

9.1 INTRODUCTION

Water Quality

9.1.1 The Humber receives waters from a number of rivers including the Ouse, Don, Aire and Trent. The water quality within the Humber Estuary has improved significantly over recent decades, in part due to the introduction of new laws and regulations, including the Water Framework Directive, as well as the introduction of two stage sewage treatment facilities and improvements in the quality of tributaries to the Humber (EA, 2004). East of the Humber Bridge water quality is classified as Class A "Good" under the Saline Water Quality Classification Scheme, with the upper Humber and tidal rivers classified as Class B, "Fair" (EA, 2004), based upon average conditions along the banks of the estuary.

9.1.2 The main sources of contaminants have been the result of effluent discharges directly into the estuary, however historical development of various industries around the estuary has also led to some pollution by oil and chemicals. A River Basin Management Plan for the Humber has been introduced to help resolve residual existing water quality issues in order to achieve the water standards identified in the Water Framework Directive (WFD).

9.1.3 This chapter addresses the issue of water quality and details the approach to assessing the potential impacts of AMEP on water quality. *Section 9.5.28* describes the potential impacts to water quality whilst *Section 9.8* assesses their significance in relation to the WFD water bodies that they have the potential to affect. Further information on the Project with respect to the WFD can be found in *Annex 9.4*.

Sediment Quality

9.1.4 This chapter also describes legislation, standards and guidelines relevant to sediment quality, the sedimentary baseline environment within the AMEP site boundary, the impact assessment criteria and methodology relating to the potential impacts associated with disturbance of sediments of this nature, and an assessment of the significance of these impacts to the wider environment. *Section 9.5.28* describes the potential impacts to sediment quality whilst *Section 9.9* assesses their significance.

- 9.1.5 This chapter also discusses the current status of intertidal and subtidal sediments in the Humber Estuary, with reference to particulate and organic matter that has been deposited by the Humber Estuary.
- 9.1.6 The sedimentary habitats of the intertidal and subtidal areas of the AMEP site are characterised as intertidal and subtidal mudflats, which are protected as part of a Natura 2000 site under Annex I of the Habitats Directive. These areas are proposed for development into a new quay and changes to the existing sediment quality have the potential to occur as a result of capital dredging during construction and maintenance dredging during the operation of AMEP.

9.2 *LEGISLATION, POLICY AND GUIDANCE*

Water Quality Related EU Directives

- 9.2.1 At EU level a range of environmental Directives consider water quality and provide standards against which it may be assessed. Those most pertinent to the AMEP development are detailed in this section.

The Water Framework Directive (WFD) (2000/60/EC)

- 9.2.2 The WFD is the most substantial piece of EU water legislation to date and is designed to improve and integrate the way water bodies are managed throughout Europe. In the UK, much of the implementation work will be undertaken by competent authorities. It came into force on 22 December 2000, and was transposed into UK law in 2003. Member States must aim to reach good chemical and ecological status in inland and coastal waters by 2015. The chemical status of a water body is prescribed by hydrochemical standards that must be met whilst ecological status is based on the biology, chemistry (physico-chemical and specific pollutants), hydrology and morphology of a water body. The WFD is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands, which depend on the aquatic ecosystems ;
- promote the sustainable use of water ;
- reduce pollution of water, especially by ‘priority’ and ‘priority hazardous’ substances; and
- ensure progressive reduction of groundwater pollution.

9.2.3 The WFD UK Technical Advisory Group (UKTAG, 2008) identified a range of standards and conditions designed to help support ecological status classification. These include dissolved oxygen, dissolved inorganic nitrogen and temperature.

The Dangerous Substances Directive (76/464/EEC)

9.2.4 The Dangerous Substances Directive 76/464/EEC (DSD) and its “daughter” Directive, the Environmental Quality Standards Directive 2008/105/EC (EQSD) control discharges that are liable to contain dangerous substances and that go to inland, coastal and territorial surface waters.

9.2.5 Dangerous substances are toxic substances that pose the greatest threat to the environment and human health, aquatic life and water quality. They include certain industrial chemicals, pesticides and metals. They are not only found in sewage and trade discharges, but water passing through contaminated land and old mines can wash dangerous substances out into the environment. Rainwater runoff from roads and some industrial sites can also release dangerous substances into watercourses.

9.2.6 The Directive specifies two lists of Dangerous Substances. List I covers those which are particularly toxic, persistent, and which may tend to accumulate in the environment. List II covers substances whose effects are still toxic, but less serious.

9.2.7 The Directive requires that pollution by List I substances is eliminated and pollution by List II substances is minimised. To do this, all discharges that are liable to contain dangerous substances must be authorised. The Directive also specifies some requirements for environmental monitoring.

Environmental Quality Standards Directive 2008/105/EC

9.2.8 The Environmental Quality Standards Directive in the field of water policy is a “daughter” directive to the WFD and the Dangerous Substances Directive. It lays down environmental quality standards (EQS) for a range of pollutants in line with the strategy described in the Water Framework Directive (2000/60/EC). The aim of this is to progressively reduce pollution from priority substances by ‘*ceasing and phasing out emissions, discharges and losses of priority hazardous substances*’. The impact assessment for water quality presented in this section refers to EQS as significance criteria.

9.2.9 Pollution by Dangerous Substances is defined as an exceedence of an Environmental Quality Standard (EQS) in the water. The EQS of a substance is based on the toxicity of the substance. It defines a concentration in the water below which the substance will not have a polluting effect or cause harm to plants and animals. If the concentration in the water is less than the EQS then pollution may be considered to be eliminated. The EQSD set the EQSs for List I substances across Europe. Each country in the EC is required to set its own EQSs for List II substances.

The Urban Waste Water Treatment Directive (91/271/EEC)

9.2.10 The Urban Wastewater Treatment Directive regulates the collection and treatment of waste water from domestic sources and from industry. Its objective is to protect the environment from the negative effects of urban waste water and discharges from certain industrial sectors, such as food and drink processing plants.

9.2.11 In the UK, the Directive is implemented through the Urban Waste Water Treatment Regulations 1994.

The Bathing Water Directive (2006/7/EC)

9.2.12 The 2007 Bathing Water Directive is an updated version of a previous Bathing Water Directive 76/1160/EEC. It aims to set more stringent water quality standards and also puts a stronger emphasis on beach management and public information.

9.2.13 The Bathing Water Directive is relevant to AMEP because there is a designated bathing beach at Cleethorpes and discharges from AMEP may have the potential to affect the ability of this designation to comply with the water quality standards.

The Shellfish Hygiene Directive (91/492/EEC)

9.2.14 The Shellfish Waters Directive aims to protect shellfish populations, and maintain the high quality of shellfish in coastal waters. The Directive sets the standard for water quality in estuaries and other areas where shellfish grow and reproduce.

9.2.15 The Humber Management Scheme states that cockle beds are currently closed in the Humber Estuary but that they are expected to reopen at an undetermined future date. As such, it is important to consider the implications of this Directive with respect to water quality. Under this Directive, waters that are inhabited by shellfish need to be monitored for certain substances.

National Water Quality Related Legislation and Plans

The Marine and Coastal Access Act 2009 (MCAA)

9.2.16 The MCAA created the Marine Management Organisation (MMO) which now controls the environmental, navigational, human health and other impacts of construction, deposits and removals in the marine area.

9.2.17 The MCAA provides a new licensing system which succeeds the previous FEPA system.

The Environmental Permitting (EP) (England and Wales) Regulations 2010

9.2.18 The EP Regulations widen the existing environmental permitting and compliance system in England and Wales by integrating existing permitting regimes covering water discharge consenting, groundwater authorisations and radioactive substances regulation authorisations and the outcomes of the Waste Exemptions Order Review into the Environmental Permitting system.

Humber River Basin Management Plan (RBMP)

9.2.19 The Humber RBMP is designed to address a range of environmental pressures on the water environment across the Humber river basin district. It includes information on the current status of surface water bodies in the river basin, and details objectives relevant to the future status of those water bodies and actions proposed for the delivery of those objectives.

Marine Policy Statement

9.2.20 The Marine Policy Statement is the framework for preparing Marine Plans and taking decisions affecting the marine environment. It outlines the requirements to ensure the Project has taken into account any relevant RBMP or supplementary plan, that any development will not cause a deterioration in status of any water to which the WFD applies, and that impacts on the quality of designated bathing waters and shellfish waters are also considered.

Sediment Quality

9.2.21 There is no EU or UK legislation that specifically regulates estuarine sediment quality. Relevant guidance however includes the following;

- Humber Maintenance Dredge Protocol - The UK Government has drafted a protocol that has been applied to certain port authorities including for the Humber with regard to maintenance dredging that has the potential to affect Natura 2000 sites, SPAs, or SACs. In such cases, the maintenance dredging is considered as a “plan or project” for the purposes of the Habitats Directive and assessed in accordance with Article 6(3) of the Directive.
- CEFAS Action Levels (ALs) - These guidelines are non-statutory contaminant concentrations for dredged material that serve as a tool for decision-making with regard to dredge spoil disposal. Contaminant levels in dredged material below the lower threshold levels are of no concern or are unlikely to influence a dredge licensing decision.
- Dutch quality standards (IADC/CEDA, 1997) – These standards are reference values used in environmental remediation work. Contaminant levels in dredged material below these standards are considered safe for sea disposal and do not pose a significant environmental risk.
- Canadian Guidelines Threshold Effect Level (TEL) – These guideline threshold levels are based on the proven ecotoxicological associations between chemicals and aquatic organisms. Contaminant levels in dredged material below these levels are unlikely to affect even sensitive species in the Humber Estuary.

9.3 ASSESSMENT METHODOLOGY AND CRITERIA

- 9.3.1 Impacts to water and sediment quality will be considered in terms of impacts to the physical, chemical and biological water quality through comparison with the existing baseline conditions, whilst sediment quality will be considered in terms of chemical quality. For consideration in terms of physical sediment quality see *Chapter 7*.
- 9.3.2 The proposed methodology and criteria used in the EIA to assess impacts on water and sediment quality is set out below:
- 9.3.3 Define the baseline water and sediment environment, describing existing conditions within that area and gaining an understanding of the importance, sensitivity and value of the various water and sedimentary environmental features close to AMEP.

- 9.3.4 Identify and assess the potential temporary and long-term impacts and their magnitude (including zone of influence) relating to the construction and operation of the scheme and temporary and permanent cumulative impacts associated with any existing or planned developments in the area (taking into consideration mitigation measures that are an integral part of the scheme).
- 9.3.5 Develop measures to avoid, mitigate or compensate for identified impacts and to maximise any opportunities for environmental enhancement.
- 9.3.6 Evaluate and report the significance of residual impacts to the water and sediment environment assuming the implementation of the mitigation measures developed for the scheme.
- 9.3.7 The assessment takes account of existing and potential water uses and users, dependent species, habitats and receptors within, and associated with, the catchments that may be influenced by the proposals.
- 9.3.8 As described in *Chapter 2*, the identification of significant effects take into account the nature and duration of site-specific effects, wider effects, positive and negative effects, temporary and permanent effects, direct and indirect effects, and secondary and cumulative effects.

Sensitive Receptors

Water Quality

- 9.3.9 Sensitive receptors in relation to water quality will include surface waters, groundwater, flora and fauna and human health. Sensitive receptor locations to be assessed include Cleethorpes bathing beach, located approximately 13 km downstream of AMEP, and commercial shellfish (cockle beds) operations at Cleethorpes and Grimsby which although currently closed may be brought back into operation at an unspecified future date (EA, 2004). The surface water bodies designated under the WFD are also considered to be a sensitive receptor in terms of water quality.

Sediment Quality

- 9.3.10 The environmental receptors for changes to sediment quality are the Natura 2000 site, and the species that rely on the intertidal and subtidal habitats close to AMEP (ie benthic invertebrates and birds).

Significance Criteria

- 9.3.11 Criteria used for determining the risk to water quality are set out in Environmental Quality Standards (EQS) produced by the WFD UKTAG (2008) in line with the EU EQS Directive. EQS are identified for a range of water quality characteristics including temperature, dissolved oxygen and for a range of specific pollutants including trace metals.
- 9.3.12 Impacts will be assessed as significant if the impacts to water quality result in an exceedance of standards or guidance values, such as EQS for water quality or CEFAS Action Levels for sediment quality. Any resultant non-compliance with WFD will also be considered as significant with regards to water quality. If impacts do not result in a non-compliance or exceedance of standards they will be considered to be non-significant. Further details are available in *Table 9.1*.

Table 9.1 *Categories of Significance*

Categories of Significance

An impact will be considered to be **not significant** where the impact will not exceed the appropriate standards or guidance values (eg EQS for water quality or CEFAS Action Level 2 for sediment quality) and for water quality do not result in non-compliance with the WFD.

Significant impacts are those where an effect will be experienced, and the impact magnitude is sufficient to result in an exceedance of the applicable standards or guidelines, or which results in a non-compliance with the WFD.

9.4 *CONSULTATION*

- 9.4.1 In relation to water and sediment quality, the consultation responses received and the way in which they are addressed are outlined in *Annex 2.4*.

9.5 *BASELINE*

Water Quality

- 9.5.1 Within the vicinity of AMEP there are several surface water bodies assessed under the Water Framework Directive (*Figure 9.1*). The results for those nearest AMEP, in terms of ecological and chemical quality, are presented in

9.5.2

Table 9.2. The closest of these water bodies is North Killingholme main drain, an artificial water body, which runs along the north-west corner of the site boundary.

Table 9.2 Chemical Quality Data for Surface Water Features

Topic	North Killingholme main drain	Harborough Marsh drain	Skitter Bk / E Halton Bk from Ulceby Skitter to Humber Estuary	Mawnbridgedrain	Lacey Beck / River Freshney Catchment (to N Sea)
Waterbody ID	GB104029067580	GB104029067570	GB104029067650	GB104029067540	GB104029067530
Hydromorphological Status	Artificial	Not Designated A/HMWB	Heavily Modified	Not Designated A/HMWB	Heavily Modified
Current Ecological Quality*	Moderate Potential	Moderate Status	Poor Potential	Moderate Status	Poor Potential
Current Chemical Quality	Good	Does Not Require Assessment	Does Not Require Assessment	Does Not Require Assessment	Does Not Require Assessment
2015 Predicted Ecological Quality	Moderate Potential	Moderate Status	Poor Potential	Moderate Status	Moderate Potential
2015 Predicted Chemical Quality	Good	Does Not Require Assessment	Does Not Require Assessment	Does Not Require Assessment	Does Not Require Assessment
Overall Physico-Chemical Water Quality	Moderate	-	Moderate	Moderate	Moderate
Dissolved oxygen (%)	Good	-	High	Moderate	High
pH	High	-	High	High	High
Overall specific pollutant quality	Moderate	-	Good	Moderate	High
Copper	High	-	-	-	High

Source: EA(2010a)

* Ecological Quality is recorded on a scale of high, good, moderate, poor or bad status for waterbodies not defined as Artificial or Heavily Modified Waterbodies (HMWB). "High" denotes largely undisturbed waterbodies. For A/MWB ecological potential is identified ranging from maximum to good to moderate to poor to bad.

9.5.3 The Humber Estuary itself is also assessed and rated under the WFD. The assessments and ratings for the Humber Lower Unit where AMEP is located are indicated in *Table 9.3*.

Table 9.3 *Estuary Ecological and Chemical Quality*

Topic	Humber Lower
Waterbody ID	GB530402609201
Typology Description	Mixed water column, macro-tidal, extensive intertidal zone
Hydromorphological Status	Heavily Modified
Current Ecological Quality	Moderate Potential
Current Chemical Quality	Fail
2015 Predicted Ecological Quality	Moderate Potential
2015 Predicted Chemical Quality	Fail
Overall Physico-Chemical Water Quality	Moderate
Dissolved oxygen (%)	High
Overall specific pollutant quality	Moderate
Copper	High

Source: Environment Agency website (2011).

9.5.4 As presented in *Table 9.3* there is no expected change in trend of ecological or chemical quality by 2015.

9.5.5 The WFD surface water bodies identified are classed as being at risk from pressures including point and diffuse source pollution, water abstraction and flow regulation, morphological alteration and alien species.

9.5.6 There is one WFD groundwater body close to AMEP, Grimsby Ancholme Louth Chalk Unit. The details of the classification and attributes of this water body are given in *Table 9.4*.

Table 9.4 *Groundwater chemical water quality*

WFD parameter	Grimsby Ancholme Louth Chalk Unit
Waterbody ID	GB40401G401500
Current quantitative quality	Poor
Groundwater dependent terrestrial ecosystems (quantitative impacts)	Good
Impact on surface waters	Good
Saline or other intrusions	Good
Resource balance	Poor
Current chemical quality	Poor
Upward chemical trend	Yes
2015 predicted quantitative quality	Poor
2015 predicted chemical quality	Poor
Overall risk	At risk
No. of measures listed (waterbody level only)	13

Source: EA (2010a)

SSSI, SPA, SAC and Ramsar designated areas

- 9.5.7 The Humber Estuary is also classified as a Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar site to protect and conserve the wetlands the diverse fauna and fauna present. Where these designations apply, the most stringent objective of the WFD, SPA or Ramsar applies. With regards to water quality, the WFD provides the most stringent criteria.
- 9.5.8 SSSIs do not have the status of protected areas under the WFD. “Favourable condition” under SSSIs relates to High Ecological Status, or, at sites which have been degraded to such extent that restoration to this level is not possible, it equates to Good Ecological Status.
- 9.5.9 The Humber Estuary is also classified as a Site of Special Scientific Interest (SSSI). Units 94 and 183 of the SSSI are located closest to AMEP. They are classified as “Unfavourable recovering”. Unit 183, located approximately 10 km upriver of AMEP, was classified as such

due to the fact water quality parameters have failed within the last six years due to oxygen sag impacting on sea lamprey and the estuary features (Natural England, 2010).

9.5.10 North Killingholme Haven Pits SSSI, designated for their importance as large saline lagoons with rich fauna, are located immediately to the north of AMEP. The Pits are non-tidal, although through means of a manually controlled pipe, estuarine water passes into the Pits at certain states of the tide meaning the water is very saline. The current conditions at the site are described as “unfavourable no change” (Natural England, 2010).

Physical water quality parameters

9.5.11 A survey of water quality (IECS, 2010a) (*Annex 7.4*) was conducted within the Humber Estuary with sampling locations across the intertidal and subtidal zone to inform the EIA (*Figure 9.2*). Sampling was conducted using a YSI multi-parameter water quality monitor (Sonde) calibrated to zero with measurements recorded throughout the day covering the full range of tidal conditions, ebb, flood and slack water.

Figure 9.2 *Sample locations (May/June 2010)*



Source: IECS (2010a)

Temperature

- 9.5.12 The IECS water quality survey data (IECS, 2010a) showed little variability in temperature data, with variation of less than 1 °C (17.8 – 18.7 °C). Elevated water temperatures can have a negative impact on water quality including potentially reducing dissolved oxygen concentrations.
- 9.5.13 Temperature monitoring of the mid and outer estuary from samples taken in 2006 found water temperatures ranged from 3.3 °C up to 20.8 °C (EA, 2007) (see *Table 9.5*) reflecting temperature variability across the course of the year. The measured May/June water temperatures sit comfortably within the established temperature range for the estuary.

Table 9.5 *Temperature within the mid and outer Humber Estuary*

Site	Temperature range (°C)
Albert Dock	3.3 - 18.6
Saltend	4.3 - 20.8
Spurn Point	3.9 - 18.7

Source: EA (2007)

Suspended solids

- 9.5.14 The Humber Estuary is one of the most turbid in the British Isles (Uncles *et al.*, 2006). Very high concentrations of fine suspended sediments often occur within the Humber Estuary as a result of the macro-tidal nature combined with muddy bed sediments.
- 9.5.15 Suspended sediment concentrations throughout the estuary demonstrate a large degree of variability. Sediment concentrations within the middle and inner estuary are often around 5 g/l, reaching up to 14 g/l at the turbidity maximum zone (Boyes and Elliott, 2006). Levels in the outer estuary are generally lower (*Table 9.6*). The outer estuary extends from Spurn Head to a line across the estuary between Grimsby and Hawkins Point. The middle estuary extends as far as the Humber Bridge, where it leads to the inner estuary that extends to Trent Falls.
- 9.5.16 The baseline bathymetry and hydrography study by IECS (IECS, 2010b) (*Annex 9.1*) demonstrates that typical suspended sediment concentrations near to AMEP measured in September 2010 range from

100 mg/l at slack water on a neap tide to 400-500 mg/l during the neap tide ebb flow. Concentrations during the spring tides reached 1 600 mg/l during peak flood flow and were in excess of 800 mg/l on the ebb flow. These concentrations are considered high. Lower suspended sediment concentrations were recorded on the slack tides both near the surface and at depth. Further details about suspended sediments are provided in *Chapter 8*. The recorded suspended solid loads within the Humber Estuary fall within known ranges.

Table 9.6 *Recorded suspended solid loads within the Humber Estuary*

Site	Suspended solids range (mg/l)
Albert Dock	432 - 1690
Saltend	18 - 728
Black Loft Jetty	126 - 4000
Spurn Point	1 - 160

Source: EA (2007)

Dissolved oxygen

9.5.17 Within UKTAG (2008), a minimum standard of 4 mg/l dissolved oxygen (95 percentile) is identified at the good-moderate status boundary in fully marine waters, rising to 5 mg/l in low salinity waters reflecting greater oxygen solubility with decreasing salinity. The EQS for dissolved oxygen is 55 percent saturation at the 5 percentile, dissolved oxygen levels should be greater than 55 percent for 95 percent of the time. Dissolved oxygen levels in the nearest WFD surface water body, North Killingholme main drain, were recorded as good (*Table 9.2*). Dissolved oxygen for the Humber Estuary Lower unit is defined as "high" under the WFD (*Table 9.3*). Historically, occasional failures in the upper estuary have been recorded.

Inflows/Outfalls

9.5.18 The major freshwater inflows in the Humber Estuary are from the Ouse and Trent, with smaller inflows nearer to AMEP. Inflows and outffalls can have a dramatic impact on localised water quality. Water abstraction can reduce the amount of water flowing through channels across mudflats impacting on the size and structure. Changes to the freshwater runoff across mudflat habitat within the Humber may impact on wading birds such as Redshank. Freshwater inflows within

the Humber Estuary currently influence seed germination and both plant and prey species abundance (EA, *Habitats Directive - Humber Estuary*, Date Unknown).

- 9.5.19 Cooling water intake and existing outfalls from two gas-fired power stations are located immediately north of AMEP. Whilst the outflows are relatively small, the discharge waters are on average 8 °C and 11 °C warmer than the ambient water temperature in summer and winter respectively (*Annex 9.2, Annex 9.3*). This temperature difference rapidly differs, however; a detailed baseline analysis is included in *Annex 9.2* and *Annex 9.3*.

Physico-chemical water quality parameters

- 9.5.20 Significant improvements in estuarine quality have been experienced in the Humber in recent decades following the installation of secondary sewage treatment works and improvements in industrial discharges in the upstream catchments.

Contaminants

- 9.5.21 Recommendations have been made by UKTAG (2008) for EQS for 18 specific pollutants and substances known to be discharged into UK waters in significant quantities. The capacity of the Humber to assimilate contaminants is great. EQS in relation to trace metals, trace organic substances and pesticides is generally achieved. Some contaminants however may exceed the EQS, due to a legacy of contaminated sediments. Historically the main issues relating to water quality in the Humber Estuary have been depleted oxygen and elevated copper concentrations. Following the implementation of additional sewage treatment works there has been great improvement in dissolved oxygen levels in recent decades.

- 9.5.22 Copper concentrations however, on occasion, continue to exceed the EQS value of 5 µg/l (EA, *Habitats Directive - Humber Estuary*, Date Unknown). Copper concentrations in the nearby WFD surface water bodies and within the Humber Estuary itself have been classified as "high" under the WFD (*Table 9.2 and Table 9.3*). Whilst the annual copper concentrations now meet the EQS, the levels are occasionally exceeded. This non-compliance is likely to be a result of the legacy of contaminated sediments within the estuary and hence compliance is likely to take time to achieve.

Microbiological water quality parameters

- 9.5.23 Biological water quality is considered in relation to Cleethorpes Beach, designated under the European Bathing Water Directive. Cleethorpes is located approximately 13 km from the AMEP site and has been monitored as part of the Blue Flag programme which includes looking at water quality. The award of the Blue Flag recognises that no industrial, wastewater or sewage-related discharges affect the beach area and requires 95 percentile compliance with microbiological parameters (Table 9.7).

Table 9.7 *Standard / limit values for microbiological parameters (95 percentile values)*

Directive/Standard	Parameter	Limit values
Bathing Waters Directive	Faecal Colibacteria (<i>Escherichia coli</i>)	10,000 cfu/100 ml
	Intestinal <i>Enterococci</i> / <i>Streptococci</i>	2,000 cfu/100ml
Blue Flag limit values	Faecal Colibacteria (<i>Escherichia coli</i>)	250 cfu/100 ml
	Intestinal <i>Enterococci</i> / <i>Streptococci</i>	100 cfu/100 ml

Source: Blue Flag (2010)

- 9.5.24 Bathing water quality within Yorkshire and along the Humber has improved significantly over recent decades. In 1990 six bathing waters in the region failed the mandatory health standards required by the EC Bathing Waters Directive. By 2009, of the 21 bathing waters that were monitored there were no failures (EA, 2009).

Sediment Quality

- 9.5.25 The intertidal and subtidal zone along the north-east facing shore of the AMEP site is characterised by mudflats that consist of estuarine silts, sands, and gravels. Chapter 7 presents information on the physical particulate composition of the sediments in the Humber Estuary, whilst this section is concerned by the chemical quality of the estuarine sediments.

Sediment contamination

- 9.5.26 The Humber Estuary is known to have historically received contaminants from a number of industrial and urban sources. Trace metals, polychlorinated biphenyls (PCBs), hydrocarbons, and

tributyltin (TBT) are all known to be present in the sediments of the Humber, and they are transient within the system as a result of tides, currents, bioturbation, and maintenance dredging. Contaminants were measured as being particularly high in the 1990s, but the EA has recorded a decrease in levels since then to the present, reflecting tighter effluent controls and improved industrial management systems.

9.5.27

The sediment survey of the AMEP site assessed contaminant levels at the surface of the intertidal zone, and above and below the subsurface of the subtidal zone using Vibrocores. The concentrations of contaminants identified in the samples are presented in *Table 9.8* with exceedances of the standards and guidelines listed in *Section 9.2* are colour coded for reference. In addition CEFAS has undertaken testing on sediment samples collected from within the proposed AMEP dredge area. Sediment samples were analysed for a range of metals, DBT, TBT, PCBs and PAHs. Minimum and maximum concentrations of contaminants from 18 stations within the turning area, approach channel and berthing pocket are presented in *Table 9.8*. No samples exceeded Action Level 1 or 2 for TBT, DBT and PCB, where available, and no samples exceeded Action Level 2 for any of the tested metals. CEFAS also analysed THC from these 18 stations. Values for THC ranged between 79 and 1230 mg/kg. All but one value exceeded the CEFAS Action Level 1 for THC, which is 100 mg/kg dry weight (ppm).

Table 9.8 Contaminant concentrations against standards and guidelines

Contaminant	Unit	UK CEFAS Action Level 1	UK CEFAS Action Level 2	Dutch Standards	Canadian Guidelines	Intertidal (Surface)		Subtidal (Surface)		Subtidal (Vibrocure)		CEFAS samples	
						Min	Max	Min	Max	Min	Max	Min	Max
<i>Heavy metals</i>													
Arsenic	mg/kg	20	100	29	7.24	13.8	18.9	14.3	29.6	3.38	30.9	7.5	50
Cadmium	mg/kg	0.4	5	0.8	0.7	0.296	0.533	0.185	0.44	0.141	0.469	0.12	0.46
Chromium	mg/kg	40	400	100	52.3	31.6	45.7	10.7	35.4	4	42.5	15	96
Copper	mg/kg	40	400	35	18.7	23.5	31.4	7	49.9	3.16	26.6	11	53
Lead	mg/kg	50	500	85	30.2	35.4	54.6	26.7	57.7	2.34	48.8	8.8	135
Mercury	mg/kg	0.3	3	0.3	0.13	<0.14	<0.14	<0.14	0.177	<0.14	<0.14	0	0.36
Nickel	mg/kg	20	200	35	15.9	22.1	32.4	10.2	19	4.13	28.4	14	53
Zinc	mg/kg	130	800	140	124	112	145	66.7	115	13.1	131	56	287
<i>Organo tins & PCBs</i>													
Di-butyl-tin	mg/kg	0.1	-	-	-					<0.02	<0.02	<0.002	0.01069
Tri-butyl-tin	mg/kg	0.1	-	-	-					<0.02	<0.02	<0.003	0.03615
PCBs, sum of ICES 7	µg/kg	100	-	-	-	<3	<3	<3	<3	<3	<3	0.00087	0.03022
<i>PAHs</i>													
Acenaphthene	µg/kg	100	-	-	6.71	29.8	50.9	18.5	41.4	<8	54.8	0.35	33.59
Acenaphthylene	µg/kg	100	-	-	5.87	19.9	28.3	<12	27.5	<12	43.6	0.8	118.58
Anthracene	µg/kg	100	-	-	46.9	62	111	38.5	95.2	<16	127	1.53	154.13
Benzo(a)anthracene	µg/kg	100-	-	-	74.8	169	282	90	268	<14	237	8.41	443.13
Benzo(a)pyrene	µg/kg	100	-	-	88.8	167	258	118	278	<15	250	8.45	575.9
Chrysene	µg/kg	100	-	-	108	152	243	79.4	189	<10	186	5.65	371.13
Dibenz(ah)anthracene	µg/kg	10	-	-	6.22	<23	48.6	<23	43.32	<23	45.7	2.2	104.04
Fluoranthene	µg/kg	100	-	-	113	304	507	165	377	<17	433	9.99	850.17
Fluorene	µg/kg	100	-	-	21.2	46.7	72.4	25.4	72.4	<10	75	3.33	210.17
Naphthalene	µg/kg	100	-	-	34.6	150	237	52.6	177	<9	112	9.55	567.79
Phenanthrene	µg/kg	100	-	-	86.7	251	406	127	264	<15	287	12.75	848.19
Pyrene	µg/kg	100	-	-	153	291	464	162	347	<15	375	9.22	668.9

Source: Compiled by ERM.

9.5.28 Maximum contaminant concentrations in dredged sediments from other harbours within the Humber Estuary that are currently disposed of at the designated disposal sites contain more contamination than dredged sediments at the AMEP (see *Table 9.9*). The other harbours and dates of contamination measurements considered in *Table 9.9* are:

- Albert Dock (Hull) – 1999;
- Alexandra Dock (Hull) – 1999 and 2001;
- King George Dock (Hull) – 1999 and 2001;
- Immingham – 2001;
- Royal Dock (Grimsby) – 2001; and
- Sunk Dredged Channel – 2001.

Table 9.9 *Contamination Concentrations of Other Humber Estuary Harbours Compared with AMEP (mg/kg)*

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	DBT	TBT
Other Harbours	65.2	0.8	125	78.5	146.7	0.4	57.1	320.7	0.72	0.105
Max										
AMEP	50	0.53	96	53	135	0.36	53	287	0.011	0.036
Max										
Other Harbours	17.6	0.1	27.9	12.5	33.8	0.1	16.2	83.8	0.001	0.002
Min										
AMEP	3.38	0.12	4	3.16	2.34	0	4.13	13.1	<0.002	<0.003
Min										

Source: *Table 9.8* above and Able.

9.6 IMPACTS

Water Quality

9.6.1 The impacts to water quality in the Humber Estuary that result from activities planned to occur during the construction and operational phases are detailed in this section.

Construction Phase

9.6.2 During the construction phase of the proposed development, and specifically of the new quay, there is the potential for sediment disturbance and the release of contaminants. This disturbance could result in a higher suspended sediment load, the release of contaminants from the estuarine sediments, decreased dissolved oxygen levels, and decreased light penetration. These factors have the potential to affect sensitive ecological receptors such as macrophytes, fish, and benthic invertebrates.

- 9.6.3 Disturbed contaminants may dissociate from fine sediment particles and be released from the interstitial water as sediments are disturbed and suspended into the water column, reducing water quality and also potentially affecting sensitive downstream receptors. They could also potentially settle onto or bind to estuarine sediments with the potential for them to be released at a later time in a more biologically active soluble form.
- 9.6.4 Increased construction traffic on-site and in the Humber Estuary, the movement of construction machinery and excavation activities, temporary stockpiling of material and wheel washing could all lead to the deterioration of water quality due to higher fine sediment delivery through surface water run-off.
- 9.6.5 The accumulation of litter due to increased activity in and around the AMEP site could affect the water quality of the Humber Estuary with consequences for estuarine organisms that may ingest it.
- 9.6.6 There is the potential for accidental spillages of oils, lubricants and other industrial substances during the construction phase that may deteriorate water quality. These spillages are commonly associated with the transport of material to or from storage areas on-site as a result of inappropriate storage facilities or poorly managed construction practices.

Operational Phase

- 9.6.7 The physical structure of the new quay has the potential to impact on the mixing of existing outfalls from two gas fired power stations. Of particular concern is the possibility of changing the temperature at the intake. Modelling conducted for the EIA (*Annex 9.2 and 9.3*) has assessed the zone of influence of these discharges with AMEP present and the impacts to water quality have been determined (see from *Paragraph 9.8.32*).
- 9.6.8 During the operational phase there will be the potential for accidental leaks and spills that may release contaminants into surface waters. This may occur during the transport of material or as a result of the wind turbine assembly process. The EIA has assessed the likelihood and potential magnitude of these events in the residual impact sections below.
- 9.6.9 AMEP will result in an increased area of hard standing than currently exists with the potential for run-off and drainage to surface waters to increase. This has the potential to cause higher sedimentation rates and a higher suspended solids load in the receptor water bodies.

Sediment Quality

Construction Phase

- 9.6.10 The dredging operations will result in a sediment plume that will deposit on the bed of the estuary. This has the potential to affect the sediment quality of the depositional areas, particularly if the sediment plume contains contaminants. The EIA has assessed the expected magnitude of the plume and its likely zone of influence in terms of its deposition and its consequential impacts to sediment quality in the residual impact sections below. No other impacts are anticipated to sediment quality on the AMEP site as the existing sediments at the site will be removed. Impacts from the dredging and removal of sediments are assessed as impacts to water quality or to the sedimentary regime. For impacts to physical sediment properties, see *Chapter 8*.

9.7 MITIGATION MEASURES

- 9.7.1 This section highlights the mitigation measures that will be used to avoid, reduce or mitigate the potentially significant impacts associated with the construction and operational phases of AMEP.

Water Quality

Construction Phase

- 9.7.2 As with all construction sites, the potential for negative impact on surface water quality exists as a result of accidental spillage of fuels and oils from the construction phase.
- 9.7.3 Specific mitigation measures include:
- storage of oils and fuels in sealed containers in a sealed bunded area away from water;
 - briefing of site staff highlighting the need for tight control of potentially polluting chemicals;
 - ensure clean up procedures are in place in case of accidental spillages of oils and fuels;
- 9.7.4 A dredge plume assessment has been conducted to address the potential for dredging operations to affect the marine environment (see *Chapter 8*). The following mitigation measures have been included in relation to dredging and dredge disposal:

- Reduce the dredged area to as small as reasonably practicable by opting for the design option with the smallest dredging footprint and fewest environmental consequences;
- Reduce the percentage of solids in the overflow to be as low as possible using suitably qualified and experienced contractors;
- Inspection and monitoring of dredging activities to evaluate the effectiveness of impact prevention strategies, and adjust where necessary;
- Optimise the trailing velocity of the dredger to minimise raising suspended sediments during dredging operations;
- Minimise the need for overflowing during dredge operations by recirculation of jetting water;
- Use of "green valves" to prevent surface suspension of fine particulates;
- Carry out dredge disposal only in designated disposal sites using disposal techniques that minimise dispersal of sediments.

Operation Phase

9.7.5 Specific mitigation measures may include:

- storage of oils and fuels in sealed containers away in a sealed bunded area from water;
- briefing of site staff highlighting the need for tight control of potentially polluting chemicals;
- ensure clean up procedures are in place in case of accidental spillages of oils and fuels; and
- need for maintenance dredging will be reduced as far as practically possible.

9.7.6 Additional studies have been carried out to quantify the impact on intakes of the Centrica and EON power plants (*Annex 9.2, Annex 9.3 and Annex 8.3*). These studies have led to recommendations for maintenance dredging to be carried out at discrete intervals to prevent sedimentation at the EON and Centrica intakes.

Sediment Quality

9.7.7 No further specific mitigation in relation to sediment quality is proposed in addition to that relating to dredging as outlined under water quality.

9.8 WATER QUALITY RESIDUAL IMPACTS

9.8.1 Impacts to water quality are assessed in line with the applicable environmental quality standards (EQS) for WFD waterbodies. The WFD parameters that account for water quality included in this assessment include:

- transparency (as affected by suspended solids);
- dissolved oxygen;
- specific pollutants (including copper);
- the current list of WFD Priority Substances.

9.8.2 In addition, the assessment takes account of changes in water circulation with repercussions on water temperature near the outfalls.

9.8.3 The Environment Agency has recently published guidance on the impact assessment of marine dredging on WFD water bodies (EA, 2010b), which is applicable to all new dredging operations including those proposed for AMEP. The guidance recommends the assessment of impacts from dredging in terms of whether the proposed activity will have a significant non-temporary effect on the status of one or more WFD parameters at water body level. The emphasis is on the potential for the proposed activity to affect a parameter sufficiently to lower its existing status class.

9.8.4 The method presents a screening table of trigger criteria and thresholds that are designed to identify effects that are likely to be significant at water body level. Some of the triggers are precautionary where there is a lack of scientific evidence linking the effects of dredging and dredge disposal to WFD parameters. The triggers are explained and the assessment undertaken in *Annex 9.4*.

9.8.5 The potential impacts of AMEP on the baseline conditions for water quality and sediment quality are presented below. Potential impacts are assessed in terms of the likelihood of changes occurring to the parameters that are used to determine status class by the WFD.

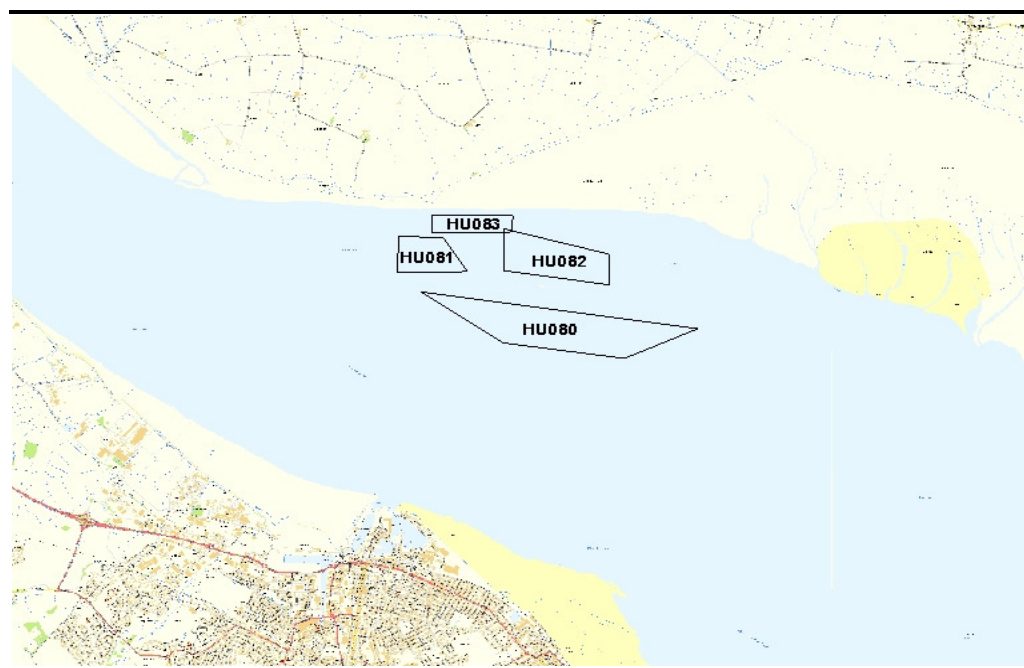
- 9.8.6 Changes are predicted in terms of the spatial area affected, the duration of the change and the recoverability of the receptor following completion of AMEP.
- 9.8.7 The significance of any predicted effects is specified in relation to appropriate standards and thresholds relevant to the parameter of concern, which is accompanied by a discussion of the issue including the level of confidence and certainty associated with the impact assessment.
- 9.8.8 Of particular relevance are the WFD status class boundaries (UKTAG, 2008). Impacts to water quality will be assessed in line with the EQS and whether any changes to the EQS affect the status classification of the waterbodies under the WFD. The current classification of the nearby WFD waterbodies can be found in *Table 9.2* and *Table 9.3*.
- 9.8.9 Changes to water quality also have the potential to result in subsequent changes to the areas classified under the Humber Sites of Special Scientific Interest (SSSI), Special Protection Area (SPA), SpecialArea of Conservation (SAC) and Ramsar.

Direct Impacts to Water Quality from the Construction Phase

Sediment plume

- 9.8.10 AMEP represents a significant capital dredging project involving the removal of surface alluvium, sand and gravels and subsurface glacial till. The material will be disposed of within the estuary at specific disposal locations (*Figure 9.3*). The non-erodible glacial till will be disposed of at HU081, HU082 and/or HU083.

Figure 9.3 *Proposed dredge disposal locations within the Humber Estuary*

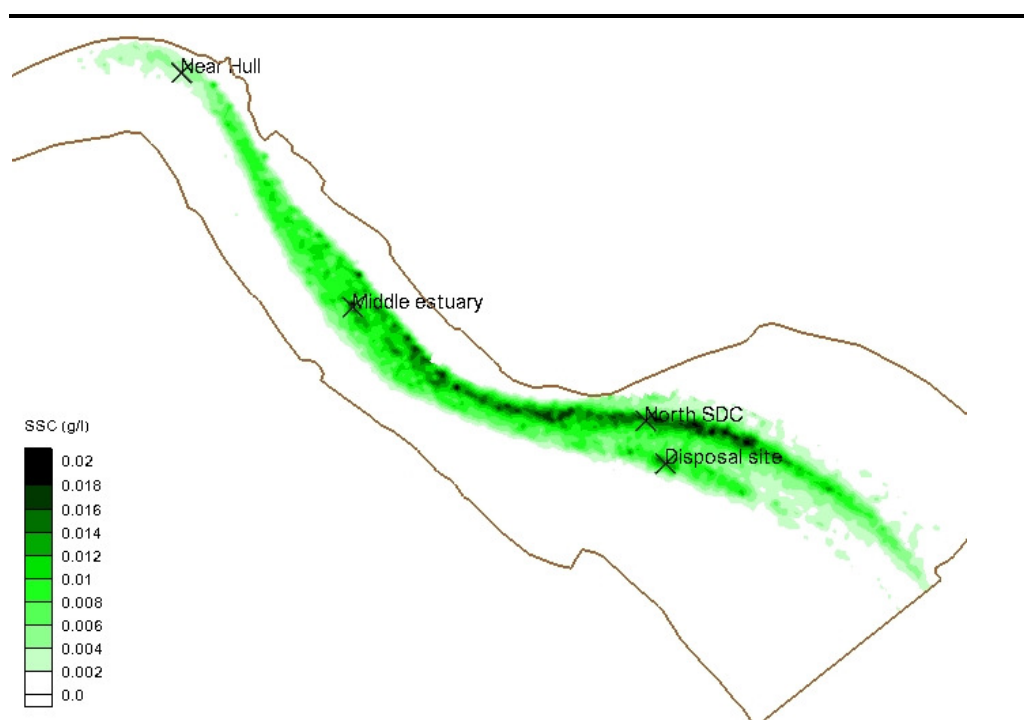


Source: CEFAS (2011) Pers. Comm.

- 9.8.11 The disposal of the stiff glacial till clay at these sites is highly unlikely to add significantly to background suspended sediment concentrations (SSCs) due to the strongly cohesive nature of the material. It can be assumed that disposal of glacial till from AMEP will add negligible material to the background SSCs, resulting in no significant impact on water quality.
- 9.8.12 The erodible material will be disposed of at site HU080 (Middle Shoal). Following sediment disposal plume modelling by JBA Consulting (see *Chapter 8*) it is anticipated that the majority of sediment disposed of at the site will be contained within a dynamic plume which spreads approximately 100 m radially from the location of the disposal ship along the estuary bed, depositing virtually all coarse material.
- 9.8.13 It is anticipated that some fine material, constituting approximately 25 percent of the total disposed load, will be directly entrained into the water column during sediment descent, forming the passive plume (*Chapter 8*). The passive plume disperses away from the disposal site adding to the background SSCs. Following sediment plume modelling it is estimated that the disposal of the capital dredge material may lead to short-term increases in SSCs in the tidal channels within the estuary of up to 80-100 mg/l by the end of the disposal programme with short lived peaks of up to 250 mg/l during disposal. The sediment plume may reach as far upriver as up to Hull, however, the increase in SSCs will be significantly reduced by this stage to just 10-20 mg/l (*Figure 9.4*).

The modelling has shown that increases in SSC brought about by the dredging quickly disappear within days of completion of the dredge disposal operations. Modelling studies on the capital dredge sediment plume dispersion around the AMEP site predicts peak increases in (depth-average) concentration that exceed 100 mg/l in the vicinity of the dredging and are less than 100 mg/l further away (see *Annex 8.4*). The capital dredge plume disperses more than 12 km to the north on a flood tide and up to 12 km to the south on an ebb tide, though concentration increases at this distance are generally below 20 mg/l. The excess sediment introduced in the water column from either dredging or dredge disposal constitutes a short term adverse impact when compared to historic ranges of suspended sediment concentrations recorded within the Humber Estuary (*Table 9.6*). This re-occurring impact is sustained for the duration of dredging and disposal of alluvium over the two years of construction with clearly elevated SSCs restricted to an area of the middle and outer estuary alongside the main tidal channel (see *Figure 9.4*). It is not likely that the dredge plume will change the long-term outlook for the WFD status of the Humber Estuary lower unit nor prevent it from recovering. Owing to the large range of natural suspended sediment concentrations experienced at these locations, and the limited period of impact, these increases are not considered to be unduly onerous for the operation of the intakes. It can be concluded that the impact of the sediment plume associated with dredging during construction on water quality is not significant. Impacts to aquatic ecology are addressed in *Chapter 10*.

Figure 9.4 *Average SSCs during the last day of a 14-day period of intermittent sediment release at the Middle Shoal disposal site*



- 9.8.14 Potential mitigation measures to minimise suspended sediments during the dredging operations were introduced in *Paragraph 9.7.5*.
- 9.8.15 Modelling has also revealed potential changes to bed shear stresses leading to potential erosion at the foreshore in front of North Killingholme Pits. However, given that water exchange into and out of the Killingholme Pits is governed by a manually operated pipe system that is located within the small inlet to the south of the Humber Sea Terminal and north of Humber workboats, ie it is not on the foreshore, the resulting suspended sediment is unlikely to enter the Killingholme Pits and hence no impacts to the Killingholme Pits are predicted.
- 9.8.16 Modelling studies have also established likely excess suspended sediment concentrations at the intakes (see *Annex 8.4*). The proposed capital dredging of alluvium by trailer suction hopper dredger (TSHD) will cause increases in suspended sediment concentrations at the southern (E-on) intake of up to 180mg/l (near bed) and at the northern (Centrica) intake of up to 60mg/l (near bed). The proposed dredging of sand/gravel by TSHD will cause increases in suspended sediment concentrations at the E-on intake of up to 200mg/l (near bed) and at the Centrica intake of up to 400mg/l (near bed). These increases are considered to be shortlived (three and one weeks respectively) and within the large natural range of suspended sediment concentrations at these locations. They are not expected to affect the operation of the intakes. The same study also reveals that dredging by backhoe dredger is predicted to produce excess concentrations that are smaller than those for the TSHD.

Resuspension of contaminated sediments

- 9.8.17 Resuspension of contaminated sediments may occur due to sediment disturbance as a result of dredging. Introduction of dissolved oxygen (DO) through disturbance can result in a positive change in redox potential and consequently a reduction in sediment pH (Eggleton and Tomas, 2004). These changes can cause mobilisation and transfer of metals. Within partially oxidised sediments, where the redox potential and DO do not change significantly, the release of metals is negligible (Forstner, 1989). In addition, most released contaminants are scavenged by ferric hydroxide in an oxic environment (Lee and Jones-Lee, 2007) or bind as sulphides or are sorbed onto iron sulphides that were formed under anoxic conditions.
- 9.8.18 Copper is of particular concern within the Humber, with copper classified as 'high' under the WFD. Low mobilisation of metal

contaminants into the dissolved phase during dredging has been observed (De Groote *et al.*, 1998; Van Den Berg *et al.*, 2001) and demonstrated through simulated dredging studies (Bonnet *et al.*, 2001). Resuspension of contaminated sediments due to dredging is therefore assessed to have an insignificant impact on water quality. Impacts on aquatic ecology are discussed in *Chapter 10*.

Changes in ambient water temperature

- 9.8.19 During construction of the quay there is a possibility of changing flow patterns near the intake and outfall structures of the E.On and Centrica power stations with implications for the ambient water temperature. These impacts will not differ from the impacts foreseen during operation as discussed in *Paragraph 9.8.32* and following.

Change to WFD chemical status as a result of dredging and disturbance of contaminants

- 9.8.20 As discussed previously dredging and disturbance of contaminants is likely to have limited impacts on water quality. Impacts to specific contaminants identified under the WFD, such as copper, and those on the current WFD list of Priority Substances will therefore be minimal. The Lower Humber Unit is classified as "Fail" in relation to current chemical quality and the chemical status of the waterbody is not expected to improve by 2015. Impacts due to disturbance by dredging are therefore not significant for the Humber Lower Unit. The North Killingholme main drain is located upstream of the dredge site and dredge disposal site, away from the main dredge plume (*Figure 9.4*). Any contaminants disturbed by the dredging activities will have been diluted to such an extent that there will be no significant impact on WFD chemical water quality of the North Killingholme main drain. Chemical quality of the Harborough Marsh Drain, Skitter Bk / E Halton Bk from Ulceby Skitter to Humber Estuary, Mawnbridge Drain and Laceby Beck / River Freshney Catchment (to N Sea) is not assessed under the WFD.

Site run-off and storm drainage

- 9.8.21 Run-off from the construction site will include rainwater run-off and the drainage of other liquid from the construction site. The uncontrolled release of construction site run-off has the potential to affect the water quality of the Humber Estuary and other nearby water bodies within its tidal range.
- 9.8.22 Particulate matter including dust that may arise during construction activities, particularly where heavy vehicles are used, will be contained

in run-off discharges with the potential to increase the turbidity of the water column at the point of discharge. Uncontrolled run-off discharges also have the potential to cause elevated concentrations of pollutants in the water column where chemicals and materials used in the construction process are able to enter the marine environment. This is particularly true of stormwater flows, which have the potential to cause a sudden influx of sediments and contaminants to the marine environment that may have accumulated in drainage systems and on surfaces over time. Pollutants include fuels, oils and lubricants, heavy metals, chemical oxides, de-icing compounds, and material abraded from vehicles such as tyres and brake linings. Some of these substances may contain toxic or bioaccumulating chemicals such as PAHs, nonylphenols, and heavy metals, which can cause physiological responses in marine organisms including mortality in particularly sensitive organisms and in extreme cases. The volume and composition of run-off discharges will control the magnitude and extent of these potential impacts. The topography of the construction site and the nature of the manufacturing envisaged will limit the amount of suspended matter and associated contaminants that enters the estuarine environment.

- 9.8.23 Site run-off and stormwater will be disposed of through surface water drainage via an outfall pipe into the Humber. This will drain through gravity at low tide and via a new pumping station at high tide, to be installed as part of the proposed scheme for upgrading the Killingholme Marshes drainage system further details of which are available in *Chapter 13*. Additional surface water mitigation measures are identified in *Chapter 13*.
- 9.8.24 Measures relevant to water quality which will be implemented include:
- minimising pollution risk - eg drip trays on mechanical equipment such as pumps and generators, fail-safe bunded storage of fuel and cement and other materials to prevent spillage to groundwater, watercourses or the sea; and
 - construction materials will be prevented from entering watercourses or the sea and blocking either the channels or culverts.
- 9.8.25 Sediment traps may be required to allow any sediment carried by surface water runoff to settle out and be trapped on site, prior to the runoff discharging to inland watercourses or the sea.
- 9.8.26 With these measures implemented, it is unlikely that a significant impact on water quality occurs.

Indirect Impacts to Water Quality from the Construction Phase

Changes to sand quality at Cleethorpes beach

- 9.8.27 The disposal footprint for AMEP is not located close to Cleethorpes beach. Given the distance from the dredge plume to the beach and the predominant direction of sediment plume parallel to the tidal flow no significant impacts will occur. The distance from the dredge plume to Cleethorpes beach is great enough that any contaminants resuspended through dredging will have been diluted or settled out and will not impact on sand quality at Cleethorpes beach.

Changes to Bathing Water quality at Cleethorpes beach

- 9.8.28 The designation of Cleethorpes beach as a Blue Flag awarded bathing beach under the Bathing Waters Directive is a function of its microbiological condition. In order for AMEP to have an impact on Bathing Water quality at Cleethorpes beach, it would have to provide a source of faecal colibacteria or intestinal Enterococci/Streptococci and for that source to contaminate the Bathing Waters at Cleethorpes. The only potential sources of these indicator organisms are sewage discharges from the AMEP construction site, which will be discharged to the mains sewage. Existing sewage treatment works will be upgraded by the statutory undertaker to increase capacity (see *Chapter 13*). The agreed level of treatment will be sufficient to maintain compliance with all relevant legal instruments, there will be no impact to Bathing Water quality from AMEP.

SSSIs, SACs, SPAs, Ramsar

- 9.8.29 The Humber Estuary SSSI units located closest to AMEP are classified as "Unfavourable recovering" due to a sag in dissolved oxygen levels (Natural England, 2011). As previously discussed in the context of the WFD, the construction of AMEP, predominantly the dredge spoil disposal which has the potential for the greatest effects, is not anticipated to impact significantly upon the dissolved oxygen levels within the Lower Humber Unit where AMEP is located. The Humber Estuary, like many others, experiences a seasonal natural dissolved oxygen sag in the upper reaches (ie further into the estuary than AMEP), especially in relation to the Turbidity Maximum Zone (Lee and Jones-Lee, 2007). However, dissolved oxygen levels in the Killingholme area of the Humber Estuary (near AMEP) are reported to be good in general and in comparison to other areas of the river and estuary (Elliot and Boyes, 2005). Considering dredge spoil disposal will occur at regular intervals throughout the dredging period, dissolved oxygen

levels in the water column are likely to recover between dumping events. Any temporary reduction in dissolved oxygen concentration is unlikely to cause major water quality deterioration, even for very short periods. The tidal currents will also reoxygenate water. A study has shown that dissolved oxygen concentrations decrease only slightly (in the study case by approximately 1.5 mg/l) for only a very short time period (recovery of over 90% in less than 5 minutes and recovery of 100% in 10 minutes) when large amounts of sediment containing large amounts of oxygen-demanding materials are dumped in an open water disposal site (Lee and Jones-Lee, 2007). In addition, most released contaminants would be scavenged by ferric hydroxide in an oxic disposal site watercolumn and not affect water quality further. In this particular study, open-water disposal of even contaminated sediments was concluded not to cause water quality problems because of the short exposures (Lee and Jones-Lee, 2007). Dredge disposal related to AMEP is therefore unlikely to significantly impact on dissolved oxygen levels in the Humber Estuary SSSI.

- 9.8.30 The new quay development is not anticipated to impact on the water quality of the North Killingholme Haven Pits. The only pipeline used to control the saline environment of the pits is located within a small inlet to the south of the Humber Sea Terminal and north of Humber Work Boats not on the foreshore. No further impacts on the water quality of the North Killingholme Haven Pits are anticipated.
- 9.8.31 Given the minor impacts to water quality during construction previously discussed no further impacts to water quality are anticipated on the SAC, SPA or Ramsar site. The impacts of any changes in water quality on aquatic ecology and birds are discussed in *Chapters 10 and 11* respectively.

Direct Impacts to Water Quality from the Operational Phase

Power plant intakes/thermal re-circulation

- 9.8.32 Studies into the thermal dispersion of the cooling water from the E.On and Centrica power stations have been undertaken (*Annex 9.2 and 9.3*) in order to assess the extent to which the proposed quay development will alter the existing flow of the thermal plumes and the potential for this to affect water temperatures entering the adjacent cooling water intakes for both power stations.
- 9.8.33 Under existing conditions, the thermal effluent from both outfalls is rapidly dispersed so that the water abstracted by the Centrica intake is likely to be less than 0.1 °C above the ambient temperature. Temperatures at the E.On intake are predicted to be 0.75 °C higher than

current water intake temperatures. With the proposed development in place, these intake temperatures may increase slightly, by less than 0.2 °C for most of the time. Peaks of around a 0.25 °C increase are predicted, with very short duration.

- 9.8.34 Studies have found that the adverse impacts of cooling water outfalls are restricted to an area close to the thermal plume with resulting temperatures of less than 27 °C having no detrimental impacts (BEEMS, 2011). The increase in ambient water temperature at the intake location as a result of AMEP when added to the current baseline temperature remains below 22 °C. The increase in ambient water temperature will therefore have no significant impact.

Thermal effects on WFD water bodies

- 9.8.35 The local increase in ambient water temperature will have no significant impact upon the WFD waterbodies located near to AMEP, specifically the Lower Humber Unit and North Killingholme Pits. The highest current water body temperature identified is 20.8 °C (Table 9.5). A mere 0.25 °C increase in water temperature at the intake implies that the WFD temperature boundary for the whole unit will not be exceeded (Table 9.10).

Table 9.10 UKTAG Proposed boundaries for temperature

	Temperature (°C) (Annual 98-percentiles)			
	High	Good	Moderate	Poor
Cold water	20	23	28	30
Warm water	25	28	30	32

Source: UKTAG (2008)

Drainage of foul water from sewage and trade effluent

- 9.8.36 During operation, there will be foul water drainage from the on-site sanitary systems.
- 9.8.37 Following discussions with the Environment Agency and Anglian Water, foul drainage will be discharged to an improved public sewer network (Annex 9.5). An additional package treatment plant may be used for a small customs office. If a package treatment plant is required a water discharge permit will be obtained prior to any discharge.

Accidental leaks and spills

- 9.8.38 The potential for accidental leaks and spills that may release contaminants into surface waters may occur during the transport of material, shipping or as a result of the wind turbine assembly process

during operation. The impacts of any accidental leakage or spills will depend on the scale and nature of any potential incident and thus is difficult to predict.

- 9.8.39 In order to minimise the impacts of any potential accidents and spill pollution, risk reduction measures such as drip trays on mechanical equipment and fail-safe bunded storage of fuel and other materials to prevent spillage to watercourses may be employed. Temporary sediment traps may be required to allow any sediment carried by surface water runoff to settle out and be trapped on site, prior to the runoff discharging to inland watercourses or the sea.

Litter

- 9.8.40 Workers may increase litter present at and around AMEP, increasing the risk of ingestion by marine species. Mitigation methods to minimise litter and waste are identified in *Chapter 23*. Waste management systems will be in accordance with international standard ISO 14001 (Environmental Management Systems). As a minimum measures to minimise litter will include:

- providing clearly labelled, appropriate containers for segregated collection of materials (including in office accommodation);
- providing appropriate collection and storage facilities for segregated materials and wastes (including flotsam); and
- ensuring the appropriate labelling of wastes to facilitate recycling and appropriate disposal.

Maintenance dredging

- 9.8.41 Maintenance dredging will be carried out as part of AMEP. Sediment modelling by HR Wallingford (as presented in *Annex 8.3*) suggests that maintenance dredging of erodible material will be on a comparable scale with the capital dredging during construction. As impacts to the water column from capital dredging are considered not significant (see *Paragraphs 9.8.11* and *9.8.13* above) the impact of maintenance dredging on water quality is also considered to be insignificant given the scale of maintenance dredging.
- 9.8.42 Maintenance dredging will be kept to a minimum as far as practically possible. The exact method to be used will be determined as part of the statutory consents.

9.9 *SEDIMENT QUALITY RESIDUAL IMPACTS*

Impacts to Sediment Quality

Construction Phase

Capital dredging

9.9.1 During construction the removal of sediment through dredging may result in changes to the composition of surface sediments. A number of heavy metal contaminants, including copper exceed the UK CEFAS Action Level 1 Guidelines (see *Table 9.8*). The removal of sediments through dredging will cause sediment bound contaminants to become widely redistributed within the estuary with a minor portion permanently removed from the estuary with the outgoing tides to coastal waters. The overall impact is not considered to be significant, because of the wide dispersion, and tendency of contaminants to remain bound to or quickly re-adsorb upon dissociation from the sediment. It is unlikely that average sediment quality in any given location will deteriorate.

9.9.2 The dredged sediment will be disposed of at disposal sites within the Estuary. The sediment at the AMEP site contains less contamination than dredged sediments from other harbours within the Humber Estuary that are currently disposed of at the designated disposal sites (see *Table 9.9*). Given the historical legacy of contaminated sediments within the Estuary, the disposal of the contaminated sediments is unlikely to significantly impact sediment quality in and around these sites.

Operational Phase

Maintenance dredging

9.9.3 Maintenance dredging will be carried out as part of AMEP. Sediment modelling (see *Annex 8.3*) demonstrates that the impacts from maintenance dredging will be of a similar scale than those previously discussed in relation to capital dredging for construction. The impacts for maintenance dredging are therefore considered to be limited in relation to sediment quality.

9.10 *CUMULATIVE IMPACTS*

9.10.1 Cumulative impacts arise when impacts from two or more proposed developments affect the same environmental feature. A number of projects have been identified which may have cumulative impacts have

been identified in the proposed vicinity. Of these a number involve dredging activities which may have cumulative impacts on water quality. The following paragraphs highlight potential interactions and base preliminary conclusions on the limited information available. Other projects include:

- the Donna Nook Managed Realignment Scheme;
- ABP maintenance dredging within the Estuary;
- A consent to deepen the sunk dredged channel;
- Green Port Hull (also known as Hull Riverside Container Terminal and Quay 2005), to the south-west of Alexandra Dock in Hull, for which a Harbour Revision Order has been granted;
- Grimsby Ro-Ro Terminal, for a Harbour Revision Order has been granted; and
- Hull Riverside Bulk Terminal for which an application has been made.

9.10.2 According to the Humber Environmental Management Scheme, maintenance dredging takes place on a number of sites throughout the estuary where it is affected by natural cycles in silt deposition and by the weather. Dredging takes place under the Humber Conservancy Acts and the disposal of material is licensed by MMO.

9.10.3 The following maintenance dredging activities may take place within the Humber estuary during AMEP operation:

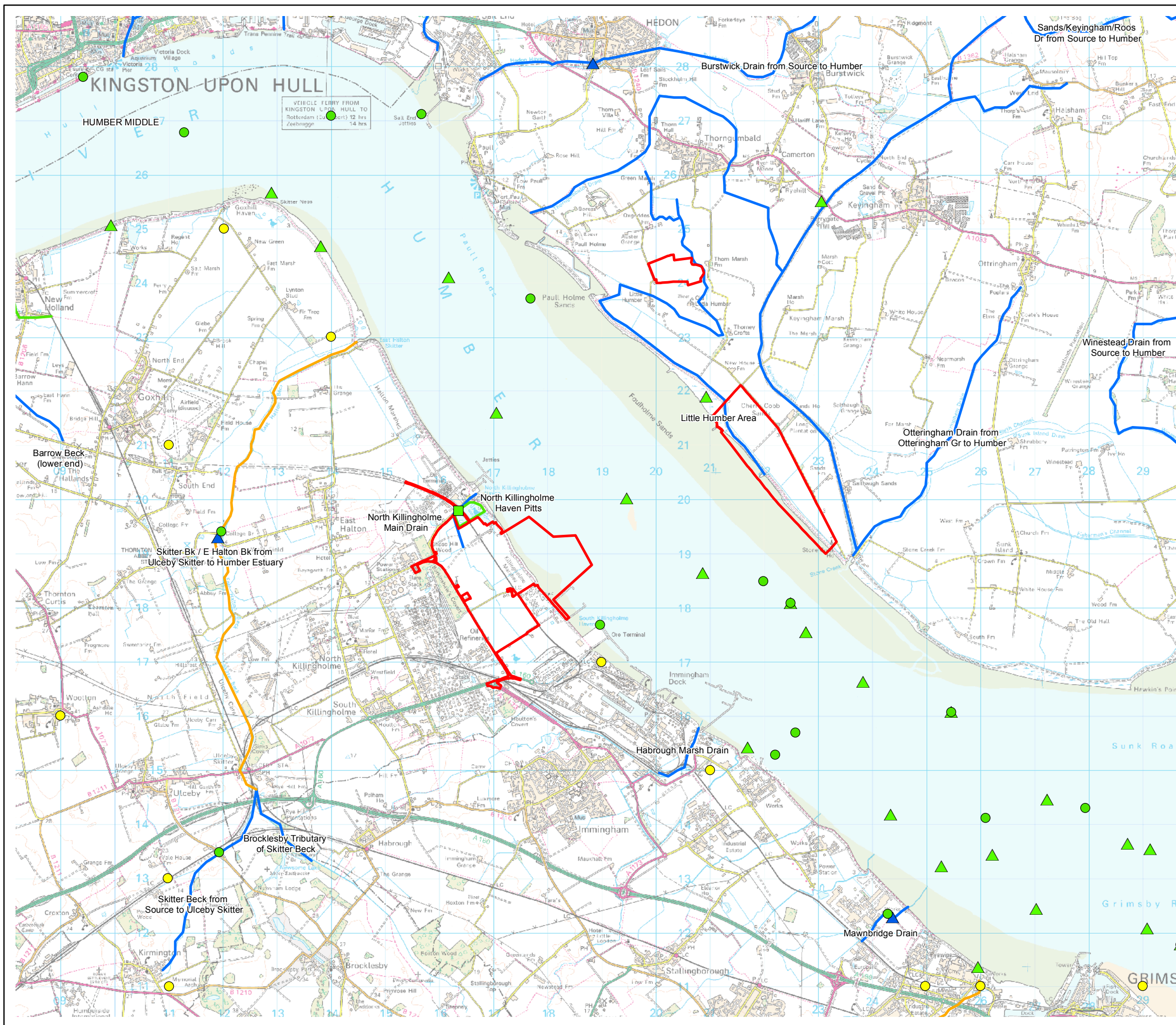
Table 9.11 *Cumulative dredging projects in the Humber Estuary*

Site	Approved?	Description of works	Frequency	Operator
Maintenance Dredging		Managed in accordance with the Humber Estuary dredging protocol.		ABP
Immingham Oil Terminal Approach Channel Deepening	Yes	Up to 4.0m tonnes	Continuous	ABP
Hull Container Terminal				ABP

Site	Approved?	Description of works	Frequency	Operator
Grimsby Ro Ro		Maintenance dredging will be required periodically.		ABP
Hull Riverside Bulk Terminal	Yes	Maintenance dredging will be performed		ABP

9.10.4 If dredging for AMEP were to occur concurrently with the maintenance dredging activities identified above the impact may be exacerbated, in relation to suspended sediment concentrations (SSCs). The cumulative impacts of maintenance dredging are not considered to be significant with regards to increased SSCs and water quality, particularly so since the majority of projects will not overlap in time and space.

9.10.5 The cumulative impact at dredge spoil disposal sites, where material is deposited at a similar time to dredge spoil for AMEP may increase the negative impact on sediment quality at the disposal site however the cumulative impact will remain insignificant as the bulk of the fine sediment and associated contaminants will resuspend and subsequently redistribute on successive tides or become trapped and buried within the sediment matrix at the site.



Key

- Application Boundaries (Red outline)
- WFD - Current Overall Status**
 - Good (Green line)
 - Moderate (Blue line)
 - Poor (Orange line)
- WFD - Current Chemical Status**
 - Good (Green square)
- WFD - Monitoring Points**
 - Previous Biology (Green circle)
 - Previous Groundwater (Yellow circle)
 - Future Biology (Green triangle)
 - Future Chemistry (Blue triangle)

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 PROJECTION: British National Grid

Rev	Date	Comments	Drw	Chk	App
B	01/12/2011	General Amendments	MTC	WB	SP
A	22/01/2010	Preliminary Issues	MTC	WB	SP



Project: ABLE Marine Energy Park
 Client: ABLE UK Ltd
 Title: Figure 9.1
 Water Framework Directive Water Bodies

PRELIMINARY

Scale: 1:70,000@A3	Drawn: MTC	Checked: WB	Approved: SP
Date: 01/12/2011	01/12/2011	01/12/2011	01/12/2011
Drawing No: ABLE_WFD.mxd	Revision: B		

File: 01082724P_MarineEnergyParkGIS_MTC_MKMAPSABLE_Template_MapA3ABLE_WFD.mxd