East Anglia
Offshore Wind

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East Anglia THREE

Chapter 8

Marine Water and Sediment Quality

Environmental Statement
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Author – Royal HaskoningDHV
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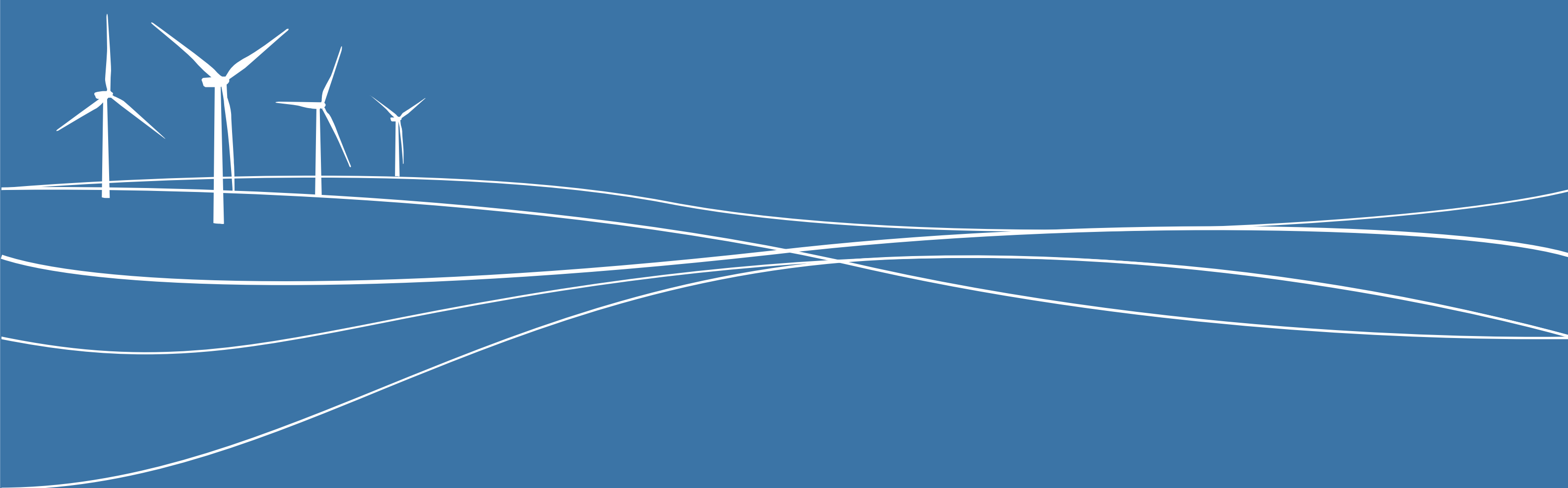

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8 MARINE WATER AND SEDIMENT QUALITY

8.1 Introduction

1. The chapter describes the existing environment with regard to marine water and sediment quality and assesses the potential impacts of the proposed East Anglia THREE project during the construction, operation and decommissioning phases. Where the potential for significant impacts is identified, mitigation measures are presented. The chapter was authored by Royal HaskoningDHV.

2. Certain elements of the assessment are informed by Chapter 7 Marine Geology, Oceanography and Physical Processes and in turn this assessment informs Chapter 10 Benthic Ecology and Chapter 11 Fish and Shellfish Ecology. Related onshore issues are considered in Chapter 19 Geology and Ground Conditions.

3. The assessment of potential impacts on marine water and sediment quality has been made with specific reference to the relevant legislation and guidance (as presented in section 8.4.1) of which the primary source are the National Policy Statements (NPS).

8.2 Consultation

4. To inform the Environmental Impact Assessment (EIA) and this Environmental Statement (ES), East Anglia THREE Limited (EATL) has undertaken a thorough pre-application consultation process, which has included the following key stages:

- Scoping Report submitted to the Planning Inspectorate (November 2012);
- Scoping Opinion received from the Planning Inspectorate (December 2012);
- Preliminary Environmental Information Report (PEIR) submitted for public consultation (May 2014); and
- Phase III report (Consultation) submitted for public consultation (June 2015)

5. A summary of the consultations carried out at key stages throughout the proposed project of particular relevance to marine water and sediment quality are presented in *Table 8.1*. Due to similarities in the location, consultations undertaken for the consented East Anglia ONE project have been considered as relevant and are also included. There were no responses to the Phase III report (consultation) which were relevant to marine water and sediment quality.

Table 8.1.Consultation Responses

Consultee	Date / Document	Comment	Response / where addressed in the ES
East Anglia THREE			
Planning Inspectorate	East Anglia THREE Scoping Opinion (The Planning Inspectorate 2012)	The potential effects of waste disposal or leakage into the marine environment should be considered within the PEIR. Reference to methods of disposal of waste arising from the construction and operation of the development should also be made.	This comment was addressed within the Preliminary Environmental Information Report (PEIR), this chapter is an update of that.
Joint Nature Conservation Committee (JNCC) and Natural England	East Anglia THREE Scoping Opinion (The Planning Inspectorate 2012)	Where available, more recent data should be used to inform the water quality assessment. Further evidence to support the conclusion that no pathway for release of contaminants or associated impact on water quality during construction activities is required.	Further samples have been taken within the offshore cable corridor and within the East Anglia THREE site to inform the assessment.
Marine Management Organisation (MMO)	East Anglia THREE Scoping Opinion (The Planning Inspectorate 2012)	The East Anglia THREE cable route crosses the former Warren Spring Environmental Research Laboratory. Sampling for contaminants within the surface sediment has revealed no traces of contamination. Continued monitoring of sediment contaminants throughout the development can be scoped out of the EIA process.	No action required.
Natural England	East Anglia THREE PEIR response (July 2014)	Given the potential contaminants associated with the windfarm during the construction, operation and decommissioning stages of this development, Natural England would expect to see the accidental spill of hazardous materials into the marine environment considered within the ES. We would also expect the production of a Marine Pollution Contingency Plan (MPCP).	This comment is addressed in sections 8.6.15 and 8.6.22. An MPCP will be a condition of the deemed Marine Licence (dML), see also Offshore Outline Construction Environmental Management Plan (OOCEMP) which is a basis for the DML condition requiring an Environmental Management Plan.
Natural England	East Anglia THREE PEIR response (July	Scour protection should be fully assessed and consideration given to the removal at the time of	This comment is addressed in section 8.6.21.

Consultee	Date / Document	Comment	Response / where addressed in the ES
	2014)	decommissioning that is not discussed at all in this chapter. Natural England highlights that its preference is for cable protection that can be easily removed at the time of decommissioning to be used to ensure that the area returns to the baseline conditions.	
MMO	East Anglia THREE PEIR response (July 2014)	Table 8.10 - Material from site 30 is not suitable for disposal to sea. Appropriate disposal of this excluded material should be specified, e.g. disposal to land.	Section 8.3.3 and section 8.6.1 Should the area in question be part of the works and any sediment disposal is required then provisions will be made at that time and EATL will apply for the appropriate disposal licences.
East Anglia ONE			
MMO	East Anglia ONE Scoping Opinion (IPC 2010)	The taking of a small number of water quality samples is recommended during the EIA. This will provide confidence, reassurance and evident that no contaminant re-suspension will be caused by the windfarm development. It is agreed that the likelihood of such contamination is low.	Five surface sediment grabs were collected to provide confidence, reassurance and evidence that there would be no contaminant re-suspension caused by the development of East Anglia ONE.
Environment Agency	East Anglia ONE Scoping Opinion (IPC 2010)	It is important to ensure that the EIA considers the prevention of pollution during construction and operation of the windfarm to prevent the deterioration of water quality.	Implementation of standard mitigation would prevent pollution incidents (see section 8.3.3).
Planning Inspectorate	East Anglia ONE Scoping Opinion (IPC 2010)	The East Anglia ONE proposed site lies completely within the former Warren Spring Environmental Research Laboratory marine disposal site. A full assessment of the environmental impacts of the consequences of disturbing this area needs to be undertaken.	Undertaken in East Anglia ONE Environmental Statement (ES) (ERM 2012). See also MMO comment above scoping out this area,
MMO and Centre for Environment, Fisheries & Aquaculture	PEIR response (2012)	Clarification should be provided in the final EIA to show that the development of the OWF is not expected to have a significant effect on water quality at any	Undertaken in East Anglia ONE Environmental Statement (East Anglia ONE 2012).

Consultee	Date / Document	Comment	Response / where addressed in the ES
Science (Cefas)		time, with the exception of the increase in suspended sediment concentrations (SSC) detailed.	

8.3 Scope

8.3.1 Study Area

6. The assessment of impacts of the proposed East Anglia THREE project on marine water and sediment quality considers the effects of two study areas:

- The East Anglia THREE site: the windfarm itself, including the wind turbine foundations, offshore platform foundations and inter-array and platform link cable routes.
- The offshore cable corridor which includes the export cable corridor (to landfall) and the interconnector cable corridor (*Figure 8.1*). Further detail of these cables is provided in Chapter 5 Description of the Development.

7. This assessment also considers impacts outside the East Anglia Zone and the wider southern North Sea, due to the potential for impacts on the marine environment to be far reaching.

8.3.2 Worst Case

8. The worst case scenario for each category of effect as a basis for the subsequent impact assessment has been established in this section.

9. *Table 8.2* outlines the worst case scenario with regards to marine water and sediment quality. Many of the impacts displayed in *Table 8.2* use numbers and scenarios quantified in Chapter 7 Marine Geology, Oceanography and Physical Processes and build on these to form the worst case for Marine Water and Sediment quality. However, as the impacts between the two chapters are different the final worst case numbers presented in the table will not be identical.

10. The worst case has been revisited since the PEIR to take account of the updates to the project design and comments received during the Section 42 consultation in 2014.

11. 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 8.2*. For operational impacts, the worst case under either approach (Single or Two Phased) has been considered in the assessment and is presented in *Table 8.2*.

Table 8.2 Worst Case Assumptions

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Construction		
Impact 1: Change in Water Quality due to Re-suspension of Sediments during installation of foundations.	**Single Phase Approach** The worst case scenario for the single phase approach would involve the maximum amount of sediment release including: 1. Sea bed preparation for 172 (see Rationale) 40m diameter gravity base foundations calculated as 17,500m^3 per foundation (see Chapter 5 Description of the Development, *Table 5.9*). Therefore, the maximum expected amount sediment released into the water column is 3,010,000m^3. 2. Sea bed preparation for the installation of gravity base or jacket foundations for up to two meteorological masts would result in a maximum sediment release into the water column of 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. Based on this information, the total maximum sediment released into the water column during construction within the East Anglia THREE site by foundation preparation would be up to 3,470,100m^3. The installation of wind turbine gravity base foundations would take up to 12 months (See Chapter 5 Description of the Development *Table 5.29*) with a maximum of two sea bed preparations for foundations per day. There would also be an additional three months, outside of this 12 month period	In either the Single Phase or the Two Phased approach (see Chapter 5 Description of the Development) 172 of the smallest wind turbines (7MW) would be installed on 40m diameter gravity base foundations requiring a maximum sediment excavation of 17,500m^3 per wind turbine of ground preparation or 100 of the largest wind turbines (12MW) would be installed on a 60m diameter gravity base foundation requiring a maximum sediment excavation of 26,000m^3 per wind turbine (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 which would result in a maximum of 3,010,000m^3 of sediment being released into the water column. In either the 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 and would require similar sea bed preparation of 10,375m^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 also release

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	where offshore electrical platform foundations would be installed (See Chapter 5 Description of the Development *Table 5.34*). **Two Phased Approach** Under the Two Phased approach, sea bed preparation to install 1 extra Jacket foundations 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 seven month periods (See Chapter 5 Description of the Development *Table 5.36* and *Table 5.37*).	subsurface materials into the water column. It has been estimated that the maximum quantity of released material under this scenario would be 82,560m^3 per wind turbine (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. **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 the additional offshore electrical platform required in the Two Phased approach. There would also be a small extension to the overall construction period.
Impact 2: Change in Water Quality due to re-suspension of sediments during inter-array, platform link and interconnector cabling installation.	**Single Phase Approach** The worst case scenario would involve the maximum amount of sediment disturbance including the excavation of 5m deep trenches to install up to 550km inter-array cables, 195km of platform link cables and 380km of interconnector cable (in 190km of cable trench). In order to install these the following could be required: 1. Sea bed preparation for up to 550km of inter-array	Under both approaches, up to four interconnector cables would connect the proposed East Anglia THREE project with East Anglia ONE. Under the Single Phased approach two cables would be installed in the same trench, therefore, a maximum of two trenches would be dug. Under the Two Phased approach one cable could be installed in up to four different trenches.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	cables and 190km of platform link cables would result in a maximum sediment release of up to 136,000m^3 2. Sea bed preparation for up to 380km of interconnector cables could result in a maximum sediment release of up to 147,493m^3. Resulting in a maximum release of 283,493m^3 of sediment. The maximum realistic speed of cable installation if jetting is used is likely to be 150-450 m/hr (Chapter 5 Description of the Development, *Table 5.22*). Under a Single Phase approach the installation of inter-array cables, platform links cables and interconnector cables will have some overlaps and take up to 21 months, but there would be only a one month overlap with the export cable installation (Chapter 5 Description of the Development, *Table 5.34*). It has been assumed that sea bed level could occur at any time through this period but would be limited to small discrete blocks of time. **Two Phased Approach** Under the worst case scenario for the Two Phased approach an additional 45km of platform link cable would be installed. However, this is not anticipated to increase the requirements for sea bed levelling from the maximum calculated for the Single Phase approach. Installation period will be for one 18 month phase followed concurrently by one 17 month phase (with no overlap in installation of cable types between phases). However, in contrast to the Single Phase approach, there could be up to six	Under either a single or a two phased approach there could be a requirement for sea bed preparation prior to the installation of offshore electrical cables. In order to provide estimates for the maximum quantities required for this comparison has been made with the work undertaken for the consented East Anglia ONE project detail of these calculations can be found in section 7.6.1.3 of Chapter 7 Marine Geology and Physical Processes. This material would be dredged from the sea bed and disposed within the East Anglia THREE site or within the parts of the East Anglia THREE export cable corridor that fall within the East Anglia Zone. Further detail is provided within the Site Characterisation Report (which is being submitted as part of this application) **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 three additional platform link cables, and an extended construction period.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	months overlap in construction of these cable types with the export cables (assessed in Impact 3), see Chapter 5 Description of the Development *Table 5.37*. The maximum realistic speed of cable installation would be the same as that described for Single Phase.	
Impact 3: Change in water quality due to re-suspension of sediments during construction in the offshore cable corridor (installation of export cabling).	**Single Phase Approach** The maximum cable installations within the offshore cable corridor would include the installation of up to 664km of export cables. The maximum realistic speed of cable installation using jetting is likely to be 150-450m/hr and this would continue for approximately 22 months (See Chapter 5 Description of the Development *Table 5.34*) In order to install the export cables up to 324,484m^3 of material could be excavated from within the export cable corridor in order to level the sea bed for cable installation (*Table 7.20* in Chapter 7 Marine Geology, Oceanography and Physical Processes). **Two Phased Approach** Under the Two Phased approach the maximum distance of installed export cable would be the same, and therefore the same amount of sea bed levelling would occur however, the installation would take approximately 22 months extending over a 30 month period (See Chapter 5 Description of the development *Table 5.37*).	Under either the Single Phase or the Two Phased approach up to four export cables would be installed. The worst case cable installation techniques would be jetting / vertical injector techniques, which relies on either fluidisation or liquefactions of the sea bed.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Impact 4: Change in water quality due to re-suspension of contaminants within sediment.	As above for Impacts 1, 2 and 3.	The worst case scenario relates to activities that involve the most re-suspension of near surface sediment. Sub-surface sediments have not been exposed to the water column and contaminant sources; therefore, they are likely to contain low levels of contamination. Whereas, near-surface sediments are likely to contain higher concentrations of contaminants due to their exposure to the water column. Therefore, the worst case scenario would involve the installation of gravity base structures. The rationale relating to sea bed preparation and installation of gravity base structures as well as the cable installation are therefore relevant here.
Impact 5: Change in water and sediment quality due to accidental releases or Spills of Construction Materials or Chemicals	**Single Phase Approach** It is anticipated that an average of 55 vessels would be on site at any time during the construction of the proposed East Anglia THREE project with a total of 5,685 vessel trips required (details provided in Chapter 5 Description of the Development section 5.5.15.8). **Two Phased Approach** It is anticipated that up to 55 vessels would be on site at any time during the construction of the proposed East Anglia THREE project with a total of 7,636 (3,852 during phase 1 and 3,784 during phase 2) vessel trips required over the two phases (details provided in Chapter 5 Description of the Development section 5.5.15.8).	The greater the number of vessels on site the greater the potential is for accidental spillage.
Impact 6: Change in water quality due to works at the	Installation of cables into pre-installed ducts (See method described in Chapter 5 Description of the Development).	At landfall, the offshore export cable would be installed into ducts which would be installed during the construction of the East Anglia

Impact	Key design parameters forming the realistic worst case scenario	Rationale
offshore export cable Landfall	This will involve accessing the foreshore and excavating the ends of the ducts to allow the cables to be pulled through. Using the short duct method would represent the worst case scenario	ONE project. There are two methods for installing the export cables under the landfall. This would be in a 'long' or 'short' duct (installed by East Anglia ONE). The 'long' duct would be installed below the sea bed up to 1,100m from the base of the cliff. The 'short' method would have a shorter offshore set-back distance and an offshore trench would be excavated towards deeper water. The excavation of the offshore trench for the short duct method would represent the worst case as a greater amount of sediment would be disturbed
Operation		
Impact 1: Deterioration in water quality due to re-suspension of sediments associated with scouring.	The worst case scenario approach would involve the maximum amount of sediment being released due to scouring including: 1. The maximum sediment released in terms of the total volume for the site, relates to the 40m diameter gravity base foundations which has been calculated at 627,112m^3 (see Chapter 7 Marine Geology, Oceanography and physical processes *Table 7.6* and rationale column). 2. The maximum sediment released as a result of scour associated with seven foundations for electrical platforms and accommodation platforms has been has been assumed to be similar to 60 diameter gravity base foundations which is up to 5,573m^3 per foundation (see Chapter 7 Marine Geology, Oceanography and physical processes *Table 7.6* and rationale column). Therefore, the total sediment released would be 39,011m^3. 3. The maximum sediment released as a result of scour	Under the worst case scenario operational impacts assume that the project has been constructed under the Two Phased approach as that would result in the greatest amount of infrastructure installed. 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 may potentially cause the formation of scour holes around the foundations. The largest wind turbines (12MW) would be installed on 60m diameter gravity base foundations and the smaller wind turbines (7MW) would be installed on 40m diameter gravity base foundations. Therefore, the 60m diameter foundations represent the worst case for a single wind turbine foundation, however, a greater amount of sediment would be released with 172 of the smaller 40m diameter gravity base foundations. An assumption has been made that the six foundations for converter and collector station and one for the accommodation platform (under a Two Phased approach) would result in a similar amount of scour as

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	around the two meteorological mast foundations has been assumed to be up to 3,646m^3 (that of a 40m diameter foundation) and therefore the total sediment released would be 7,292m^3. In total up to 673,415m^3 of sediment could be released due to the effects of scour. All of the above are based on a 1 in 50 year return period.	that of a 60m diameter gravity base foundation. A conservative assumption has been made that the foundations for the meteorological mast foundations would release approximately the same amount of sediment as the 40m diameter gravity base structures for the wind turbines. This is a conservative estimate as the meteorological mast foundations would be up to 20m in diameter (Chapter 5 Description of the Development, *Table 7.17*).
Impact 2: Deterioration in water quality due to release of hazardous materials, specifically accidental spillages	Sources of hazardous materials would be from the installed structures and from vessels visiting the site. The worst case scenario involves: 1. Maximum number of installed structures would be 181. 2. Maximum average number of visits by large vessels per annum conducting "big operations" would be up to 730. 3. Maximum average number of windfarm support vessel trips to site per annum 4,000. Total maximum number of visits by vessels per year of operation is approximately 4,730.	Installed infrastructure under a Two Phased approach would include; up to 172 wind turbines, three collector and three converter stations, two meteorological masts and one accommodation platform. Access to installations would be by a variety of vessels and helicopters. Large jack-up vessels may be required to operate for significant periods to carry out maintenance work associated with the larger components of the windfarm e.g. wind turbine blades or substation transformers. Smaller specifically designed service vessels would carry out the smaller operations whilst crew transfer vessels would transport personnel to the site for small scale maintenance procedures Therefore, the worst case scenario provides for the maximum level of operational activity and therefore, the highest likelihood of an incident occurring due to increased vessels / activities.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Decommissioning		
Impact 1: Deterioration in water quality due to re-suspension of sediments associated with the removal of foundations.	The worst case scenario would involve the decommissioning of gravity base foundations with a 60m diameter base. It is anticipated that upon decommissioning, foundations would be removed at or just below the surface.	Likely to be of a similar magnitude to Construction Impact 1
Impact 2: Deterioration in water quality due to re-suspension of sediments associated with cable removal.	Cables would be cut off where they enter wind turbines, converter and collector stations and buried cable would be left in situ.	Likely to be of a similar magnitude to Construction Impacts 2 and 3

8.3.3 Embedded Mitigation Specific to Marine Water and Sediment Quality

12. EATL is committed to the use of best practice techniques and due diligence throughout all construction, operation and maintenance activities (see Offshore Outline Construction Environmental Management Plan (OOCEMP) which has been submitted as part of the DCO application).

13. Oils and lubricants used in the wind turbines would be biodegradable where possible and all chemicals would be certified to the relevant standard.

14. If dredging of the sea bed for cable installation was required in the vicinity of site 30 (*Figure 8.1*) EATL would make use of any opportunity to further analyse the levels of arsenic within that area. If consistently high levels of the contaminant were found across this area an appropriate method of disposal for any dredged material from that area would be agreed with the MMO prior to any construction activities taking place within the offshore cable corridor.

15. All wind turbines would incorporate appropriate provisions to retain spilled fluids within the nacelle and tower. In addition, converter and collector stations would be designed with a self-contained bund to contain any spills and prevent discharges to the environment.

16. Best practice procedures would be put in place when transferring oil or fuel between converter and collector stations and service vessels. Appropriate spill plan procedures would also be implemented in order to appropriately deal with any unexpected discharge into the marine environment, these would be included in a Marine Pollution Contingency Plan (MPCP) to be agreed post-consent.

17. To avoid discharge or spillage of oils it is anticipated that the transformers would be filled for their operational life and would not need interim oil changes.

8.4 Assessment Methodology

8.4.1 Legislation, Policy and Guidance

18. The assessment of potential impacts on marine water and sediment quality has been made with specific reference to the relevant NPS. These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the proposed East Anglia THREE project are:

- Overarching NPS for Energy (EN-1) (DECC 2011a); and
- NPS for Renewable Energy Infrastructures (EN-3) (DECC 2011b).

19. The specific assessment requirements for marine water and sediment quality, as detailed in the relevant NPS, are repeated in the following paragraphs. EN-1 Paragraph 5.15.1 states that "*Infrastructure development can have adverse effects on the water environment, including groundwater, inland surface waters, transitional waters and coastal waters. During the construction, operation and decommissioning phases, discharges would occur. There may also be an increased risk of spills and leaks of pollutants to the water environment. These effects could lead to adverse impacts on health or on protected species and habitats and could, in particular, result in surface waters, ground waters of protected areas failing to meet environmental objectives established under the Water Framework Directive''.*

20. EN-1 Paragraph 5.15.2 continues to state that "*where the project is likely to have adverse effects on the water environment, the application should undertake an assessment of the existing status of, and impacts of the proposed project, on water quality, water resources and physical characteristics of the water environment as part of the Environmental Statement of equivalent''.*

21. Paragraph 2.6.189 of EN-3 notes that "*The construction, operation and decommissioning of offshore energy infrastructure can affect marine water quality through the disturbance of sea bed sediments or the release of contaminants with subsequent indirect effects on habitats, biodiversity and fish stocks''.*

22. Of further relevance to water and sediment quality are paragraphs 2.6.191 and 2.6.192 of EN-3 where it is stated that:

- *"The Environment Agency regulates emissions to land, air and water out to 3 nautical miles (nm). Where any element of the wind farm or any associated development included in the application to the Infrastructure Planning Commission (IPC) (now the Planning Inspectorate) is located within 3nm of the coast, the Environment Agency should be consulted at the pre-application stage on the assessment methodology for impacts on the physical environment''.*
- *"Beyond 3nm, the Marine Management Organisation (MMO) is the regulator. The applicant should consult the MMO and Centre for Environment, Fisheries and Aquaculture Science (Cefas) on the assessment methodology for impacts on the physical environment at the pre-application stage''.*

23. The principal European and International policy and legislation used to inform the assessment of potential impact on marine water and sediment quality for this project includes:

- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (the Water Framework Directive (WFD));
- Directive 2008/105/EC Priority Substances establishing Environmental Quality Standards for contaminants in water;
- Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive);
- Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC (the Bathing Waters Directive); and
- The International Convention for the Prevention of Marine Pollution by Ships (MARPOL Convention) 73/78.

24. These key European Directives are transposed into UK law through a number of regulations set out below.

8.4.1.1 Water Framework Directive (WFD)

25. The WFD is a key piece of European legislation relating to the protection of water quality and the ecological status of freshwaters, transitional waters and coastal waters out to one nautical mile (nm).

26. The WFD provides a mechanism by which regulatory controls on human activities, that have the potential to impact on water quality, can be managed effectively and consistently. In addition to a range of inland surface waters and groundwater, the WFD covers transitional waters (estuaries and lagoons) and coastal waters out to 1nm. Existing regulations that will eventually be subsumed by the WFD include the Freshwater Fish Directive (consolidated as 2006/44/EC), the Shellfish Waters Directive (consolidated as 2006/113/EC) and the Dangerous Substances Directive (76/464/EEC). The WFD is implemented in England and Wales primarily through the Water Environment (WFD) (England and Wales) Regulations 2003 (known as the Water Framework Regulations).

27. UK surface waters have been divided into a number of discrete units termed 'water bodies', with typologies that relate to both their physical and ecological characteristics. Based on ecology and water quality, these water bodies have then been classified into different status classes which have specific objectives in relation to achieving good ecological status.

28. The WFD requires that all inland and coastal waters must reach at least 'good' status by 2015 and that the status of all surface water bodies should not deteriorate.

Individual water bodies that have been modified to the extent that it will not be possible for them to meet the WFD targets are categorised as Heavily Modified Water Bodies.

8.4.1.2 Priority Substances Directive

29. This directive establishes Environmental Quality Standards (EQS) for priority substances and priority hazardous substances identified in Annex X of the Water Framework Directive. Where EQS have not been superseded, limit values and environmental quality standards set by the ‘Dangerous Substances Directive’ listed in Annex IX of the WFD remain in force. The Priority Substance Directive is implemented in England and Wales by the River Basin District Typology, Standards and Groundwater Threshold Values (WFD) (England and Wales) Directions 2010. Compliance with these standards forms the basis of good surface water chemical status under the WFD.

8.4.1.3 Marine Strategy Framework Directive

30. The objective of the Marine Strategy Framework Directive (2005/56/EC) (MSFD) is to achieve “good environmental status’’ in Europe’s seas by 2020, to enable the sustainable use of the marine environment and to safeguard its use for future generations.

31. The MSFD establishes a comprehensive structure within which EU Member States are required to develop and implement the cost effective measures necessary to achieve or maintain “good environmental status’’ in the marine environment.

32. The Directive establishes European Marine Regions and requires Member States to apply an ecosystem based approach to the management of human activities. The timetable for implementation of the strategy is from July 2010 through to December 2016. In the UK, the Directive is implemented via the Marine Strategy Regulation, 2010.

33. In coastal waters out to 1nm, both the WFD and the MSFD apply. However, in these areas, the MSFD only applies for aspects of good environmental status that are not already addressed by the WFD. These include issues such as the impacts of marine noise and litter, and certain aspects of biodiversity, but not water quality.

8.4.1.4 Bathing Waters Directive

34. The revised Bathing Waters Directive came into force in 2015. Designated bathing waters also come under the umbrella of protected areas as identified by the WFD. The revised directive sets more stringent water quality standards and also puts a stronger emphasis on beach management and public information. The bacterial parameters monitored are:

- *Escherichia coli*; and
- Intestinal enterococci.

35. The Directive has also put into place three new compliance categories – excellent, good and sufficient, as well as the existing poor quality and classification is based on four years' worth of data.

8.4.1.5 MARPOL Convention 73/78

36. The UK is also a signatory to the International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) and all ships flagged under signatory countries are subject to its requirements, regardless of where they sail. The convention includes regulations aimed at preventing and minimising pollution from ships, both accidental and that arising from routine operations.

8.4.1.6 Other UK Policies and Plans

37. Other UK policies and plans of relevance to this chapter are the Marine Policy Statement (MPS, HM Government 2011) and the East Inshore and East Offshore Marine Plans (HM Government 2014). These documents guide decision making with regard to marine developments and signpost the relevant legislation to be followed.

38. The MPS 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. Section 2.6.4 of the MPS states that:

"Developments and other activities at the coast and at sea can have adverse effects on transitional waters, coastal waters and marine waters. During the construction, operation and decommissioning phases of developments, there can be increased demand for water, discharges to water and adverse ecological effects resulting from physical modifications to the water environment. There may also be an increased risk of spills and leaks of pollutants into the water environment and the likelihood of transmission of invasive non-native species, for example through construction equipment, and their impacts on ecological water quality need to be considered."

39. 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" is of relevance to this Chapter as this covers policies and commitments on the wider ecosystem, set out in the MPS including those to do with the MSFD and the WFD, as well as other environmental, social and economic considerations. Elements of the ecosystem considered by this objective include

"water quality characteristics critical to supporting a healthy ecosystem and pollutants that may affect these".

8.4.2 Data Sources

8.4.2.1 Published Data

40. The information presented in this section has been collated from relevant published literature as well as ESs produced for other projects in the region. *Table 8.3* summarises the key data sources used.

Table 8.3 Data Sources Features

Data	Year	Coverage	Confidence	Notes
Metals	Cefas (1998)	Offshore and coastal waters around England and Wales	High	Monitoring of non-radioactive contaminants in the aquatic environment, including metals.
Nutrients	OSPAR (2010)	North East Atlantic	High	The Quality Status Report 2010 describes the current status and trends in water quality for regional seas including the North Sea.
Dissolved Oxygen	Cefas (1997- 2001)	UK waters	High	Results from various Cefas monitoring cruises.
	Canadian Council of Ministers of the Environment (CCME) (2002)	Canada	High	Canadian Water Quality Guideline for the Protection of Aquatic Life.
Sediment Analysis	Marine Ecological Surveys Ltd (MESL) (2011)	North Sea	High	Five surface sediment grabs sampled for contaminants from within the East Anglia ONE site.
	Fugro EMU (2013)	North Sea, within East Anglia THREE and FOUR sites.	High	15 surface sediment grabs sampled for contaminants from within the East Anglia THREE and East Anglia FOUR sites and offshore cable corridor.

8.4.2.2 Site Specific Survey

41. In order to provide more specific information in relation to the proposed East Anglia THREE project, additional data was collected along the offshore cable corridor, with further sampling also undertaken within the East Anglia THREE site. The survey was undertaken in 2013 and the report can be found in *Appendix 10.4*.

42. The survey plan included sub-sampling of sea bed sediments for subsequent analysis of contaminants from 15 sampling sites within the offshore cable corridor and the East Anglia THREE site. During the survey, a 0.1m^2 stainless-steel Day grab was used to collect sea bed samples for analysis. Samples were submitted to a specialist UKAS accredited chemistry laboratory for the analysis of the following contaminants:

- Arsenic;
- Cadmium;
- Chromium;
- Copper;
- Lead;
- Mercury;
- Nickel;
- Zinc;
- Organotins: Tributyltin (TBT), Dibutyltin (DBT);
- Polychlorinated biphenyls (PCBs);
- Polycyclic Aromatic Hydrocarbons (PAHs); and
- Petroleum hydrocarbons.

8.4.3 Impact Assessment Methodology

43. The assessment of impacts within this chapter follows the general methodology set out in Chapter 6 Environmental Impact Assessment Methodology.

44. The assessment of water quality impacts is based on the standards outlined in the WFD or comparison of concentration to the baseline environment where possible (for example in relation to suspended solid concentrations).

45. The context of the contaminants found within the sediments of the East Anglia THREE site is established through the use of recognised guidelines and action levels. These are:

- Cefas Action Levels for the disposal of dredged material (Cefas 2000); and
- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment 2002).

46. The Cefas Action Levels are used as part of a 'weight of evidence' approach to assessing the suitability of material for disposal at sea, but are not themselves statutory standards. The majority of the materials assessed against these standards arise from dredging activities but they are considered an acceptable way of assessing the risk to the environment from other marine activities as part of the EIA process. They are particularly useful in this context as they provide for an element of background concentration, particularly in relation to metals. Selected current Action Levels for standard contaminants are set out in *Table 8.4.*

Table 8.4 Selected Cefas Action Levels (taken from Cefas 2000)

Contaminant	Action Level 1 (mg/kg)	Action Level 2 (mg/kg)
Arsenic	20	100
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Mercury	0.3	3
Lead	50	500
Zinc	130	800
Organotins (TBT, DDT)	0.1	1
PCBs (sum of ICES 7)	0.01	None
PCBs (sum of 25 congeners)	0.02	0.2

47. Cefas guidance (Cefas 2000) indicates that, in general, contaminant levels below Action Level 1 are not considered to be of concern and are, therefore, likely to be approved for disposal at sea thus pose minimal risk to the environment. Material with contaminant levels above Action Level 2 are generally considered to be unsuitable for disposal at sea and therefore are likely to pose a greater risk. Dredged material with contaminant levels between Action Levels 1 and 2 requires further consideration of additional evidence before an assessment can be made.

48. The Canadian Sediment Quality Guidelines involved the derivation of Interim marine Sediment Quality Guidelines (ISQGs) or Threshold Effect Levels (TEL) and Probable Effect Levels (PEL) from an extensive database containing direct measurements of toxicity of contaminated sediments to a range of aquatic organisms exposed in laboratory tests and under field conditions (CCME 2002). As a result, they are often

used in EIA in order to provide an indication regarding the potential risk to marine ecology.

49. However, these values are not statutory standards and were designed specifically for Canada. They are therefore based on the protection of pristine environments so the findings should be treated as precautionary for UK waters. In the absence of suitable alternatives, however, it has become commonplace for these guidelines to be used by regulatory and statutory bodies in the UK, and elsewhere, as part of a 'weight of evidence' approach. The use of these standards within impact assessments for offshore windfarm projects is also widely accepted.

50. Selected Canadian guidelines are presented in *Table 8.5*, and comprise two assessment levels. The lower level is referred to as the TEL and represents the concentration below which adverse biological effects are expected to occur only rarely (in some sensitive species for example). The higher level, the PEL, defines a concentration above which adverse effects may be expected in a wider range of organisms. The units displayed in *Table 8.5* are either milligrams or micrograms of contaminant per kilogram of sediment (mg/kg or µg/kg).

Table 8.5 Selected Canadian Sediment Quality Guideline Values (taken from CCME 2002)

Contaminant	Units	TEL	PEL
Arsenic	mg/kg	7.24	41.6
Cadmium	mg/kg	0.7	4.2
Chromium	mg/kg	52.3	160
Copper	mg/kg	18.7	108
Mercury	mg/kg	0.13	0.7
Lead	mg/kg	30.2	112
Zinc	mg/kg	124	247
Acenaphthene	µg/kg	6.71	88.9
Acenaphthylene	µg/kg	5.87	128
Anthracene	µg/kg	46.9	245
Benz(a)anthracene	µg/kg	74.8	693
Benzo(a)pyrene	µg/kg	88.8	763
Chrysene	µg/kg	108	846
Dibenz(a,h)anthracene	µg/kg	6.22	135
Fluoranthene	µg/kg	113	1494
Fluorene	µg/kg	21.2	144
Napthalene	µg/kg	34.6	391
Phenanthrene	µg/kg	86.7	544
Pyrene	µg/kg	153	1398

51. The potential for release and dispersion of sediments due to construction, operation and decommissioning of the proposed East Anglia THREE project has been informed by a physical processes assessment in Chapter 7 Marine Geology, Oceanography and Physical Processes.

8.4.3.1 Sensitivity

52. The sensitivity of a receptor is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. It is quantified via a consideration of adaptability, tolerance, recoverability and value.

53. *Table 8.6* sets out the generic criteria used in defining the sensitivity of the marine water quality receptor. Where a receptor could reasonably be assigned more than one level of sensitivity, professional judgement has been used to determine which level is applicable.

Table 8.6 Criteria used to determine the sensitivity of marine water quality receptors

Sensitivity	Definition
High	The water quality of the receptor supports or contributes towards the designation or nationally important feature and / or has a very low capacity to accommodate any change to current water quality status, compared to baseline conditions.
Medium	The water quality of the receptor supports high biodiversity and / or has low capacity to accommodate change to water quality status.
Low	The water quality of the receptor has a high capacity to accommodate change to water quality status, due, for example, to large relative size of the receiving water and capacity for dilution and flushing. Background concentrations of certain parameters already exist.
Negligible	Specific water quality conditions of the receptor are likely to be able to tolerate proposed change with very little or no impact upon the baseline conditions detectable.

8.4.3.2 Magnitude

54. Prediction of the magnitude of potential effects has been based on the consequences that the proposed East Anglia THREE project might have upon the marine water quality status (see *Table 8.7*).

55. These descriptions of magnitude are specific to the assessment of marine water quality impacts and are considered in addition to the generic descriptors of impact magnitude presented in Chapter 6 EIA Methodology. Potential impacts have been considered in terms of permanent or temporary and adverse or beneficial effects.

56. Where an effect could reasonably be assigned more than one magnitude, professional judgement has been used to determine which rating is applicable.

Table 8.7 Criteria used to determine the magnitude of marine water quality effects.

Magnitude	Definition
High	Large scale change to key characteristics of the water quality status of the receiving water feature. Water quality status degraded to the extent that a permanent or long term change occurs. An ability to meet (for example) EQS is likely.
Medium	Medium scale changes to key characteristics of the water quality status taking account of the receptor volume, mixing capacity, flow rate, etc. Water quality status likely to take considerable time to recover to baseline conditions.
Low	Noticeable but not considered to be substantial changes to the water quality status taking account of the receiving water features. Activity not likely to alter local status to the extent that water quality characteristics change considerably or EQSs are compromised.
Negligible	Although there may be some impact upon water quality status, activities predicted to occur over a short period. Any change to water quality status will be quickly reversed once activity ceases.

8.4.3.3 Impact significance

57. Impacts are assessed by relating the magnitude of an effect to the sensitivity (or value) of the receptor, which in this instance is water quality. This relationship is presented in an Impact Assessment Matrix in *Table 8.8.*

Table 8.8 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

58. As with the definitions of magnitude and sensitivity, the matrix used for a topic is clearly defined by the assessor within the context of the marine water and sediment quality assessment. The impact significance categories are divided as shown in *Table 8.9*.

Table 8.9 Impact Significance Definitions

Impact Significance	Definition
Major	Very large or large change in water quality, 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 water quality, which is likely to be an important consideration at a local level.
Minor	Small change in water quality, which may be raised as a local issue but is unlikely to be important in the decision making process.
Negligible	No discernible change in water quality.
No impact	No change in water quality, therefore no impact.

59. For the purposes of the EIA, '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.

8.4.4 Phasing

60. As discussed above in relation to the worst case, EATL are currently considering constructing the project in either a Single Phase or in a Two Phased approach. This is taken into account in the assessment as follows:

- Construction – given that there are differences in both the installed infrastructure and the impact durations for the two approaches, both the Single Phase and Two Phased approaches are assessed;
- Operation – given the limited differences in the installed infrastructure, the operational impacts are assessed only for the worst case – which is the Two Phased approach; and
- Decommissioning - given the limited differences in the infrastructure to be removed, the decommissioning impacts are assessed only for the worst case – which is the Two Phased approach.

8.4.5 Cumulative Impact Assessment

61. The cumulative impacts have been considered on marine water and sediment quality by taking into consideration other plans, projects and activities that may impact upon the development of the proposed East Anglia THREE project. For a general introduction to the methodology used for the cumulative impact assessment (CIA), please refer to Chapter 6 Environmental Impact Assessment Methodology.

62. The CIA draws from findings of earlier studies undertaken to inform the East Anglia Zonal Environmental Appraisal (ZEA) (ABPmer 2012a) which considered cumulative impacts arising from the development of the whole zone and work undertaken for the EIA for the East Anglia ONE project (ABPmer 2012b).

8.4.6 Transboundary Impact Assessment

63. The potential for transboundary impacts to occur on marine water and sediment quality as a result of the activities associated with the construction, operation and decommissioning of the proposed East Anglia THREE project have also been considered.

8.5 Existing Environment

8.5.1 Background

64. A number of peer reviewed publications, as well as primary data and grey literature[1] have been consulted in order to provide information relating to the current environmental baseline with respect to marine water and sediment quality in the study areas.

65. The majority of pollutants enter the southern North Sea through direct discharges of effluents or terrestrial run-off. Additional sources thought to be of significant concern include the activities associated with shipping, oil and gas extraction and the dumping of dredged material as well as atmospheric deposition (Jones et al. 2004).

66. In terms of the near-shore environment, the offshore cable corridor runs through the WFD water body Suffolk (GB650503520002). This is a 'Heavily Modified' water body due to the flood and coastal protection works that are present within it and is currently classified as having 'Moderate Potential'. This classification relates to the status of phytoplankton and the presence of dissolved inorganic nitrogen. In terms of chemical contaminants, this water body is considered to be at 'Good' status. The aim for this water body is to achieve 'Good Ecological Potential' by 2027 and 'Good Chemical Status' by 2015 (Further information regarding this water body is provided in Volume III, *Appendix 21.3*).

67. There are two designated bathing waters within the WFD water body, Felixstowe North and Felixstowe South; these are located 5.8km and 6.9km, respectively, from the landfall location. Both of the bathing waters have consistently met the higher standards.

[1] Unpublished or un-indexed reports which could include conference proceedings, non-indexed journals, internal reports, and student dissertations and theses.

68. Aggregate extraction and marine disposal activities can also influence marine water quality. The East Anglia THREE site does not overlap with any disposal or aggregate extraction sites. However, the offshore cable corridor is located approximately 926m to the south of dredging licence area 430 and the passes through a large former disposal site (Chapter 18 Infrastructure and Other Users, *Figure 18.3*) which was used between 1987 and 1995 to test oil dispersants by Warren Springs Environmental Research Laboratory.

69. The Warren Springs disposal site lies within the boundaries of the East Anglia ONE site. Site specific surveys undertaken to support the EIA for the East Anglia ONE project tested for volatile and semi-volatile organic compounds in five sediment grab samples taken from within the East Anglia ONE site. The analysis found no traces of contamination, therefore, it is likely that historic use of the area for oil spill modelling and dispersant product testing was of such limited extent and sufficiently long ago that no traces remain in surface sediments. This is confirmed by advice provided by the MMO informing that it can be scoped out of further assessment (*Table 8.1*).

8.5.2 Suspended Sediment Concentration

70. For full details of concentrations of suspended sediments naturally present within the East Anglia THREE site and offshore cable corridor, see Chapter 7 Marine Geology, Oceanography and Physical Processes. For ease of reference, a short summary of the findings is provided below.

71. Suspended sediments across the East Anglia Zone are typically in the range 1 to 35mg/l, with the highest values typically found along the western margin and during winter months. Concentrations do, however, increase towards the coast at Great Yarmouth and have been recorded up to 170mg/l. These elevated concentrations are thought to be generated from eroding areas of cliff line along the English east coast. A metocean survey undertaken within the East Anglia THREE site recorded suspended sediment concentrations to be in the range of 3 to 13.5mg/l throughout the winter of 2012/13. Surface values are typically less than those experienced close to, and at, the sea bed. In terms of sea bed sediment, grab sample analysis revealed that 90% of the East Anglia Zone consists of either sand, slightly gravelly sand or gravelly sand. The remaining areas are primarily characterised by sand gravel, with localised areas of muddy sand and (slightly) gravelly muddy sand.

72. The sea bed across the East Anglia THREE site is characterised predominantly by sand. The median sediment grain size (d_{50}) of a series of grab samples ranges from 0.21 to 0.36mm (medium sand) with a single sample containing a d_{50} of 0/07mm (very fine sand).

8.5.3 Site Specific Survey

73. In order to inform the baseline for sediment quality, a site specific survey was carried out in 2013 (reported in *Appendix 10.4*). The locations of the sites for which contaminant analysis was undertaken are shown in *Figure 8.1*. It should be noted that some of sample sites (33, 37, 39) are outside the East Anglia THREE site and offshore cable corridor, this is due to a refinement made in 2015 at the request of The Crown Estate. These samples are however still relevant to the assessment, providing wider context. Furthermore, sample 43 located approximately 3.1km to the north of the East Anglia THREE site boundary (*Figure 8.1*) also provides context when discussing sediment quality of the site.

74. Sediment contaminant data is summarised in *Tables 8.10* and *8.11*. Data highlighted in yellow indicate concentrations of contaminants over either Cefas Action Level 1 (*Table 8.10*) or Canadian Sediment Quality Guideline TEL (*Table 8.11*). Red indicates concentration greater than Cefas Action Level 2 or Canadian Sediment Quality Guideline PEL.

Table 8.10 Sediment Contamination Results Compared to the Cefas Action Levels.

Contaminant (mg/kg)	Site reference														
	30	33	37	39	43	49	50	51	52	53	54	55	57	58	59
As	134	8.6	35.5	16.7	47.4	4.5	51.9	14.9	68.7	24.4	37.5	19.3	23.1	11.6	6.6
Cd	0.068	<0.03	<0.03	0.062	0.072	<0.03	0.076	<0.03	0.102	0.082	0.121	<0.03	0.085	<0.03	<0.03
Cr	157	5.8	10.3	84.3	118	5.2	145	3.4	188	182	221	6.7	138	6.7	3.9
Cu	53.2	1.2	1.9	26.4	29.3	1.6	45.8	3	56.1	32.7	42.6	1.6	29.8	1.6	1.2
Hg	0.003	0.002	0.005	0.071	0.003	<0.002	0.003	0.002	0.005	0.005	0.004	0.003	0.055	0.002	<0.002
Ni	88.6	3.5	6.03	36.4	64	3.82	82.5	4.61	121	87.7	153	4.32	66.6	5.73	4.12
Pb	23.5	5.21	7.72	27.6	31.3	4.11	20.02	6.31	35	26.2	40.3	7.86	28.3	5.27	4.14
Zn	82.9	15	26.9	80.8	94.8	7.98	81.8	30.7	125	75.4	88.3	23.6	90	12.2	7.72
DBT	<0.004	<0.004	<0.003	<0.004	<0.004	<0.004	<0.004	<0.003	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
TBT	<0.004	<0.004	<0.003	<0.004	<0.004	<0.004	<0.004	<0.003	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
PCBs (sum ICES 7)	All sites <0.0001														

* Yellow indicates exceedance of Action Level 1 and Red indicates exceedance of Action Level 2

Table 8.11 Sediment Contamination Results Compared to the Canadian Interim Sediment Quality Guidelines.

Contaminant (units vary)	Site reference														
	30	33	37	39	43	49	50	51	52	53	54	55	57	58	59
As (mg/kg)	134	8.6	35.5	16.7	47.4	4.5	51.9	14.9	68.7	24.4	37.5	19.3	23.1	11.6	6.6
Cd (mg/kg)	0.068	<0.03	<0.03	0.062	0.072	<0.03	0.076	<0.03	0.102	0.082	0.121	<0.03	0.085	<0.03	<0.03
Cr (mg/kg)	157	5.8	10.3	84.3	118	5.2	145	3.4	188	182	221	6.7	138	6.7	3.9
Cu (mg/kg)	53.2	1.2	1.9	26.4	29.3	1.6	45.8	3	56.1	32.7	42.6	1.6	29.8	1.6	1.2
Hg (mg/kg)	000.3	0.002	000.5	0.071	0.003	<0.002	0.003	0.002	0.005	0.005	0.004	0.003	0.055	0.002	<0.002
Ni (mg/kg)	88.6	3.5	6.03	36.4	64	3.82	82.5	4.61	121	87.7	153	4.32	66.6	5.73	4.12
Pb (mg/kg)	23.5	5.21	7.72	27.6	31.3	4.11	20.2	6.31	35	26.2	40.3	7.86	28.3	5.27	4.14
Zn (mg/kg)	82.9	15	26.9	80.8	94.8	7.98	81.8	30.7	125	75.4	88.3	26.6	90	12.2	7.72
PCB (sum of ICES 7 µg/kg)	All sites <0.0001														
Acenaphthene (µg/kg)	2.04	<5	14.1	12	9.49	11.5	9.66	<10	<2	8.01	<5	13.1	2.37	<4	<4
Acenaphthylene (µg/kg)	<2	2.1	5.89	7.58	3.29	4.08	2.45	5.13	<2	2.83	2.12	3.8	2.52	<2	<2
Anthracene	<2	<2	<2	2.16	<2	<2	<2	<2	<2	<2	<2	<2	4.85	<2	<2
Beno(a)anthracene (µg/kg)	<2	<2	<2	6.17	<2	<2	<2	<2	<2	<2	<2	<2	14.6	<2	<2
Benzo(a)pyrene(µg/kg)	<2	<2	<2	6.33	<2	<2	<2	<2	<2	<2	<2	<2	12.7	<2	<2
Dibenzo(a,h) anthracene (µg/kg)	All sites <5														

Contaminant (units vary)	Site reference														
	30	33	37	39	43	49	50	51	52	53	54	55	57	58	59
Fluoranthene (µg/kg)	<2	<2	<2	10.8	<2	<2	<2	<2	<2	2.17	<2	<2	21	<2	<2
Fluorene (µg/kg)	All sites <10														
Napthalene (µg/kg)	<30	<30	94.2	153	64.8	102	55.1	93.9	<30	56	42.6	89.5	<30	31.8	<30
Phenathrene (µg/kg)	<10	<10	<10	14.1	<10	<10	<10	<10	<10	<10	<10	<10	21.5	<10	<10

* Yellow indicates exceedance of TEL and Red indicates exceedance of PEL.

75. A number of samples exceed the Cefas Action Level 1 for concentrations of arsenic, chromium and nickel with only one sample exceeding Cefas Action Level 1 for copper (*Table 8.10*). There was one exceedance of Action Level 2 for concentrations of arsenic recorded at site 30, however, this was the only site to exceed the Action Level 2 within the proposed East Anglia THREE project. The majority of samples that have exceeded Cefas Action Levels 1 and 2 have done so only marginally, with those exceeding Action Level 1 remaining well below Action Level 2.

76. Similarly, a number of samples exceed the TEL for concentrations of arsenic, chromium and copper, with one sample also exceeding the TEL for zinc (*Table 8.11*). Samples from sites 43 (located to the north of the East Anglia THREE site), 50 and 52 exceed the PEL for arsenic, with concentrations at site 30 also exceeding the PEL by a high amount. However, the majority of samples only marginally exceeded the TEL and PEL values.

77. Overall, only one sample (site 30) exceeded Cefas Action Level 2 and four samples (sites 30, 43 (located to the north of the East Anglia THREE site), 50 and 52) exceeded TEL values for arsenic concentrations. The elevated levels of arsenic which were recorded are typical of the region; inshore these are associated with a history of arsenic waste disposal and offshore these are associated with estuarine and geological inputs and sea bed rock weathering (Royal Haskoning 2011).

78. Site 49 is the only offshore sampling location within the East Anglia THREE site. At this site contamination levels are very low, with concentrations of all metals below Cefas Action Level 1 and Canadian Sediment Quality Guideline TEL values. Concentrations of Acenaphthene and Napthalene marginally exceed Cefas Action Level 1 at site 49; however, both results were well below Action Level 2.

79. Concentrations of chromium at site 54 exceed the PEL (*Table 8.11*) however it should be recognised that these concentrations do not exceed the Cefas action level 2 (*Table 8.10*). Levels of three PAHs were also recorded above the TELs, but none were above the PELs.

80. Detectable amounts of cadmium, mercury and lead were also recorded throughout the sites but all levels were below both the TEL and Cefas Action Level 1. Cadmium levels were below detectable levels for less than half of the sites and mercury was recorded at all but two sites, all of which were below both the TEL and Cefas Action Level 1. Levels of PCBs were below detectable levels at all sites.

81. From the information and data presented above it can be concluded that baseline water and sediment quality of the study areas is generally good and site specific

information in relation to concentrations of contaminants in sediments does not record significantly elevated levels.

8.6 Potential Impacts

8.6.1 Potential Impacts During Construction

8.6.1.1 Impact 1: Change in Water Quality due to Re-suspension of Sediments during Installation of Foundations.

82. The installation of wind turbine foundations has the potential to disturb sediments from: (i) the sea bed (surface or shallow near-surface sediments); and (ii) from several tens of metres below the sea bed (sub-surface sediments), depending on the foundation type and installation method. This re-suspension of sediments can impact the turbidity of the water column, leading to deterioration in water quality.

83. Site specific modelling of the potential increase, dispersion and deposition of sea bed sediments associated with the proposed East Anglia THREE project has not been undertaken. However, due to similarities in water depth, sediment types and metocean conditions and proximity of the East Anglia ONE and East Anglia THREE sites, it was agreed with Cefas and Natural England that the use of the modelling and studies undertaken for the East Anglia ONE project were valid proxies for use within this assessment. For full details of the assessment, please refer to Chapter 7 Marine Geology, Oceanography and Physical Processes.

Single Phase

84. The worst ase re-suspension of sediment from an individual wind turbine foundation (worst case being a 12MW wind turbine with a maximum diameter of 60m) yields a conservative dredging volume of 26,000m^3. However, the worst case scenario (as described in *Table 8.2*) for the total volume of sediment released during the construction phase is associated with the maximum number of 7MW gravity base structures (172) and the maximum foundation diameter (40m) for that wind turbine type. This yields a total dredging volume of 3,010,000m^3 for the wind turbine foundations. Also using a worst case approach, up to two meteorological masts would be installed on gravity base foundations yielding a volume of up to 20,750m^3 and jacket foundations for up to six offshore platforms (five electrical and one accommodation) would yield up to 439,350m^3.

85. Therefore, the total volume under the Single Phase approach would yield up to 3,470,100m^3 of excavated sediment.

86. In relation to the disturbance of surface sediments, the predominantly medium sand grain size present at the East Anglia THREE site indicates that any sediment disturbed

during sea bed preparation for gravity base structure foundations would remain close to the site and settle rapidly.

87. There is a possibility that some of the finer sand and mud fractions could stay in suspension for longer, however, Chapter 7 Marine Geology, Oceanography and Physical Processes (see section 7.6.1.5) concludes that these would fall to the sea bed in relatively close proximity (<1km) to its release within a short period of time.

88. Further evidence for this prediction was provided by modelling simulations undertaken for the East Anglia ONE project. This work concluded that, with the exception of the immediate area around the foundations, concentrations of suspended sediment in the plume associated with foundation installation remain within the limits of natural variation and returned rapidly to background levels following cessation of the activity.

89. Deeper sub-surface sediments within the East Anglia THREE site would become disturbed during any drilling activities that may be needed to install piles into the sea bed. The worst case scenario for a release from an individual wind turbine assumes that a 12m diameter monopile foundation would be drilled from the sea bed surface to a depth of 40m below the sea bed surface, releasing 4,524m^3 of sediment into the water column per monopile. The total worst case volume released during the construction phase is associated with the maximum number of 7MW monopiles (172) of the maximum diameter (10m) for that wind turbine type. This yields a total volume of 540,353m^3. 8m diameter monopile foundations would represent the worst case for the two meteorological masts (Chapter 5 Description of the Development, *Table 5.17*) yielding up to 4,021m^3, and jacket foundations with pin piles used for the six offshore platforms would each yield up to 11,545m^3. Therefore, the total volume increases to 555,921m^3 (see Chapter 7 Chapter 7 Marine Geology, Oceanography and Physical Processes section 7.6.1.1.2), this being spread across 180 foundation locations and a seven month build period (see Chapter 5 Description of the Development *Table 5.29*).

90. Previous modelling undertaken for the East Anglia ONE project indicated that sub-surface sediments are likely to be finer and therefore could potentially be dispersed further. However, the amounts released are likely to be less than those released during sea bed preparations for gravity base structure foundations. As a result, the concentrations found within any plume formed are likely to be lower. Again, this was confirmed in the modelling undertaken to inform the impact on suspended solid concentrations during the construction of the East Anglia ONE project which predicted that away from the immediate release locations, elevations in suspended

sediment concentration above background levels were low (<10mg/l) and within the range of natural variability.

91. Overall, the marine area in which the East Anglia THREE site is located is considered to be of low sensitivity due to the size and unconstrained nature of the North Sea. The magnitude of effect is considered to be low during the installation of foundations; although increases in turbidity are expected, the associated plume would be within natural variations of suspended solid concentrations. Conditions would also return to baseline following cessation of activities and so any impact would only be present during the installation process. Therefore, based on the above, the overall impact is predicted to be **negligible**.

Two Phased

92. There are two principal differences to the Single Phase assessment described above for the Two Phased approach. Firstly, under a worst case, there would be an additional offshore platform. If this is founded on the maximum jacket foundation structure, then the total volume of sea bed and shallow near-bed sediments that would be released could increase by a further 73,225m^3 (over the Single Phase volumes) to a total of 3,543,325m^3 (*Table 8.2*). Also, if it is founded on a jacket foundation using pinpiles, then the total volume of sub-surface sediments that would be released could increase by a further 1,924m^3 to a total of 557,845m^3 (see Chapter 7 Marine Geology, Oceanography and Physical Processes section 7.6.1.1.2). These increases are very small in comparison to the total volume assessed under the Single Phase approach and therefore will not alter the assessment of significance which remains the same for the Two Phased approach.

93. Secondly, the worst case release of sea bed sediments or shallow near-surface sediments would occur over two distinct phases, each lasting up to seven months (rather than a single 12 month period, see Chapter 5 Description of the Development, *Table 5.36*), for installation of gravity base structures. Alternatively, the worst case release of sub-surface sediments would occur over two distinct phases, each lasting up to five months (rather than a single seven month period, see Chapter 5 Description of the Development *Table 5.36*), for installation of monopiles. Whilst the above would mean that the effects would be experienced in two separate periods, with a longer duration of disturbance overall, this does not materially change the assessment of significance compared with a Single Phase approach as the impact will still cease following cessation of activities and concentrations of suspended solids will be within natural variation. Therefore, based on the above, the overall impact would remain **negligible**.

8.6.1.2 Impact 2: Change in Water Quality due to Re-suspension of Sediments during inter-array cable, platform link cable and interconnector cable installation

94. The installation of cabling has the potential to disturb the sea bed sediment in two ways: firstly, through sea bed levelling which may be required prior to cable installation in order to ensure that the cable does not become exposed post installation and secondly, through the cable installation process itself.

95. Sea bed levelling would only be required in areas where steep sided (greater than 10° in angle) sandwaves are present. In these areas sediment would be dredged from the sea bed to reduce the angle of slope. The excavated sediment would then be disposed of at the sea surface within a designated disposal site which would consist of the East Anglia THREE site and the area of the export cable corridor that falls within the East Anglia Zone. Further detail on this can found in the Site Characterisation Report which has been submitted as part of this application.

96. An explanation of the approximated sea bed levelling requirements is provided in section 7.6.1.3 of Chapter 7 Marine Geology, Oceanography and Physical Processes. It has been calculated that up to $136{,}000m^3$ of sediment would be excavated for the East Anglia THREE site and up to $147{,}493m^3$. Therefore a total of up to $283{,}493m^3$ of dredged sediment could be disposed of within the disposal site. Disposal would be over a large area and would occur in discrete periods of time over a 21 month period.

97. During the installation of the cables the sea bed could be further disturbed down to a sediment thickness of up to 5m and the worst case scenarios are presented in *Table 8.2*. The extent to which sediment is disturbed largely depends upon the installation technique. The preferred installation methods and depth of burial for the offshore electrical infrastructure would be decided after the pre-construction geotechnical ground investigation, a risk assessment and a lifetime maintenance assessment.

98. The types and magnitudes of effects have previously been assessed within an industry best practice document on cabling techniques (BERR 2008). This document has been used alongside expert-based judgement and the information provided in Chapter 5 Description of the Development and Chapter 7 Marine Geology, Oceanography and Physical Processes to inform the assessment of impacts for both approaches.

Single Phase

99. EATL would generally seek to bury the greatest amount of cable possible as this is the preferred method of cable protection. The shape and width of an offshore trench is usually driven by the installation method and tools as well as soil

characteristics, outer cable diameter and minimum available width of excavator (see Chapter 5 Description of the Development section 5.5.14.1.7).

100. The worst case scenario for cables is that 283,493m^3 of sediment that could be excavated for sea bed preparation and disposed of within the disposal site and excavation of trenches to install up to 550km of inter-array cables, 195km of platform link cables and 380km of the interconnector cable. The worst case scenario in terms of sediment release during the installation of these cables is considered to be jetting (BERR 2008). Sediment release volumes as a result of cabling activities are expected to be much lower than that associated with foundation installation activities. This is because the overall sediment release volumes would be low (with jetting covering a few hundred metres per hour, see Chapter 5 Description of the Development Table 5.22) and confined to near the sea bed along the alignment of the cables, with sediment settling rapidly in close proximity to the activity (BERR 2008). Sediment release from the installation of cables across the East Anglia THREE site and interconnector cable corridor during construction would be spread over a combined area of 545km^2 over a period of approximately 20 months (see Chapter 5 Description of the Development Table 5.34).

101. Overall, the marine area within which the East Anglia THREE site and offshore cable corridor is located is considered to be of low sensitivity. The magnitude of effect is considered to be negligible during installation of the cables due to the small footprint of release (i.e. at the point of jetting over a few metres width), spread over a large total area and long duration. Therefore, based on the above, the overall impact is predicted to be **negligible**.

Two Phased

102. Under the Two Phased approach there are two principal differences to the Single Phase assessment.

103. Firstly, the length of the platform link cables may increase by up to 45km to 240km. In comparison to the total length of cabling assessed as part of the Single Phase approach, this increase is relatively small and would not therefore significantly change the magnitude of effect.

104. Secondly, the worst case installation period will be for one 18 month phase followed by one 17 month phase; with no overlap in installation of cable types between phases, shown in the indicative programme (see Chapter 5 Description of the Development, *Table 5.37*).

105. Therefore, although the total volume of sediment released would increase due to additional cables, this would occur over a substantially longer period overall for the Two Phased approach (35 months as opposed to 20 months), therefore it is considered that the magnitude of effect would remain negligible. As a result, the significance of impact would be **negligible** for the Two Phased approach.

8.6.1.3 Impact 3: Change in Water Quality due to Re-suspension of Sediments during Offshore Export Cable Installation

106. As with installation of the inter-array, platform link and interconnector cables (see Impact 2 above) installation of the export cables could increase suspended sediment through both the sea bed preparation if required and through the cable installation process.

107. Modelling undertaken to inform the East Anglia ONE project EIA predicted that peak suspended sediment concentrations are likely to occur in the shallower water depths nearer to shore and approach 400mg/l at their peak. However, these plumes would be localised to within <1km of the installation location and would persist for no longer than a few hours. It is also predicted that 180 hours following cessation of installation activities, any plume would have been fully dispersed and conditions would return to baseline.

108. Any material dredged from the sea bed for the levelling of steep sand waves (predicted to be a maximum of 324,484m^3 would be disposed of offshore at the disposal site (which would comprise the East Anglia THREE site and the area of the offshore cable corridor located within the East Anglia Zone. Furthermore, as stated in Chapter 7 Marine Geology, Oceanography and Physical Processes a very small amount of seabed levelling would be require in the shallower sections of the export cable corridor, this is illustrated in *Figure 7.6*.

Single Phase

109. There are no sensitive areas such as designated bathing waters located in the inshore areas; those closest are located 6km and 9km away (i.e. they are outwith any potential plume), therefore, the sensitivity is low. Given the localised and short term nature of the effect, the potential effects would be of negligible magnitude and as a result a **negligible** impact is predicted.

Two Phased

110. Whilst there may be some differences in timing of the installation of the offshore export cables between the Single Phase and Two Phased approaches, the magnitude of effect will be similar and receptor sensitivity unchanged. Therefore, the impact significance for the Two Phased approach remains **negligible**.

8.6.1.4 Impact 4: Change in Water Quality due to Re-suspension of Contaminants within Sediment.

111. Disturbance of sea bed sediment has the potential to release sediment-bound contaminants, such as heavy metals and hydrocarbons into the water column. The data in *Tables 8.10* and *8.11* show that levels of contaminants observed within the East Anglia THREE site (site 49) are very low, with concentrations of all metals below Cefas Action Level 1 and Canadian Sediment Quality Guideline TEL values. Concentrations of Acenaphthene and Napthalene marginally exceed Cefas Action Level 1 at site 49; however, both results were well below the Canadian Sediment Quality PEL.

Single Phase

112. As stated above (section 8.5.3) contaminant levels were generally low at all sites sampled for the proposed East Anglia THREE project. Since levels of contaminants within the sediments are relatively low, any sediment released into the water column is unlikely to release significant contamination. As a result, the magnitude of effect is considered to be low.

113. In the offshore cable corridor, concentrations of contaminants are generally higher than within the East Anglia THREE site, with a number of samples exceeding the Cefas Action Level 1 and Canadian Sediment Quality Guideline TEL value for a number of metals, as well as several hydrocarbons. Concentrations of arsenic also exceed Cefas Action Level 2 and the Canadian Sediment Quality Guideline PEL value at a number of sites. The highest of which was recorded at site 30 which is within the offshore cable corridor (*Figure 8.1*). These high levels have been attributed to the local geology and natural weathering of rock (*section 8.5*) and due to the distance offshore it is less likely to have occurred as a result of anthropogenic affects.

114. Through the embedded mitigation outlined in section 8.3.3 EATL hope to ensure that any contaminated sediment from, or within the vicinity of site 30 does not affect water quality.

115. Site 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 or close to 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 the MMO a strategy for the disposal of material from this area to minimise impacts.

116. Increased concentrations of suspended solids resulting from the installation of the offshore export cables are to be significantly less than that for the foundations and

short-lived since cable installation in relation to jetting proceeds at a rate of 150 to 450m/hr per hour. As a result, any contamination that is present would be rapidly dispersed and is unlikely to cause an exceedance of water quality standards. For cable installation, the magnitude of effect is therefore also predicted to be low.

117. Overall the magnitude of effect on levels of contaminants within the water column is predicted to be low. Since the receptor is considered to be low sensitivity, the re-suspension of contaminated sediment from construction activities is expected to have a **negligible** impact.

Two Phased

118. The release of contamination into the water column is unlikely to change significantly from that assessed for the Single Phase as the key factor in this assessment is that the existing levels of contamination are relatively low. Additionally, whilst there may be changes in terms of the timescale over which the cabling will occur, the short term nature of the installation activity will ensure that any plume created will disperse rapidly. As a result, the impact assessment is the same as that for the Single Phase approach.

8.6.1.5 Impact 5: Change in Water and Sediment Quality due to Accidental Releases or Spills of Construction Materials or Chemicals

119. A wide range of vessels and construction methodologies would be employed during offshore construction ranging from boats (<24m) to large dredging vessels, tugs and barges, Dynamic Positioning (DP), heavy lift and survey vessels. In addition to the risks regarding the potential for pollution from leaks or spills of fuels carried on-board these vessels, there is also the potential for accidental pollution associated with the use of construction materials in the marine environment.

120. The Single Phased approach anticipates an average of 55 vessels on site at any time during the construction of the proposed East Anglia THREE project, with a similar number of vessels likely to be needed under a Two Phased approach. Based on a worst case scenario (172 foundations laid and the maximum lengths of inter-array cables, platform link, interconnector and export cables laid), the total number of vessels movements is predicted to be up to 5,700 for a Single Phased approach. Under a Two Phased approach, the maximum number of vessel movements during the construction is predicted to be 7,600 (approximately 3,800 for Phase 1 and Phase 2) (see Chapter 5 Description of the Development *Table 5.31* for more information).

121. Whilst the majority of the structures would be transported to site having been pre-assembled or manufactured on land, it is likely that the use of grout would be required for all possible foundation types and cable protection may require pre or post-lay armouring using concrete for example. In addition, there is the potential for

other substances such as grease or oil and antifouling paints to be accidentally released into the marine environment.

122. EATL is committed to the use of best practice techniques and due diligence throughout all construction activities (please refer to section 8.3.3 for further detail and the Outline Offshore Construction Environmental Management Plan. A MPCP will be produced which EATL will agree with stakeholders post-consent. This details the emergency response procedure and notifications should an incident occur and sets out mitigation to prevent such events.

123. As the magnitude of the effect is difficult to assess, the assessment in this instance is considered in terms of the 'risk' of a spill or other accidental pollution event occurring. With control measures through an Environmental Management Plan and a MPCP implemented and approved through the DML for either the Single Phase or Two Phased approaches, the risk of a spill and associated adverse impact is considered to be of low likelihood and of a **negligible** significance for both the Single Phase and Two Phased approaches.

8.6.1.6 Impact 6: Change in Water Quality due to works at the Offshore Export Cable Landfall

124. At the landfall location at Bawdsey the worst case scenario includes installation of four cables into ducts pre-installed by the East Anglia ONE project. Therefore, for the proposed East Anglia THREE project, the ends of the ducts will need to be excavated, cables installed and sediment backfilled. The design of the duct at landfall is not finalised at present and therefore there are two potential options for the location of the ends of the ducts either a long option (1,100m from the foot of the cliff) or a short option closer inshore.

125. The short duct method may cause some disturbance when trenching and backfilling is needed in the areas of London Clay, further seaward in the intertidal or nearshore zone. However, these effects would be highly localised and temporary in duration. The trenching into London Clay would likely result in clumps of mud 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 be noted during these works.

126. The long duct method would cause minimal direct disturbance. Given that these works require a small amount of excavation to expose the ducts, the potential effects on suspended sediment concentrations in the water column in terms of magnitude are predicted to be negligible. Additionally, the designated bathing waters in closest proximity to the landfall site are situated 6km and 9km from the landfall location and therefore the sensitivity of the water is deemed to be low.

Single Phase

127. Given the localised and temporary nature of the activities, a **negligible** impact is predicted on water quality as a result of the proposed landfall works.

Two Phased

128. The only difference to the above assessment for the Two Phased approach would be that the landfall operations will be undertaken over two discrete periods of time. Although this increases the occurrences of disturbance, there will be less volume disturbed during each event. Therefore, a **negligible** impact is also predicted.

8.6.2 Potential Impacts During Operation

8.6.2.1 Impact 1: Deterioration in Water Quality due to Re-suspension of Sediments Associated with Scouring.

129. The localised changes in the tidal and wave regimes around each foundation structure are likely to result in localised scour of the sea bed. Therefore there is the potential for localised increased suspended sediment concentrations to impact on marine water and sediment quality. Under a worst case scenario, no scour protection would be used.

130. In order to undertake an assessment of the potential increase in suspended sediment concentrations that would result from scour around the base of foundations, scour assessments were undertaken (see Chapter 7 Marine Geology, Oceanography and Physical Processes and *Appendix 7.3* for full details). In summary, the calculated scour volume yielded by the East Anglia THREE site could be up to 673,415m^3 which is considerably less than the worst case volumes of sediment potentially released following sea bed preparation activities and therefore the magnitude of effect would also fall into the low category defined in *Table 8.7*.

131. Additionally, given the sediment types prevalent across the East Anglia THREE site, most of the small quantities of sediment released due to scour processes would rapidly settle within a few hundred metres of each foundation. The situation would be similar but with a lower magnitude of effect around any areas of cable protection.

132. Based on this information, the magnitude of effect is assessed as negligible due to the temporary and localised nature of increase in suspended sediment concentrations but also due to the likelihood that any change would be within the limits of natural variation. Overall, therefore an impact of **negligible** significance is expected.

8.6.2.2 Impact 2: Change in Sediment and Water Quality as a result of the release of Hazardous Materials, specifically Accidental Spillages and Discharges of grey water.

133. Accidental spillage of lubricants, oils or chemicals during the operational phase may occur directly from wind turbines themselves or from vessels present on site during maintenance activities. In addition to the control measures required under the MARPOL Convention Regulations, EATL will produce the MPCP in agreement with stakeholders post-consent.

134. As the magnitude of the effect is difficult to assess, the assessment in this instance is considered in terms of the 'risk' of a spill or other accidental pollution event occurring. Since the MPCP will be in place, the risk of a spill and associated adverse impact is considered to be of low likelihood and of a **negligible** significance.

8.6.3 Potential Impacts During Decommissioning

8.6.3.1 Impact 1: Deterioration in Water Quality due to Re-suspension of Sediments and Contaminants due to Removal of Infrastructure

135. At decommissioning, the foundation structures would be removed (to just below the sea bed) which is likely to result in disturbance to sediments. It is anticipated that all cables would be cut where they join wind turbine foundations or offshore platforms and left in situ. Potential impacts are therefore anticipated to be similar in nature to those outlined for foundation installation during the construction phase, although much reduced in magnitude (unless sediment quality has deteriorated significantly during the lifespan of the proposed East Anglia THREE project due to outside influences (i.e. a general reduction in water quality and presence of contaminants)). It is therefore considered that any impacts would be **negligible.**

8.6.3.2 Impact 2: Deterioration in Water Quality due to release of Hazardous Materials, Specifically Accidental Spillages

136. Any fluids or contaminants contained within the structures on decommissioning have the potential to leak into the marine environment. A decommissioning plan will be required by the Secretary of State under the Energy Act 2004. The plan will reduce the likelihood of these releases through the visual monitoring of the structures during their removal. Operating procedures contained within the decommissioning plan would be developed in order to address this potential risk.

137. As the magnitude of the effect is difficult to assess, the assessment in this instance is considered in terms of the 'risk' of a spill or other accidental pollution event occurring. Since control measures would be in place, the risk of a spill and associated adverse impact is considered to be of **low** likelihood and of a **negligible** significance.

8.7 Cumulative Impacts

138. Potential impacts to the water and sediment quality are:

- Change in water quality due to re-suspension of sediments;
- Deterioration in water quality due to re-suspension of contaminants; and
- Deterioration in sediment and water quality in relation to accidental spillages and discharges of grey water and chemicals.

139. These impacts would mostly be temporary, small scale and localised for the proposed East Anglia THREE project. Given the distances to other activities in the region (e.g. other offshore windfarms, aggregate extraction) and the localised nature of the impacts there is no pathway for interaction between impacts cumulatively. Whilst it is recognised that across the East Anglia Zone or southern North Sea there would be additive impacts, the overall combined magnitude of these would be negligible relative to the scale of the wider area.

140. Therefore, given that the impacts assessed for proposed the 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 water and sediment quality would be **negligible**.

141. There is potential for the installation of the offshore export cables to act cumulatively with dredging activities within dredging licence area 430 to reduce water quality. The dredging site is located approximately 926m from the offshore cable corridor and therefore in the event that dredging activities were being conducted in the southern extent of area 430 simultaneously with the export cable installation in the northern most extent of the offshore cable corridor elevated levels of sediment may occur. The installation of the offshore export cable was predicted to be of negligible magnitude and the likelihood of the scenario described occurring is low; therefore the cumulative impact would be **negligible**.

8.8 Transboundary Impacts

142. The eastern boundary of the East Anglia THREE site lies in close proximity to the Netherlands international marine boundary. As per the cumulative impacts listed above, it is considered that the temporary, small scale and localised nature of the impacts means that there is no pathway for transboundary impacts to occur (i.e. any impacts would remain largely within the East Anglia THREE site). For the offshore cable corridor the impacts would be temporary, small scale and localised and as this

is fully within UK waters there is no pathway for transboundary impact. As a result, no potential transboundary impacts have been identified.

8.9 Inter-relationships

143. The construction, operation and decommissioning phases of the proposed East Anglia THREE project would cause a range of effects on marine water and sediment quality. 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 North Sea.

144. These effects have the potential to form an inter-relationship and directly impact the water and sediment quality and have the potential to manifest as sources for impacts upon receptors other than those considered within the context of this chapter.

145. There is the potential for an inter-related impact between marine physical processes and marine water and sediment quality during all phases of development. For example, changes to hydrodynamics may cause the re-suspension of contaminants as well as increase turbidity in the water column, which has to the potential to cause deterioration in water quality (see Chapter 7 Marine Geology, Oceanography and Physical Processes).

146. As none of the impacts to water and sediment quality were assessed individually to have any greater than a minor adverse impact it is considered unlikely that they would inter-relate to form an overall significant impact on water and sediment quality.

147. Similarly, impacts on marine water and sediment quality from the proposed East Anglia THREE project have the potential to affect other receptors such as benthic ecology, fish and shellfish ecology and marine mammal ecology. This could be either in isolation or in combination with impacts from other topics such as geology, oceanography and physical processes. The information provided in this chapter has been considered in turn by each relevant linked chapter to establish the potential for and significance of inter-related impacts.

148. No inter-relationships have been identified where an accumulation of residual impacts on marine water and sediment quality and the relationship between those impacts gives rise to a significant impact or give rise to the need for additional mitigation.

149. *Table 8.15* summarises the inter-relationships that are considered of relevance to marine water and sediment quality and identifies which other receptors could be affected by impacts to marine water and sediment quality.

Table 8.15 Chapter topic inter-relationships

Topic and description	Related Chapter (influencing)	Related Chapter (affected)	Where addressed in this Chapter
Construction			
Deterioration in water quality due to re-suspension of sediments during construction.	Chapter 7 Marine Geology, Oceanography and Physical Processes	Chapter 10 Benthic Ecology and Chapter 11 Fish and Shellfish Ecology.	Section 8.6.1
Deterioration in water quality due to re-suspension of sediments during cable installation.			
Deterioration of water quality due to re-suspension of sediments.			
Operation			
Deterioration of water quality as a result of scouring.	Chapter 7 Marine Geology, Oceanography and Physical Processes	Chapter 10 Benthic Ecology and Chapter 11 Fish and Shellfish Ecology	Section 8.6.2
Decommissioning			
Deterioration of water quality due to re-suspension of sediments and contaminants.	Influencing parameter: Chapter 7 Marine Geology, Oceanography and Physical Processes	Chapter 10 Benthic Ecology and Chapter 11 Fish and Shellfish Ecology	8.6.3

8.10 Summary

150. This chapter discusses the existing marine water and sediment quality within the vicinity of the proposed East Anglia THREE project. The impact assessment has taken into account the general requirements of key European and national legislation and

policy concerning environmental quality standards for chemical contaminants and guideline values to determine sediment quality.

151. A review of existing literature as well as data obtained from a site specific survey has determined that sediment and water quality throughout the East Anglia THREE site and offshore cable corridor is considered to be generally good, with the offshore sample sites having lower levels of contamination than the nearshore sites. The assessment has considered the impacts of the disturbance and re-suspension of sediments and contaminants as well as accidental releases and spills that may arise during construction, operational and decommissioning activities, on the existing water and sediment quality.

152. The information provided in this chapter suggests that the extent and severity of the activities associated with the project's construction, operation and decommissioning are not significant enough to have an adverse impact on marine water and sediment quality. Therefore, along with this information and through the implementation of the embedded mitigation, the impacts of the proposed East Anglia THREE project on marine water and sediment quality are anticipated to be negligible.

153. *Table 8.16* summarises the sensitivity, magnitude and significance of the predicted impacts as well as mitigation measures and residual impacts from the construction, operation and decommissioning phases of the proposed project.

Table 8.16 Potential Impacts Identified for Marine Water and Sediment Quality

Potential Impact	Mitigation	Receptor	Value/ Sensitivity	Magnitude	Significance
Construction					
Re-suspension of sediments during foundation installation	N/A	Water quality	Low	Negligible	Negligible
Re-suspension of Sediments during inter-array cable, platform link cable and interconnector cable installation	N/A	Water quality	Low	Negligible	Negligible
Re-suspension of contaminants during offshore cable installation	N/A	Water quality	Low	Negligible	Negligible
Risk of accidental pollution	N/A	Water quality	Low	Negligible	Negligible

Potential Impact	Mitigation	Receptor	Value/ Sensitivity	Magnitude	Significance
Re-suspension of sediments (landfall)	N/A	Water quality	Low	Negligible	Negligible
Operation					
Re-suspension of sediments from scour	N/A	Water Quality	Low	Negligible	Negligible
Deterioration in water quality due to release of hazardous materials, specifically accidental spillages	N/A	Water Quality	Low	Negligible	Negligible
Decommissioning					
Re-suspension of sediments and contaminants	N/A	Water Quality	Low	Negligible	Negligible
Risk of accidental pollution	N/A	Water Quality	Negligible	Negligible	Negligible

154. Overall, impacts on marine water and sediment quality are predicted to be negligible, including both cumulative and transboundary impacts and no mitigation or monitoring in addition to that already outlined in the assessment is deemed necessary.

8.11 References

ABP Marine Environmental Research Ltd. (ABPmer) (2012a). *East Anglia Offshore Wind Zonal Environmental Appraisal Report. Appendix G – Physical Processes Baseline and References.*

ABP Marine Environmental Research Ltd. (ABPmer) (2012b). *East Anglia Offshore Wind Project ONE Windfarm: Marine geology, oceanography and physical processes environmental baseline*. Report R3945. May 2012.

BERR (2008). *Review of Cabling Techniques and Environmental Effects applicable to the Offshore Windfarm Industry*.

Canadian Council of Ministers of the Environment (CCME) (2002). *Canadian sediment quality guidelines for the protection of aquatic life: Summary tables.* Update In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Centre for Environmental, Fisheries and Aquaculture Science (Cefas) (1997). *Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1994.* Lowestoft: Cefas. Science Series Aquatic Environment Monitoring Reports, No.47.

Centre for Environmental, Fisheries and Aquaculture Science (Cefas) (1998). *Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1995 and 1996.* Lowestoft: Cefas. Science Series Aquatic Environment Monitoring Reports, No.51.

Centre for Environmental, Fisheries and Aquaculture Science (Cefas) (2000). *Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1997.* Lowestoft: Cefas. Science Series Aquatic Environment Monitoring Reports, No.52.

Centre for Environmental, Fisheries and Aquaculture Science (Cefas) (2001). *Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1998.* Lowestoft: Cefas. Science Series Aquatic Environment Monitoring Reports, No.53.

Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2004). *Offshore Shore Windfarms: Guidance note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements: Version 2*, June 2004.

Department of Energy and Climate Change (DECC) (2011a). *Overarching National Policy Statement for Energy (EN-1)*, London: The Stationary Office.

Department of Energy and Climate Change (DECC) (2011b). *National Policy Statement for Renewable Energy Infrastructure (EN-3)*, London: The Stationary Office.

East Anglia ONE (2012). *East Anglia ONE, Environmental Statement Volume 2 Chapter 7: Marine Water and Sediment Quality*. A report to East Anglia Offshore Wind Farm Limited.

Fugro EMU (2013). *EAOW Area Three and Four Cable Route Benthic Characterisation Report*. A report to East Anglia Offshore Wind Limited.

HM Government (2011) UK Marine Policy Statement

HM Government (2014) East Inshore and East Offshore Marine Plans

Infrastructure Planning Commission (IPC) (2010). *Scoping Opinion Proposed East Anglia ONE Offshore Windfarm,* November 2010.

The Planning Inspectorate (2012). *Scoping Opinion Proposed East Anglia THREE Offshore Windfarm*, December 2012.

Marine Ecological Surveys Limited (MESL) (2011). *East Anglia Offshore Windfarm preliminary Environmental Investigation*: *Benthic Biological Characterisation Report.*

OSPAR (2010). *Quality Status Report 2010*. OSPAR Commission. London.

Royal Haskoning (2011). *Galloper Wind Farm Project, Environmental Statement Chapter 10: Marine Water and Sediment Quality.* A report to Galloper Wind Farm Limited. Date 20/09/11.

Stanev, E.V., Dobrynin, M., Pleskachevsky, A., Grayek, S. and Gunther, H. (2008). Bed shear stress in the southern North Sea as an important driver for suspended sediment dynamics. *Ocean Dynamics*, 59, pp.183-194.

Chapter 8 Ends Here