturbance of up to 4.92km^2 (0.13% of the total SPA area).	An area of the Outer Thames Estuary would be disturbed by installation of the export cables. Chapter 5 Description of the Development section 5.5.14.1.7 details the width of disturbance caused from installation of cables as 47.3m. The worst case scenario for this impact would not change under a Two Phased approach for construction.
Operation		
Impact 1: Permanent Habitat Loss	The maximum possible sea bed footprint of the project including scour protection. The scour assessment *Appendix 7.3* shows that the maximum scour holes would be smaller than the maximum area of scour protection as specified in Chapter 5 Description of the Development. Under the worst case scenario the Two Phased approach would have the size of footprint is based on the following: **Two Phased approach** Under a Two Phased approach the size of footprint is based on the following: 1. 60m gravity base foundations and scour protection calculated as 25,500m^2 per foundation (see Chapter 5 Description of the Development *Table 5.10*). Therefore, for 100 foundations (see Rationale column) the maximum area of disturbance would be 2.55km^2. 2. Gravity base foundations for offshore electrical platform and accommodation platform foundations with associated scour protection would amount to footprint of 16,800m^2 each. Under a Two Phased approach there would be up to 7 such structures totalling 0.10km^2 3. The gravity base foundation and scour protection footprint for two meteorological masts would be 0.01km^2.	The scenario described gives rise to the greatest area of permanent sea bed habitat loss. Areas impacted by scour would be changed irreversibly and would therefore count as habitat loss, however it has been shown in Chapter 7 Marine Geology, Oceanography and Physical Processes that the area taken by scour protection is likely to be larger than the areas which would experience scour apart from in water depths less than 15m. The areas, which would be occupied by cable protection, are based on calculations displayed in *Table 5.25* and *Table 5.27* in Chapter 5 Description of the Development. It is expected that any requirement for cable protection would be considerably reduced following further detailed design studies. **Two Phased approach** Under the Two Phased approach, much of the worst case scenario would be identical to that of the Single Phase, with the exception of offshore electrical platforms platform link

Impact	Key design parameters forming the worst case scenario	Rationale
	4. Cable protection due to inability to bury for up to 550km inter-array cable would result in a footprint of up to 0.17km^2 5. Cable protection for up to 240km of Platform Link cable would result in a footprint of up to 0.07 km^2. 6. Protection associated with cable crossing for platform link cables would result in a footprint of up to 0.01 Km^2. Total footprint during operation within the East Anglia THREE site which could be subject to permanent habitat loss is therefore 2.92km^2 (0.95% of the East Anglia THREE site area). 7. Cable protection due to an inability to bury interconnector cables (between East Anglia THREE and East Anglia ONE) would result in a footprint of up to 0.11km^2. 8. Protection associated with cable crossing for interconnector cables would result in a footprint of up to 0.02km^2. Total footprint during operation of the interconnector cables is therefore 0.14km^2 (0.06% of the Interconnector cable corridor area). 9. Cable protection due to an inability to bury export cables would result in a footprint of up to 0.20km^2. 10. Protection associated with cable crossing for export cables would result in a footprint of up to 0.03km^2. Total footprint which could be subject to permanent habitat loss during operation of the export cables is therefore 0.23km^2 (0.05% of the export cable corridor area). Under the Two Phased approach, the overall total footprint which could be subject to permanent habitat loss would therefore be 3.23km^2 (0.37% of the overall project area).	cables and interconnector cables. Under the worst case scenario for the Two Phased approach there would be 1 additional electrical platform and 3 additional platform link cables, and 2 additional interconnector cable trenches to protect. All of which would result in a greater amount of material placed on the sea bed to protect the infrastructure.
Impact 2: Physical Disturbance through maintenance	The maximum area of disturbance during operation is difficult to predict at this stage therefore estimates have been given based upon industry experience. It has been estimated that a maximum of two visits by jack-up vessels to the East	An estimate of the maximum area for physical disturbance during operation is calculated. This area would be only temporarily disturbed and would rapidly recover.

Impact	Key design parameters forming the worst case scenario	Rationale
activities	Anglia THREE site per day with a footprint of 1,800m^2 would form the majority of the physical disturbance during operation. This would lead to a total area of up to 1.31km^2 per year (the equivalent of 0.43% of the East Anglia THREE site). There may be the need to perform maintenance operations on electrical cables during the lifetime of the proposed project. It has been estimated that the following average number of cable maintenance / replacement would be carried out per year (See Chapter 5 Description of the Development *Table 5.38*): 1. Inter array cables 2 2. Platform length cables 1 3. Interconnector cables 1; and 4. Export cables 2	The rate of cable failure has been calculated as approximately 2.86 failure / 1,000km / year (Chapter 5 Description of the Development 5.5.17.3). Under the Two Phased approach the maintenance requirements are expected to be similar to that of the Single Phase approach
Impact 3: Smothering through increased suspended sediment	The maximum amount of sediment that would be placed into suspension due to changes in tidal regime around infrastructure with no scour protection has been calculated based on scour produced by gravity base foundations. This has been calculated as 5,573m^3 per 60m and 3,646m^3 per 40m gravity base foundation (see Chapter 7 Marine Geology, Oceanography and physical processes *Table 7.6*). Therefore, for 174 (172 wind turbine and two meteorological mast) 40m diameter foundations and seven (six electrical platforms and one accommodation platform) 60m diameter foundations (see Rationale column) the maximum expected amount scour material released into the water column is 673,415m^3. All of the above are based on a 1 in 50 year return period.	The need for scour protection would not be determined until the wind turbine location and associated foundation types are known. Therefore, the worst case scenario involves the use of no scour protection which would result in sediment being bought into the water column. Of all the foundation options under consideration, 60m diameter gravity base foundations would cause the greatest amount of scour. However, the worst case for increased suspended sediment from wind turbine foundation installation would be 172 of the 40m diameter gravity base foundations. It has been assumed that the worst case for up to seven (worst case under the Two Phased approach) foundations for offshore platforms would result in a similar amount of scour to that of the 60m gravity base foundations as calculated in Chapter 7 Marine Geology, Oceanography and physical processes *Table 7.6*). It has also been assumed that the scour caused by

Impact	Key design parameters forming the worst case scenario	Rationale
		meteorological mast foundations would be equivalent to the 40m diameter gravity base foundations calculated in (Chapter 7 Marine Geology, Oceanography and Physical Processes *Table 7.6*). Although, in reality it would be less than this as the size of foundations would be 20m in diameter (See Chapter 5 Description of the Development *Table 5.17*. As scour would take place immediately following installation, the release of scour from each piece of infrastructure would be sequential rather than concurrent.
Impact 4: Re-mobilisation of contaminated sediments	As described in Impact 3 above	The worst case would involve the maximum amount of suspended sediment released into the water column. This is calculated in the row above.
Impact 5: Colonisation of introduced substrate	The introduction of new hard structures with a maximum surface area provided by the following project infrastructure: 1. Gravity base foundations for wind turbines 2. Gravity base foundations for offshore platforms and meteorological masts, 3. Inter-array cable protection, 4. Platform link cable protection and crossings; 5. Interconnector cable protection and crossings; 6. Export cable protection and crossings.	Gravity base foundations are likely to provide the largest surface area for potential colonisation and therefore are considered to be the worst case scenario. It is not possible to accurately calculate the surface area that would be available for colonisation. It would however be greater than the figure presented for “footprint” in operation Impact 1 (above) as the former is a 3-D metric, whilst the latter is 2-D.
Impact 6: Potential impacts on sites of marine conservation interest	A small area of the export cable corridor overlaps with the Outer Thames SPA (approximately 94.81km^2). The worst case scenario would be that the maximum amount of cable protection would be located within this overlapping section. EATL have committed to ensuring that a maximum of 2.5% of the export cables length to the west of the crossing point with the Greater Gabbard Offshore Wind farm export cables is covered with cable protection. The overlap between the	The described scenario would lead to cable protection installed within the SPA.

Impact	Key design parameters forming the worst case scenario	Rationale
	cable corridor and the SPA is to the west of this crossing point. Therefore, cable protection covering an area of up to 0.01km^2 could be placed within the SPA, this represents 0.01% of the area of overlap with the SPA and 0.0002% of the total SPA area.	
Impact 7: Electromagnetic Fields (EMF)	The greatest impact from EMF would occur if cables are buried to the shallowest depth of 0.5m, and the maximum amount of cable of the maximum cable rating is utilised, based on: 1. The maximum length of inter-array (up to 75kV of alternating current) cables would be up to 550km 2. The maximum length of platform link cables would be up to 240km of up to 400kV direct current cables under the HVDC solution or up to 45km of 600kV alternating current cables under the LFAC solution. 3. The maximum length of interconnector cables (up to 600kV) would be 380km (up to 600kV). 4. The maximum length of export cable (up to 600kV) would be 664km. The total length of cable laid under the Two Phased approach would be up to 1,834km.	The scenario described would pertain to the largest possible area that could be impacted by EMF. Given the uncertainty over effects on benthic species, the assessment uses a spatial footprint rather than differentiating between AC and DC. Under either electrical solution (See Chapter 5 Description of the Development, section 5.5.1.3) the inter-array cables would be up to 75kV of alternating current, and the platform link, interconnector, and export cables would be up to 400kV under the HVDC solution or 600kV under the LFAC solution.
Decommissioning		
Impact 1: Temporary Physical disturbance	The maximum area of disturbance during decommissioning is based on: **Two Phased Approach** 1. Removal of 100 60m gravity base foundations and scour protection calculated as 25,500m^2 per foundation with a combined footprint of 2.5km^2 (see construction impact 1). 2. Removal of seven offshore platform foundations and scour protection calculated as 16,800m^2 per foundation with a combined footprint of 0.12km^2. (see construction impact 1)	The maximum area of disturbance caused by decommissioning of the proposed East Anglia THREE project would result from removal of foundations, scour protection and cable protection. See construction impact 1 for rationale on the worst case number and size of foundations that would be removed. All buried cables would simply be cut at the ends and left in-situ. The removal of cable protection would be agreed with

Impact	Key design parameters forming the worst case scenario	Rationale
	3. Removal of up to two meteorological masts and scour protection, each with a footprint of 2,830m^2 and a combined area of 0.01km^2. 4. The footprint of the jack-up barge removing 109 foundations (based on a jack up barge footprint of 1,200m^2 and three movements per foundation and the use of the maximum 100 wind turbine foundations) the maximum disturbance would be 0.39km^2. 5. Removal of cable protection placed due to inability to bury up to 10% of the 550km inter-array cable would result in a footprint of up to 0.17km^2 6. Removal of cable protection placed due to inability to bury up to 10% of the 240km of Platform link cable would result in a footprint of up to 0.07km^2. Total decommissioning footprint of disturbance within the East Anglia THREE site during decommissioning would be approximately 3.25km^2 (1.07% of the East Anglia THREE site). 7. Removal of cable protection placed due to inability to bury up to 10% of 380km of interconnector cables (between East Anglia THREE and East Anglia ONE) would result in a footprint of up to 0.11km^2 (0.05% of the interconnector corridor. 8. Removal of cable protection placed due to inability to bury up to 10% of 664km of export cable: 0.2km^2 (0.04% of the export cable corridor). Total decommissioning footprint of disturbance offshore of the East Anglia THREE project under a Two Phased approach is 3.56km^2 (0.41% of the offshore project area).	the relevant authority at the time however worst case for disturbance would be its removal. See operation impact 1 for rationale with regard to cable protection calculations. It has been assumed that cable protection associated with cable crossings would be left in-situ in order to protect other assets.
Impact 2: Smothering due to increased suspended sediment	As per details in construction impact 2 (above) for increased suspended sediment concentration and sediment deposition (although predicted to be much less in reality – see comment under rationale).	Any impacts produced during decommissioning would be less than those described during the construction phase (Construction impact 1) due to absence of sea bed preparation, which is the main source of increased suspended sediment concentration during the construction

Impact	Key design parameters forming the worst case scenario	Rationale
		phase.
Impact 3: Re-mobilisation of contaminated sediments	As per details in construction impact 3 (above) for re-mobilisation of contaminated sediments (although predicted to be much less in reality.	See text in the row above
Impact 4: Underwater noise and vibration	Noise created by the removal of foundations using cutting machinery	The removal of monopiles or piles for jacket foundations to 1-2m below sea bed level is likely to involve the use of cutting machinery. This is would create underwater noise and vibration which is likely to be substantially less than that created during the installation of monopiles
Impact 5: Loss of habitats and species colonising hard structures	As per details in operation impact 5 above. It is assumed that all colonised hard substrate would be removed see Chapter 5 Description of the development.	Assumed that all project infrastructure above sea bed level would be removed during decommissioning, resulting in the loss of colonised substrate.

10.3.3 Embedded Mitigation specific to Benthic Ecology

19. Embedded mitigation relating to the benthic ecology is summarised below:

- Careful site selection of the East Anglia THREE site and offshore cable corridor has been carried out to avoid, as far as possible, European designated sites and any proposed Marine Conservation Zones (MCZ).

- EATL would conduct a pre-construction survey, which would assess the presence and extent of Habitats of Principal Importance / Annex 1 reef [2] habitats as detailed in the In Principle Monitoring Plan (IPMP). Should such habitats be identified in close proximity to proposed foundation locations EATL would agree appropriate mitigation with Natural England and the MMO, which may include a post-construction survey to confirm no impacts to these habitats had been sustained.

- Micro-siting of foundations and cables would be employed in accordance with the marine licence to avoid Habitats of Principal Importance as far as is practicable.

- Sea bed disturbance would be minimised by not placing gravity base structures in areas where sandwaves are greater than 5m, therefore reducing the potential for increased suspended sediment, reducing the potential for habitat impact.

- The aim would be to bury as much cable as possible therefore reducing the effects of EMF and reducing the need for cable protection and the amount of introduced hard substrate.

- Should dredging be required in the vicinity of station 30 (see *Figure 8.1*) where elevated levels of arsenic have been detected, EATL would collect further data to assess the extent of the affected area and if found to be extensive would agree with the MMO a strategy for the disposal of material from this area to minimise impacts.

- The use of pre-installed (by East Anglia ONE) ducts would reduce the potential for impacts at the landfall location.

[2] It should be noted that Natural England and MMO's recent advice is for *Sabellaria spinulosa* reef outside of current designated Annex 1 sites to be referred to as a "Habitat of Principal Importance" in line with Section 41 of the NERC act. However, as this terminology may not be recognised by all, the term Annex I habitat is also used (and has historically been used by Natural England and others in the consultation responses).

- EATL would aim keep the use of cable protection to a maximum of 2.5% of the export cables to the west of the cable crossing location with the Greater Gabbard Offshore Wind Farm export cables. This ensures that the amount of introduced substrate and permanent habitat loss is limited to relatively small areas.

- Best-practice techniques including appropriate vessel maintenance would be used at all times to minimise the potential for contamination as outlined in the Marine Pollution Contingency Plan (MPCP) and International Convention for the Prevention of Pollution from Ships (MARPOL).

10.4 Assessment Methodology

10.4.1 Legislation, Policy and Guidance

20. The characterisation of the benthic ecology baseline and the assessment of potential impacts has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIP). Those relevant to benthic ecology within the proposed East Anglia THREE project are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a); and

- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011b).

21. *Table 10. 3* summarises the relevant NPS text as well as providing the sections in this ES where each is addressed.

Table 10.3. NPS Assessment Requirements

NPS requirements	NPS reference	Section Reference
An assessment of the effects of installing cable across the intertidal zone should include information, where relevant, about: 1. Any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice; 2. Any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice; 3. Potential loss of habitat; 4. Disturbance during cable installation and removal (decommissioning); 5. Increased suspended sediment loads in the intertidal zone during installation; and 6. Predicted rates at which the intertidal zone might recover from temporary effects.	Section 2.6.81 of NPS EN-3	1. Chapter 4 Site Selection and Alternatives 2. Chapter 5 Description of the Development 3. Section 10.6.2 4. Section 10.6.1 and 10.6.3 5. Section 10.6.1 6. Section 10.6.1
Applicants are expected to have regard to guidance issued in respect of Food and Environmental Protection Act (FEPA) [now Marine Licence] requirements.	Section 2.6.83 NPS EN-3	Section 10.4.1
Where necessary, assessment of the effects on the subtidal environment should include: 1. Loss of habitat due to foundation type including associated sea bed preparation, predicted scour, scour protection and altered sedimentary processes; 2. Environmental appraisal of inter-array and cable routes and installation methods; 3. Habitat disturbance from construction vessels' extendible legs and anchors; 4. Increased suspended sediment loads during construction; and 5. Predicted rates at which the subtidal zone might recover from temporary effects.	Section 2.6.113 of NPS EN-3	1. Section 10.6.2 2. Section 10.6 3. Section 10.6.1 and 10.6.2 4. Section 10.6.1 5. Section 10.6.1

NPS requirements	NPS reference	Section Reference
Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the Infrastructure Planning Commission (IPC) (now the Planning Inspectorate) should expect the applicants to have considered may include: Surveying and micrositing of the export cable route to avoid; 1. Adverse effects on sensitive habitat and biogenic reefs; 2. Burying cables at a sufficient depth, taking into account other constraints, to allow the sea bed to recover to its natural state; and 3. The use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.	Section 2.6.119 of NPS EN-3	1. section 10.3.3 2. section 10.3.3 3. section 10.6.2.5 Colonisation of hard substrate would represent a change to the baseline environment is therefore not considered desirable.
Where cumulative effects on subtidal habitats are predicted as a result of the cumulative effects of multiple cable routes, it may be appropriate for applicants for various schemes to work together to ensure that the number of cables crossing the subtidal zone is minimised and installation / decommissioning phases are coordinated to ensure that disturbance is reasonably minimised.	Section 2.6.120 of NPS EN-3	EATL are working with representatives of the Greater Gabbard Offshore Wind Farm and Galloper Wind Farm to agree appropriate methods for cable crossings to minimise impacts

22. The Marine Policy Statement (MPS, HM Government 2011) provides the high-level approach to marine planning and general principles for decision making that contribute to achieving this vision. It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high level objective of '*Living within environmental limits'* covers the points relevant to benthic ecology, this requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.

- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.

- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

23. With regard to the East Inshore and East Offshore Marine Plans (HM Government 2014) Objective 6 *"To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas"* and Objective 7 *"To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas"* are of relevance to this Chapter as these cover policies and commitments on the wider ecosystem, set out in the MPS including those to do with the Marine Strategy Framework Directive and the Water Framework Directive (see Chapter 3 Policy and Legislative Context and Chapter 8 Marine Water and Sediment Quality for more details) , as well as other environmental, social and economic considerations.

24. Other guidance on the requirements for windfarm studies are provided in the documents listed below:

- Cefas (2004) Offshore Windfarms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA requirements: Version 2.

- Cefas (2010) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA licence conditions, with input from the Food and Environment Research Agency (FERA) and the Sea Mammal Research Unit (SMRU).

- Office of the Deputy prime Minister (ODPM) (2001) Guidance on Environmental Impact Assessment in Relation to Dredging Applications.

- Defra (2005) Nature Conservation Guidance on Offshore Windfarm Development. A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9.

25. The principal guidance documents used to inform the baseline characterisation and the assessment of impacts are as follows:

- Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Centre for Environment Fisheries and Aquaculture Science.

- Wyn & Brazier (2001); Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook.
- Marine Management Organisation (MMO) et al. (2010) Guidance on the Assessment of Effects on the Environmental and Cultural Heritage from Marine Renewable Developments.
- Ware and Kenny (2011) Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites.
- Institute of Ecology and Environmental Management (IEEM) (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal.
- Environmental impact assessment for offshore renewable energy projects – Guide. PD 6900:2015
- Marine Management Organisation (2014) Review of environmental data associated with post-consent monitoring of licence conditions of offshore wind farms.

10.4.2 Data sources

10.4.2.1 Available literature

26. A desk study of available information was undertaken, both to inform the initial survey design and to provide regional characterisation information for the assessment.

27. Sources included, but were not limited to:

- East Anglia Offshore Wind Zone Environmental Appraisal (ZEA) (East Anglia Offshore Wind 2012);
- Regional Environmental Characterisation (REC) studies (Emu 2009 and the University of Southampton and Limpenny et al. 2011);
- Relevant published literature;
- Marine Life Information Network (MarLIN);
- The Mapping European Sea bed Habitat (MESH) project;
- Consultation responses (See section 10.2); and
- The East Inshore and East Offshore Marine Plans (MMO 2014)

10.4.2.2 Primary data sources

28. Data from three separate survey campaigns commissioned by East Anglia Offshore Wind (EAOW) have been used to inform the benthic ecology baseline. These include: surveys of the East Anglia Zone, surveys of the East Anglia ONE offshore cable corridor and site specific surveys of the East Anglia THREE site and offshore cable corridor. Data have been collected using three different sampling methodologies:

- Grab samples to characterise the infauna (i.e. animals living within the sediment);
- Beam trawls to characterise the epifauna (i.e. animals living attached to the sea bed); and
- Video footage to identify the presence and extent of biogenic reefs (i.e. reef structures created by organisms).

29. *Table 10.4* summarises the different surveys and methodologies that have informed the benthic assessment. For information regarding the geophysical surveys, which were used to inform the benthic ecology assessment, please refer to *Table 7.12* in Chapter 7 Marine Geology, Oceanography and Physical Processes.

30. The East Anglia Zone surveys, which were completed in 2010, were designed to inform site selection within the zone. During these surveys 643 grab samples were taken; 566 of these were arranged in a grid pattern across the zone to characterise the area and a further 77 were located to target features of interest (such as sandwaves or slopes identified through the zone wide geophysical survey). A full report from this survey as well as analyses of these data are presented in *Appendix 10.2*.

31. The East Anglia THREE offshore cable corridor shares part of the East Anglia ONE offshore cable corridor (See Chapter 5 Description of the Development for further detail). Therefore, samples acquired from the East Anglia ONE offshore cable corridor survey are relevant to the East Anglia THREE offshore cable corridor. A full report from this survey as well as analyses of these data is presented in *Appendix 10.3*.

32. There is a deep water shipping route that passes through the East Anglia Zone and due to safety concerns, the Zone surveys did not collect samples within this route. To address these data gaps, East Anglia THREE Limited (EATL) commissioned Fugro Emu Ltd. to conduct a further benthic survey within areas of the offshore cable corridor, which cross the deep water shipping route. In order to ascertain the scope

of this survey, APEM Ltd. were commissioned to conduct a statistical power analysis (*Appendix 10.5*) to identify the number of samples needed to accurately characterise the benthic communities within the East Anglia THREE site. The results of the power analysis concluded that the East Anglia Zone survey provided a sufficient number of samples to characterise the infaunal and epifaunal communities of the East Anglia Zone and therefore the likely effects of the construction and operation of the proposed windfarm projects within it.

33. The power analysis also concluded that 36 further grab samples would be required to accurately characterise the infaunal communities of the East Anglia THREE offshore cable corridor and three beam trawl samples would be required to adequately characterise the epifaunal communities.

34. The final survey consisted of 49 grab samples, 39 within the East Anglia THREE offshore cable corridor five from within the East Anglia THREE site and five from within what was, at the time of the survey the location of the East Anglia FOUR site. The additional five were not a requirement of the power analysis however it was considered that extra samples would further support the data already obtained. Six beam trawl samples were acquired from within the East Anglia THREE offshore cable corridor (the survey report is presented in *Appendix 10.4*).

Table 10.4. Primary Data Sources (surveys)

Data	Year	Coverage	Confidence	Notes
Zone grab sample survey	2010	The East Anglia Zone	High	643 samples acquired across the East Anglia Zone. 566 in a grid and 77 samples designed to target areas of interest.
Zone beam trawl survey	2010	The East Anglia Zone	High	78 samples acquired across the East Anglia Zone to characterise the area
Zone Video Survey for reef forming species	2010	The East Anglia Zone	High	Drop down video tows targeting epifaunal species
East Anglia ONE offshore cable corridor grab sample survey	2011	East Anglia ONE offshore cable corridor	High	41 samples acquired along the East Anglia ONE offshore cable corridor
East Anglia THREE / FOUR grab sample survey	2013	East Anglia THREE / FOUR sites and offshore cable corridor	High	49 samples acquired over the East Anglia THREE and FOUR sites and offshore cable corridor
East Anglia THREE / FOUR Beam trawl survey	2013	East Anglia THREE / FOUR sites and offshore cable corridor	High	12 beam trawl samples located in the East Anglia THREE site and offshore cable corridor

35. *Table 10.5* shows the number of samples that have been acquired from the campaigns across the East Anglia THREE site and the offshore cable corridor. These are the data that are used to determine the receptors within the two study areas.

Table 10.5. Samples Within Study areas

Study Area	Grab samples	Trawl samples	Video samples
The East Anglia THREE site	43 (38 from the Zone survey and five from the East Anglia THREE / FOUR survey)	7 trawls (Four from the Zone survey and three from the East Anglia THREE / FOUR survey)	50 (42 from the Zone survey and eight from the EA THREE / FOUR survey)
The offshore cable corridor	126 grabs (47 from the Zone surveys 38 from the East Anglia THREE / FOUR survey and 41 from East Anglia ONE cable corridor survey)	17 trawls (11 from the Zone Survey and six from the THREE / FOUR survey)	143 (58 from the Zone Surveys, 44 from the East Anglia THREE / FOUR Survey and 41 from the East Anglia ONE Cable corridor survey)

36. Detailed methodology for how the samples were collected is presented in the reporting of each survey (see *Appendix 10.2*, *Appendix 10.3* and *Appendix 10.4*) however, a brief summary is provided below.

10.4.2.2.1 Using Video Footage

37. To minimise the environmental impact of the surveys, a video camera was dropped to the sea bed prior to the use of any potentially destructive sampling techniques (grab or beam trawl sampling). The "drop down" digital video and stills cameras were mounted within a frame and towed astern of a vessel over the sea bed surface, at a speed of approximately 0.5knots for circa ten minutes. Following the completion of an ecological review of the geophysical data, the sea bed imagery acquired during all surveys was inspected on the vessel in 'real time' in order to assess the presence, or otherwise, of important benthic habitats at stations which were indicated as being of possible importance.

38. This technique also aided characterisation of the sea bed sediments and habitat types.

10.4.2.2.2 Sampling for infauna

39. Throughout all three benthic survey campaigns the positions of all benthic grab stations were recorded using dGPS with a nominal accuracy of within 2m. All benthic samples were obtained using a standard $0.1m^2$ mini-Hamon grab deployed from the survey vessel. At each station the grab was lowered to the sea bed and, once triggered, an offset positional fix was obtained and the grab was recovered onto the deck of the survey vessel.

40. Each sample was discharged into a plastic box and a photograph was taken. The sample was then either accepted or rejected dependent on volume (sample sizes of above five litres were accepted). A maximum of three attempts were made at each station to obtain the correct sample size. Where all three samples were smaller than five litres in volume, the largest sample was retained for processing and a decision was made as to whether removing a sub-sample for particle size distribution (PSD) analysis was appropriate.

41. Where sample volumes allowed, three small sub-samples were obtained from the sediment in the box and the pooled sample of between 0.5 and 1.0L was retained in a labelled plastic bag for subsequent particle size distribution analysis.

42. Following sub-sampling, the residual grab samples were washed with seawater over a 1mm sieve to remove fine particles. The residual samples were preserved in formalin and sealed for transportation to the laboratory.

43. Where *S.spinulosa* was observed within a grab sample, detailed field notes were prepared and additional photos were taken of any significant amounts identified during sieving.

44. In the laboratory all fauna were extracted from each sample, identified to the highest taxonomic level and enumerated. The sub-samples of sediment were subject to full particle size analysis and were sieved over the range 31.5 to 0.063mm on the Wentworth scale. The results were expressed as absolute percentage retained on each sieve size.

10.4.2.2.3 Sampling for Epifauna

45. Epibenthic samples were obtained in the East Anglia Zone and the East Anglia THREE site using a 2m scientific beam trawl towed at speeds between 1 and 2 knots. A bottom time of 10 minutes or 500m distance per trawl was maintained throughout the different surveys. Following deployment of the trawl, each sample was brought aboard the vessel, discharged into a box or tray and was photographed.

46. Fish and invertebrates sampled during trawling were sorted, enumerated, identified and weighed on board the survey vessel and, wherever possible, were returned to the sea alive. Invertebrates and fish species that could not be accurately identified during the survey were preserved in 10% formaldehyde and brought back to the laboratory for verification.

47. Where large numbers of similar sized fish and invertebrates were encountered, subsampling was carried out (i.e. fractions of the samples were used to represent a larger group). Gobies, hermit crabs and small gurnards were identified to family level. Encrusting and colonial species were recorded on a presence and absence basis.

10.4.2.3 Statistical analysis

48. Multivariate statistical analysis of data from each survey campaign was conducted separately to characterise the benthic and epibenthic communities and investigate the relationships between the communities and the abiotic environment. The analyses used the Plymouth Marine Laboratories PRIMER v6 (Plymouth Routines in Multivariate Ecological Research) suite of programs. Further detail of these separate analyses is presented in *Appendix 10.2*, *Appendix 10.3* and *Appendix 10.4*

49. Data were then were combined to form infaunal and epifaunal master data sets. All fish species were removed from the data as they are not considered part of the benthos and are considered within Chapter 11. The master data sets were also

subjected to multivariate statistical analysis in order to characterise the benthic communities, the detail of which is presented in *Appendix 10.6*.

50. Following a fourth- route transformation, both data sets were then subjected to hierarchical clustering to identify sample groupings based on the Bray Curtis index of similarity. A 20% similarity slice was used to separate infaunal communities and a 48% slice was used to separate epifaunal communities.

10.4.3 Impact Assessment Methodology

51. The data sources summarised above in *Table 10.4* were used to characterise the existing environment (section 10.5). Each impact, which has been identified using expert judgment and through consultation with Statutory Nature Conservation Bodies via the Evidence Plan Process is then assessed in terms of its significance using the following methods. The definitions for the sensitivity, value and magnitude of effect were also agreed in consultation during the Evidence Plan Process (see *Appendix 10.1*).

52. The general approach to the assessment of the significance of each impact is detailed in Chapter 6 EIA Methodology and an explanation of how this is applied to benthic ecology within the proposed East Anglia THREE project assessment is described below.

10.4.3.1 Sensitivity

53. The sensitivity of the receptor for each impact is characterised as one of four levels, high, medium, low or negligible. The description of each level is given in *Table 10.6,* below.

54. The sensitivity of biotopes has been assessed using the methodology developed by the Marine Life Information Network (MarLIN) and through the examination of online resources or through published research (Tyler-Walters et al. 2004 and 2011). It is recognised that the MarLIN assessments, although useful when assessing the sensitivity of biotopes and species, have limitations. The assessments are constructed based on a literature review of available data and no empirical testing of the sensitivity has been conducted.

55. With regard to the sensitivity of species, similarities between impacts caused by windfarms and the aggregates industry have been assumed.

Table 10.6. Definitions of the different Sensitivity Levels for Benthic Ecology

Sensitivity	Definition
High	Individual receptor (species or habitat) has very limited or no capacity to accommodate, adapt or recover from the anticipated impact.
Medium	Individual receptor (species or habitat) has limited capacity to accommodate, adapt or recover from the anticipated impact.
Low	Individual receptor (species or habitat) has some tolerance to accommodate, adapt or recover from the anticipated impact.
Negligible	Individual receptor (species or habitat) is generally tolerant to and can accommodate or recover from the anticipated impact.

10.4.3.2 Value

56. In addition, the 'value' of the receptor forms an important element within the assessment for instance if the receptor is a protected species or habitat or has an economic value. Example definitions of the value levels for benthic ecology receptors are given in *Table 10.7*.

Table 10.7. Definitions of the Value Levels for Benthic Ecology receptors

Value	Definition
High	Internationally or nationally important
Medium	Regionally important or internationally rare
Low	Locally important or nationally rare
Negligible	Not considered to be particularly important or rare

57. It is important to understand that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. Annex I habitat) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.

10.4.3.3 Magnitude

58. The magnitude of effect has been considered in terms of the spatial extent, duration and timing (seasonality and / or frequency of occurrence) of the effect in question. Expert judgment has been employed to consider and evaluate the likely effect on the species, population or habitat identified. The definitions of magnitude of effect are provided in *Table 10.8*.

Table 10.8. Definitions of the Magnitude Levels for a Benthic Ecology Receptor

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and / or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.
No change	No loss of extent or alteration to characteristics, features or elements.

10.4.3.4 Impact significance

59. Following the identification of receptor value and sensitivity and magnitude of the effect, it is possible to determine the significance of the impact using the matrix presented in *Table 10.9*.

Table 10.9. Impact Significance Matrix

Sensitivity	Magnitude				
	High	**Medium**	**Low**	**Negligible**	**No change**
High	**Major**	**Major**	**Moderate**	**Minor**	**No Impact**
Medium	**Major**	**Moderate**	**Minor**	**Negligible**	**No Impact**
Low	**Moderate**	**Minor**	**Minor**	**Negligible**	**No Impact**
Negligible	**Minor**	**Negligible**	**Negligible**	**Negligible**	**No Impact**

60. The matrix (and indeed the definitions of sensitivity and magnitude) are used as a framework to aid understanding of how a judgement has been reached for each impact assessment, not a prescriptive formula, and the narrative of each impact assessment is important.

61. Through use of this matrix, an assessment of the significance of an impact can be made in accordance with the definitions in *Table 10.10*.

Table 10.10. Impact Significance Definitions

Impact Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, likely to be an important consideration at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

62. For the purposes of this EIA and specifically the benthic ecology assessment, 'major' and 'moderate' impacts are deemed to be significant. In addition, whilst 'minor' impacts are not significant in their own right, they may contribute to significant impacts cumulatively or through interactions.

63. Embedded mitigation (as previously described in section 10.3.3) has been referred to and included in the initial assessment of significance of an impact. If an identified impact requires further mitigation then the residual impact is evaluated. If no further mitigation is required, is likely to have a positive ameliorating effect or if no further mitigation is practicably achievable, then the assessment of significance of an impact would remain as the initial assessment.

10.4.4 Cumulative Impact Assessment

64. Cumulative impacts have been assessed through consideration of the extent of influence of changes or effects upon benthic ecology arising from the proposed East Anglia THREE project and those arising from other projects either already constructed (where applicable) or in the planning process. These include the East Anglia ONE and a future East Anglia project, and particularly with regards to cables crossing the export cables for Greater Gabbard Offshore Wind Farm and Galloper Offshore Wind Farm. Other nearby sea bed activities including marine aggregate extraction and marine disposal are also considered. Although it is recognised that commercial fishing is a major modifier of the benthic environment, this has been

occurring for hundreds of years and is therefore considered part of the existing environment described in section 10.5.

65. The benthic ecology cumulative impact assessment draws from findings of earlier studies undertaken to inform the East Anglia ZEA (EAOW 2012) and Chapter 7 Marine Geology, Oceanography and Physical Processes which uses empirical assessment to provide a level of magnitude of effects which may apply to benthic ecology.

66. The format of the cumulative impact assessment has been discussed and agreed as part of the Evidence Plan Process (see *Appendix 10.1*).

10.4.5 Transboundary Impact Assessment

67. Transboundary impacts have been assessed through consideration of the extent of influence of changes or effects and their potential to impact upon benthic ecology receptor groups that are located within other EU member states.

68. Transboundary impacts were considered in the Scoping Report and it was concluded that for benthic ecology, "*transboundary impacts are unlikely to occur or are unlikely to be significant.*" (East Anglia THREE Ltd 2012). To date, EATL have not received any consultation responses questioning this statement. This position is supported by the physical processes assessment (see Chapter 7 Marine Geology, Oceanography and Physical Processes). However, for the purposes of a comprehensive assessment transboundary effects are considered within this impact assessment at a high level.

10.5 Existing Environment

69. The environmental baseline, including descriptions of sediment type, infauna and epifauna, is presented for the East Anglia THREE site and offshore cable corridor which includes the intertidal area at the landfall. A description of protected areas and important species in the vicinity of the project is also provided.

10.5.1 Sea Bed Sediments

70. The sea bed sediment across the East Anglia THREE site and interconnector cable corridor is relatively homogeneous and is characterised predominantly by sand, with some muddy sand (*Figure 10.2*). These sediment types are typical of the types of bedforms (sandwaves, megaripples, sand ridges) that are present. Muddy sand occurs in deeper areas and correlates with locations where the surficial sediments are a thin veneer and the underlying muddy Brown Bank Formation is close to sea bed. At these locations bedforms are absent. The most common sediment grain size

is medium sand with one sample collected containing very fine sand[3] (very fine sand).

71. The sea bed across the proposed East Anglia THREE offshore cable corridor is predominantly sand. The median sediment grain size (d_{50}) of a series of grab samples mostly ranges from 0.23 to 0.50mm (medium sand) with a small number of samples with a d_{50} in the coarse sand or very fine sand classes. Further information on sediments is presented in Chapter 7 Marine Geology, Oceanography and Physical Processes and in particular *Appendix 7.2*. Sea bed sediments are displayed in *Figure 10.2*

72. Multivariate analysis of the samples collected during the East Anglia Zone Survey found that there was a significant relationship between biological communities and sediment type (*Appendix 10.2*).

10.5.2 Infaunal Communities

73. In the following sections, infauna (as sampled by grabs) is taken to mean species that live in, or partially buried within, and below the sediment. Epifauna (sampled by benthic trawls) is taken to mean species that live on the surface of the sea bed. All fish (including sandeels) and cephalopods (squid and cuttlefish) species have been removed from the benthic and epibenthic data set as they are not considered to be benthic species. These data however are incorporated into Chapter 11 Fish and Shellfish Ecology.

10.5.2.1 Infaunal communities in the East Anglia Zone

74. Abundance of individuals in the infauna ranged from 2,240 (station 441, Zone survey) to 2 (station 41 in the East Anglia THREE / East Anglia FOUR survey and station 35 in the East Anglia ONE offshore cable corridor survey). Infaunal abundance varies across the East Anglia Zone with generally higher values recorded in the west of the zone and along the eastern extent of the East Anglia THREE offshore cable corridor (*Figure 10.3*).

75. Species richness across the East Anglia Zone (identified as the number of different species found at each grab sample site) ranged from 70 (station 100 in the East Anglia Zone survey) to 2 (at station 41 in the East Anglia THREE / FOUR survey and station 35 in the East Anglia ONE offshore cable corridor survey). The pattern of species diversity was less defined than abundance with midrange values across most of the East Anglia Zone (*Figure 10.4*).

[3] (d_{50}) ranges from 0.21 to 0.36mm (medium sand) and d_{50} of 0.07mm respectively

76. Biomass (ash free dry weight) follows a slightly different pattern with the largest values occurring in the eastern side of the zone *Figure 10.5*.

77. As detailed in section 10.4.2.2 several different primary data sets have been collected from the East Anglia Zone, East Anglia ONE export cable corridor survey and East Anglia THREE / FOUR survey. In order to characterise infaunal communities across all of these data sets, grab samples that had not been located to target specific features were combined to create a larger data set and subsequently reanalysed for this assessment using PRIMER V6. This allowed a consistent approach to defining communities for this assessment rather than having three different analyses as reported in *Appendix 10.2*, *Appendix 10.3, Appendix 10.4*). The combined infaunal data set included 566 grab samples from the East Anglia Zone survey, 49 from the East Anglia THREE and FOUR survey and 39 samples from the East Anglia ONE cable corridor survey (total 654).

78. The infauna identified and enumerated within the combined data set are displayed as number of individuals in each class in *Diagram 10.1* and by number of species in each class in *Diagram 10.2*.

79. By far the most numerate class were the polychaetes accounting for 57% of all individuals identified across the East Anglia Zone and East Anglia THREE offshore cable corridor. They were also the most numerate class in terms of species identified with 43% of all species identified as polychaetes.

80. The most numerous polychaete in the combined data set was *S. spinulosa* with a total of 8,702 individuals present across 108 sample stations. The greatest number found in a single sample was 1,660 and in total 12 station samples contained more than 100 individuals. Further detail about *S. spinulosa* and its importance within the study areas is provided in sections 10.5.5 and 10.6. *Spiophanes bombyx* was also very numerous with 3,697 individuals identified across the East Anglia Zone and East Anglia THREE offshore cable corridor. This species was less numerous overall than *S. spinulosa*, however, it was identified at over four times as many sample stations (423). Other species of polychaete, which were not as abundant at individual sample stations as *S. spinulosa*, but were identified at a greater number of sample stations include:

- *Nephtys cirrosa* (987 individuals found at 418 stations);
- *Nephtys* species which could only be identified to genus (355 individuals found at 194 sample stations);
- *Glycera* sp. (406 individuals found at 177 sample stations);

- *Ophelia borealis* (943 individuals found at 270 sample stations);
- *Ophelia sp.* which could not be identified to species level (789 individuals found at 152 sample stations); and
- *Scoloplos armiger* (640 individuals found at 198 sample stations).

81. Malacostracan crustaceans were the next most numerate (5,026 individuals identified) class both in terms of individuals and number of species (145 species identified). The most numerous was the long clawed porcelain crab *Pisidia longicornis* with 996 individuals identified at 27 sample stations. This high abundance was mainly due to an aggregation at station 420. Many other species within the class were more evenly distributed across the East Anglia Zone, these included:

- *Abludomelita obtusata* (818 individuals found at 56 sample stations);
- *Bathyporeia elegans* (561 found at 170 sample stations); and
- *Urothoe brevicornis* (785 individuals at 194 sample stations).

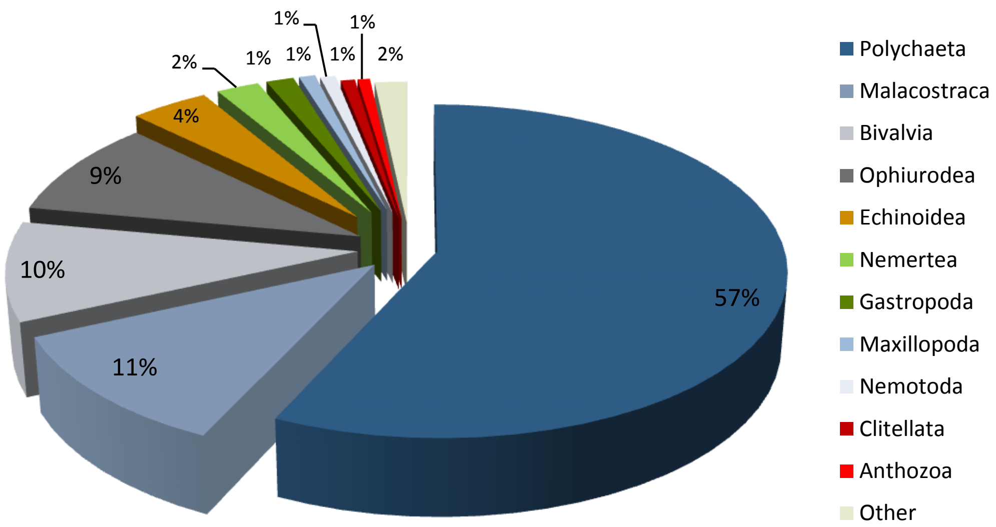


Diagram 10.1 Infaunal breakdown for the East Anglia Zone (Includes data from Zone, East Anglia ONE Cable corridor and East Anglia THREE / FOUR surveys): Number of individuals by class. Where species identification to class is not possible, species are displayed by phylum (for example Nemertea and Nematoda).

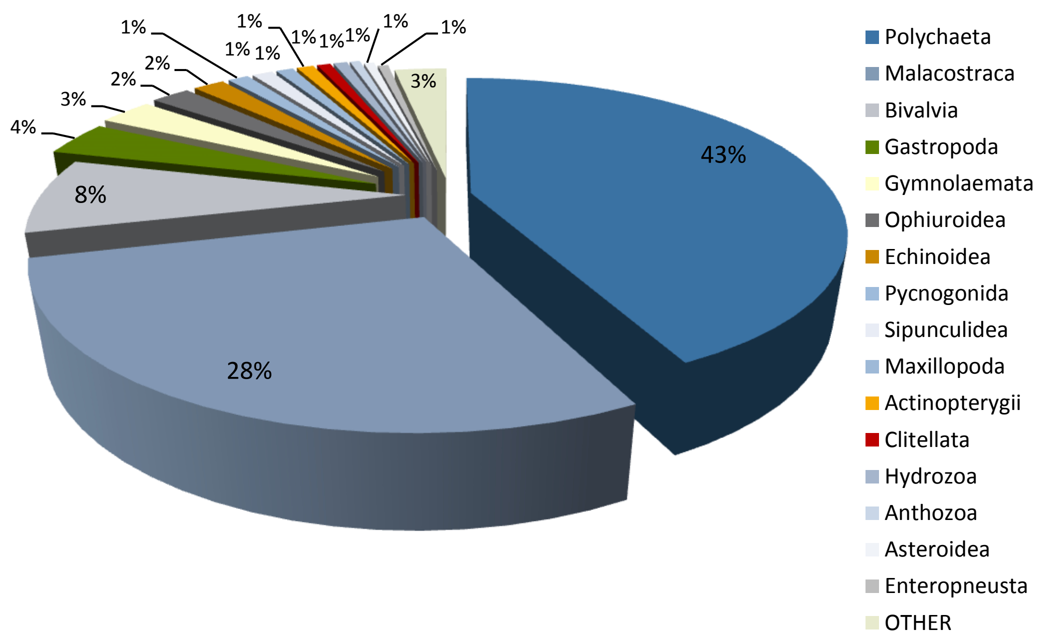


Diagram 10.2 Infaunal breakdown for the East Anglia Zone (Includes data from Zone, East Anglia ONE Cable corridor and East Anglia THREE / FOUR surveys: Number of species by class. Where species identification to class is not possible, species are displayed by phylum (for example Nemertea and Nematoda).

82. Bivalve molluscs made up approximately 10% of all the individuals identified. The most common bivalve species was *Abra alba* (1,637 found across 96 sample stations). Other species of bivalve such as *Fabulina fabula* (810 individuals at 145 sample locations) and unidentified species within the genus *Spisula* (204 found across 102 sample stations) were also numerous.

83. In order to characterise the benthic communities across the three infaunal data sets described in section 10.4.2, the data sets were combined (as described above) and cluster analysis was conducted using PRIMER V6 which identified 18 different faunal groups within the East Anglia Zone and East Anglia THREE offshore cable corridor. Details of the analysis are presented in *Appendix 10.6*, the infaunal groups are presented in *Table 10.11* and their locations are displayed in *Figure 10.6*.

84. The relationship between the biotic and abiotic elements within a habitat is encompassed in the term biotope (biotope is defined as the combination of an abiotic habitat and its associated community of species). The biotope codes displayed in *Table 10.11* were assigned using the current UK Marine Classification System v4.05 (Connor et al. 2004). Biotopes were allocated to the groups identified by the cluster analysis and a summary of the codes assigned to each is displayed in *Table 10.11.* It should be recognised that the assignment of biotope codes is subjective; groupings identified do not always fit easily into the defined categories.

Where available, the biotope allocations have been taken from the survey reports (*Appendix 10.4* and Chapter 9 of the East Anglia ONE ES) and where not available these have been assigned by the author.

85. The assignment of biotopes allows the assessment of the sensitivity within Section 10.6 by using the sensitivities defined by MarLIN and Tyler-Walters et al. (2004 and 2011).

Table 10.11. Faunal Groups across the East Anglia Zone and the East Anglia THREE offshore cable corridor study area identified using cluster analysis. Green Highlights Faunal Groups only found in the East Anglia THREE and FOUR survey.

Faunal Group	Dominant species	Common name of group	Sediment	Water depths (m) LAT	Number of stations			Equivalent Biotope (s)
					Zone	East Anglia THREE Site*	Offshore cable corridor	
A	*Pisione remota*	A polychaete worm	Gravelly Sand	42.8 - 45	2	0	1	SS.SCS.CCS (Circalittoral coarse sediment)
B	Nemertea *Notomastus spp.*	Ribbon worms A bristleworm	Sand with mud and gravel	20 - 32	2	0	2	SS.SCS.CCS SS.SMU.CSaMu (Circalittoral sandy mud)
C	*Thia scutellata*	Thumbnail crab	Sand	32.9 - 41.1	2	0	2	SS.SSa.CFiSa (Circalittoral fine sand) SS.SSa (Sublittoral sands and muddy sands)
D	Mytilidae Nemertea	Mussels Ribbon worms	Gravelly sand	12.8 - 42.6	11	0	10	SS.SCS.CCS SS.SCS.ICS (Infralittoral coarse sediment) SS.SMx.CMx (Circalittoral mixed sediment) SS.SMx.IMx (Infralittoral mixed sediment)

Faunal Group	Dominant species	Common name of group	Sediment	Water depths (m) LAT	Number of stations			Equivalent Biotope (s)
					Zone	East Anglia THREE Site*	Offshore cable corridor	
E	*Sabellaria spinulosa* Mytilidae Ascidiacea Nematoda *Polydora caulleryi*	Ross worm Mussels Sea squirts Round worms A bristleworm	Mixed substrate (including hard clays)	3.2 - 17.2	8	0	4	SS.SCS.ICS SS.SMx.IMx
F	Copepoda *Spio goniocephala*	 A polychaete worm	Sand	16.9 - 42.7	4	0	0	Not assigned as faunal community is absent from proposed project SA
G	*Ophelia borealis* *Polycirrus* *Spisula*	A bristleworm A polychaete worm A surf clam	Sand	32.4 - 36.3	4	0	0	Not assigned as faunal community is absent from proposed project SA
H	*Goodallia triangularis* *Lumbrineris cingulata*	A bivalve mollusc A polychaete worm	Sand	28.7 - 39.6	2	0	0	Not assigned as faunal community is absent from proposed project SA
I	*Nephtys hombergii* *Nucula nitidosa* *Spiophanes bombyx*	A catworm A bivalve mollusc A bristleworm	Sandy Mud	2.1 - 13	3	0	2	SS.SCS.ICS SS.SMu.ISaMu (Infralittoral sandy mud) SS.Ssa.IMuSa (Infralittoral muddy sand)

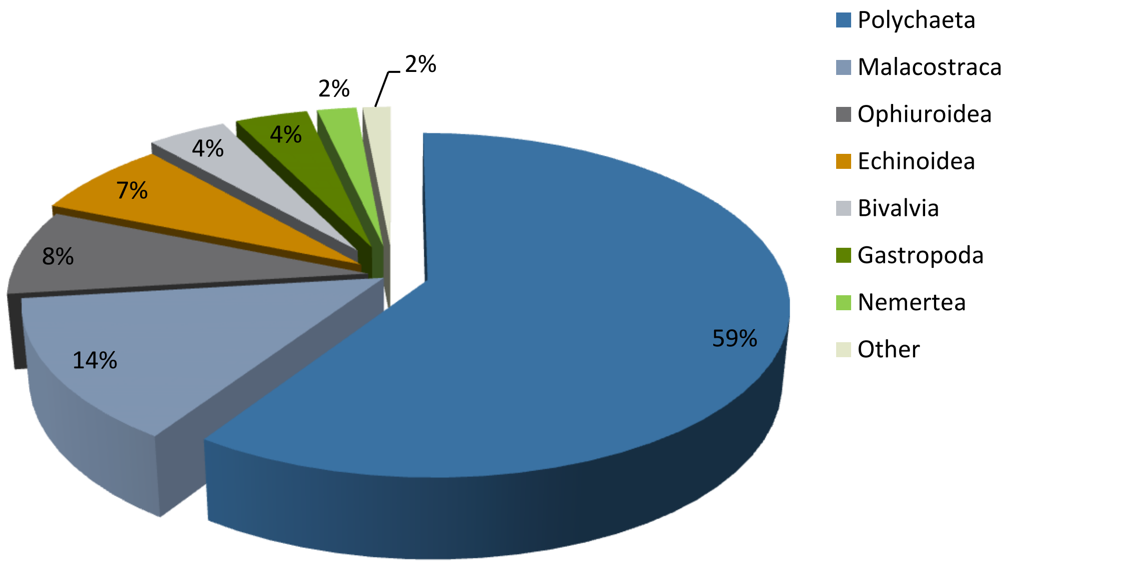
Faunal Group	Dominant species	Common name of group	Sediment	Water depths (m) LAT	Number of stations			Equivalent Biotope (s)
					Zone	East Anglia THREE Site*	Offshore cable corridor	
J	*Spiophanes bombyx*	A bristleworm	Muddy fine sand	5.6 - 38.2		0	2	SS.SSa.IFiSa (Infralittoral fine sand)
K	*Scoloplos armiger*	A bristleworm	Sand	41.4 - 44.4	2	0	0	Not assigned as faunal community is absent from proposed project SA
L	*Asclerocheilus intermedius* *Nephtys cirrosa* *Ophelia borealis*	A polychaete worm White catworm A bristleworm	Gravelly sand	30.3 - 52.1	34	4	20	SS.SCS.CCS SS.SMx.CMx SS.SSa.CFiSa
M	*Nephtys cirrosa* *Spiophanes bombyx* *Nemertea*	White catworm A bristleworm Ribbon worms	Sand and Gravelly sand	9.2 - 62.3	222	4	16	SS.SCS.CCS SS.SSa.CFiSa SS.SSa.IFiSa
N	*Nephtys cirrosa* *Spiophanes bombyx* *Polinices pulchellus*	White catworm A bristleworm Gastropod snail	Sand and Muddy sand	22.7 - 55.7	259	29	8	SS.SCS.CCS SS.SSA.CFiSa
O	*Nephtys cirrosa* *Ophiocten affinis*	White catworm A brittlestar	Sand	38 - 53.5	9	0	2	SS.SSa.CFiSa
P	*Gastrosaccus spinifer*	A shrimp	Sand	54.3 - 12.4	11	0	2	SS.SCS.CCS

Faunal Group	Dominant species	Common name of group	Sediment	Water depths (m) LAT	Number of stations			Equivalent Biotope (s)
					Zone	East Anglia THREE Site*	Offshore cable corridor	
	Ophiuroidea	Brittlestars						SS.SMX.CMx SS.SSa.CFiSa SS.SSa.IFiSa
Q	Nemertea Ophiuroidea *Spiophanes bombyx*	Ribbon worms Brittlestars A bristleworm	Mixed sediments from mud to gravel sands and gravel with high mud content	20 - 52.1	69	5	7	SS.SCS.CCS SS.SCS.ICS SS.SMU.CSaMu SS.SMx.CMx SS.SSa.CFiSa
R	*Glycera lapidum* Ophiuroidea *Spiophanes bombyx*	A polychaete worm Brittlestars A bristleworm	Sandy Gravel	13.5 - 45.1	2	0	1	SS.SSa.IFiSa

10.5.2.2 Infaunal communities in the East Anglia THREE site

86. The infaunal communities within the East Anglia THREE site are dominated by many of the same species groups as the East Anglia Zone. Polychaetes are the most numerous class in terms of individuals followed by Malacostraca. The East Anglia THREE site however, is less diverse than the Zone containing a fewer number of species (146 compared with 512).

87. The infauna identified and enumerated within the combined data set are displayed as number of individuals in each class in *Diagram 10.3* and by number of species in each class in *Diagram 10.4*.



88.

Diagram 10.3 Infaunal breakdown for the East Anglia THREE site (including data from the Zone surveys and EA THREE / FOUR surveys): Number of individuals by class. Where species identification to class is not possible, species are displayed by phylum (for example Nemertea).

89. The species composition of the East Anglia THREE site differs slightly from that of the East Anglia Zone. *S. spinulosa* is far less abundant with only 15 individuals found across nine stations. Other polychaetes such as *Spiophanes bombyx* (935 individuals found across 37 stations) and *Nephtys cirrosa* (81 individuals at 30 stations) are more numerous. Also of note was a high abundance of *Capitella sp.* at station 163 in the north of site. This species is known for its aggregating behaviour which is sometime associated with areas of pollution.

90. The Malacostracan *Urothoe brevicornis* was the most abundant crustacean across the East Anglia THREE site with 98 individuals found across 18 sample stations. This species was also important in the context of the East Anglia Zone being found at more stations than any other species in its class as well as being the third most abundant in terms of individuals identified. *Bathyporeia elegans* (53 individuals found across 16 sample stations) was the next most abundant species identified across the East Anglia THREE site. Also of note was the high abundance of *Abludomelita obtusata* at sample station 162, as this species usually has a preference for sediment with a high mud content (between 10 and 40%).

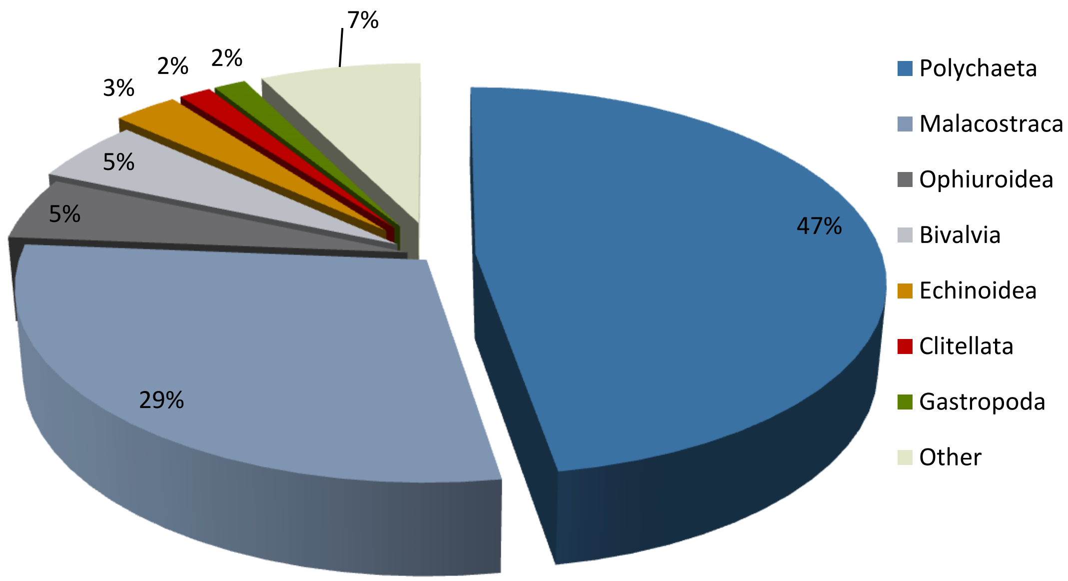


Diagram 10.4 Infaunal breakdown for the East Anglia THREE site (including data from the Zone surveys and EA THREE / FOUR surveys): Number of species by class. Where species identification to class is not possible, species are displayed by phylum (for example Nemertea and Nematoda).

91. In terms of number of individuals recorded, the echinoderm classes of brittlestars Ophiuroidea (8.02%) and sea urchins Echinoidea (7.2%) represent a greater relative proportion in the East Anglia THREE site than they do in the East Anglia Zone. This is not due to greater abundance of brittlestars, rather a lack of other classes. Species of brittlestar are not easy to identify and therefore unidentified ophiuroidea were recorded at 60% of grab samples within the East Anglia THREE site sample stations (compared with 67% across the site). 117 individuals of the urchin *Echinocyamus*

pusillus were found at 10 stations and 47 *Echinocardium cordatum* were identified across 18 stations in the East Anglia THREE site.

92. In terms of number of species recorded, the echinoderms are also of greater significance, with the brittlestars comprising 5% of the recorded species from the East Anglia THREE site compared with just 2% from the East Anglia Zone. Again this is not due to the site containing high brittlestar species diversity, rather the relatively low numbers in other classes.

93. The multivariate analysis showed four different "faunal groups" present within the East Anglia THREE site; groups M, N and Q (*Figure 10.6*). These were very much analogous to the three identified from the original East Anglia Zone surveys (*Appendix 10.2*) with the addition of a fourth group (L) from the East Anglia THREE / FOUR survey and one outlier which is also from the East Anglia THREE / FOUR survey (*Figure 10.6*).

94. These groups are described in the East Anglia Zone survey report (*Appendix 10.2*) as

- Group E: Brittlestars (ophuroidea), ribbon worms (nemertea) and the bristleworm *Spiophanes bombyx*;
- Group H: *S. bombyx*, the catworm *Nephtys cirrosa*, necklace shell *Polinices (Euspira) pulchellus* and the bristleworm *Scoloplos armiger*; and
- Group J: *N. cirrosa, S. bombyx* and nemertea.

95. And these correspond to groups Q, N and M respectively in *Table 10.11* and *Figure 10.6*

96. These groups are all closely related with overlap of characterising fauna in many of the faunal groups.

97. The most common community within the East Anglia THREE site is N (equivalent to group H in the ZEA report *Appendix 10.2*) and was identified at 29 of the 43 sample stations (*Table 10.11*).

98. In addition to the grab samples used for the sea bed characterisation a further 77 samples were included in the East Anglia Zone surveys. These stations were targeted towards features of interest as identified using the geophysical survey data (see *Appendix 10.2* for further detail) to provide EAOW with robust information on potential Annex I habitats in the form of either *Mytilus* mussel beds or *Sabellaria* reefs.

99. Five of these targeted samples (*Figure 10.7*) were within the East Anglia THREE site. When included in the multivatriate analysis all five of these fitted with the existing groups E and H, which are equivalent to Q and N in *Table 10.11*.

10.5.2.3 Infaunal communities in the Offshore cable corridors

100. Many of the same species groups dominate the infaunal communities within the offshore cable corridor as the East Anglia Zone (*Diagram 10.5*). Polychaetes are the most numerous group followed by Bivalvia, Malacostraca Ophiuroidea and Echinoidea, albeit in a slightly different order. Bivalves are more dominant in the offshore cable corridor than in the East Anglia Zone.

101. An average of 54.9 individuals per sample were identified across the offshore cable corridor, which is below the average of 67.5 individuals across the East Anglia Zone, and the average number of species identified per sample was also lower (13.46 compared with 14.9).

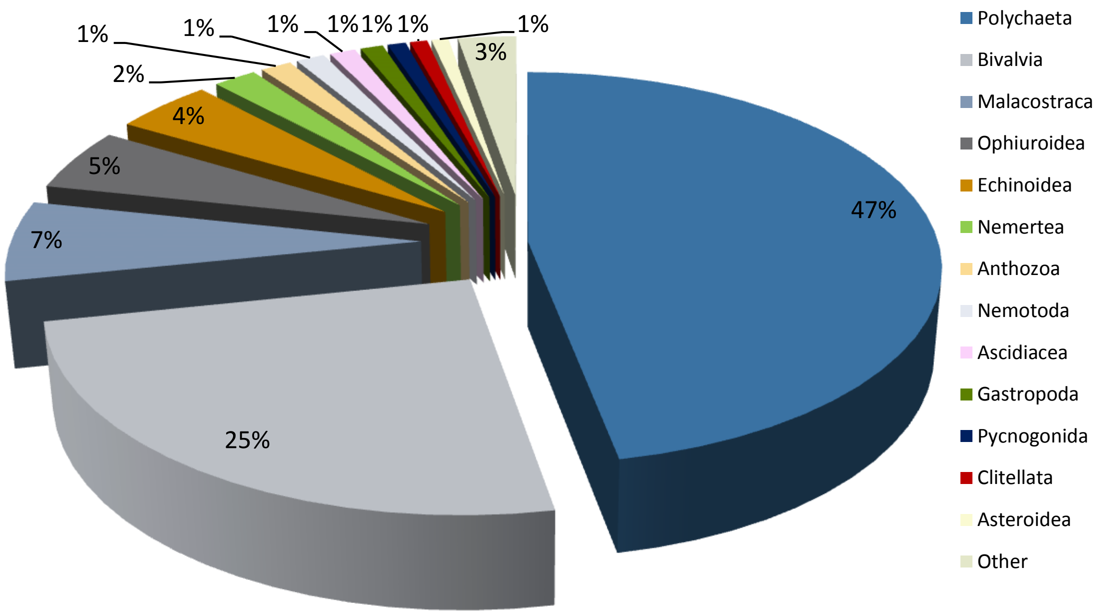


Diagram 10.5 Infaunal breakdown for the offshore cable corridor (including data from the East Anglia Zone Survey, East Anglia ONE export cable corridor survey and East Anglia THREE / FOUR survey): Number of individuals by class. Where species identification to class is not possible, species are displayed by phylum (for example Nemertea and Nematoda).

102. Polychaetes, bivalves and crustaceans of the class Malacostraca dominate the offshore cable corridor in terms of number of species identified which is in line with the pattern observed in the East Anglia Zone (*Diagram 10.2* and *10.6)* albeit that

across the Zone Malacostraca are more dominant and within the offshore cable corridor Bivalvia are more dominant.

103. The species compositions of the offshore cable corridor differ slightly from that of the East Anglia Zone. Within the dominant class, the polychaete *S. spinulosa* is far less abundant with 219 individuals found across 13 sample stations. Other polychaetes such as *Spiophanes bombyx* (238 individuals found across 36 stations) *Sphaerosyllis bulbosa* (278 individual across 5 stations) *Nephtys cirrosa* (103 individuals identified across 47 stations) and *Ophelia borealis* (67 individuals identified across 27 stations) were more widespread.

104. The most abundant bivalves which make up almost triple the proportion in the offshore cable corridor than they do in the East Anglia Zone (*Diagram 10.5 and 10.1*) were from the family Mytilidae (437 individuals identified across 18 sample stations). The fact that individuals were not been identified to species level has meant that there is a slight over representation in the data. Other abundant bivalves include *Abra alba* (323 individuals identified across seven sample stations) and *Nucula nucleus* (87 individuals identified across five sample stations).

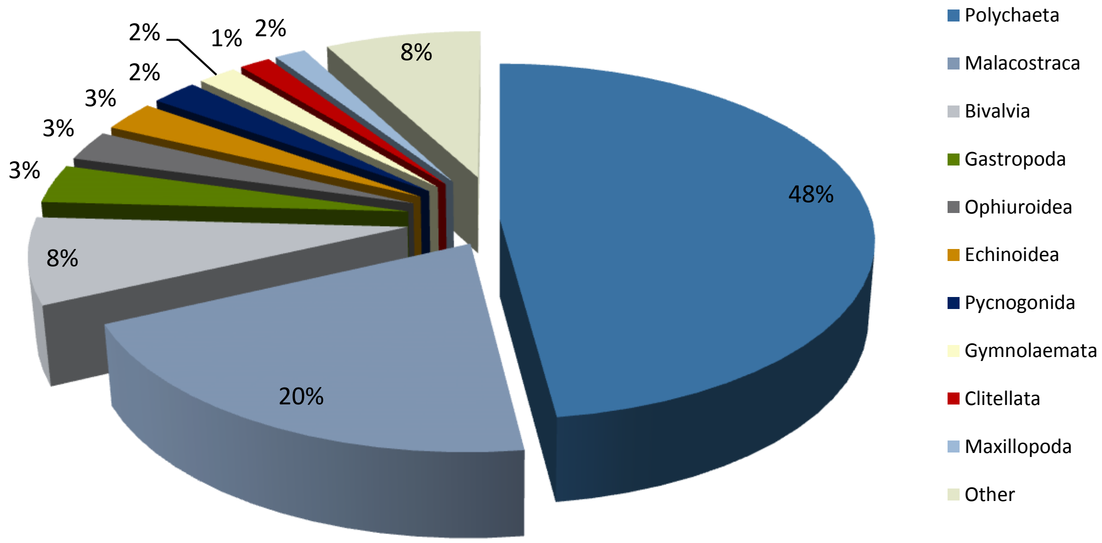


Diagram 10.6 Infaunal breakdown for the offshore cable corridor: Number of species by class (including data from the East Anglia Zone Survey, East Anglia ONE export cable corridor survey and East Anglia THREE / FOUR survey).

105. Although there were less individuals within the class Malacostraca than Bivalvia (*Diagram 10.5*) there were far more species of Malacostraca identified (*Diagram 10.6*). The most dominant and widespread species were *Urothoe brevicornis* (44

individuals identified across 14 stations), which was one of the most abundant and widespread species within the East Anglia Zone and *Ampelisca spinipes* (40 individuals identified across 8 sample stations). *A. spinipes* was relatively more abundant across the offshore cable corridor than across the East Anglia Zone.

106. The multivariate analysis showed that 14 different "faunal groups" were present across the offshore cable corridor. These ranged from faunal groups L, M, N, Q (which were the four groups present within the East Anglia THREE site), O and C (*Table 10.11*) in the offshore parts to B, D, J and E in areas closer to shore (*Figure 10.6*). Given the range of substrate types across the offshore cable corridor, from sands and gravels offshore to muddier sediment nearshore this diversity is to be expected.

107. The northern part of the offshore cable corridor is dominated by infaunal groups L and M (Figure 10.6) which are equivalent to biotopes SS.SCS.CCS, SS.SMx.CMx and SS.SSa.CFiSa (*Table 10.11*). The part of the offshore cable corridor that overlaps with the East Anglia ONE site is almost exclusively biotope SS.Ssa.CFiSa.EpusOborApri, with a small section of SS.SCS.CCS.MedLumVen (*Figure 10.11*).

10.5.2.4 Targeted samples

108. During the East Anglia Zone surveys 77 grab samples were acquired to target features of interest as identified using the geophysical survey data (see *Appendix 10.2* for further detail). Two of these samples (*Figure 10.7*) are located within the offshore cable corridor. When incorporated into the multivariate community characterisation these samples fitted into groups Q and N.

10.5.3 Epifaunal Communities

109. The following section describes the epibenthic communities within the three study areas. As detailed in section 10.4.2.2 several surveys were undertaken within the East Anglia Zone, East Anglia THREE site and offshore cable corridor. In order to characterise epifaunal communities, two of these data sets, the East Anglia Zone and the East Anglia THREE / FOUR epibenthic surveys were combined to create a larger data set.

110. As previously stated, benthic data was collected prior to a refinement of the export cable corridor and establishment of a interconnector cable corridor. This ES contains a smaller export cable corridor whose boundary is within the larger export cable corridor which was analysed for the PEIR. When analysing the impact on the epibenthic communities it has been considered appropriate to include all survey samples from the original PEIR assessment as these are still relevant to the assessment as they provide context and represent the existing environment.

111. The epibenthic data are semi quantitative; therefore, in terms of comparing samples across the survey area it has less meaning than using the infaunal grab data as described in section 10.5.2. However, a semi-quantitative comparison still gives an indication of the relative abundance of the different species.

112. Many fish species (including sandeels) were recorded within the epifaunal data; these have been removed from this analysis, as fish are not considered part of the benthic community for the purposes of this assessment. These are considered in Chapter 11 Fish and Shellfish Ecology.

10.5.3.1 Epifaunal Communities in the East Anglia Zone

113. Epifaunal abundance varies across the East Anglia Zone with relatively high abundances occurring in the north-west and low abundances in the East Anglia THREE site (*Figure 10.8*). Species diversity (identified as the number of different species found within a sample) was more evenly distributed over the East Anglia Zone with slightly higher diversity recorded in the western half (*Figure 10.9*).

114. By far the most dominant class of organism within the epifauna were the Malacostraca (*Diagram 10.9*) which include crabs, lobsters, shrimp, krill, and amphipods. Within this group the brown shrimps *Crangon allmanni* (35,354 individuals identified across 83 sample stations) and *Crangon crangon* (1,773 individuals identified across 43 sample stations) were numerous. These two species play an important ecosystem function role within the southern North Sea and are a key food source for flatfish. Also abundant were the hermit crabs Paguridae (1,897 individuals identified across 88 sample stations) and the crab *Liocarcinus holsatus* (1,946 individuals identified across 81 sample stations).

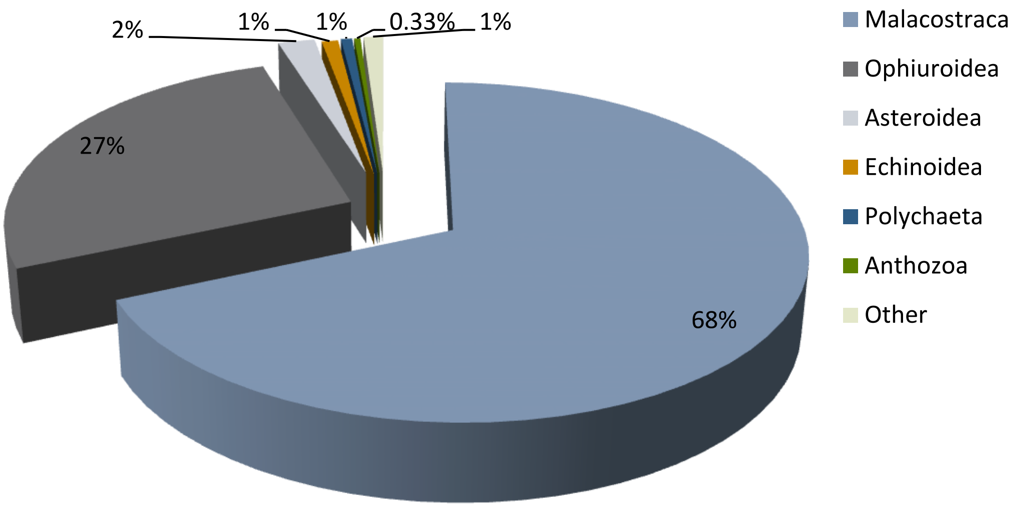


Diagram 10.9 Epifaunal breakdown for the Zone: Number of individuals by class (Includes data from the East Anglia Zone Survey and the East Anglia THREE / FOUR survey).

115. The next most abundant class in terms of number of individuals identified were the brittlestars (Ophiuroidea) (*Diagram 10.9*). However, in terms of species this class constituted only 3.49% (*Diagram 10.10*). Brittlestars often show aggregation behaviour and this was reflected in the fact that up to 1,700 *Ophiura albida* were identified in a single sample.

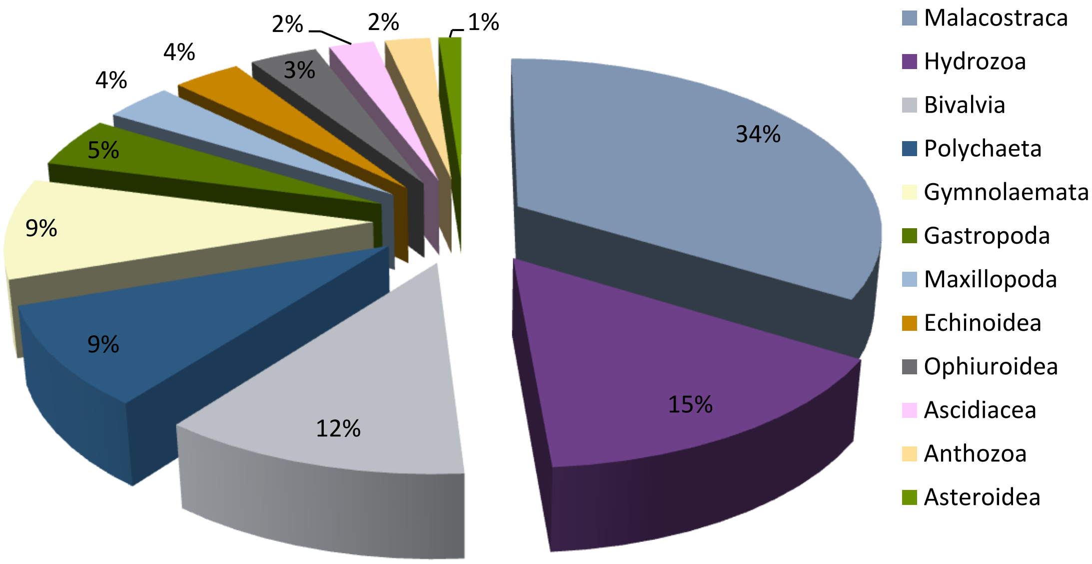


Diagram 10.10 Epifaunal breakdown for the East Anglia THREE site: Number of species by class (Includes data from the East Anglia Zone Survey and the East Anglia THREE / FOUR survey).

116. The class Hydrozoa constituted over 15% of the species identified within the East Anglia Zone with *Hydractinia echinata* (found at 69 sample stations) and *Tubularia* sp. (identified at 30 sample stations) the most widely distributed.

117. In order to characterise the epibenthic communities across the two data sets, the data were combined (as described above) and cluster analysis was conducted using PRIMER V6 (see *Appendix 10.6* for further detail). The result of which identified six different epifaunal groups within the East Anglia Zone. These are presented in *Table 10.12* below and their locations are displayed in *Figure 10.10*

118. Within the East Anglia Zone the multivariate analysis showed six distinct faunal assemblages at the 48% similarity level (*Appendix 10.6*). A 48% similarity suggests that all of the identified communities are relatively similar and therefore the epibenthic environment across the zone is very homogenous. Details of the epibenthic faunal groups are provided in *Table 10.12*

Table 10.12. Epifaunal Groups identified using Cluster analysis for the East Anglia Zone and offshore cable corridor

Faunal Group	Dominant species (% contribution)	Common name	Average similarity	Number of stations
A	*Crangon allmanni (only one sample in group)*	Brown shrimp	(only one sample in group)	(only one sample in group)
B	*Crangon allmanni* (9.71) *Pomatoceros* (9.44) *Paguridae* (27.21)	Brown shrimp A tube worm Hermit crabs	53.03	3
C	*Crangon allmanni* (14.64) *Asterias rubens* (13.87) *Paguridae* (13.00)	Brown shrimp Common starfish Hermit crabs	52.82	4
D	*Paguridae* (16.67) *Crangon allmanni* (13.76) *Philocheras* (8.59)	Hermit crabs Brown shrimp A crustacean	59.29	30
E	*Crangon allmanni* (43.01) *Paguridae* (15.49) *Liocarcinus holsatus* (12.17)	Brown shrimp Hermit crabs Flying crab	60.99	2
F	*Ophiura ophiura* (17.01) *Ophiura albida* (14.73) *Crangon allmanni* (13.41)	A brittlestar Serpent's table Brittlestar Brown shrimp	60	49

119. The distribution of these groups formed a clear pattern with areas in the south-west of the zone dominated by group D and the northern part of the zone dominated by group F. All communities in the East Anglia THREE site were group F whilst the offshore cable corridor study area supported groups D and B (*Figure 10.10*).

10.5.3.2 Epifanal Communities within the East Anglia THREE Site

120. Within the East Anglia THREE site brittlestars (Ophiuroidea) were more dominant than they were across the East Anglia Zone (*Diagram 10.11 and 10.9*). They were present in all trawls with abundances ranging from between 30 to 186. The apparent dominance of the Ophiuroidea is not due to higher numbers of individuals in the site (mean number per trawl is 99 within the site compared to 186 across the Zone), but rather to a lack of individuals from other classes.

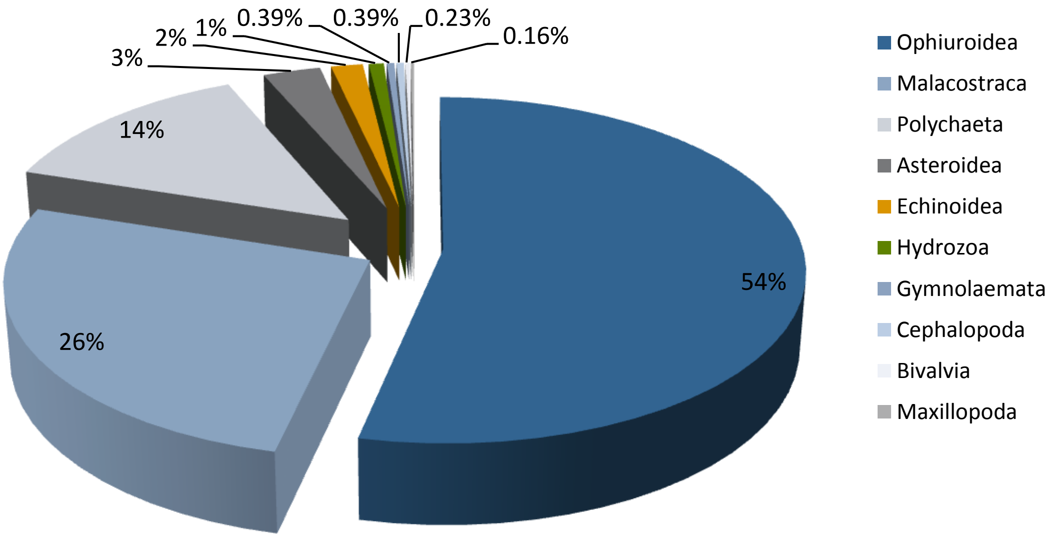


Diagram 10.11 Epifaunal breakdown for the East Anglia THREE site (including data from the East Anglia Zone Survey and the East Anglia THREE / FOUR surveys): Number of individuals by class.

121. The class Malacostraca comprised a very similar percentage of the individuals identified across the East Anglia Zone as they did within the East Anglia THREE site whilst polychaetes were relatively more abundant within the East Anglia THREE site than across the East Anglia Zone.

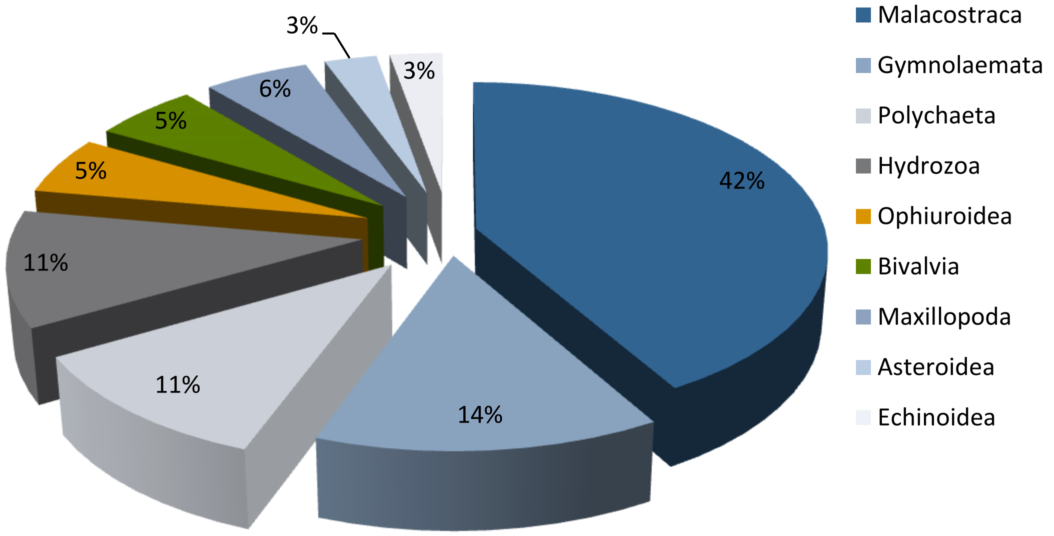


Diagram 10.12 Epifaunal breakdown for the East Anglia THREE site: Number of species by class (including data from the East Anglia Zone Survey and the East Anglia THREE / FOUR surveys).

122. The class Gymnolamata were more highly represented in terms of the number of species than number of individuals, however, this is due to the fact that bryzoans were only recorded as present and were not enumerated.

123. Multivariate analysis shows that the same epifaunal group was present in all benthic trawl samples acquired across the East Anglia THREE site (*Figure 10.10*).

10.5.3.3 Epifaunal Communities within the Offshore Cable Corridor Study Area

124. The epifaunal makeup of the offshore cable corridor is very similar to that of the Zone with Malacostraca, Ophiuroidea and Asteroidea being the three most prevalent classes (*Diagram 10.13*). As with the East Anglia Zone the shrimp *Crangon allmanni* (114 individuals identified across 7 sample stations) and the crab *Liocarcinus holsatus* (74 identified across 6 sample stations) were the most abundant crustaceans.

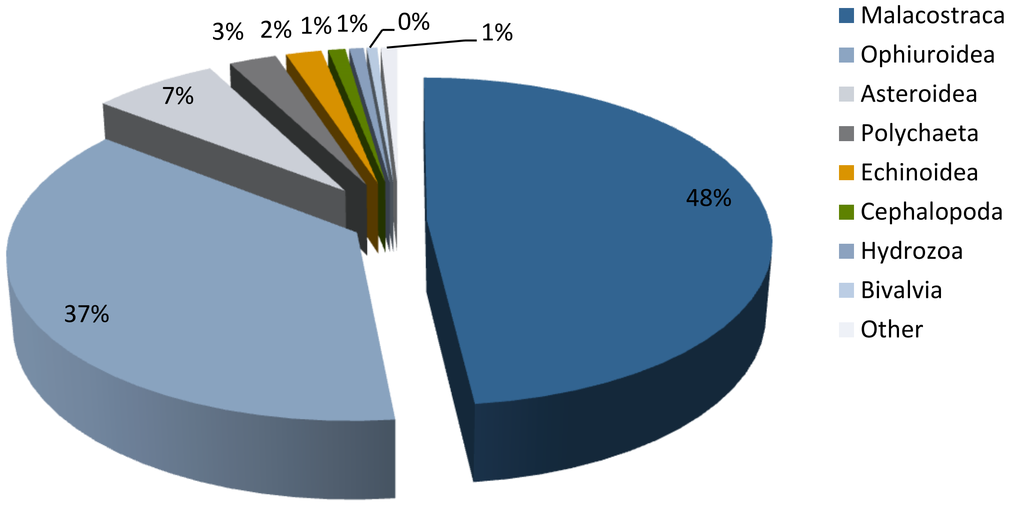


Diagram 10.13 Epifaunal breakdown for the offshore cable corridor study area (Includes data from the Zone survey and the East Anglia THREE / FOUR surveys): Number of individuals by class.

125. Ophiuroidea were numerous in terms of individuals identified within the export cable corridor (*Diagram 10.13*) with *Ophiura albida* (1283 identified across 15 sample stations) and *Ophiura ophiura* (506 identified across 12 sample stations) dominating, however, as with the East Anglia Zone, very few species within this class were identified (*Diagram 10.14*).

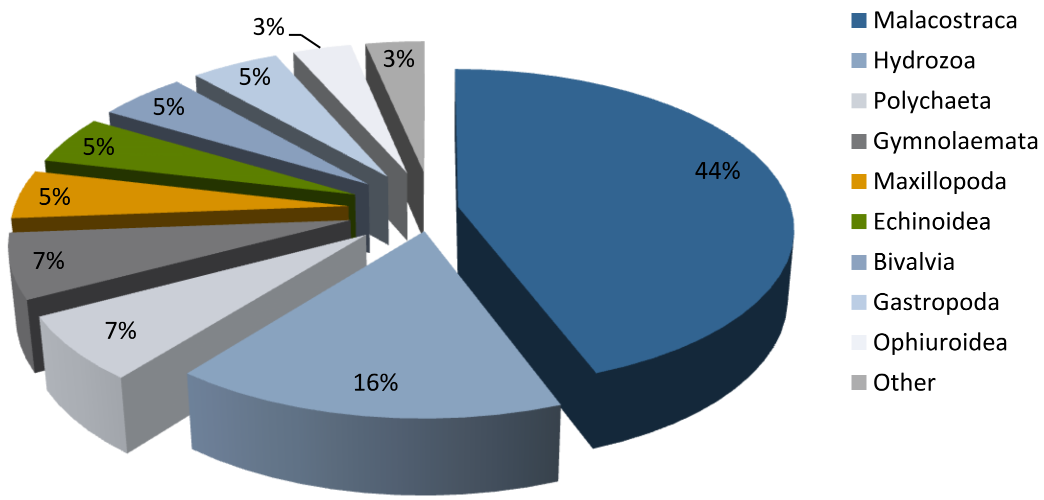


Diagram 10.14 Epifaunal breakdown for the offshore cable corridor study area (Includes data from the Zone survey and the East Anglia THREE / FOUR surveys): Number of species by class.

126. In terms of number of species within the offshore cable corridor study area, Hydrozoa were the second most numerous (*Diagram 10.12*) with *Hydractinia echinata* being present at 12 of the 16 sample stations. The Hydrozoans were far less dominant in terms of individuals recorded (*Diagram 10.11*).

10.5.4 Landfall and Intertidal Habitat

127. The landfall location for the East Anglia THREE offshore export cables is at Bawdsey cliffs to the south-west of the Martello tower at Bawdsey. During the identification of the most suitable landfall location surveys were conducted at two sites (termed the northern site and the southern site), the results of both of these surveys are presented in section E of *Appendix 10.3*. The eventual chosen location was the northern site which was surveyed in August 2011.

128. The predominant habitat at the landfall location is shingle, which is present from the mid to low shoreline. At the southern end of the landfall the shingle runs into larger pebbles and rock higher up the shore. A relatively steep gradient marks the change from the larger pebbles and rocks to vegetated shingle on the high shore, which gradually transitions into an area of trees and shrubs. An area of shingle and sand mix is also present along the high shore. Vegetated shingle runs along the top of the shoreline until it reaches an area of eroding cliff.

129. The Bawdsey cliffs are formed of red crag and London clay. During surveys, clay from the cliff was visible on the shore and had been deposited in some quantity lower on the shore. This had been compacted and was visible at low tide. The compacted clay deposited on the lower shore was covered in *Ulva sp*., a genus of alga associated with freshwater runoff. Freshwater was noted to be running onto the shore from the cliff face in some areas at this site. Burrow holes were identified in the clay during the survey and the shells of piddocks (bivalve molluscs) *Pholas dactylus* and *Petricola pholadiformis* were removed from some (though these were dead). Several grass species were present in the area of Annex I vegetated shingle habitat along with the sea kale *Crambe maritima*.

130. Biotope mapping was carried out within the intertidal area using EUNIS and Marine Nature Conservation Review (MNCR) biotope codes and these are displayed in Figure 9.11 Volume 2 of the East Anglia ONE Environmental Statement. The lower shore was described as ‘littoral coarse sediment’ (A2.1) using the EUNIS codes and LS.LCS.Sh.Bar.Sh (Barren littoral shingle) using the MNCR scheme to provide further description. The upper parts of the shore contained vegetated shingle and are described under EUNIS as ‘upper shingle with open vegetation’ (B2.3).

10.5.5 Protected Habitats and Species

131. The following sections discuss protected sites and the potential for designation of habitats that overlap with or are in the vicinity of the East Anglia THREE site and the offshore cable corridor. These include Special Protection Areas (SPAs), Marine Conservation Zones (MCZs), Special Areas of Conservation (SAC) and associated Annex I Habitats, Site of Community Importance (SCIs), Sites of Special Scientific Interest (SSSI), and species and habitats listed on the UK Biodiversity Action Plan (BAP).

10.5.5.1 Habitats

132. Three habitats of potential ecological importance (which fit the definition of Annex I Habitats under the Habitats Directive (92/43/EEC) and are considered as Habitats of Principal Importance under Section 40 of the Natural Environment and Rural Communities Act 2006 (NERC act)) were identified within the offshore cable corridor and the East Anglia THREE site:

- *Sandbanks;*
- *Sabellaria spinulosa* reef (also referred to as *Sabellaria* reef); and
- Vegetated shingle.

10.5.5.1.1 Sabellaria spinulosa Reef

133. *S.spinulosa* has the potential to form dense aggregations and reef-like structures in certain conditions. A report assessing the importance of such reefs located just to the north of the East Anglia Zone highlights the significance of such features to the ecology of the surrounding area (Pearce et al 2011a).

134. During East Anglia Zone grab surveys *S.spinulosa* was found to be present at 108 of the 566 characterisation sample stations (*Figure 10.12*) with abundances at these stations ranging from 1 to 1,660 individuals. During analysis of the East Anglia Zone an exercise was conducted to determine likely presence of *Sabellaria* reef across the East Anglia Zone. This exercise assigned a value of between 1 and 5 depending on the 'reefiness' of suspected areas of *Sabellaria* reef (where a score of 5 is highly likely to be reef, Gubbay 2007). The results showed that there was an area within the north of the East Anglia THREE site with scores of 1 and 2 and there was a site in within the offshore cable corridor that has a score of 3 (*Appendix 10.2*). No sites were identified within the interconnector cable corridor.

135. A similar exercise was undertaken using the East Anglia THREE survey data which also used the five stage procedure to assess 'reefiness' at suspected reef locations

(See *Appendix 10.3* for details). Site 46 in the north of the East Anglia THREE site was classified as medium / high resemblance to *Sabellaria reef*.

136. The East Anglia ONE export cable corridor survey identified potential for *Sabellaria* reef to be present at station 19, which is located on the southern edge of the offshore cable corridor (*Figure 10.12* and *Appendix 10.3*).

10.5.5.1.2 Vegetated Shingle.

137. Coastal vegetated shingle is considered rare globally and is listed on Annex I of the EU Habitats Directive ('perennial vegetation of stony banks'). It supports a unique range of flora and fauna that are adapted to the harsh conditions that are present at such locations. Several species of birds including terns, gulls and waders nest on shingle with their eggs coloured to blend in with the shingle environment. The steep profiles, which naturally occur over time on shingle shores, create a natural sea defence. Vegetated shingle was present throughout both sites surveyed. The Suffolk coast holds around 15% of Britain's vegetated shingle resource and some areas, such as neighbouring Orfordness (Shingle Street), are designated as SACs. The impacts to this Annex I habitat are assessed in Chapter 23 Ecology.

10.5.5.1.3 Sandbanks.

138. Sandbanks which are permanently covered by seawater, described in the Directive as 'Sublittoral sandbanks which are slightly covered by seawater all the time' are also Annex I habitat with potential to be located within the offshore cable corridor. This is a difficult habitat to define however, this Annex I habitat was not noted in the East Anglia Zone surveys, the East Anglia ONE cable corridor surveys or the survey of the East Anglia THREE site and offshore cable corridor.

139. The East Inshore and Offshore Marine Plan (MMO 2014) does, however identify a very small area of potential Annex I Sandbank which lies within the western extent of the East Anglia THREE export cable corridor.

10.5.5.1.4 Other Habitats

140. Evidence acquired from the underwater video and stills imagery gathered as part of the benthic characterisation surveys indicate that other habitats (which meet the definitions of Annex I habitats) such as mussel beds, geogenic (rock based) reefs and submarine structures caused by leaking gases are not present across the Zone (*Appendix 10.2*).

10.5.5.2 Marine Protected Areas

141. There are a number of protected areas in the vicinity of the proposed East Anglia THREE project. The export cable corridor intersects the Outer Thames Estuary SPA (*Figure 10.14*). This SPA is designated for wintering populations of red-throated

diver *Gavia stellata* that it supports. The primary prey of the red-throated diver are fish species although they are also considered to occasionally consume crustaceans and molluscs. Regionally the Haisborough, Hammond and Winterton SAC is designated for the Annex I sandbank habitats. This SAC incorporates both Smiths Knoll and Hearty Knoll, which are north and outside the East Anglia THREE site.

142. The government is creating a network of marine protected areas around the UK through the designation of Marine Conservation Zones (MCZs). These are designated under the Marine and Coastal Access Act (MCAA) (2009). In the southern North Sea, Net Gain (one of four regional organisations set up to identify MCZs around the UK) recommended the Orford Inshore draft MCZ (dMCZ1b) for designation, which was adjacent to the southern edge of the offshore cable corridor (Net Gain 2011). In November 2013 the first substantial suite of 27 MCZs in England and Wales were designated, but this did not include the Orford Inshore site.

143. Further designations are expected in 2015, however at this stage the Orford Inshore recommended MCZ is not being considered for designation and therefore in line with guidance provided by the MMO it is not considered within his EIA.

10.5.5.3 Habitats of Principal Importance

144. The NERC Act came into force on 1st Oct 2006. Section 41 (S41) of the Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The S41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under section 40 of Act, to have regard to the conservation of biodiversity in England, when carrying out their normal functions. The following Habitats of Principal Importance have been identified within the East Anglia THREE site and offshore cable corridor:

- *Sabellaria spinulosa* reef; and
- Subtidal sands and gravel.

145. *Sabellaria* reef has already been discussed above.

146. Subtidal sands and gravel sediments are the most common habitats found below the level of the lowest low tide around the coast of the United Kingdom. The sands and gravels found in the North Sea are largely formed from rock material (BRIG 2008 (updated 2011)). This is a very broad definition and therefore large areas of the sea bed encompassed by the East Anglia THREE site and offshore cable corridor could qualify as this habitat. Given the ubiquity of this habitat, impacts upon the habitat have not been highlighted within the assessment, although the assessment does

look at the impacts upon biotopes that would be encompassed within the habitat definition.

10.5.5.4 Intertidal Protected Areas

147. The landfall location is situated on the Suffolk coastline, an area that supports a diverse range of habitats such as salt marshes, estuaries and cliffs. Several areas receive protection under UK and international conservation legislation, mainly due the presence of wildfowl, waders and migratory bird species that utilise these habitats.

10.5.5.5 Species of Conservation Concern

148. Species and habitats recorded during the infaunal and epifaunal surveys were compared against the current information, relevant to UK waters, for those identified as of conservation interest. This included, but was not restricted to, the following legislative drivers and conventions:

- The Wildlife and Countryside Act 1981 (WCA81);
- Habitats Directive (Annex I Habitats and Annex II Species) as expressed in UK legislation (The Conservation of Habitats and Species Regulations 2010);
- MCAA 2009;
- Natural Environment and Rural Communities Act 2006
- The UK Biodiversity Framework; and
- OSPAR Threatened and/or Declining Species and Habitats.

149. The amphipod *Apherusa ovalipes* was identified in the East Anglia Zone Survey report (*Appendix 10.2*) as a species of conservation concern present within the East Anglia Zone. The species is included in the JNCCs list of "Rare marine benthic flora and fauna in Great Britain" (Sanderson 1996a). This species was present at station 20 within the offshore cable corridor (as identified within the East Anglia ONE cable corridor survey).

150. The mantis shrimp *Rissoides desmaresti* was found at targeted samples stations 760, 762 and 780 and in sample 271 of the non-targeted samples. Its presence was noted in the survey report (*Appendix 10.2*) as a rare species within UK waters however, *Rissoides desmaresti* is not listed under any importance categories or protected under any legislation. None of the sample stations listed above are within the East Anglia THREE site or the offshore cable corridor, however 762 is located just to the north of the offshore cable corridor.

151. Mussels, particularly *Mytilus edulis* and *Modiolus modiolus* are considered important as they are a good prey source and where found in high densities they have potential to create biogenic reef which could qualify as an Annex I habitat (see section 10.5.5.1). Although there was no evidence from any of the benthic survey campaigns of mussels forming biogenic reef, individuals of these species were recorded at various locations across the zone (*Figure 10.13*).

152. Two invertebrate species of potential conservation interest were recorded in the East Anglia THREE site. *Obelia sp*. was recorded in trawl 2 in the offshore cable corridor and at stations 2 and 4 in the western part of the offshore cable corridor and specimens of *Ophelia sp*. and *Ophelia sp*. (juv) were recorded at trawl 12 within the East Anglia THREE site. These genera include species such as *Obelia bidentata* and *Ophelia bicornis* which are listed in Sanderson (1996b) as being nationally rare.

153. Natural England raised concerns about the possible impacts of the proposed East Anglia THREE project on brittlestar during both the PEIR consultation (*Table 10.1*). There concerns related to the fact that brittlestars seem to represent a greater importance to the community structure within the East Anglia THREE site compared with the East Anglia THREE Zone and that these were on the OSPAR list of Threatened and/or Declining Species and Habitats. Analysis of all grab samples from across the Zone shows that 67% of samples contained Ophiuroidea compared to 60% within the East Anglia THREE site indicating that presence within the site was lower than the surrounding area. Further analysis has shown that the mean number of brittlestar individuals and species recorded in grab samples across the Zone (6.35 and 1.17 respectively) is greater than within the East Anglia THREE site (5.0 and 1.09). Furthermore, no species from the class Ophiuroidea are included in the most recent OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR 2008) nor are brittlestar beds included as a habitat on that list.

154. At a meeting in 2015 (*Table 10.1*), Natural England recommended post construction monitoring to assess the impacts of the project on brittlestar beds. However, evidence from the benthic surveys suggest that brittlestars are not present within the East Anglia THREE site in aggregations which could be described as beds:

- The maximum number of brittlestars recorded in any grab samples from within the East Anglia THREE site was 32 and the mean number was 5 (The Zone had 6 samples containing more than 100 individuals with a mean number of 6.4);
- Brittlestars were not listed as conspicuous species during the East Anglia THREE / FOUR video surveys (*Appendix 10.4* (Appendix D.1)); nor

- No brittlestars are evident in the still images from the East Anglia THREE / FOUR video surveys (*Appendix 10.4* (Appendix D.2)).

155. Therefore given that the evidence suggests that the East Anglia THREE site does contain brittlestar beds EATL do not propose to do any surveys specifically designed to monitor the impacts of the proposed East Anglia THREE project on brittlestar beds.

10.5.5.6 Other Important Species

156. Brown shrimps and *Crangon allmani* were found within many of the epifaunal surveys. Brown shrimp are not protected in the UK but are important commercial species and play an important role in ecosystem function and energy flow within the southern North Sea. *Crangon* spp. are an important prey source for many commercially important fish species such as cod (*Gadus morhua*), plaice (*Pleuronectes platessa*) and juvenile bass (*Dicentrarchus labrax*) (Steenbergen et al. 2011) and are also predated by some sea birds (See Chapter 11 Fish and Shellfish Ecology for an assessment of the impacts on these species).

157. The edible crab *Cancer pagurus*, whilst not a protected species in the UK, is a key predator of a variety of crustaceans and molluscs and therefore has an important ecosystem function. Edible crab is also an important commercial shellfish species throughout the North Sea, but was only found at one station in the various benthic surveys, with additional individuals being captured during the beam trawls.

10.5.6 Context and Summary

158. The benthic species and habitats found within the East Anglia THREE site are considered broadly typical of those that exist within the East Anglia Zone. Species abundance and diversity are generally quite low within the East Anglia THREE site compared to that of the Zone.

159. The predominant habitats are sands and gravels and these determine infaunal and epifaunal communities which are present. Such communities are dominated by polychaetes such as, *Spiophanes bombyx* and *Nephtys cirrosa*, crustaceans such as *Urothoe brevicornis* and *Bathyporeia elegans* and echinoderms such as Ophiuroidea *sp*. and *Echinocyamus pusillus*.

160. The homogeneity of the benthic ecology across the East Anglia THREE site is evident by the fact that only four different infaunal communities were identified as present, all of which were extremely similar.

161. The habitats and species found within the East Anglia THREE site and within the offshore cable corridor are analogous to findings of other surveys that have been

conducted within the region. Examples include the Regional Environmental Characterisation (REC) studies (Emu and the University of Southampton 2009 and Limpenny et al. 2011) and characterisation surveys for other offshore windfarm environmental impact assessments (Hornsea Offshore Wind Farm project One, Greater Gabbard Offshore Wind Farm, Galloper Wind Farm and Dogger Bank Creyke Beck).

162. Of particular relevance are the Outer Thames Estuary SPA and the East Coast RECs, which overlap with the export cable corridor. Both of these studies found that sediment type was the greatest predictor for the benthic communities present and that the infauna was dominated by many of the polychaetes which dominate the data from the East Anglia THREE site surveys such as *Nephtys cirrosa, Urothoe brevicornis* and *Bathyporeia elegans* (Emu and University of Southampton 2009).

163. No biogenic or rocky reef areas were confirmed in the combined survey and data analysis for the East Anglia THREE site and offshore cable corridor. Areas of potential *Sabellaria spinulosa* reef were identified, however these did not score highly on the “reefiness” scale.

164. Few other potential Habitats of Principal Importance and protected species were identified as present within the East Anglia THREE site and offshore cable corridor. The exception to this is subtidal sands and gravel as this is a very broad definition and therefore large areas of the sea bed encompassed by the East Anglia THREE site and offshore cable corridor could qualify as this habitat. A very small section of the offshore cable corridor overlaps with the Outer Thames Special Protected Area (SPA), which is designated for red- throated diver.

10.6 Potential Impacts

165. The potential impacts that may occur during construction, operation and decommissioning of the proposed East Anglia THREE project are listed in *Table 10.2* along with a description of the worst case scenario for each impact.

166. The receptors for each impact are described within the text of each assessment. All of the receptors have been identified within the Existing Environment section 10.5. Benthic species or habitats which are not considered to have any potential to be impacted by the proposed East Anglia THREE project have not been presented within the baseline.

167. Many of the impacts assessed within this section take a study area based approach whereby impacts in the East Anglia THREE site are assessed separately to the impacts within the offshore cable corridor.

168. The rationale behind this approach is that in many cases the mechanism for the impact (or source) is very different i.e. within the East Anglia THREE site large permanent foundations would be installed however within the offshore cable corridor, most impacts would be temporary in nature. Furthermore, the receptors themselves are different i.e. the East Anglia THREE site only contains communities found in deeper water whereas the offshore cable corridor contains shallow water and intertidal communities. However, when this approach is taken, a summary section is provided which combines the assessment for both the site and the offshore cable corridor to provide an assessment of the overall impact.

169. Unless otherwise specified, the export cable and interconnector cable study areas are assessed together as there is both geographical overlap and the source of impacts within these study areas will be almost identical.

170. For some of the impacts this summary section is not required for example when the source of impact and the receptor are similar across study areas or when the impacts are seen across only one of the study areas.

171. All construction impacts, and relevant operation and decommissioning impacts are assessed for both the Single Phase and the Two Phased approach (See Chapter 5 Description of the Development) as illustrated in *Table 10.2.*

10.6.1 Potential Impacts During Construction

10.6.1.1 Impact 1: Temporary Physical Disturbance.

172. There is potential for physical disturbance to habitats and species of interest to occur during construction within the East Anglia THREE site, along the offshore cable corridor, including at the landfall site. Impacts within these three separate areas have been assessed separately as potential sources of impacts vary across the study areas.

173. It should be noted that EATL have produced an IPMP which makes provisions for pre-construction surveys to identify Habitats of Principal Importance (i.e. biogenic reef). If such habitats were detected it would be agreed (with Natural England and the MMO) how to best minimise the impacts to these receptors. The design plan would be informed by these pre-construction surveys and be submitted to the MMO prior to construction. Mitigation would typically include micro-siting of foundations and cables to avoid any such features.

Single Phase

174. During construction, work required for installation of the windfarm (foundations, inter-array cables, converter stations, collector stations, accommodation platform,

meteorological masts, and buoys) and construction plant (i.e. jack-up vessel feet) would result in the physical disturbance of benthic habitats and species over a maximum area of approximately 38.87km^2 (see *Table 10.2*). This would include the physical disturbance of habitats due to the introduction of side-cast and / or drill arising material from sea bed preparation of foundation drilling works.

175. Physical disturbance would be temporary, occurring over a maximum of 33 months (*Table 10.2*), with some disturbance, such as that caused by jack-up vessels only lasting a matter of days (section 5.5.15.5 of Chapter 5 Description of the Development).

176. Habitat loss caused by the installation of objects on the sea bed would be permanent and these have therefore been considered within Operation Impact 1 (section 10.6.2). This is taken into account when assessing the magnitude of the impact.

177. Within the East Anglia THREE site three different biotopes, identified using the method described by Connor et al. 2004, were present. The sensitivity of these habitats or derivatives of these biotopes to physical disturbance as identified by (Tyler-Walters et al. 2004) is displayed in *Table 10.13*.

Table 10.13. Biotope sensitivities to physical disturbance within the East Anglia THREE site (Tyler-Walters et al. 2004) extrapolated from level four biotope assessments

Biotope	Biotope description	Intolerance	Recoverability	Sensitivity
SS.SSa.CFiSa	Circalittoral fine sand	Tolerant to intermediate	High to very high	Very low to Low
SS.SCS.CCS	Circalittoral coarse sediment	Tolerant to intermediate	High	Low
SS.SMU.CSaMu	Circalittoral sandy mud	Intermediate	High	Low

178. The information provided in *Table 10.13* indicates that the sensitivity of infaunal biotopes within the East Anglia THREE site to physical disturbance is between very low and low (on the Tyler-Walters scale). Furthermore, the biotopes present within the East Anglia THREE site are common across the East Anglia Zone (as stated above) and wider southern North Sea indicating low ecological value and therefore the sensitivity of infaunal biotopes is assigned as low in accordance with *Table 10.8.*

179. Of further interest, due to its importance as a food source for flatfish, the brown shrimp, was found to be present in the majority of epibenthic samples within the East Anglia THREE site (*Appendix 10.2* and *Appendix 10.4*). This species is

considered to have very low sensitivity to physical disturbance (Neal 2008) and therefore for the purposes of this assessment is considered to have low sensitivity. The impact to this species is likely to be of negligible significance.

180. As described in section 10.5.5.1.1 the north of the East Anglia THREE site includes an area which has been identified as having potential for *S. spinulosa* reef (*Figure 10.12*). As any direct impacts on *S. spinulosa* reef would be avoided through the embedded mitigation measure of micro-siting of foundations and cables to avoid known areas of potential reef habitat (if presence is confirmed by pre-construction surveys) the magnitude of temporary physical disturbance on this feature is considered to be low.

181. Due to the natural temporal and spatial variation of *S. spinulosa* reef (Gubbay 2007) it is difficult to establish the distribution in any given area at any given time. Therefore, the pre-construction surveys, which EATL have committed to (section 10.3.3) would provide the best opportunity to establish where *S. spinulosa* reef may be present and best identify how to avoid impacts to these features.

182. It is recognised that, if disturbed, there can be a high recoverability rate of *S. spinulosa* reef where conditions are suitable (OSPAR 2013). As the conditions across the East Anglia THREE site are relatively homogeneous and surveys reveal areas with potential to support reefs within the East Anglia THREE site, it is likely that suitable conditions may occur across the site and the Zone. Therefore, any disturbed reef is likely to re-establish, post-disturbance event or re-establish in another location of the East Anglia Zone or wider area. Taking a precautionary approach, the sensitivity of *S.spinulosa* reef is assessed as being medium. Therefore, the impact of temporary physical disturbance on *S.spinulosa* reef would be of **minor adverse** significance.

183. Within the East Anglia THREE site the sensitivity of infaunal biotopes and species of interest identified within the infaunal surveys are all assigned as negligible or low in accordance with *Table 10.8*. Therefore the overall sensitivity is considered to be low.

184. An area of physical disturbance of 38.54km^2, is a large area, however it is small when taken in context of the entire East Anglia THREE site (12.64%) and within the wider southern North Sea and therefore the magnitude of disturbance of these habitats is low.

185. With low magnitude and a low sensitivity the impact of physical disturbance within the East Anglia THREE site would be considered of **minor adverse** significance. Due to the homogenous nature of the sea bed and habitats across the East Anglia THREE site and the comprehensive surveys that have been undertaken, the confidence level in the accuracy of this assessment is considered high.

10.6.1.1.1 Offshore Cable Corridor

186. Physical disturbance in the offshore cable corridor would be limited to impacts caused by the installation of up to four export cables over a total distance of 664km and the installation of up to four interconnector cables in two trenches totalling 190km of trench. The installation of cable protection and cable crossings are regarded as permanent habitat loss and are considered in Operation Impact 1 (section 10.6.2) and cumulative impacts, section 10.7.2. It should be noted however, that installed cable protection would be no wider than the 47.3m width of disturbance (Chapter 5 Description of the Development section 5.5.14.1.17) assessed within this impact.

187. At this stage of the proposed East Anglia THREE project it is not known what methods of cable installation would be used at which locations along the export cable and interconnector cable corridors. Therefore, it has been assumed that the worst case would result in a 47.3m wide corridor of disturbance (Chapter 5 Description of the Development section 5.5.14.1.17) along the entire length of the export and interconnector cable corridors impacting a combined area of 40.39km^2. Although not an insignificant area, 40.39km^2 when taken in context of the combined export cable and interconnector cable corridor areas (7.07%) and within the wider southern North Sea is relatively small and therefore the magnitude of disturbance to these habitats is low.

188. In addition to the biotopes identified during the East Anglia THREE / FOUR survey (*Appendix 10.4*) further biotopes have been identified within the offshore cable corridor using data collected during surveys of the East Anglia Zone and East Anglia ONE export cable corridor (*Appendix 10.2 Appendix 10.3* and *Figure 10.11*). It can be seen that the majority of the offshore cable corridor within the East Anglia ONE site has been assigned the biotope SS.Ssa.CFiSa.EpusOborApri.

189. *Table 10.14* below provides a summary of the sensitivities of these biotopes to physical disturbance.

Table 10.14. Biotope sensitivities to physical disturbance within the offshore cable corridor (MarLIN website and Tyler-Walters et al. 2011 and 2004) level three sensitivities are extrapolated from level four and five biotopes assessments.

Biotope	Biotope description	Intolerance	Recoverability	Sensitivity
SS.SCS.ICS	Infralittoral coarse sediment	Intermediate	High	Low
SS.SMx.IMx	Infralittoral mixed sediment	Intermediate	High	Low
SS.SSa.IMuSa	Infralittoral muddy sand	Intermediate	High	Low
SS.SMu.ISaMu	Infralittoral sandy mud	Intermediate	High	Low
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis*, *Lumbrineris spp.* and venerid bivalves in circalittoral coarse sand or gravel	Intermediate	High	Low
SS.Smx.CMx.MysThyMx	*Mysella bidentata* and *Thyasira spp*. in circalittoral muddy mixed sediment	Intermediate	High	Low
SS.SCS.ICS.HeloMsim	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand	Not available but it has low sensitivity to substratum loss		
SS.SSa.CFiSa.ApriBatPo	*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	Not available		
SS.SSa.CMuSa.AalbNuc	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	Intermediate	High	Low
SS.Ssa.CFiSa.EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	Not available		

190. *Table 10.14* indicates that the majority of biotopes within the offshore cable corridor can be considered to be of low sensitivity. For those with no available assessment given the similarities between the biotopes and biotope SS.SSa.CMuSa.AalbNuc (*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment) it is considered that these are also of low sensitivity. As none of the biotopes identified are considered to be rare within the southern North Sea the value of this particular receptor is considered to be low (*Table 10.6*).

191. Subtidal sands and gravel are present throughout the entire East Anglia Zone (*Figure 10.2*) as well as the remainder of the southern North Sea. Dredging, jetting and trenching would all lead to temporary disturbance of this habitat but it is expected to recover quickly as a result of the bed shear within the region. The area of this habitat that may be affected by cable installation constitutes a small proportion of the available habitat in the southern North Sea resulting the assignment of a low magnitude.

192. The East Anglia ONE benthic survey identified the potential for *S. spinulosa* reef at one location in the offshore cable corridor (*Figure 10.12*) with a reef value score of 3 out of 5. Further information on how this score has been derived is provided in section E.2.1 of *Appendix 9.1* of the East Anglia ONE Environmental Statement (East Anglia One Limited 2012).

193. The East Anglia THREE / FOUR survey also identified possible *S. spinulosa* crust at one location within the northern part of the offshore cable corridor (*Figure 10.12*).

194. Any direct impacts on *S. spinulosa* reef would be avoided through the embedded mitigation measure of micro-siting export cables to avoid confirmed areas of potential reef habitat if possible.

195. Mussels belonging to the family Mytilidae were present throughout the nearshore section of the export cable corridor (*Figure 10.13*) although it should be noted that no reef structures formed by mussels were identified. Mussels are of interest due to their potential as a food source (both commercially and ecologically) and their potential to form biogenic reef which is an Annex I habitat. Mussels are intolerant of substratum loss because they require hard substrata to attach to but are likely to recover quickly through rapid larval recruitment. If a mussel is displaced but not damaged, it has the ability to reattach to new substrata so it is considered tolerant of displacement (Tyler-Walters 2008). Mytilidae are therefore considered to have a low sensitivity to the effect of physical disturbance during export cable installation. Again if any potential reef is located in pre-construction surveys these would be avoided by micro-siting export cables.

196. The important flat fish food source brown shrimp and the commercially exploitable edible crab were identified as present within the offshore cable corridor. These species are highly mobile and would be expected to evade the disturbance caused by dredging, jetting and trenching activity. Furthermore, these species are both assessed by MarLIN as having low sensitivity and high recoverability to physical disturbance (Neal 2008, Neal and Wilson 2008). Taking this into account, along with the fact that neither are considered to be rare, the sensitivity of these receptors is considered to be low.

197. As both the magnitude of temporary physical disturbance and the sensitivity of receptors within the offshore cable corridor are considered to be low, the significance of the impact is likely to be **minor adverse** (*Table 10.9*).

198. At the cable landfall, the worst case scenario for physical disturbance would be the that the ducts for cable pull through had been installed by East Anglia ONE using the 'short' duct method (see Chapter 5 description of the Development for further detail). Disturbance to the intertidal habitats would occur where machinery, i.e. the tracked excavator, is required to excavate the end of the duct. This would be carried out over a few weeks and given the small scale and temporary nature of this impact the magnitude is considered to be low.

199. Much of the lower shore at the landfall site has been described as 'littoral coarse sediment' (A2.1) using the EUNIS codes and LS.LCS.Sh.Bar.Sh (Barren littoral shingle) using the MNCR scheme. This habitat is very common along North Sea coastline and due to the barren nature of the existing ecology, this biotope is not considered sensitive to disturbance. This area of coastline regularly experiences physical disturbance from natural sources and therefore is considered to have a negligible sensitivity.

200. Taking into consideration the embedded mitigation of using the HDD method, the low sensitivity and low magnitude of the impact along with the low value of the receptor it is predicted that the impact to intertidal ecology would be **negligible**.

10.6.1.1.2 Summary of Impact 1

201. To conclude, the greatest magnitude of impact of physical disturbance on benthic ecology that would be caused by the construction of the proposed East Anglia THREE project under a Single Phase approach is low and the greatest sensitivity is medium. It is unlikely that there would be any interactions between the different study areas and therefore the overall worst case impact of physical disturbance is considered to be of **minor adverse** significance. As a result, no mitigation over that which is embedded (section 10.3.3) within the project design is suggested. Due to the comprehensive survey work conducted across the study areas the confidence in this assessment is high.

Two Phased

202. The area of physical disturbance caused under a Two Phased approach would be slightly greater than that of a Single Phase approach (90.4 km^2 compared with 79.26km^2) with impacts spread over a greater time period (42 months as opposed to 41 see Chapter 5 Description of the Development *Table 5.34* and *5.37*). Although the size of the impacted area would be greater, the activities would be more spread out (Chapter 5 Description of the development *Table 5.37*) and therefore the overall

magnitude of impacts is considered to be low. Therefore, the impact of physical disturbance during construction under a Two Phased approach is considered to be of **minor adverse** significance.

10.6.1.2 Impact 2: Increased Suspended Sediment Concentrations

203. Increases in suspended sediment concentrations within the water column may occur due to the installation of foundations and inter-array and platform link cables in the East Anglia THREE site, and through the installation of interconnector and export cables in the offshore cable corridor.

204. Other activities such as the disturbance of the sea bed by jack up vessels or the placement of anchors and cable protection, are not likely to increase the suspended sediment concentrations levels to an extent where they would cause an impact to benthic species or habitats (Chapter 7 Marine Geology, Oceanography and Physical Processes section 7.6.1.7).

205. Increased suspended sediment load has the potential to affect the benthos through blockage to the sensitive filter feeding apparatus of certain species and / or smothering of sessile species upon deposition of the sediment.

Single Phase

10.6.1.2.1 East Anglia THREE Site

206. Chapter 7 Marine Geology, Oceanography and Physical Processes identifies that installation of wind turbine foundations has the potential to disturb sediments from the sea bed and from several tens of metres below the sea bed, depending on the foundation type and installation method.

207. To install foundations, the sea bed would also potentially require levelling which involves the removal of sediment by a dredge. The worst case scenario would involve the release of this sediment into the water column at its surface layer by the dredger vessel. This process would cause localised and short term increases in suspended sediment concentrations both at the point of dredging at the sea bed and, to a greater extent, at the point of its discharge back into the water column at the water surface.

208. The worst case scenario involves an excavation of the sea bed to level an area of sandwaves up to 5m in height. The maximum volume of excavation for a single wind turbine gravity base foundation would be 26,000m^3; this is associated with a 60m diameter gravity base structure. However the worst case scenario, as described in *Table 10.2*, involves the sea bed preparation for 172 gravity base foundations of the smaller (40m diameter) foundations.

209. Sea bed preparation for meteorological masts foundations could require the excavation of up to 20,750m^3 and sea bed preparation for up to six foundations for electrical platforms and an accommodation platform could require excavation of up to 439,350m^3 (*Table 10.2*). Therefore, a total sea bed preparation for these foundations could result in a maximum of 3,470,100m^3 of sediment being released into the water column. Foundations would be installed over a maximum 26 month period (Chapter 5 Description of the Development, *Table 5.34*) with a maximum of two sea bed preparation events for foundations within a 24 hour period.

210. Sea bed preparation to level the sea bed for cable installation may also be required within the East Anglia THREE site where steep sided sand waves occur. As with the seabed preparation for foundations, the worst case being considered is that sediment would be dredged from the sea bed and released at the sea surface.

211. A detailed explanation of the methodologies that would be used and how the quantities required have been calculated is provided in section 7.6.1.3 of Chapter 7 Marine Geology, Oceanography and Physical Processes. It has been estimated that up to 136,000m^3 of sediment could be dredged from within the East Anglia THREE site (see *Table 7.20*) in preparation for inter-array and platform link cable installation.

212. EATL are submitting an application to dispose of this excavated material within an area that would contain the East Anglia THREE site and the parts of the offshore cable corridor that fall within the East Anglia Zone (see the Site Characterisation Report for further detail). However, any material dredged from the East Anglia THREE site would, most likely, be deposited within the site and any material dredged from within the offshore cable corridor would be disposed of within part of the offshore cable corridor situated within the Zone.

213. The mean grain size of sea bed sediments across the East Anglia THREE site is in the range 0.21 – 0.36mm (medium sand). Very small percentages of gravels and muds are present. It is predicted that sediment disturbed from the sea bed during installation would remain close to the bed and rapidly settle. The material released at the water surface from the dredger vessel would rapidly (seconds to minutes) fall to the sea bed as a highly turbid dynamic plume.

214. Some of the finer sand fraction from this release and the very small proportion of muds are likely to stay in suspension for longer and form a passive plume, which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a notable plume for less than half a tidal cycle and sediment would fall to the sea bed in relatively close proximity (<1km) to its release. Therefore, if foundations were to be located on the boundary of the site, habitats and species up

to 1km from the East Anglia THREE site may be affected by increased suspended sediment concentrations.

215. *Figure 7.4.* shows that the main direction of travel of sediment plumes (which would be in line with the tidal ellipses) is likely to be north - south. *Figures 10.6* and *10.10* show that faunal communities (both infaunal and Epifaunal) north and south of the East Anglia THREE site are very similar in composition to those within the East Anglia THREE site. Using studies from the East Anglia ONE project as a proxy it has been predicted that suspended sediment concentrations around the release locations would remain high (orders of magnitude in excess of natural background levels) for a very short duration (seconds to minutes) as the dynamic plume falls to the bed. Elevations in suspended sediment concentration above background levels within the passive plume would be low (<10mg/l) and within the range of natural variability.

216. Delft3D plume modelling studies (ABPmer 2012b) conducted for East Anglia ONE considered the bed level changes resulting from deposition of sediments from the passive plume due to sea bed preparation for 15 foundations. For the most part, the deposited sediment layer across the wider sea bed was found to be less than 0.2mm thick and did not exceed 2mm anywhere.

217. Taking a conservative approach, the magnitude of the impact of increased suspended sediment concentrations is considered to be medium in the near field (confined to a small area likely to be of the order of a few hundred metres from each foundation location) and of low magnitude in the far field (<1km). In order to comply with the worst case approach a medium level of magnitude is taken through to the assessment.

218. The detail of the inter-array and platform link cabling is dependent upon the final project design, but present estimates are that the total length of these cables would be up to 745km (550km inter-array and 195km platform link cables) in length. The worst case cable laying technique for increasing suspended sediment concentrations would be sea bed levelling with a dredge and installation of the cable by jetting.

219. The installation of the inter-array and platform link cabling has the potential to disturb sediments from the sea bed to shallow depths of up to 5m. The magnitude of effect that could be caused are assessed in Chapter 7 Marine Geology, Oceanography and Physical Processes as being far less than those created by the installation of foundations. This is because the overall sediment release volumes would be lower. Therefore, the magnitude of the impact from inter-array and platform link cable installation can be considered as low.

220. Potential receptors to the impacts of increased suspended sediment and smothering include the three biotopes identified within the East Anglia THREE site as well as a number of individual species which have either commercial or conservation value.

221. Of the biotopes identified as present across the East Anglia THREE site, none are considered to be sensitive to increased suspended sediment concentrations using the MarLIN assessments and all are considered to have low sensitivity to smothering by sediment deposition (*Table 10.15*). Furthermore, the deposited sediment layer is only likely to be in the region of 0.2mm thick, which is far less than the amount considered during the MarLIN sensitivity assessments and is far less than would be expected to occur under natural variation. Therefore, the sensitivity of biotopes within the East Anglia THREE site to increased suspended sediment concentrations and smothering is considered to be low.

Table 10.15. Biotope sensitivities to increased suspended sediment within the East Anglia THREE site extrapolated from assessments of level four of the biotope classifications.

Biotope	Biotope description	Tolerance	Recoverability	Sensitivity
Increased Suspended Sediment Concentrations				
SS.SSa.CFiSa	Circalittoral fine sand	High	High	Not sensitive
SS.SCS.CCS	Circalittoral coarse sediment	High	High	Not sensitive
SS.SMU.CSaMu	Circalittoral sandy mud	High	High	Not sensitive
Smothering				
SS.SSa.CFiSa	Circalittoral fine sand	Moderate	High	Low
SS.SCS.CCS	Circalittoral coarse sediment	Moderate	High	Low
SS.SMU.CSaMu	Circalittoral sandy mud	Moderate	High	Low

222. When considering biotopes and species within the East Anglia THREE site the medium magnitude, low value of receptor and a low sensitivity can be considered to amount to an impact that is of **minor adverse** significance in accordance with *Table 10.9.*

10.6.1.2.2 Offshore Cable Corridor

223. The detail of cable lengths, installation methods etc., of the export and interconnector cabling is dependent upon the final project design, but present estimates are that the total length of export cables may be up to 664km in length and that Interconnector cables would be up to 380km installed into 180km of trenches (Chapter 5 Description of the Development).

224. The installation of the offshore cabling has the potential to disturb sediments in two ways, firstly through a requirement to level steep sided sand waves prior to cable installation and secondly through the installation process itself.

225. A detailed explanation of the methodologies that would be used for sea bed preparation and how the quantities have been calculated is provided in section 7.6.1.3 of Chapter 7 Marine Geology, Oceanography and Physical Processes. It has been estimated that up to 385,841m^3 of sediment could be dredged from within the offshore cable corridor (see *Table 10.2* for worst case and *Table 7.20* for background numbers) in preparation for inter-array and platform link cable installation. This sediment would then be disposed of within a designated disposal area which would include the East Anglia THREE site and the area of the offshore cable corridor which falls within the East Anglia THREE Zone (providing EATL are successful with their disposal site application).

226. It can be seen in *Figure 7.6* that the majority of steep sided sandwaves are located in the offshore sections of the offshore cable corridor. In the interest of minimising vessel movement, it is likely that the majority of sediment dredged from these areas would be disposed locally within the part of the offshore cable corridor which it is hoped will be designated as part of the disposal site.

227. The sea bed in the area around the offshore cable corridor (export cable and interconnector cable corridor) is predominantly sand. The median sediment grain size (d_{50}) of a series of grab samples mostly ranges from 0.23 to 0.50mm (medium sand) with a small number of samples with a d_{50} in the coarse sand or very fine sand classes.

228. Sediment from the sea bed surface to depths of up to 5m over the length of export and interconnector cables could be disturbed as the cables are installed. The combined export cable corridor and interconnector cable corridor (known as the offshore cable corridor) covers a total area of 571km^2. The worst case scenario for the suspension of sediment would be to install all electrical cables using jetting techniques. Other techniques also being considered are described in Chapter 5 Description of the Development, section 5.5.14). It seems likely that jetting would only be used for a small proportion of the cable instillation.

229. The assessment of changes in suspended sediment concentrations during offshore export cable installation has been considered in Chapter 7 Marine Geology, Oceanography and Physical Processes.

230. Overall sediment release volumes are predicted to be low and the majority (apart from the excavated material for sea bed levelling) would be confined to near the sea

bed along the alignment of the offshore export cables, and the rate at which the sediment is released into the water column from the jetting process would be relatively slow. Sand sized particles would settle out within 1km of the jetting operations whereas mud particles would be advected a greater distance and persist in the water column from hours to days.

231. In water depths greater than 20m Lowest Astronomical Tide (LAT), peak suspended sediment concentrations would be typically less than 100mg/l, except in the immediate vicinity of the release location.

232. In shallow water depths nearer to shore (less than 5m LAT) the potential for dispersion is more limited and therefore the concentrations are likely to be greater, approaching 400mg/l at their peak. This is far greater than typical background values of up to 170mg/l recorded in the vicinity of the coast at Great Yarmouth (ABPmer 2012b).

233. Considering the findings of the relative assessments within Chapter 7 Marine Geology, Oceanography and Physical processes the magnitude of the impact is considered to be low in the offshore section of the offshore cable corridor and medium in the nearshore section where water depths are shallower.

234. The installation of export and interconnector cables, under a Single Phase approach, would take up to 35 months, but there would be a six month gap between the two.

235. Of the biotopes which have been identified as present within the offshore cable corridor through the East Anglia ONE export cable corridor survey, the East Anglia THREE survey and through the East Anglia Zone survey, none are considered to be sensitive to increased suspended sediment concentrations or smothering by deposition of material (*Table 10.16*) using the MarLIN assessments. Therefore, the sensitivity of biotopes in the offshore cable corridor is considered as low in accordance with *Table 10.6*.

236. Furthermore, none of the habitats identified would be considered rare or of high value in accordance with *Table 10.7*.

Table 10.16. Biotope sensitivities to suspended sediment and smothering within the Offshore cable corridor (MarLIN website) level three sensitivities are extrapolated from level four and five biotopes assessments.

Biotope	Tolerance	Recoverability	Sensitivity
Increased suspended sediment			
SS.SCS.ICS	High	Very high	Very low
SS.SMx.IMx	High	Very high	Very low
SS.SSa.IMuSa	High	Very high	Very Low
SS.SMu.ISaMu	High	Very high	Very low
SS.SCS.CCS.MedLumVen	Moderate	High	Low
SS.Smx.CMx.MysThyMx	Moderate- Low	High	Low
SS.SCS.ICS.HeloMsim	Moderate	High	Low
SS.SSa.CFiSa.ApriBatPo	Moderate	High	Low
SS.SSa.CMuSa.AalbNuc	Moderate	High	Low
SS.Ssa.CFiSa.EpusOborApri	Moderate	High	Low
SS.SBR.PoR.SspiMx	High	High	Not sensitive
Sediment deposition			
SS.SCS.ICS	High	Very high	Very low
SS.SMx.IMx	Moderate	High	Low
SS.SSa.IMuSa	High	Very high	Very low
SS.SMu.ISaMu	Very high	Not relevant	Not sensitive
SS.SCS.CCS.MedLumVen	Moderate	High	Low
SS.Smx.CMx.MysThyMx	Moderate- low	High	Low
SS.SCS.ICS.HeloMsim	Moderate	High	Low
SS.SSa.CFiSa.ApriBatPo	Moderate	High	Low
SS.SSa.CMuSa.AalbNuc	Moderate	High	Low
SS.Ssa.CFiSa.EpusOborApri	Moderate	High	Low
SS.SBR.PoR.SspiMx	High	High	Not sensitive

* all Biotopes identified in Table 10.15 were also present within the offshore cable corridor

237. When considering biotopes within the offshore cable corridor a worst case medium magnitude, with low value receptors and a low sensitivity can be considered to amount to an impact that is of **minor adverse** significance in accordance with *Table 10.9*.

238. At the landfall location the pre installation of the 'short' duct method is considered the worst case scenario as excavating the seaward end of the ducts, installing cables

and backfill may cause disturbance of the sediment in the nearshore zone (See Chapter 7 Marine Geology, Oceanography and Physical Processes Impact 7.6.1.8). However, these effects would be highly localised and temporary in duration. The trenching into London Clay would likely result in clumps of material to be displaced and back-filled, rather than the material breaking down into its constituent silt and clay particles. It is therefore unlikely that significant changes in suspended sediment concentration would occur during these works. The back-filling of the trench would result in no noticeable change in coastal morphology after completion of the offshore cable installation at the landfall location and therefore the magnitude of the impact would be low.

239. The impact of increased suspended sediment and smothering would only be observed in the lower shore environment. The lower shore is described as 'littoral coarse sediment' (A2.1) using the EUNIS codes and LS.LCS.Sh.Bar.Sh (Barren littoral shingle) using the MNCR scheme. This habitat is very common along North Sea coastlines and due to the barren nature the ecology which exists, this biotope is not considered sensitive to increased suspended sediment or smothering. Furthermore, it is considered likely that the environment at the landfall location would regularly receive greatly increased levels of suspended sediment and smothering through natural events including storms and so the existing environment would be well adapted to such events.

240. The sensitivity of the receptors to the impact of increased suspended sediment and smothering to species and habitats present at the landfall would be negligible. With the negligible sensitivity and low magnitude of effect the impact is considered to be of **negligible** significance at the landfall.

10.6.1.2.3 Receptors Across Both Offshore Cable Corridor and the East Anglia THREE Site

241. *S. spinulosa* thrives in conditions of elevated turbidity, it uses the sediment to build the tubes within which it lives. Reefs are tolerant of short-term smothering but in the long-term significant sediment deposition may result in reduced growth and impaired feeding ability (OSPAR 2010). However, a study carried out by Last et al. (2011) found that *S. spinulosa* reef is tolerant of burial for up to 32 days and continues to build tubes while buried. Further evidence compiled by Marine Aggregate Levy Sustainability Fund (MALSF) found that there were no adverse effect due to increased suspended sediment to *S. spinulosa* reefs found within close proximity to active aggregate dredging sites (Pearce et al. 2011b).

242. These results indicate that increased suspended sediment and smothering arising from the construction phase of the project would not have a detrimental impact on *S. spinulosa* reef and as a result a low sensitivity is assigned. As a result of the low

sensitivity and the embedded mitigation designed to avoid interaction with biogenic reefs through micro-siting (section 10.3.3), the impact of increased suspended sediment on *S. spinulosa* reefs would be negligible.

243. The elevated turbidity and sediment deposition resulting from sea bed disturbance is unlikely to impact other species of interest such as brown shrimp and edible crab as both species are generally not considered to be sensitive to smothering by fine sediment. However, female crabs are more sensitive to the effect of increased sedimentation during sedentary stages which occur when baring eggs. Both species forage using both smell, taste and vision and consequently elevated turbidity may affect their foraging ability (Neal 2008).

244. Given the low sensitivity of the receptors and the medium magnitude of the effect the overall impact of increased suspended sediment on both brown shrimp and edible crab is considered of **minor adverse** significance.

10.6.1.2.4 Summary of Impact 2

245. In summary, the increased suspended sediments caused by the construction of the proposed East Anglia THREE project using a Single Phase approach may cause impacts of up to minor adverse significance in both the East Anglia THREE site and the offshore cable corridor. It is unlikely that there would be significant interaction between activities carried out within the East Anglia THREE site and the offshore cable corridor (See Chapter 7 Marine Geology, Oceanography and physical processes) and therefore the overall impact of smothering of benthic habitats and species would be considered to be of **minor adverse** significance.

246. There is high confidence in this assessment due to the comprehensive site-specific data available and the detailed study conducted into the levels of increased suspended sediment that would be caused by construction (Chapter 7 Marine Geology, Oceanography and Physical Processes).

Two Phased

247. Under a Two Phased approach there would be a small increase in the maximum quantity of sediment released as a result of sea bed preparation for the installation of foundations (3,543,325m^3 as opposed to 3,470,100m^3) however this would occur over a 28 month time period with an eight month gap between phases (Chapter 5 Description of the Development, *Table 5.37*). This extended timescale would allow sediment to settle out of suspension and therefore the magnitude of the impact would be less than that of the Single Phase approach.

248. The amount of sediment disturbed through cable installation would also be greater under a Two Phased approach (1,834km of cables trenched as opposed to 1,599km).

However, there is no overlap of each type of cable installation (inter-array, platform link, interconnector and export) across the two phases (Chapter 5 Description of the Development *Table 5.37*). Therefore, although the amount of sediment disturbance is greater than the Single Phase, the activity is less intense allowing for settlement of suspended sediment and therefore the magnitude of impact would be similar.

249. Under a Two Phased approach the impact of increased suspended sediment concentrations is considered to be of **minor adverse** significance.

10.6.1.3 Impact 3: Re-mobilisation of Contaminated Sediments

Single Phase

250. Given the low levels of contaminants in the sediments of the East Anglia THREE site and the majority of the offshore cable corridor, changes in water and sediment quality due to re-suspension of contaminants have been assessed as negligible (Chapter 8 Marine Water and Sediment Quality).

251. Elevated levels of arsenic were found to be present at sample station 30, which is within the offshore cable corridor (*Figure 8.1*). These were attributed to the local geology and were not thought to have occurred due to anthropogenic affects. Station 30 is in an area with few steep sandwaves (*Figure 7.6*) and therefore it is unlikely that sea bed levelling for cable installation would be required in that area. Should dredging be required at this site EATL would collect further data to assess the area affected by elevated arsenic levels and if found to be extensive would agree (with Natural England and the MMO) a strategy for the disposal of material from this area to minimise impacts.

252. As a result, it is predicted that there would be **no impact** to the benthic ecology caused by construction of the proposed East Anglia THREE project.

253. Also assessed within Chapter 8 Marine Water and Sediment Quality is the potential for accidental releases or spills of construction materials or chemicals. EATL is committed to ensuring that all vessels would adhere to the requirements of the MARPOL Convention Regulations with appropriate preventative and control measures. Therefore, it is considered likely that there would be **no impact** to the benthic environment due to accidental releases or spills.

Two Phased

254. There would be no significant differences to the above assessment arising from a Two Phased approach and therefore the assessment considers that there would be **no impact**.

10.6.1.4 Impact 4: Underwater Noise and Vibration

255. The installation of monopile foundations or pin piles for jackets would require them to be driven into the sea bed (as described in Chapter 5 Description of the Development). If piled foundations are installed, this could potentially have an adverse impact on the benthos in the immediate vicinity of each wind turbine or meteorological mast.

Single Phase

256. Under a Single Phase approach the installation of monopiles would occur over a 15 month period with one pile installed at a time or over an 8 month period where up to two monopiles could be installed concurrently.

257. Chapter 9 Underwater Noise and Vibration contains further details of noise that would be created by the construction activities. The worst case as outlined in this chapter would be the use of a 3,500KJ energy hammer with up to two piles being driven at the same time.

258. The effects of noise on benthic species are poorly understood. A number of studies have shown that some species are able to detect sound. Horridge (1966) found the hair-fan organ of the common lobster *Homarus vulgaris* to act as an underwater vibration receptor. Lovell et al. (2005) showed that the common prawn *Palaemon serratus* is capable of hearing sounds within a range of 100 to 3,000Hz, and the brown shrimp, which was identified as present within the East Anglia site and offshore cable corridor, has shown behavioural changes at frequencies around 170Hz (Heinisch and Weise 1987).

259. It is therefore clear that the noise created by certain construction activities would be audible to certain benthic species. Although the benthos is likely to be habituated to ambient noise such as that created by shipping or wave action, the noise created by piling may cause alarm and fear mechanisms. This has been found to be the case during seismic explorations involving noise up to 250dB at 10 to 120Hz (Richardson et al. 1995) whereby polychaetes tended to retreat into the bottom of their burrows or retracted their palps, and bivalve species withdrew their siphons. Furthermore, the air-filled cavities within certain invertebrate species may alter the transmission of sound waves through their bodies, which could potentially cause physiological damage. Therefore, taking a conservative approach the sensitivity of benthic species is considered medium.

260. The extent of any risk of physiological damage or mortality would be localised around foundations where noise generation would be at the highest magnitude. Therefore, the magnitude of the impact of noise and vibration on benthic species is

considered to be low. A medium sensitivity and low magnitude equates to an impact of **minor adverse** significance.

Two Phased

261. Under a Two phased approach monopiles would not be installed concurrently (as may be the case under a Single Phase and installation would occur over two 8 month periods separated by 10 months. Therefore, the magnitude is considered marginally less than that of the Single Phased approach, however it is still likely to be within the low category (*Table 10.8*) and therefore the impact under a Two Phased approach is considered to be of **minor adverse** significance.

10.6.1.5 Impact 5: Potential Impacts on Sites of Marine Conservation Interest

262. *Figure 10.14* illustrates that an area of the export cable corridor overlaps with the Outer Thames SPA. The overlap is 95km^2 (*Table 10.2*) and within this up to 104km (four export cables, 26km of which could be installed within the SPA) of export, cable could be installed. The effects of the proposed East Anglia THREE project upon the integrity of the Outer Thames SPA and its designated features is further assessed within the Habitat Regulations Assessment (HRA) which has been submitted as part of this application.

Single Phase

263. Installation of these cables using a worst case trench width of 17.3m and 15m spoil width either side (Chapter 5 Description of the Development, section 5.5.14.1.7) would create an area of disturbance of up to 4.92km2 (0.3% of the total SPA area). The disturbance would occur over a maximum period of 22months, although there would be numerous breaks in the period as export cable was installed outside of the SPA.

264. It is recognised that the benthic community is an important supporting feature of the Outer Thames Estuary SPA, designated for red-throated divers.

265. The assessment of the effects of the proposed East Anglia THREE project on the these benthic features and the assessment of likely significant effects and effect on integrity are considered in the HRA report which has been submitted as part of this application.

266. Chapter 7 Marine Geology, Oceanography and Physical Processes assess the magnitude of effects on the sea bed of the Outer Thames Estuary SPA (and therefore the integrity of the site) as negligible in section 7.6.1.6.1 and therefore given that only 0.13% (Table 10.2) of the SPA is affected the magnitude of this impact is considered to be negligible. Therefore, under this EIA assessment, the impacts of construction in reducing food source for designated species of the Outer Thames

SPA, under a Single Phase approach is considered to be of negligible significance. For the assessment of the effects of the East Anglia THREE project on the Outer Thames SPA using HRA criteria see the HRA report which has been submitted as part of this application.

Two Phased

267. There would be no significant difference in the impact under the Two Phased approach and therefore the impact is considered to be of **negligible** significance.

10.6.2 Potential Impacts During Operation:

10.6.2.1 Impact 1: Permanent Habitat Loss through placement of infrastructure on the sea bed.

268. Habitat loss during operation would occur from two main sources; placement of structures on the sea bed and scour associated with these structures. The scour assessment conducted for the proposed East Anglia THREE project (Chapter 7 Marine Geology, Oceanography and Physical Processes and *Appendix 7.3*) shows that the scour holes which would develop if no scour protection was placed around infrastructure would be smaller than the footprints of the proposed scour protection. Therefore, the worst case scenario for benthic ecology is likely to be the placement of scour protection.

269. If scour protection is applied it is likely to be in the form of rock, concrete mattresses, sand-filled geotextile bags, or similar.

270. Under the Single Phase approach the total overall maximum footprint of the proposed East Anglia THREE project would be 3.23km^2 (*Table 10.2*).

10.6.2.1.1 East Anglia THREE Site

271. Within the East Anglia THREE site permanent habitat loss (defined as the 25 year lifespan of the project) would be instigated by the placement of foundations structures, cable protection and scour protection associated with all of these infrastructure (*Table 10.2*).

272. As a worst case scenario it has been assumed that up to 10% of the inter-array and export cables within the East Anglia THREE site would not be buried and that instead be surface-laid and protected in some manner. Furthermore, where a cable was required to cross an existing cable or a cable associated with the proposed East Anglia THREE project, further cable protection would be required (See Chapter 5 Description of the Development, *Table 5.5.14.3*). The effects on sea bed morphology and sediment transport arising from the presence of cable protection measures would not extend far beyond the direct footprint (Chapter 7 marine Geology,

Oceanography and Physical processes). Therefore, the footprint of the cable protection is considered to be the worst case scenario.

273. As discussed in Construction Impact 1 (section 10.6.1.1) four distinct infaunal groups were identified (*Figure 10.6*) within the East Anglia THREE site with all except group L (considered to be an outlier) common across the East Anglia Zone as shown in *Table 10.11*. These infaunal groups correspond to three biotopes identified using the method described by Connor et al. (2004). The sensitivity of these biotopes to substratum loss (equivalent to permanent habitat loss) is shown in *Table 10.17.*

Table 10.17. Biotope Sensitivities to Substratum Loss within the East Anglia THREE site (MarLIN and Tyler-Walters) extrapolated from level four and five biotopes assessments

Biotope	Biotope description	Intolerance	Recoverability	Sensitivity
SS.SSa.CFiSa	Circalittoral fine sand	Intermediate	very high	Low
SS.SCS.CCS	Circalittoral coarse sediment	High	High to very high	Low to moderate
SS.SMU.CSaMu	Circalittoral sandy mud	High	High	Moderate

274. *Table 10.17* indicates that the sensitivity of infaunal biotopes within the East Anglia THREE site to permanent habitat loss is at worst of moderate sensitivity (according to Tyler-Walters et al. 2004). Therefore, the sensitivity of infaunal biotopes surveyed within the project marine boundaries is considered to be medium in accordance with *Table 10.6*.

275. Of further interest, due to its importance as a food source for flatfish, the brown shrimp, was found to be present in the majority of epibenthic samples within the East Anglia THREE site (*Appendix 10.2* and *Appendix 10.4*). Brown shrimp are assessed to have low sensitivity to substratum loss (Neal 2008).

276. It is predicted that the total area of habitat loss, which includes the footprint of all installed infrastructure, and inter-array and platform link cable protection along with its scour protection would be 3.89km^2. This area is approximately 0.96% of the East Anglia THREE site which is not significant, especially when assessed in the context of the southern North Sea. Therefore, the magnitude of the impact would be considered to be low.

277. As the benthic receptors within the East Anglia THREE site (the three different biotopes and brown shrimp) all have a medium or low sensitivity to the impact of permanent habitat loss and the magnitude of the impact is considered low the impact within the East Anglia THREE site would be of **minor adverse** significance.

10.6.2.1.2 Offshore Cable Corridor

278. Within the offshore cable corridor direct habitat loss would occur where cable protection is placed. It is anticipated that cable protection may be required over a maximum of 10% of the offshore export cables east of the crossing with the Greater Gabbard Offshore Wind Farm export cables and up to 2.5% of the export cables to the west of this point. This could lead to an area of up to 0.30km^2 being directly impacted by the placement of cable protection (*Table 10.2*).

279. The amount of scour which would occur changes with depth and distance from the shoreline with any works in cable protection close to shore potentially creating scour holes. The seaward limit at which physical processes could potentially affect shoreline and nearshore sediment transport and therefore scour is called the closure depth and, as a worst case assumption, is considered to be in a water depths of less than 15m (Chapter 7 Marine Geology, Oceanography and Physical Processes). EATL have made a commitment to limit the amount of cable protection in these nearshore areas to a maximum of 2.5% of the export cables (section 10.3.3).

280. The magnitude of effects on sea bed morphology around such cable protection is considered in Chapter 7 Marine Geology, Oceanography and Physical Processes to be high in the near field and low in the far field. As the near field effects would only be experienced over a maximum of a few hundred meters from the cable protection the overall magnitude of effect is considered to be at worst medium.

281. As discussed previously, in addition to the biotopes identified during the East Anglia THREE site survey (*Appendix 10.4*), further biotopes have been identified using data collected during the Zonal survey and the East Anglia ONE cable corridor survey (*Appendix 10.3*). The sensitivity of these biotopes to habitat change (equivalent to permanent habitat loss) is displayed in *Table 10.18.*

Table 10.18. Biotope Sensitivities to Habitat Change within the offshore cable corridor (MarLIN website and Tyler-Walters et al. 2004) level three sensitivities are extrapolated from level four and five biotopes assessments

Biotope	Intolerance	Recoverability	Sensitivity
SS.SCS.ICS	N / A	N / A	Low
SS.SMx.IMx	N / A	N / A	Low
SS.SSa.IMuSa	N / A	N / A	Low
SS.SMu.ISaMu	Intermediate	High	Low
SS.SCS.CCS.MedLumVen	Moderate	Low	Low
SS.Smx.CMx.MysThyMx	N / A	N / A	Low
SS.SCS.ICS.HeloMsim	N / A	N / A	Low

Biotope	Intolerance	Recoverability	Sensitivity
SS.SSa.CFiSa.ApriBatPo	Low	Low	Low
SS.SSa.CMuSa.AalbNuc	N / A	N / A	Low
SS.Ssa.CFiSa.EpusOborApri	Low	Low	Low
SS.SBR.PoR.SspiMx	Not sensitive	High	Low

282. All of the biotopes recorded within the offshore cable corridor are considered to be within the category of offshore sands and gravels. *Table 10.18* indicates that the identified biotopes all have a low sensitivity to habitat change.

283. The important prey brown shrimp and commercially important crab edible crab were identified as present in surveys which covered the offshore cable corridor. These species are highly mobile and would be expected to evade the initial construction impact (Construction impact 1) and return to the impacted area within a short period of time. These species are assessed by MarLIN as having low and moderate sensitivity to substratum loss (which is considered equivalent to permanent habitat loss) (Neal 2008 Neal and Wilson 2008). Taking this into account, a medium sensitivity is assigned to this receptor.

284. Mussels belonging to the family Mytilidae were present throughout the nearshore section of the export cable corridor. They are of potential interest due to their commercial value, their potential to form Annex I biogenic reefs and their value as a potential prey item. Mussels are intolerant of substratum loss because they require hard substrata to attach to but are likely to recover through rapid larval recruitment. If a mussel is displaced but not damaged, it has the ability to reattach to new substrata so is tolerant of displacement (Tyler-Walters 2008). Once placed on the sea bed the cable protection is likely to provide additional substrate for the mussels to colonise.

285. Mytilidae are therefore considered to have a low sensitivity to the effect of habitat loss from cable protection.

286. The benthic receptors within the offshore cable corridor all have a medium or low sensitivity to the impact of permanent habitat loss. The magnitude of this impact, as previously discussed, is considered to be low. Therefore, the significance of the impact within the offshore cable corridor would be **minor adverse**.

287. As the offshore cable would remain buried under the intertidal region throughout the operational life of 25 years, no cable protection would be required and as such **no impacts** to benthic ecology would take place.

10.6.2.1.3 Summary of Operation Impact 1

288. The impact of permanent habitat loss both within the East Anglia THREE site and the offshore cable corridor has been assessed as being at worst of minor adverse significance. It is unlikely that there would be any interactions between the different study areas and therefore the overall impact of permanent habitat loss caused during the operational life of the project would be of **minor adverse** significance.

Two Phased

289. Under a Two Phased approach, the principal difference to the Single Phase assessment is that there could be a larger project footprint due to the addition of one electrical platform and additional cable protection associated with the greater length of platform link cables and interconnector cable trenches. The overall increase in project footprint would be small, from to 3.15 to 3.23, and it is not considered a significant change. Therefore, the impact of permanent habitat loss under a Two Phased approach would be considered of minor adverse significance.

10.6.2.2 Impact 2: Physical Disturbance through Maintenance Activities

290. There is potential for physical disturbance to benthic organisms and habitats during operation where maintenance activities require the use of a jack- up vessels and where cable maintenance, replacement or repair is required.

Single Phase

10.6.2.2.1 East Anglia THREE site

291. It is very difficult to predict the level and extent of maintenance activities that may occur during operation. However, it has been estimated that a maximum of two visits by jack-up vessels to the East Anglia THREE site per day could occur. Assuming each vessel has a footprint of 1,800m^2, this would form the majority of the physical disturbance during operation and would lead to a total area of up to 1.31km^2 being disturbed per year (the equivalent of 0.34% of the East Anglia THREE site).

292. As previously described in Construction Impact 1 (section 10.6.1.1), jack-up barge feet would penetrate the sea bed disturbing the habitat and affecting the organisms within the footprint. The duration of the effect would be temporary and whilst individuals directly within the footprint would not recover, the numbers of individual affected would be concerned would be small and there would be no long lasting effects on the wider habitat. Taking this into account, the magnitude of effect would be low.

293. Maintenance work may also be required on cables installed within the East Anglia THREE site. However, it is expected that if the cables are buried to their target depth of between 0.5 and 5m there would be minimal amounts of maintenance required. It has been estimated that on average approximately two cable maintenance events

or repairs may be required for inter-array cables and one platform link cable per year (See Chapter 5 Description of the Development *Table 5.38*). Therefore, the magnitude of physical disturbance during operation is predicted to be negligible.

294. The receptors to physical disturbance during operation would be the same receptors as those identified in section 10.6.1.1. (Construction Impact 1). These receptors were identified as being of low sensitivity (section 10.6.1), therefore given the negligible magnitude of effect the impact of physical disturbance during operation is predicted to be of **negligible** significance.

10.6.2.2.2 Offshore Cable Corridor

295. The export and interconnector cables could also require maintenance that may result in physical disturbance. As with the windfarm cables, it is expected that, if the export and interconnector cables are buried to their target depth of between 0.5 and 5m, there would be minimal amounts of maintenance required and any repair operations would involve temporary and infrequent activity. EATL have estimated that on average approximately two cable maintenance events or repairs may be required for export cables and one for interconnector cables per year (See Chapter 5 Description of the Development *Table 5.38*). Therefore, the magnitude of the impact is likely to be negligible.

296. As previously discussed, the habitats within the offshore cable corridor are typical of the East Anglia Zone and the southern North Sea.

297. The sensitivity of the species and habitats within the offshore cable corridor to physical disturbance is discussed in section 10.6.1 (Construction Impact 1) with the conclusion being that sensitivities were either low or medium.

298. Negligible magnitude and medium sensitivity indicate that physical disturbance would be of **negligible** significance to benthic habitats and species within the offshore cable corridor.

10.6.2.2.3 Summary of Operation Impact 2

299. The impact of physical disturbance has been assessed as being of negligible significance for both the East Anglia THREE site and the offshore cable corridor. It is unlikely that there would be any interactions between the sources of impact within the different study areas and therefore the overall impact of physical disturbance caused by the operation of the project would be of **negligible** significance.

Two Phased

300. There would be no significant difference in the impact under the Two Phased approach and therefore the impact is considered to be of **negligible** significance.

10.6.2.3 Impact 3: Smothering due to increased Suspended Sediment Concentrations

301. Changes in the tidal and wave regimes around foundation structures and cable protection are likely to result in localised scour of the sea bed under a worst case that involves no scour protection being placed around such structures. As the source of the impact would occur in both study areas the assessment of this impact is not separated in the same way that other impacts have been.

302. As discussed in Operation Impact 1 (section 10.6.2.1) empirical scour assessments have been completed to determine scour depths, areas and associated sediment volumes for the worst case foundation type of gravity base structures (Chapter 7 Marine Geology, Oceanography and Physical Processes). Further information on the scour assessment methodology is presented in *Appendix 7.3*.

Single Phase

303. The worst case scour volumes, which are presented in *Table 10.2*, are considerably less than the worst case volumes of sediment potentially released following sea bed preparation activities considered in Construction impact 2 (section 10.6.1.2) and therefore the magnitude of this effect would be less.

304. In addition, given the sediment types prevalent across the East Anglia THREE site, and the offshore cable corridor, most of the small quantities of sediment released due to scour processes would rapidly settle within a few hundred metres of each foundation or cable protection structure. Therefore, the magnitude of the impact is likely to be negligible to low.

305. The receptors of this impact are discussed in Construction Impact 2 (section 10.6.1.2) where it was concluded that their sensitivity was between low to medium. A low magnitude and a medium sensitivity to this impact indicate that smothering due to increased suspended sediment during operation of the project would result in an impact of **minor adverse** significance.

Two Phased

306. Under a Two Phased approach there would be a small increase in the maximum expected amount scour material released into the water column due to the addition of one electrical platform (*Table 10.2*). This increase would result not result in a significant change to the magnitude of the impact and therefore smothering through increased suspended sediment under a Two Phased approach would result in an impact of **minor adverse** significance.

10.6.2.4 Impact 4: Re-mobilisation of contaminated sediments

307. Given the absence of contaminants present in the sediments of the East Anglia THREE site and the offshore cable corridor, changes in water and sediment quality

due to re-suspension of contaminants during operation have been assessed as negligible (Chapter 8 Marine Water and Sediment Quality). As a result, the impact on benthos is expected to be **no impact**.

Single Phase

308. Also assessed within Chapter 8 Marine Water and Sediment Quality is the potential for accidental releases or spills during maintenance activities. EATL is committed to ensuring that all vessels would adhere to the requirements of the MARPOL Convention Regulations with appropriate preventative and control measures. In accordance with DML requirements a Marine Pollution Contingency Plan will also be in place during construction and operations. This would ensure that the chances of such an impact occurring is small. Therefore, it is considered likely that there would be **no impact** to the benthic environment due to accidental releases or spills.

Two Phased

309. There would be no significant difference in the impact under the Two Phased approach and therefore the impact of re-mobilisation of contaminated sediments is considered to be of **negligible** significance.

10.6.2.5 Impact 5: Colonisation of Introduced Substrate

310. When assessing the colonisation of introduced substrate it is important to note that any introduced substrate is considered to be a change from the existing environment presented in section 10.5 and is therefore cannot be considered to be beneficial in ecological terms.

311. All project infrastructure that has a sub sea-surface element would represent a potential substrate for colonisation by marine fauna and flora, including species that may not currently be found within the existing environment. Therefore, the assessment of this impact does not make a distinction between sources of impact in the two different study areas as is the case with other impacts.

312. The addition of hard substrate is of particular importance given the otherwise sedimentary environments found within the East Anglia Zone where substrates for colonisation by encrusting epifauna are very limited.

Single Phase

313. Hard substrates introduced by the project would include foundations and scour protection for wind turbines, electrical platforms, accommodation platform, meteorological masts and cable protection. It is difficult to calculate the exact area of introduced substrate due to its 3- dimensional nature, but under the worst case scenario, which assumes the maximum amount of introduced substrate, the area of introduced substrate would be in excess of the $3.23km^2$ area calculated for the

project footprint (*Table 10.2* operational Impact 1). This calculation is based on the worst case which would arise from the installation of gravity base foundations as it is unlikely that the other foundation types under consideration would provide a greater surface area.

314. Studies of operational windfarms in the North Sea have found that widespread colonisation of sub-sea surfaces occurs. Lindeboom et al. (2011) demonstrated that at the Egmond aan Zee Offshore Windfarm in Dutch waters, new hard substrate led to the establishment of new faunal communities and new species. Clear biological zones were evident with mussels dominating the foundations between 7 and 10m deep while below 10m depth foundations were colonised by tubes of the small crustacean *Jassa sp*. and anemones (*Metridium senile, Sargartia spp*. and *Diadumene cincta*). During surveys, 33 species were found to have colonised the monopiles and 17 species on the scour protection after two years of monitoring (Lindeboom et al. 2011).

315. Studies in the UK have identified increases of benthic species including crabs (*C. pagurus*) and lobsters (*H. gammarus*) from colonisation of sub-surface structures by subtidal sessile species (Linley et al. 2007) on which they can feed.

316. Monitoring at Horns Rev 1 Offshore Windfarm in Danish waters showed that the sub-surface structures were colonised by 11 species of algae and 65 invertebrate taxa within two years of the completion. In addition, mobile invertebrates (decapods and molluscs) were found on the scour protection and sessile species had settled on the monopiles.

317. Monitoring at the Alpha Ventus windfarm in German waters, which uses jacket foundations, found that the mussel *Mytilus edulis* contributed the largest part of the biomass (75%) on the upper 5m of wind turbine foundations whilst deeper areas of foundations were dominated by the amphiopod *Jassa* sp (ICES 2012).

318. It has been suggested by consultees of other windfarms that the introduced hard substrate could act as ‘stepping stones’ for colonisation by non-native species into UK coastal waters. However, it is not possible to assign a clear impact to this potential issue. In 2009, Cefas conducted a review of the state of the benthic ecology around Round One windfarms (Cefas 2009), in this review no invasive or non-native species were observed although monitoring was recommended throughout the life span of all windfarms.

319. Gravity base structures and associated scour protection are likely to represent the worst case scenario as they have the greatest surface area and therefore the most potential for changing the biodiversity. Lindeboom et al. (2011) found that new hard

substrate introduced by the construction of the Egmond aan Zee Offshore Windfarm acts as a new type of habitat with a higher biodiversity of benthic organisms and indicated a possible increased use of the area by the benthos, fish, marine mammals and some bird species. Neither the surrounding soft sediment benthic community nor bivalve recruitment was found to be affected by the windfarm during the first year of operation.

320. Cable protection used to protect the inter-array, platform link, interconnector and export cables would also be colonised by the species and communities discussed above. In the worst case scenario, up to 10% of the export cables to the east of the Greater Gabbard Offshore Wind Farm export cable crossing point and up to 2.5% of the export cable to the west of this point would be protected with rock armour, mattresses or sand-filled geotextile bags creating introduced hard substrate.

321. The change of habitat from a sandy sea bed to hard substrate would result in potential increases in the diversity and biomass of the marine community of the area through colonisation of the structures. However, there is likely to be only a small interaction between the remaining available sea bed and the introduced hard substrate and any interactions would be highly localised.

322. As previously discussed the species and habitats within the East Anglia THREE site and the offshore cable corridor are typical of those within the East Anglia Zone and wider southern North Sea. Given the localised nature of such habitat alteration, and the low value of the receptors the magnitude of the impact is considered to be low.

323. Sensitivity of the receptors is difficult to assess but due to their ubiquity in the region and the scale of these changes in relation to the communities present in the wider area, it is unlikely that the changes would result in any significant broad scale community or biodiversity changes. The sensitivity of the receptor is therefore considered to be at worst within the medium category (*Table 10.6*).

324. When considering changes to existing communities the impact of colonisation of new substrate within the proposed East Anglia THREE project is likely result in a impact of **minor adverse** significance. Confidence in the accuracy of this assessment is low (as it is difficult to predict exactly what species would colonise the structures) and therefore a precautionary rating has been used when assigning the sensitivity of the impact.

325. The potential for colonisation of structures by non-native species, allowing them to extend their geographical range is also a possibility. Depending on the species, there is potential for secondary ecological changes to occur where there is competition between the non-native species and the native community.

326. Wilhelmsson and Malm (2008) noted examples of anthropogenic structures that constitute suitable habitats for non-indigenous species. Specifically, the study recorded that numerous specimens of the intertidal giant chironomid *Telmatogeton japonicus*, an Asian invasive species known to have been transported around the world in ship ballast and on ship hulls, were recently found in the splash zone on several of the wind turbines at Utgrunden on the Swedish Baltic coast and at other sites in Denmark. The species has also been recorded on offshore buoys in Belgium. The authors note that the first recordings in Denmark of two amphipods, *Jassa marmorata* and *Caprella mutica*, were also made at offshore windfarm sites.

327. Potential non-native invasive species impacts are an emerging consideration for other proposed offshore developments including aquaculture, current, tidal or wave energy generation as well as the increasing number of mobile deep water drilling rigs and proposed floating production, storage and offloading facilities. Although ship ballast water appears to be the largest single vector for non-native marine species, bio-fouling communities on ships and petroleum platforms and the placement of human-made structures that provide new habitat are also identified as contributors (Glasby et al. 2007).

328. Under embedded mitigation EATL have committed to applying best-practice techniques including appropriate vessel maintenance as outlined in the International Convention for the Prevention of Pollution from Ships (MARPOL). This would minimise the risk of the introduction of non-native species.

329. Given the required minimum distances between the wind turbines (675m between wind turbines in a row and 900m between rows) and potential scour protection material, it is not anticipated that the changes would constitute any form of linked reef-like feature. Allowing for this fact and the embedded mitigation the magnitude of the effect is considered to be low. The sensitivity of the existing environment is considered to be medium. The potential negative impact therefore of the provision of hard substrate acting as a vector for non-native species is considered to of **minor adverse** significance.

Two Phased

330. Under a Two Phased approach there could be one extra foundation and up to 2.5% greater amount of cable protection which could be colonised. However the magnitude is still considered to be low and therefore the significance of the impact under a Two Phased approach would be of minor adverse significance.

10.6.2.6 Impact 6: Potential Impacts on Sites of Marine Conservation Interest

331. A small area of the offshore cable corridor overlaps with 94.81km^2 of the Outer Thames SPA.

332. The Outer Thames Estuary SPA is designated for red-throated divers which feed mainly on fish but also on molluscs, crustaceans and polychaetes. An assessment of the impacts of the proposed East Anglia THREE project on red-throated divers can be found in Chapter 13 Offshore Ornithology and an assessment of the effects of the project on the integrity of the Outer Thames SPA can found in the HRA report which has been submitted as part of this application.

333. Changes in the physical processes due to cable protection could lead to a change in population of molluscs, crustaceans and polychaetes within the effected part of the SPA and therefore may have the potential to affect the integrity of the SPA.

334. The worst case scenario would be that the maximum amount of cable protection would be located within the overlapping section (*Table 10.2*). The maximum percentage of cable protection installed would be 2.5% of the length of export cables located within the SPA. Therefore, an area up to $0.01km^2$ of cable protection could be placed within the SPA, this represents 0.01% of the area of overlap with the SPA and 0.0002% of the total SPA area (*Table 10.2*).

335. As red throated divers mainly feed on fish their sensitivity to changes in populations of benthic species is considered to be low, and therefore the potential impact of the proposed East Anglia THREE project on the designated feature of the SPA is considered to be of low magnitude.

336. Chapter 7 Marine Geology, Oceanography and Physical Processes assesses the magnitude of effect of such cable protection on the Outer Thames Estuary SPA (and therefore the integrity of the site) as being of minor adverse significance (section 7.6.2.7) and therefore given that only 0.0002% of the SPA is affected the magnitude of this impact is considered to be low.

337. As previously discussed in Construction Impact 1 the sensitivity of the benthic ecology to disturbance within the offshore cable corridor is considered to be low and therefore the impact to the Outer Thames SPA by reduction in prey source for red-throated divers is likely to be of **negligible** significance.

338. There would be no difference in impact on the Outer Thames SPA under a Two Phased approach.

10.6.2.7 Impact 7: Electromagnetic Fields (EMF)

Single Phase

339. EMFs as a result of the presence of inter-array, platform link, interconnector and export cables may be detected by the some benthic species. EMFs are strongly attenuated and decrease as an inverse square of distance from the cable (Gill and

Bartlett 2010), any effects would therefore be highly localised. Furthermore, it is the aim of EATL to bury as much of the cable as possible to 5m depth reducing the effect of EMF, although it is recognised that cable may, in some locations, only be buried to 0.5m . Therefore, the magnitude of such an impact is considered negligible.

340. Evidence for sensitivity to EMFs comes from physiological and behavioural studies on a small number of marine invertebrates and no direct evidence of impacts to invertebrates from undersea cable EMFs exists. Biological effects studies have demonstrated small responses to magnetic fields in the development of echinoderm embryos and in cellular processes in a marine mussel, however at intensity fields far greater than those expected from undersea cables (Normandeau et al. 2011).

341. As discussed in other impacts the value of the benthic habitats and species within the East Anglia THREE site and offshore cable corridor is relatively low. This coupled with the fact that there is little evidence to suggest that benthic species would be adversely impacted by EMF (Chapter 9 Underwater Noise and Vibration and Electromagnetic Fields), the sensitivity of the receptor is considered to be negligible. In accordance with *Table 10.9* a **negligible** significance is therefore predicted.

Two Phased

342. There would be no significant difference in the level of impact under a Two Phased approach. There would be a slight increase in the amount of installed cables of the up to 1,834km as opposed to 1,789km (*Table 10.2*) however it is not considered that this would change the magnitude of the impact.

10.6.3 Potential Impacts during Decommissioning

343. On expiry of the lease for the proposed East Anglia THREE project, EATL would remove all structures, except cables and pin piles deeper than 1 to 2m, and return the sea bed to a usable state in accordance with the DECC decommissioning guidance (DECC 2011). If further guidance is available at the time of decommissioning than EATL would follow this guidance.

344. During the decommissioning phase, there is potential for wind turbine, foundation and cable removal activities to cause changes in suspended sediment concentrations and / or sea bed or shoreline levels as a result of sediment disturbance effects.

345. The types of effect would be comparable to those identified for the construction phase, namely:

- Impact 1: Physical Disturbance;
- Impact 2: Increased Suspended Sediment Concentrations;

- Impact 3: Re-mobilisation of Contaminated Sediments; and
- Impact 4: Underwater Noise and Vibration.

346. The magnitude of effects in all cases are predicted to be similar to those identified for the construction phase. The sensitivity of receptors during the decommissioning phase is difficult to predict as the benthic communities may change through the lifespan of the project due to changes in the environment such as sea temperature, wave regime and sea level. Furthermore, new communities would establish themselves on the hard substrate as discussed in Operational Impact 5 (section 10.6.2.5) and as it is not yet known what these communities would be, it is impossible to assess the sensitivity of them. It is however, anticipated that similar levels of sensitivity as those identified in the construction impacts would be broadly valid for the decommissioning phase. Therefore, it is anticipated that any decommissioning impacts would be **minor adverse** at worst**.**

10.7 Cumulative Impacts

347. There is potential for cumulative impacts on the benthic environment caused by the proposed East Anglia THREE project combined with marine aggregate dredging activity, the Galloper Wind Farm and Greater Gabbard Offshore Wind Farm, and from other projects within the East Anglia Zone.

348. Potential for cumulative impacts to manifest is considered in terms of the East Anglia THREE site and the offshore cable corridor separately and together.

10.7.1 East Anglia THREE site

349. The potential cumulative impacts to the benthos caused by interactions of activities within the East Anglia THREE site and other activities are:

- Physical disturbance and habitat loss;
- Increased suspended sediment concentrations;
- Re-mobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Colonisation of foundations and cable protection.

350. These impacts would mostly be temporary, small scale and localised. Given the distances to other activities in the region (e.g. other offshore windfarms and aggregate extraction, see Chapter 18 Infrastructure and Other Users) and the highly localised nature of the impacts above there is **no pathway** for interaction between

impacts cumulatively. Whilst it is recognised that across the East Anglia Zone and wider southern North Sea there would be additive impacts, the overall combined magnitude of these would be negligible relative to the scale of the habitats affected. In addition, given the ubiquity and low ecological sensitivity of habitats across the southern North Sea (and indeed across areas deemed suitable for development) sensitivity is also likely to be low or negligible at a cumulative scale.

351. In the case of physical disturbance and smothering during construction there is only potential for such additive impacts if project construction schedules overlap. Again although there may be an additive impact these are likely to be of negligible magnitude. In cases where sensitive habitats are present (e.g. biogenic reef), effects would be avoided where possible by micro-siting and design in those projects (as has been committed to for the proposed East Anglia THREE project), therefore there would be **negligible** or **no impacts** to these features.

352. Therefore, given that the impacts assessed for the proposed East Anglia THREE project (i.e. project level impacts) are considered negligible or would be avoided by design it is considered that at a cumulative (i.e. additive) level, impacts upon the benthos would be **negligible**.

10.7.2 Export Cable Corridor

353. There is potential for cumulative impacts to occur through the interactions between the proposed East Anglia THREE project export cable and export cables from other windfarms as well as interactions with aggregate extraction sites.

10.7.2.1 Impact 1: Physical Disturbance and Habitat Loss

354. There is a potential for cumulative impacts to occur within the export cable corridor where the export cables of many different windfarms would be in close proximity to each other. Up to eight cables from the East Anglia ONE and the proposed East Anglia THREE project would be installed roughly parallel to each other and share the same export cable corridor to the landfall.

355. It is possible (dependent upon the final design) that the locations at which cable burial would not be possible and cable protection would be required would coincide for all three projects creating a concentration of cable protection in one area.

356. Furthermore, the eight cables would cross three export cables from Greater Gabbard Offshore Windfarm and potentially up to three cables from Galloper Offshore Windfarm *Figure 10.14*. This would result in up to 48 cables crossings which may have a total area of approximately 0.02km^2.

357. Depending on the nature of how these cables would be crossed and what materials would be used, the magnitude of this cumulative impact could be medium with so many crossings in a concentrated in a single area, although this footprint is small in the wider context**.** As discussed previously the sensitivity of the habitats and species present within the export cable corridor is considered to be low and species and habitats would be expected to recover rapidly after disturbance even if construction periods of windfarms were to overlap. Therefore, the impact is of **minor adverse** significance is predicted.

10.7.2.2 Impact 2: Increased Suspended Sediment Leading to Smothering

358. The marine aggregate extraction licence Area 430 is located approximately 925m north of the northern boundary of the export cable corridor. Aggregates option area 446 is also located in the vicinity of the export cable route (*Figure 18.3*), however, this site is not active and therefore is not considered in the cumulative impact assessment.

359. Sediment plumes from dredging vessels can extend on the tide for up to 2.5km from the vessel. If aggregate dredging takes place in Area 430 at the same time as the export cable corridor installation work, there would be potential for cumulative impacts from elevated turbidity and smothering on the benthos within the footprint of the two sediment plumes. However, as a result of the limited duration and low probability of this scenario occurring, combined with the low sensitivity of the habitats present to increased suspended sediment concentrations and smothering (as previously discussed, Construction Impact 3 and Operation Impact 3) the cumulative impacts are considered to be at worst minor adverse significance.

10.7.2.3 Impact 3: Colonisation of Introduced Substrate

360. As previously discussed in section 10.7.2.1 there could be up to 48 cable crossings between the East Anglia cables from projects ONE, East Anglia THREE and the Greater Gabbard Offshore Wind Farm and potentially Galloper Wind Farm export cables. These cable crossings would require cable protection at each crossing point. The nature of the cable protection is likely to be concrete mattresses 6m long by 3m wide by 0.3m high (Chapter 5 description of the development, section 5.5.14.3). These would represent the introduction of a hard substrate in an otherwise sediment habitat and would therefore be colonised by marine flora and fauna.

361. Work is ongoing to complete cable crossing agreements with Greater Gabbard Offshore Wind Farm and Galloper Wind Farms. In order to complete this assessment it has been assumed that at each of the 48 cable crossings cable protection covering an area of up to 342m^2 (19 mattresses). This equates to a total introduced surface

area of approximately 0.02km^2 of introduced substrate, which in the context of the wider North Sea is considered of low magnitude.

362. As discussed in Operation Impact 5 (section 10.6.2.5) it is not possible to quantify what species would colonise the cable protection (although a summary of the types of organisms likely to colonise hard structures is provided in section 10.6.2.5). Previous studies of offshore structures indicate that the change from sandy sea bed to solid substrate would result in potential increases in the diversity and biomass of the marine community of the area through colonisation of the structures. However, there is likely to be only a small interaction between the remaining available sea bed and the introduced hard substrate and any interactions would be highly localised.

363. Sensitivity of the receptors is difficult to assess but due to their ubiquity in the region and the scale of these changes in relation to the communities present in the wider area, it is unlikely that the changes would result in any significant broad scale community or biodiversity changes. The sensitivity of the receptor is therefore considered to be at worst within the medium category.

364. When considering changes to existing communities the cumulative impact of colonisation of the combined cable crossings and associated cable protection would likely result in an impact of **minor adverse** significance. Confidence in the accuracy of this assessment is low and therefore a precautionary rating has been used when assigning the sensitivity of the impact.

10.7.2.4 Impact 4: Impact to the Outer Thames Estuary SPA

365. With regard to the Outer Thames SPA, impacts could come from the installation and operational effects of cable protection. This could be up to 1% of the East Anglia ONE export cables and up to 2.5% of the proposed East Anglia THREE export cables within the SPA. In addition, all these cables would cross the Greater Gabbard Offshore Wind Farm and Galloper Wind Farm export cables within the SPA (see cumulative impact 2 above) with the potential for up to 48 crossings.

366. This SPA is designated to protect the nationally important wintering populations of red-throated diver that it supports (see Chapter 13 Offshore Ornithology). The primary prey of the red-throated diver is fish species although they occasionally consume crustaceans, molluscs and marine worms (Natural England 2012).

367. It is unlikely that installation of the cables would change the population of crustaceans, molluscs and worms within the SPA to an extent that there would be a noticeable change in population of the red-throated divers and therefore the sensitivity of the receptor (the Outer Thames Estuary) is considered to be low.

368. With a medium magnitude and a low sensitivity the cumulative impact on the Outer Thames SPA is considered to be of **minor adverse** significance.

369. In order to reduce this cumulative impact EATL have made a commitment to work with Greater Gabbard and Galloper offshore windfarms to reduce the impact on the Outer Thames Estuary SPA by where possible ensuring that cable crossings are located outwith the boundaries of the SPA. Furthermore, EATL have made a commitment to limit the amount of cable protection used in water depths of less than 15m LAT to 2.5% of the export cable and it is believed that with further detailed design work this figure would be reduced still further.

370. This would have the effect of reducing the changes to sea bed morphology and sediment transport (Operation impact 7 in Chapter 7 Marine Geology, Oceanography and Physical Processes), which in turn reduces the impacts to benthic ecology (and so crustacean, molluscs and worms) therefore reducing the impacts to red throated divers and the integrity of the Outer Thames SPA.

10.7.3 The Project as a Whole

371. The proposed East Anglia THREE project is only predicted to act cumulatively with other projects to impact upon benthic ecology only within the offshore cable corridor. Impacts from the East Anglia THREE site are not predicted to act cumulatively with any other developments or with the East Anglia THREE offshore cable corridor due to the geographical and temporal separation.

10.8 Transboundary Impacts

372. As the impacts listed in section 10.7.1 would all be highly localised, temporary and small scale there are no pathways for potential transboundary impacts. Therefore, no transboundary impacts have been identified for the benthic ecology receptor groups of other EU member states.

10.9 Inter-relationships

373. The construction, operation and decommissioning phases of the proposed East Anglia THREE project would cause a range of effects on the benthic ecology. The magnitude of these effects has been assessed individually above in section 10.6 using expert judgement, drawing from a wide science base that includes project-specific surveys and previously acquired knowledge of the benthic ecology within the North Sea.

374. These effects not only have the potential to directly impact the benthic ecology receptors but may also manifest as sources for impacts upon receptors other than those considered within the context of this chapter. The assessments of significance

of these impacts on other receptors are provided in the chapters listed in the third column of *Table 10.19*. In addition, the table shows where other chapters have been used to inform the benthic ecology assessment in column two.

Table 10.19. Chapter topic inter-relationships

Topic and description	Related Chapter (influencing)	Related Chapter (affected)	Where addressed in this Chapter
Smothering of species and habitats by increased suspended sediment	7 - Marine Geology, Oceanography and Physical Processes 8 – Marine Water and Sediment Quality	11 - Fish and Shellfish Ecology 14 – Commercial Fisheries	Section 10.6.1 and 10.6.2
Temporary habitat disturbance	7 - Marine Geology, Oceanography and Physical Processes	11 - Fish and Shellfish Ecology 14 – Commercial Fisheries	Section 10.6.1
Release of contaminated Sediment	8 – Marine water and sediment quality	11 - Fish and Shellfish Ecology 14 – Commercial Fisheries	Section 10.6.1
Impact to the Outer Thames SPA due minor decrease in potential food source for primary feature	7- Marine Geology, Oceanography and Physical Processes	Chapter 13 - Offshore Ornithology	Section 10.6.2 and section 10.7.2
Habitat Loss		11 - Fish and Shellfish Ecology 14 – Commercial Fisheries	Section 10.6.2

10.10 Summary

375. The construction, operation and decommissioning phases of the proposed East Anglia THREE project would cause a range of effects on the benthic ecology which are summarised in *Table 10.20*. The magnitude of these effects has been assessed using expert assessment, drawing from a wide science base that includes project-specific surveys and assessments from other chapters of this ES.

376. The receptors that have been identified in specific relation to benthic ecology include a number of benthic habitats and species of interest due to ecosystem value and the value to commercial fishermen. The Outer Thames Estuary SPA was also identified as an indirect receptor due to the fact that its primary designation (red-throated diver) feed on benthic species.

377. The effects that have been assessed are anticipated to result in changes of **negligible** or **minor adverse** significance to the above-mentioned receptors. No additional mitigation measures, other than those which form part of the embedded mitigation, are suggested.

378. It should be noted that impacts under a Two Phased approach have all been assessed as having the same significance as those under which would occur under a Single Phase approach. Therefore, the content of *Table 10.20* is relevant to both the Single Phase and Two Phased approaches.

Table 10.20 Potential Impacts Identified for Benthic Ecology

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction						
Temporary Physical disturbance	Benthic Habitats and species	Negligible to Medium	Low	Minor adverse	None	Minor adverse
Smothering due to increased suspended sediment	Benthic Habitats and species	Low	Low to medium	Negligible to Minor adverse	None	Minor adverse
Re-mobilisation of contaminated sediments	Benthic Species	Low	Negligible	Negligible	None	Negligible
Underwater noise and vibration	Benthic Species	Negligible	Negligible	Negligible	None	Negligible
Potential impacts on sites of marine conservation interest	Outer Thames SPA, integrity and designated feature	Low	Low	Negligible	None	Negligible
Operation						
Permanent habitat loss	Benthic Habitats and species	Low to Medium	Low	Negligible	None	Minor adverse
Physical Disturbance through maintenance activities	Benthic Habitats and species	Low	Low	Negligible	None	Negligible
Smothering through increased suspended sediment	Benthic Habitats and species	Low to Medium	Negligible to low	Minor adverse	None	Minor adverse
Re-mobilisation of contaminated sediments	Benthic Habitats and species	Negligible	Negligible	Negligible	None	Negligible
Colonisation of foundations	Benthic Habitats and species	Low to Medium	Low	Minor adverse	None	Minor adverse

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
and cable protection						
Impacts on sites of marine conservation interest	Outer Thames SPA, integrity and designated feature	Low	low	Negligible	Under 2.5% cable protection within SPA	Negligible
EMF	Benthic Species	Negligible	Negligible	Negligible	None	Negligible
Decommissioning						
Temporary Physical disturbance	Benthic Habitats and species	Negligible to Medium	Low	Minor adverse	None	Minor adverse
Smothering due to increased suspended sediment Benthic Habitats and species	Benthic Habitats and species	Low	Low to medium	Negligible to Minor adverse	None	Minor adverse
Re-mobilisation of contaminated sediments	Benthic Habitats and species	Low	Negligible	Negligible	None	Negligible
Underwater noise and vibration	Benthic Species	Negligible	Negligible	Negligible	None	Negligible

379. Potential cumulative impacts of the proposed East Anglia THREE project are focused around the export cables and are summarised in *Table 10.21*.

Table 10.21 Potential Cumulative Impacts Identified for Benthic Ecology

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
All cumulative impacts for the East Anglia THREE Site	Benthic Habitats and species	Negligible	Negligible	Negligible	None	Negligible
Impacts with the East Anglia THREE export cable						
Physical Disturbance and Habitat Loss	Benthic Habitats and species	Low	Medium	Minor adverse	None	Moderate adverse
increased suspended sediment leading to smothering	Benthic Habitats and species	Low	Negligible	Not significant.	None	Not significant.
Colonisation of Introduced Substrate	Benthic Habitats and species	Medium	Low	Minor adverse	None	Minor adverse
Impact to the Outer Thames Estuary SPA	Outer Thames Estuary SPA	Low	Medium	Minor adverse	None	Minor adverse

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Chapter 10 Ends Here