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Has SEA influenced the development of the Humber Estuary Flood Risk Management Strategy (UK)?

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Abstract

The Humber Estuary drains one fifth of the land surface of England and approximately 300,000 people live within the floodplain which also supports nationally important port and industrial complexes. In the mid 1990s the Environment Agency was responding to deteriorating flood defences in the Humber Estuary through the piecemeal development of 'urgent' refurbishment and improvement projects which were justified locally and did not provide a coherent approach to standards of protection and economic justification. At the same time the Habitats Directive was changing our understanding of the management needs of the Estuary and the designation as a Special Protection Area (SPA), possible Special Area of Conservation (pSAC) and Ramsar Site placed new legislative requirements on the projects being promoted. The failure of individual flood defence schemes to address this and the needs of other stakeholders, led to a loss of confidence amongst the consultees and severe delays in the approval and promotion of urgent flood defence work.

As a consequence the Environment Agency (the body responsible for the management of flood risk in England and Wales) commenced the development of the Humber Estuary Flood Risk Management Strategy to provide a long term plan (100 years) for sustainable flood protection in the Estuary. The Strategy is based upon sound technical, environmental and economic studies and comprises a range of approaches to flood defence that meet the needs of the population living in the floodplain, nationally important industry and infrastructure and the nature conservation interests of the estuary.

This paper shows how SEA has informed the development of the Strategy at all stages and discusses the lessons learned in relation to objective setting, appraisal of 'strategic' impacts, stakeholder involvement and management of environmental risks/opportunities through the hierarchical decision-making process.

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1. INTRODUCTION & STRATEGY DEVELOPMENT

1.1 The Study Area

The Humber is one of the North Sea's principal estuaries with a catchment of 24,472 km^2, approximately one fifth of the land area of England. The catchment's population is nearly 11 million with over 300,000 of those living within the floodplain (**Figure 1**), which is protected to varying standards by existing flood defences. The estuary has the UK's largest ports' complex (Goole, Hull, Immingham /Grimsby) and large clusters of chemical, oil refining, food processing and electricity generating industries. The hinterland of the estuary also supports high quality agriculture and the Estuary itself is renowned for its inter-tidal habitats and bird populations. Its importance for nature conservation is recognised by national and international designations, in particular the inter-tidal areas are designated as a Special Protection Area (SPA) and Ramsar Site, and the entire estuary is also designated as a possible Special Area of Conservation (pSAC). These designations are referred to as European Sites and the UK Government has a duty (under the EU Habitats and Wild Birds Directives to protect them as part of the Natura 2000 network.

1.2 Need for the Strategy

Currently flood protection is provided by 235km of defences largely comprising grassed earth embankments, heavier rock/stone protected banks and sheet piled/concrete walls in port/industrial areas. The defences are generally in reasonable condition, but the standard of flood protection is considered insufficient (or will be in the near future) in places, where defences are low and threatened by overtopping, or where wave action threatens to breach them due to local deterioration. (see **Figure 1 and Photos 1 and 2**).

Records show that **water levels in the Humber are rising**, relative to the land, at a rate of nearly 2mm per year. This rate is predicted to increase as a result of climate change and, unless action is taken, this will increase flood risk in many areas. In addition this is also causing loss of inter-tidal habitats within the estuary due to **coastal 'squeeze'** (i.e. where inter-tidal habitats cannot migrate inland with rising sea levels due to presence of defences).

Historically the management and improvement of flood defences in the Humber Estuary was undertaken in a somewhat *'ad hoc'* manner, schemes for specific locations being developed and promoted independently as the need was identified. This did not provide an integrated and consistent approach to the provision of defences, contributed to some **loss of confidence from key stakeholders**, and resulted in schemes proving increasingly difficult to promote due to the inability to demonstrate that such works would not have an adverse effect on the nature conservation interests of the Estuary.

1.3 Objectives of the Strategy

In 1997, in response to the need for a changed approach to the provision of flood defences in the Estuary, the Environment Agency (who have responsibility for flood risk management in England and Wales) began the process of developing a long-term tidal defence strategy (the Humber Estuary Flood Defence Strategy, hereafter referred to as 'the Strategy') in partnership with organisations such as relevant local authorities, English Nature, Associated British Ports (ABP) and many other governmental and non-governmental organisations. The following broad objectives were identified for the strategy:

- **To develop a coherent and realistic plan for the estuary's flood defences** that is: compatible with natural estuary processes; compatible with adjacent developments, including preferred options for adjoining lengths of frontage; and sustainable, taking into account future environmental changes in sea level and in the climate; and

- To ensure that all proposals are technically feasible; economically viable; environmentally appropriate; and socially acceptable.

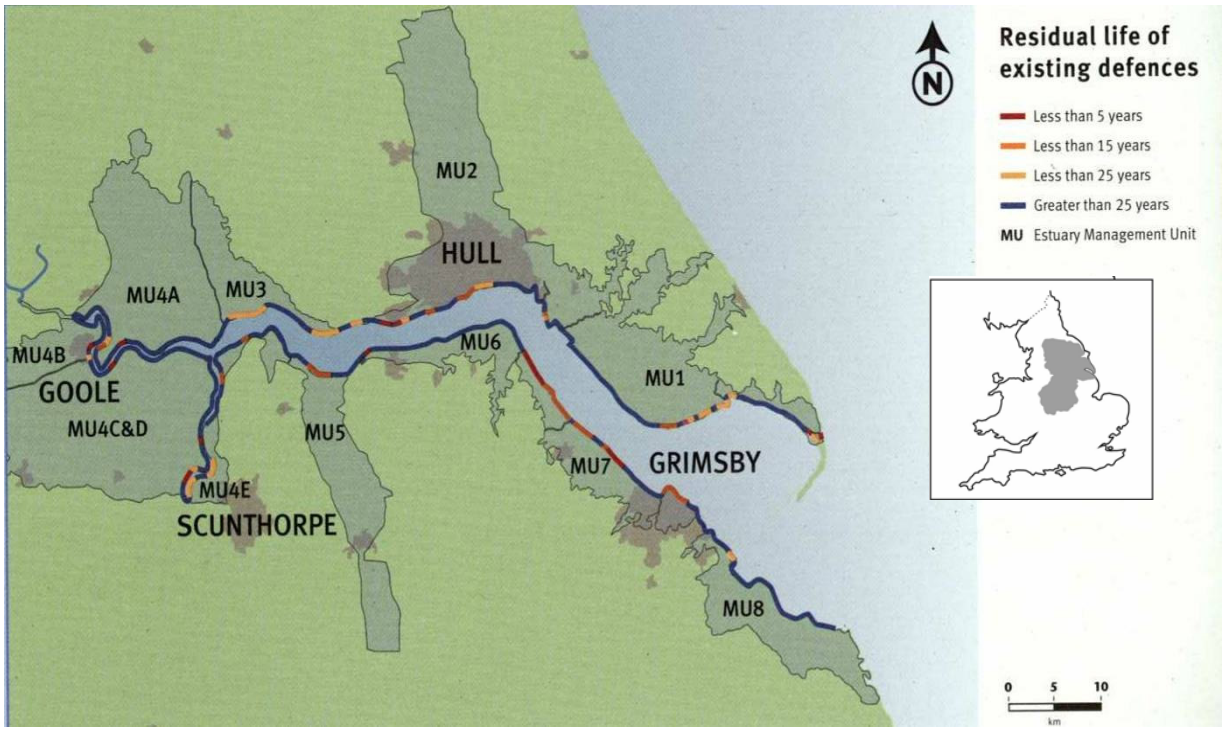


Figure 1 – Map showing the residual life of the existing defences and the study area (divided into management units, MUs) which approximates to the 100 year flood outline. Inset map shows the location of the 'Humber catchment'

Photos 1 & 2 showing deterioraton of the existing defences in the Humber at 1) Paull Village on the north bank and 2) Immingham on the south bank

1.4 Development of the Strategy

(a) Framework for Strategy Development

The Strategy development process is summarised in **Figure 2**, which outlines how environmental considerations, especially those related to the protection and enhancement of the European Site(s), have been integrated at all stages. The stages of strategy development are described further in the following sections.

(b) The Humber Estuary Shoreline Management Plan (HESMP)

In September 2000 following three years of environmental, geomorphological, economic and engineering investigations the first phase of strategy development resulted in production of the **Humber Estuary Shoreline Management Plan (HESMP)**. The HESMP identified the preferred flood management policy for each of the estuary management units. The policies recommended in the HESMP were as follows:

- Hold the existing defences where there is no justification for moving them.
- Identify sites where moving the defences ('managed realignment') will provide flood defence benefits, taking social, environmental and economic issues into account, and establish a programme for moving these defences. Two types of site will be identified.
  - Sites where moving the defences will provide flood defence benefits directly.
  - Sites where moving the defences will provide flood defence benefits indirectly, by reducing the effects of sea level rise.
- Support the creation of new inter-tidal habitat to maintain the estuary's nature conservation status.

(c) The Humber Estuary Coastal Habitat Management Plan (CHaMP)

To inform further Strategy development the Environment Agency and English Nature (with contributions from various other organisations) then prepared a **Coastal Habitat Management Plan (CHaMP)**, to identify actions needed for future management of the European Site in the light of the HESMP conclusions. The CHaMP identified the likely habitat losses, over the next 50 years, associated with coastal 'squeeze' and resulting from reconstruction/maintenance of flood defences where a 'hold the line' policy was proposed. **The CHaMP estimated that over the next 50 years 590ha of inter-tidal habitat would be lost to coastal 'squeeze'**. With additional direct/footprint losses from improvements and maintenance, and allocations for risk, the need for new inter-tidal habitat was identified as approximately 720ha over the next 50 years.

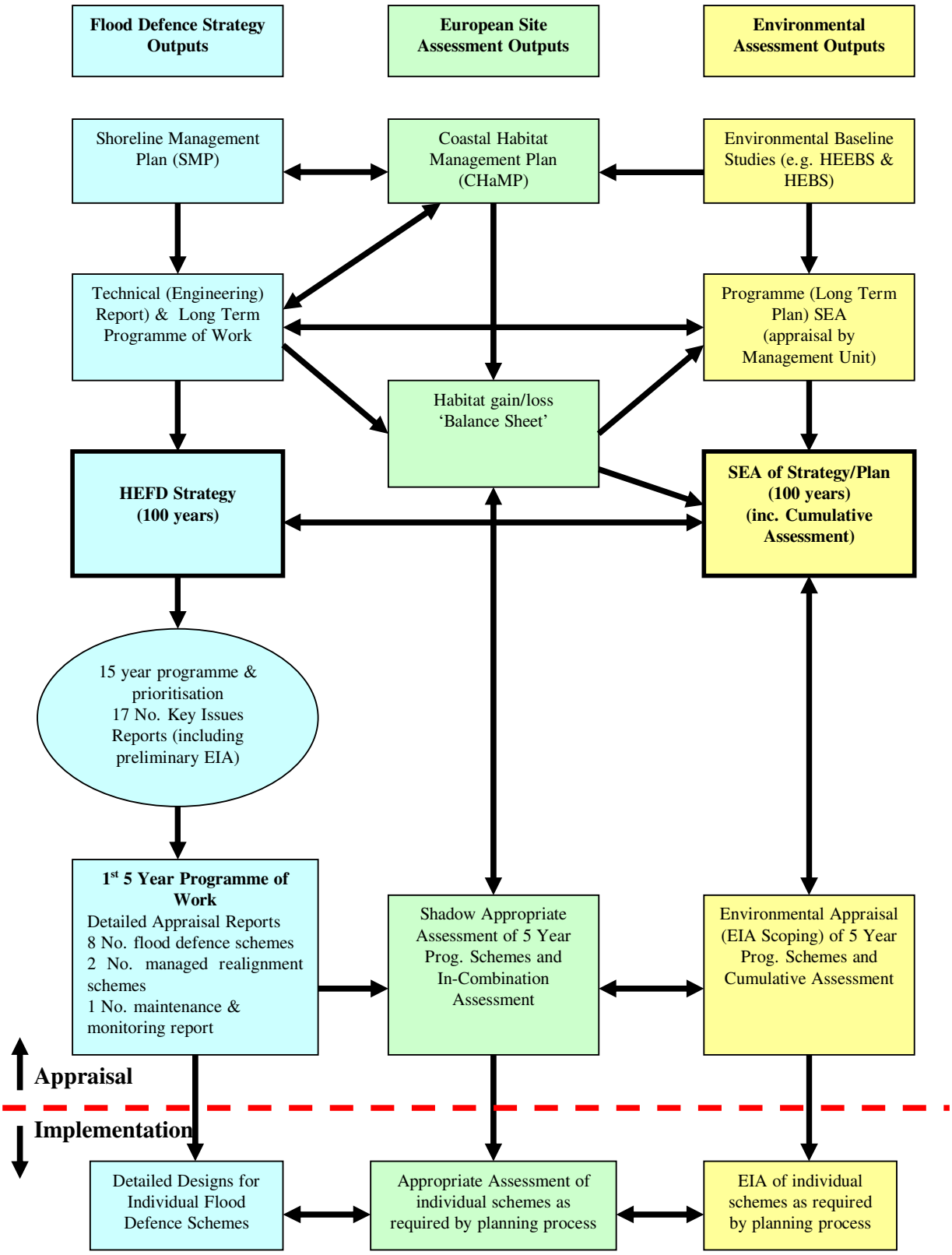
(d) Production of the Long Term Plan

The next stage of Strategy development involved the production of a long term plan (LTP) which identified the works needed over the next 100 years, their priority and the level of investment needed to provide the justifiable standard of protection. An environmental appraisal of the LTP was undertaken, which also included **appraisal of the 'alternative managed realignment sites'** (i.e. areas where the existing defences could be set back to create new inter-tidal habitat and provide flood risk management benefits through reduced costs or reduced water levels e.g. **Photo 3**). Where a lower standard of defence appeared more justifiable opportunities were also sought to identify a number of 'washland/flood storage' areas for inclusion within the Strategy. These are areas where **controlled overtopping of the defences might provide benefits through reducing water levels**, especially in the inner estuary, during times of flood.

(e) Production of a Draft Humber Estuary Flood Defence Strategy

Recent studies concentrated on prioritisation and programming of the works required over the next 100 years, and the development of the first five-year package/programme of work, which can be presented for Government funding. This process has been documented as a Draft Strategy and an SEA Environmental Report (as discussed further in this paper) was produced to accompany this and to provide a basis for public/stakeholder consultation. Public Consultation on the 'draft' Humber Flood Risk Management Strategy was started in August 2005.

Figure 2 **Humber Estuary Flood Defence Strategy Framework for Environmental Assessment**



1.5 SEA: Context & Approach

Following the adoption of the European Community Directive on *'the assessment of the effects of certain plans and programmes on the environment' (2001/42/EC),* the requirement for Strategic Environmental Assessment (SEA) in England and Wales was formalised in July 2004 with the publication of *The Environmental Assessment of Plans and Programmes Regulations 2004 (SI 2004 1633).*

Statutory SEA is not required for Flood Risk Management Strategies, but the Environment Agency is applying the process as a matter of internal policy and government guidance, and intends as far as possible to follow the statutory requirements as a demonstration of environmental leadership and best practice.

It is important to realise that in 2004 when the decision was made to apply a more formal SEA process to the development of the Strategy a number of key decisions had already been made. However these decisions were not made in the absence of any consideration of environmental issues. In fact environmental appraisal had been central to the development of the Strategy thus far. This can be illustrated with reference to Figures **2 and 3,** and the following sections which demonstrate how a 'tiered' approach to environmental appraisal and risk management evolved and provided a sound framework for Strategy development.

Figure 3: Management of environmental risk through 'tiering'

Tier 1: Humber Estuary Shoreline Management Plan
The development of the HESMP, which set the 'policy' with regard to flood risk management, was supported by:

- Development of a strategic (GIS based) environmental baseline (specifically addressing key areas of estuarine geomorphology, inter-tidal habitats and archaeological/heritage value).
- Production of the CHaMP, which identified the key ecological issues (including inter-tidal habitat creation requirements) to be addressed/considered, and by
- Extensive consultation with key stakeholders and the public (with regard to preferred policy options and their alternatives).

Tier 2: Long Term Plan and Strategy Development
The development of the Strategy and Long term Plan was an iterative process, the options for each management unit being investigated within the constraints of the policy decisions taken earlier. Decisions were supported by high level environmental appraisal of options for each location and publication of an SEA Report dealing with the implications of the preferred 100 year strategy. The Draft Strategy and SEA Report are currently out to public consultation before finalisation of the Strategy.

Tier 3: 5-Year Programme/Package of Work
For the purposes of funding and implementation the first 5 years of priority schemes for the Strategy were identified and examined in more detail (akin to preliminary EIA or scoping level investigation) to ensure their promotability and stakeholder support. A shadow 'appropriate assessment' was also conducted to demonstrate how the schemes will address requirements of the Habitats Regulations. The results of this appraisal were published as an annex to the SEA Report.

Tier 4: Projects/Schemes
It is understood by all stakeholders that the majority of the individual flood risk management schemes will require planning permission, EIA and formal 'appropriate assessment' to gain consents prior to implementation. However the strategic studies have already dealt with the key environmental risks and outlined how these will be managed through detailed design, consenting and implementation.

As mentioned earlier, by the time it was decided to formalise the SEA process within the development of the Strategy many key decisions (including selection of preferred options) had been made. Thus there was the potential for the SEA process to lose value and become a **simple 'box ticking'** exercise. The remainder of this paper explains how the SEA of the 'preferred option' was used to:

1.6 Consultation

Consultation was central to the development of the Strategy to ensure that a wide range of stakeholders were drawn into the development process and to promote support within these. In summary the key consultation groups have been:

- The Steering Group – an extensive group of around 25 key organisations drawn from relevant statutory and non-statutory consultees, set up to allow consultation on and review of documentation and progress.
- The Liaison Panel – a smaller group of key organisations, comprising a subset of the Steering Group, set up to help make decisions on approaches to consultation etc.
- Landowners and tenants – specific consultation exercises and documents were aimed at this group, mainly in connection with the potential managed realignment and flood storage sites.
- Other organisations and the wider community – organisations not represented on the above groups were consulted at 'formal stages' as were the wider community, through documents and newsletters.

Issues raised during the various consultation exercises and used to inform Strategy development included:

- The need to make clear links between the Strategy and the CHaMP and to maintain a record of predicted/actual habitat gains/losses.
- The requirement for consideration of the effects of the Strategy in combination with the plans of others.
- The need for clear prioritisation of the work programme based on understanding of risk.
- The potential for major managed realignment schemes to have adverse effects on navigation interests through changed estuary processes.
- The difficulty in explaining the impacts of a 100 year strategy to the public – i.e. decisions made now that have significant consequences in perhaps 20 or 50 years time.

2. SEA OF THE HUMBER FLOOD RISK MANAGEMENT STRATEGY

2.1 Approach to SEA

The approach to SEA of the draft strategy comprised:

- Establishment of a strategic environmental baseline, examination of other relevant plans and programmes and identification of key environmental issues;
- Development of SEA objectives and appraisal criteria against which the Strategy could be tested
- Assessment of the impacts of the preferred schemes on achievement of the SEA objectives using a source-pathway-receptor approach;
- Examination of cumulative impacts; and
- Consideration of implementation issues such as mitigation, monitoring, strategy review and management of uncertainty

2.2 Environmental Baseline and Key Issues

The review of the existing environment within the study area identified key environmental issues as follows:

Population & human health- safety, security and social/physical well-being for 300,000 people living in the floodplain; commercial interests, population and properties are concentrated within the urban areas of Hull, Goole and Immingham/Grimsby; industrial and port facilities are located at Hull and Immingham.

Land use- most of the land surrounding the estuary is farmed (amongst the most fertile in the country) and there are close links to food production industries in Hull and Goole; standards of protection and flood frequency will have an impact on quality of land for farming; the ports are vital to both regional and national economic well-being; to achieve the regional economic vision, and the ports and associated businesses will need opportunities to develop in the estuary and on the land nearby.

Flora, fauna and biodiversity- the estuary is designated at an international level (pSAC/SPA/Ramsar Site) for its nature conservation importance; there are a number of international, national and local designations landward of the existing defence; maintaining the defences on their current alignment will result in the loss of inter-tidal habitats in front of the defences as a result of coastal 'squeeze'; the Strategy must 'compensate' for direct inter-tidal habitat losses but, more importantly, through managed realignment schemes provides an opportunity to replace coastal 'squeeze' losses, and meet requirements of the CHaMP.

Archaeology & cultural heritage- the estuary and its floodplain contain a complex array of historic buildings, settlements, landscapes and known archaeological sites that are a fundamental component of the regional identity; there is a risk that Strategy implementation will be affected by 'unknown' or buried archaeological interests.

Recreation & amenity- there are a significant number of formal and informal recreational and amenity facilities around the estuary and options should seek to maintain and, where possible, enhance these facilities; these features are not generally significant at the strategic level, other than perhaps with regard to the extensive footpath around the Estuary which is often facilitated by existing defences.

Landscape- Spurn Head is designated as an area of Heritage Coast; at a local level there is the potential for schemes to bring about landscape changes (e.g. managed realignment schemes potentially resulting in agricultural land reverting to inter-tidal habitats) however the nature of the effects at individual locations is very subjective.

Material assets- the study area contains the Humber Bridge and a number of major transport routes, including motorways, trunk roads and national railway lines, linking urban centres and rural communities; a number of major services such as high pressure gas pipelines cross under the Estuary.

2.3 Impact of 'do nothing'

SEA guidance suggests that the environmental effects of the **'do nothing'** scenario should be reviewed (i.e. in the absence of the Strategy and with no future work or maintenance of flood defences). The key effects of this scenario were summarised as follows:

- Progressive deterioration of defences and increased likelihood of overtopping.
- Coastal squeeze and erosion of the foreshore and undermining of defences due to sea level rise.
- Failure of defences over time resulting in progressive inundation and abandonment of flood cells.
- Loss of property, businesses and employment.
- Pollution and health risks.
- Changes in the water level regime and associated impacts on navigation.

This would result in **major negative** impacts on human beings, land use, material assets and the historic environment. Immediate impacts on biodiversity and the European Site could be severe through pollution risks for example, although recovery of the natural environment in the long term might create benefits.

SEA guidance also suggests that the environmental effects of the **'business as usual scenario'** should be reviewed i.e. in the absence of the Strategy there would be no planned improvement to the flood defences but there would be continued maintenance and urgent repair of defences. In the long term impacts would be

similar to 'do nothing' and there would be **major negative** impacts on human beings, land use, material assets and the historic environment.

2.4 Impact of the Humber Estuary Flood Defence Strategy

The 'draft' Strategy published in August 2005 comprises preferred approaches (prioritised over time) for each of the flood management units. Strategy components may be summarised as:

- Do nothing (locally)
- Hold the line schemes;
- Managed realignment schemes;
- Strategic flood storage or water level management schemes; and
- Maintenance, inspection and monitoring programme

The following sections examine the nature of the environmental impacts associated with the Strategy components and outline the plans for mitigation and further investigation. A summary of the assessment of impacts in relation to the Environmental Objectives and appraisal criteria developed through consultation and examination of key issues is provided in **Table 1**.

a) Do Nothing

In a small number of locations where the costs of 'holding the line', either now or in the long term, are not justified the preferred approach identified in the draft Strategy is to 'do nothing' or 'do minimum' whilst further investigations and consultations are carried out to establish long term implications and approach.

At present the key adverse impact of this decision is the creation of **uncertainty in the minds of the local community and land owners**. The potential long-term abandonment of defences is likely to result in gradually reducing (over time) standards of protection to local people and property leading to reduced sense of safety/security and well-being, reduction in property value, difficulties with insurance and, in time, requirement for relocation. Investigations/consultation is still ongoing with respect to final decisions for these few locations. These will concentrate on public awareness and understanding, estuary-wide equity, individual property flood protection or proofing, alternative funding for protection, exit strategies.

b) Hold the line schemes

This remains the only practical approach to managing the defences over the majority of the estuary frontage, especially where they protect densely urbanised and industrialised areas e.g. Goole, Hull and the Immingham-Grimsby-Cleethorpes area. Works may include raising the height of the defence where crest levels are low, improvement of the toe or seaward face of the defence, or installation of a cut off (normally sheet piling) to prevent seepage.

Key adverse environmental effects (and agreed mitigation) of these components were identified as:

- **Permanent loss of inter-tidal habitat** (approx. 21ha) within the European Site, over the next 50 years due to increased defence footprint. All efforts will be taken to minimise this and compensatory habitat will be provided within the Strategy as a requirement of the Habitats Directive.

- **Temporary encroachment and disturbance of inter-tidal habitat and birds** - 27ha temporary construction area and 108ha of adjacent disturbance (noise etc.). Foreshore works will be programmed to avoid wintering bird activity and new inter-tidal area will be created to mitigate/compensate.

Key beneficial impacts of these components were identified as improved longevity and standard of protection from flooding leading to:

- **Continued protection of local and regional heritage sites** (e.g. monuments and historic buildings).

Table 1: Summary of Appraisal of Strategy against Environmental Objectives

Strategic Environmental Objectives	Sub-Objectives	Indicators	Do-nothing (strategic)	Components of the Strategy			
				Hold the line	Managed Realignment	Flood Storage & Washlands	Maintenance
To protect and, where possible, enhance **flora and fauna (biodiversity)**	To minimise adverse effects on the European Site(s) and ensure direct losses are compensated (3:1 ratio- to be reviewed)	Area of inter-tidal SPA/pSAC habitat lost (or gained) due to proposal	- - 50 years + + + >100 years	- - -	+ +	+ / -	- -
	To address the adverse effects of 'coastal squeeze' on the European Site(s)	Area of habitat creation sufficient to replace losses identified in the CHaMP	+ +	- - -	+ + +	+ / -	-
To protect the **historic environment**	To minimise adverse effects on undiscovered or buried archaeology	Area and quality of 'potential' archaeological assets threatened	+ / -	+ / -	+ / -	+ / -	+ / -
	To protect designated archaeological and historic features within the floodplain	Numbers of SMs and other designated features protected from adverse effects of flooding	- - -	+ + +	+ / -	+ / -	+ +
To respond to **natural processes** and to avoid contamination and erosion	To ensure proposals do not have adverse effects on wider estuarine processes	Indirect inter-tidal habitat losses and / or adverse effects on navigation	- -	+ +	-	+ /-	+ / -
	To ensure that 'contaminated sites' are prevented from having an adverse effect on the Estuary	Potential for pollution of estuary from contaminated sites	- - -	+ +	+ / -	+ / -	+ +
To protect and where possible enhance **landscape, amenity and recreational** values	To ensure characteristic and valuable landscapes are protected & enhanced and recreational or amenity features are protected & promoted where possible	Damage/loss OR creation/enhancement of valuable features	- -	+	+	-	+
To protect and, where possible, provide opportunities for **economic development and employment** (including protection of existing land uses where appropriate)	To protect high quality agricultural land from flooding	Area of land agricultural land protected.	- - -	+ + +	-	- -	+ +
	To protect areas of employment from the adverse effects of flooding and provide a secure environment for economic activity and development	Numbers of commercial business and jobs protected	- - -	+ + +	+ + +	+ +	+ + +
To protect existing **transport infrastructure** (land and sea)	To ensure there are no adverse effects on navigation (e.g. on channels, deepwater docks and beacons etc)	Adverse effects on navigable channels / dredging requirements etc	+ / -	+ + +	+ / -	+ / -	+ +
	To prevent adverse impacts of flooding on road and rail infrastructure	Length of road and rail and accesses protected	- - -	+ + +	+	+ / -	+ + +
To maintain and, where possible, enhance public **safety, health and security**	To protect people and their property from the adverse effects (physical and psychological) of flooding	Numbers of people protected	- - -	+ + +	+ +	+ +	+ + +

Impact Significance		---	Major negative	+++	Major positive
-/+	Negligible impact or minor positives and negatives	--	Moderate negative	++	Moderate Positive
0	Not Applicable	-	Minor negative	+	Minor Positive

- **Protection of existing and future land uses and economic security** (e.g. agriculture & industry) to appropriate standards.

- **Protection of 300,000 people living within the floodplain**, providing them with an improved sense of security and well-being.

c) Managed realignment schemes

The Strategy acknowledges the need to create new inter-tidal habitat to meet the requirement for 'compensation' and replacement arising from habitat losses associated with 'hold the line' works, and coastal squeeze (as identified in the CHaMP). Subsequent to the review of a number of potential managed realignment sites, six schemes were identified for promotion. One such scheme has already been completed (**Photo 3**), one is in development and four more are planned for completion before 2040 (**Figure 4**). These schemes meet the primary purpose of replacing inter-tidal habitat to maintain the estuary's conservation value, but in cases provide flood storage that will help manage water levels during serious floods.

Key adverse environmental effects of the 'managed realignment' components were identified as:

- **Direct loss of approximately inter-tidal habitat** (approx. 10ha), within the European Site. Although significant in isolation, it is considered unavoidable if the larger habitat gains are to be secured and the requirements of the CHaMP met.

- **Changed estuarine geomorphology or processes may lead to indirect habitat losses** elsewhere in the estuary. As scheme designs are produced the geomorphological models will be used to refine designs to gain maximum benefit and to minimise adverse effects.

Key beneficial impact of the managed realignment schemes is:

- **Significant inter-tidal habitat creation in the order of 600 to 900ha** (depending on later scheme selection and design). An initial scheme at Paull Holme Strays has already created 80ha of inter-tidal habitat and a further 170ha at Alkborough is currently under construction. These schemes provide the replacement habitat requirements identified in the CHaMP, which are needed to address losses occurring from ongoing coastal 'squeeze' and from construction of 'hold the line' works.

d) Flood storage and water level management schemes

Water level modelling has shown that the provision of washlands or flood storage for extreme events reduces the water levels in the estuary upstream of the Humber Bridge. As sea levels rise flood defence standards in the estuary will decrease, but it is anticipated that the water level reduction effects of flood storage can be used to maintain standards over much of the estuary for many years. The key locations for provision of flood storage/water level management benefits are shown on **Figure 4**.

The key adverse environmental effect of 'flood storage and water level management' schemes is:

- **Periodic flooding of land**, which in areas of informal storage may result in locally significant adverse impacts on current land uses, users and owners, with potential for adverse effects on house prices, the local economy and on the 'well being' of small numbers of people living within the targeted areas. Further investigations of these schemes are required before affected parties can be identified and a consultation programme implemented to address local concerns, compensation arrangements etc.

The key benefit is that 'flood storage and water level management' components will lead to:

- **Reduction in water levels over adjacent urban areas during severe flood events** (especially in the upper estuary) providing increased longevity of existing, or improved, standards of flood protection for approximately 100,000 people, and important port and commercial areas. The benefits of water level reduction also allow deferral of expenditure on improving defence standards in other locations.

e) Maintenance inspection and monitoring programme

Detailed proposals for monitoring and maintenance have been made to ensure that the life of existing and new defences is maximised. This will reduce overall expenditure on flood defences and reduce the environmental impact of more frequent major construction works. Both the maintenance programme and method statements need to be developed in detail, in collaboration with relevant stakeholders, to minimise the impacts of the work, whilst controlling costs.

The key adverse environmental effect of the 'maintenance' activities is:

- **Damage/loss of inter-tidal habitat** (approx. 10ha) within the European site over the first 5 years as a result of the application of stone for erosion control. Subsequent 'top up' stoning would be within the existing footprint of these works. The Strategy provides compensatory habitat for maintenance losses.

The key beneficial impact of the 'maintenance' programme is in maintaining standards of protection and maximising the life of the defences leading to:

- **Protection and continued well being of 300,000 people**, their property and the port/commercial interests within the floodplain. Maintenance work will also defer further capital expenditure.

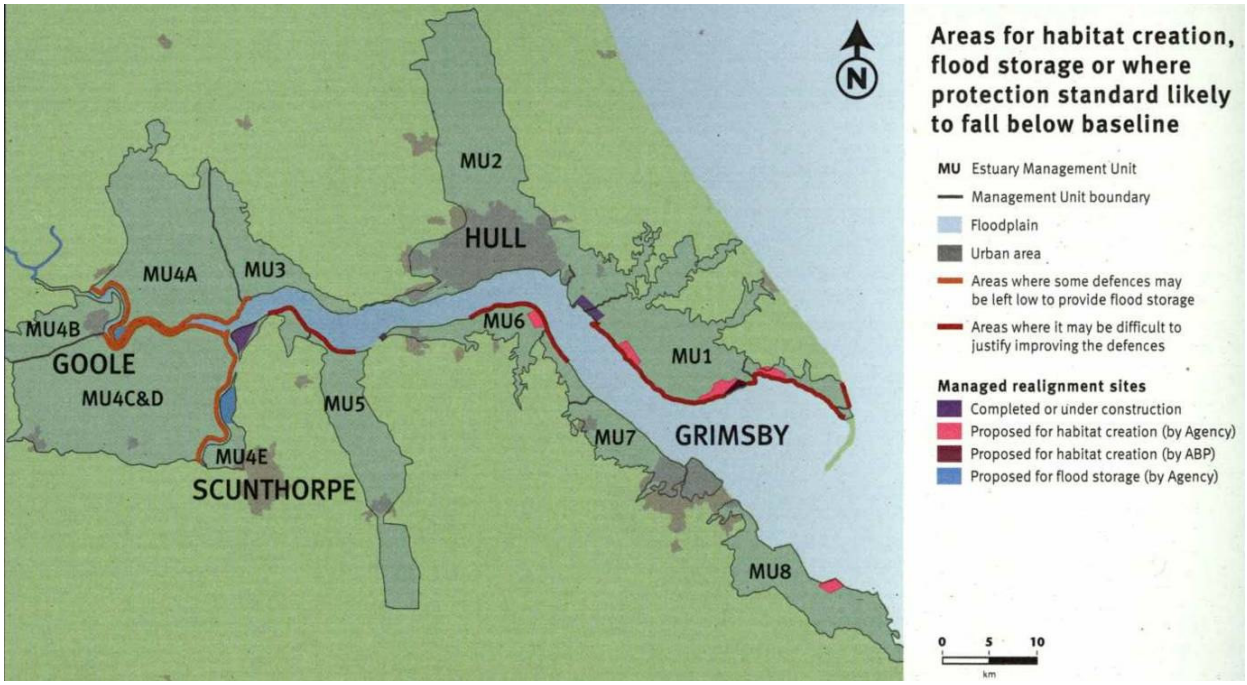


Figure 4: Managed realignment sites and areas where 'hold the line' (with a high standard of protection) is not justified and thus controlled overtopping and flood storage is being considered.

2.5 Assessment of cumulative effects

An appraisal of cumulative effects identified the following:

- No significant synergistic or cumulative effects, within the strategy, are anticipated, given the spatial and temporal distribution of the proposed works.

- No significant synergistic or cumulative effects were identified in relation to other Environment Agency activities such as adjacent flood risk management strategies, but this must continue to be reviewed.

- With regard to the plans of other parties within the estuary it was noted that:

- Improved flood protection afforded by the Strategy is likely to have a positive effect on promotion of existing and future 'terrestrial' development plans in the floodplain. The impact of these developments on the will need to be managed through the planning and EIA process.

- A second area of potential in combination effect is provided by 'wet-side' estuary-related development e.g. port developments. These were included alongside flood management in the geomorphology studies that supported the CHaMP forecasts of habitat losses.

- Continued liaison with the port authority and other developers is needed to ensure that any in-combination effects of temporal/spatial overlap are minimised through appropriate programming.

3. STRATEGY IMPLEMENTATION & MONITORING

3.1 Managing Environmental Risk and Uncertainty

The SEA was based on certain assumptions with respect to the future development or change in baseline conditions that will occur over the next 50 to 100 years i.e. the life of the Strategy. Thus there are considerable **areas of uncertainty that require monitoring or investigation** to inform the Strategy review cycle. These include:

- **Rate of sea level rise** - the Strategy and the assessment of its impacts are based on an average 6mm/yr rise in sea levels over the next 50 years. The 6mm/yr is likely to be a conservative rate and habitat replacement is likely to be more than adequate and standards of protection better than anticipated.
- **Changes in agriculture** – The Strategy assumes a continuation in the current trend of agricultural over-production and low land prices. Should this change agricultural land could become more valuable thus threatening future managed realignment sites and areas of long term abandonment.
- **Changes in nature conservation legislation** – There is potential for the interpretation of existing legislation to change through European/National case law and create changes to the requirements for habitat/species protection and habitat replacement.
- **Changes in the assumed economic development scenario.**
- **Changes in the assumed rates of population growth and migration**.

Key issues within the EIA of individual schemes were also highlighted and include those areas where potential environmental risks have been passed down for investigation at this next 'tier'. These include:

- Presence of unknown/buried archaeological remains;
- Presence of undocumented areas of contaminated land;
- Natural and social constraints to washland schemes;
- Presence of protected species.

3.2 SEA Monitoring Plan

A key component of the Strategy is the plan for maintenance, inspection and monitoring, which includes details for proposed monitoring of the condition and standard of defences etc. This also includes an SEA Monitoring Plan which includes a set of **estuary-wide and site specific monitoring proposals that will inform the Strategy review process**, allow update of habitat/loss balance sheets etc., monitor compliance with the CHaMP as well as with the impact predictions made in the SEA. A summary of the SEA monitoring plan, in relation to the predicted impacts and uncertainties is provided in **Table 2**.

3.3 Strategy Review Cycle

There is considerable uncertainty as to the requirement, priority and programme of works outside the first 15 years identified within the 100 year Strategy. This uncertainty, and that provided through certain assumptions regarding development, sea level rise etc., will be managed through regular review (5-year cycle) and full revision/update (15-20 year cycle) of the Strategy. Any requirement for 'emergency' or

'urgent' works as a result of unexpected changes in condition of the defences will be progressed and approved in the normal manner and subsequently fed into the Strategy review process.

3.4 The Way Forward

The Draft Strategy and the SEA Report were made available to key stakeholders and the public in August 2005. The **comments and concerns of consultees will be collated and taken into account** before finalising the Strategy and seeking approval from Defra (Government body responsible for funding flood defences) for implementation in spring 2006. Before implementation, **a 'post adoption statement' will be produced** updating consultees and the public with regard to any changes made to the Strategy as a result of consultation on the Draft or as a result of internal or Government review.

Following agreement and implementation of the Strategy, detailed designs and investigations to support approvals for the component schemes will be needed. These may include EIA, 'appropriate assessment' (under the Habitats Directive) and planning permission.

Photo 3 – The Paull Holme Strays managed realignment site on the north bank of the Humber showing how new inter-tidal habitat has been created by retiring the defence line and breaching the old defence embankment

Table 2: SEA Monitoring Plan: Summary

Strategic Objective	Sub-Objectives	Indicators	Significant Environmental Effects	Summary of Proposed Monitoring
To protect and, where possible, enhance **flora and fauna** (biodiversity)	To minimise adverse effects on the European Site(s) and ensure direct losses are compensated (3:1 ratio, subject to review)	Area of inter-tidal SPA/pSAC habitat lost (or gained) due to proposal	Permanent loss of SPA/pSAC inter-tidal habitat due to hold the line schemes; ongoing coastal squeeze and 'capital' stoning. Creation of inter-tidal habitat via managed realignment schemes.	Monitoring of the quantity of inter-tidal habitat losses and gains using: • High and low level LIDAR survey - annual • Aerial photography – (at least on a 5 yearly basis) • CASI – every 5 years • Update/review and circulate 'habitat balance sheet' on a 5 yearly basis
	To address the adverse effects of 'coastal squeeze' on the European Site(s)	Area of habitat creation sufficient to replace losses identified in the CHaMP	Inter-tidal habitat creation	Long-term monitoring and annual reporting of development and quality of inter-tidal habitats created within the managed realignment sites through: • Aerial and fixed point photography • Saltmarsh, benthic macro-invertebrate and bird surveys • Survey of other specific habitats created
To protect the **historic environment**	To minimise adverse effects on undiscovered or buried archaeology	Area and quality of 'potential' archaeological assets threatened	Potential to unearth or damage buried archaeological features.	No strategic monitoring required but during preparation of detailed designs appropriate assessments will be carried out including where required: • Detailed desk studies • Geophysical surveys and field walking • Invasive trial pit/core surveys. • Watching briefs and reporting
To respond to **natural processes** and to avoid contamination and erosion	To ensure proposals do not have adverse effects on wider estuarine processes	Indirect inter-tidal habitat losses and / or adverse effects on navigation	Changed estuarine geomorphology.	Potential and actual changes in estuary processes and morphology will be investigated and monitored through: • Refining of geomorphological models for use in detailed designs • Annual LIDAR and bathymetric monitoring.
	To ensure that 'contaminated sites' are prevented from having effects on the Estuary	Potential for pollution of estuary from contaminated sites	Potential to unearth unrecorded land contamination and threaten water quality.	No strategic monitoring required - During detailed design and scheme promotion ground investigations (boreholes & trial pits) will be carried out to investigate the risk of encountering contamination problems.
To protect and enhance **landscape, amenity and recreational** values	To ensure characteristic and valuable landscapes and recreational/amenity features are protected/enhanced	Damage/loss or creation/enhancement of valuable features	No strategic effects	No strategic monitoring required
To protect and, where possible, provide opportunities for **economic development and employment**	To protect high quality agricultural land from flooding	Area of land agricultural land protected.	Change from agricultural land to inter-tidal habitat (managed realignment schemes).	No monitoring strategic monitoring proposed except possibly in relation to 'washland' schemes where appropriate designs and required monitoring are still to be developed.
	To protect areas of employment from the adverse effects of flooding and provide a security for economic activity/development	Numbers of commercial business and jobs protected	Existing land uses protected providing security to users and allowing economic development.	No strategic monitoring required.
To protect existing **transport infrastructure** (land and sea)	To ensure there are no adverse effects on navigation (e.g. on channels, deepwater docks and beacons etc)	Adverse effects on navigable channels / dredging requirements etc	Changed estuarine geomorphology.	See monitoring proposed for **'natural processes'**.
	To prevent adverse impacts of flooding on road and rail infrastructure	Length of road and rail and accesses protected	Traffic disruption; road closure or rebuild (diversion).	No strategic monitoring planned.
To maintain and, where possible, enhance public **safety, health and security**	To protect people and their property from the adverse effects (physical and psychological) of flooding	Numbers of people protected	Improved sense of security from flooding and improved standard of protection.	Numbers of people and property protected by the schemes, and to what standard, will be monitored and used to inform the 5 yearly strategy review.
Uncertainty and cumulative impact assessment	The monitoring here is not objective/impact driven but will be carried out to test assumptions and investigate areas of uncertainty in order to inform the 5 yearly strategy review process.			To provide information for Strategy review the following will be monitored: • Sea level rise and Habitat losses due to coastal squeeze • Integration of other plans and projects (EA and others)

4. KEY FINDINGS AND LESSONS LEARNED

4.1 Impacts of the Strategy

- The SEA indicates that **the Strategy will provide an appropriate standard of protection from flooding to the majority of people and material assets within the floodplain** and will not conflict with plans for economic development.

- **The Strategy and SEA have provided a clear framework for the development, promotion and approval of individual schemes** that has previously been lacking. This has been appreciated by the key stakeholders in the region who have found it difficult in the past to comment on and consent schemes on a 'piecemeal' basis.

- The 'hold the line' and 'maintenance' components have potential for major negative impacts on the European Site (inter-tidal habitats and birds), but this is balanced through **provision of 'compensatory' habitat creation**.

- The 'managed realignment' components of the Strategy provide major benefits in meeting the needs of habitat creation identified in the CHaMP and **ensuring the long term integrity of the European Site** in the presence of sea level rise.

- The 'flood storage and water level management' components of the Strategy represent a 'sustainable' approach to flood management but there is considerable uncertainty associated with the local impacts on people and property. None of these schemes will be implemented within the next ten years and it is apparent that further investigation and consultation is needed during this time. Urgent work is needed to reassure people and landowners in these areas for whom **'uncertainty' creates concern and stress.**

- The 'do nothing'/'do minimum' approach being advocated at a few locations also requires urgent consultation (local people) and further investigation to **manage community awareness, stress and expectation.**

- In areas where a positive decision is being made to 'do nothing' or reduce the current standard of protection it is possible that 'human rights' challenges may be made on the basis that people who have been protected may have some **'legitimate expectation' to continued protection**. These complex issues and those of social impact, relocation, compensation and timing of exit strategies are currently being investigated in association with a number of coastal locations.

4.2 Consultation and Participation

- Rising sea levels mean that coastal flood protection is becoming increasingly difficult and costly to deliver. This is one driver for the more 'risk based' approach to flood management that is now being favoured in the UK. **Stakeholders, including the public, need to be made more aware** of this change and the implications with regard to where they choose to live and how they can manage the effects of flooding at a community/household level.

- During the course of this, and other strategic flood risk management studies, it has become apparent that **involving stakeholders and the general public in a participative way is not easy**. They are used to, and comfortable with, the nature of consultation within the EIA process, which provides a greater level of certainty with regard to what, how and where something will happen. Involving people at the strategic level often results in them asking questions about the detail (**'my back yard'**) that cannot always be answered.

- The public (and consultee bodies) need to be given **greater awareness of the concepts of 'flood risk' and 'management of uncertainty'** especially over the life of a 50-100 year strategy, if they are to contribute fully.

- There are also **logistical challenges associated with consulting hundreds of thousands of people** living within the influence of a strategy or plan area. The use of web-based information is helping in this regard but needs to be used within a toolbox of approaches that truly 'involve' people in decision making rather than simply informing them.

- The strategic consultative approach has however **restored key stakeholder confidence** in the flood risk management process.

4.3 Has SEA influenced the development of the Strategy?

Although 'formal' SEA was applied to the development of the Humber Estuary Flood Defence Strategy, somewhat late in the process it is apparent, on examination, that **strategic environmental appraisal has played a significant part throughout**. This is best demonstrated by the way the Strategy has sought to deal with the Habitats Directive issues in the estuary. The Strategy has taken on wider Government objectives and will secure the long term integrity of the site through planned habitat creation. This could never have been achieved under the historic 'piecemeal' approach to flood defence management.

The approach that has evolved illustrates the concept of 'tiering' in the management of environmental risk during the different stages of strategy/plan and scheme development.

The more formalised approach to SEA of the Draft (preferred) strategy **has not been a simple 'box ticking' exercise** it has provided a number of positive outcomes, including:

- A clear picture of the impacts of the Strategy and the mitigation/management measures agreed as a consequence;
- A clear framework for future EIA and approvals;
- A detailed environmental monitoring plan; and
- A means of conveying this to a wider audience.

5. SUPPORTING DOCUMENTATION

1. Environment Agency (1999). Humber Estuary Environmental Baseline Study. Black & Veatch Consulting Ltd
2. Environment Agency (2000). Planning for the Rising Tides: The Humber Estuary Shoreline Management Plan, September 2000.
3. Environment Agency (2002). The Humber Estuary, Consultation on Managed Realignment: Information for Landowners and Tenants, June 2002.
4. Environment Agency (2003b). The Humber Estuary, Update on Managed Realignment, July 2003.
5. Environment Agency (2004). Humber Estuary Coastal Habitat Management Plan. Black & Veatch Consulting Ltd, March 2004.
6. Environment Agency (2004). Humber Estuary Tidal Defences: Alkborough Tidal Defence Scheme Environmental Statement. Halcrow Group Ltd, November 2004.
7. Environment Agency (2005) Humber Estuary Flood Defence Strategy, 'Shadow' Appropriate Assessment. Black & Veatch Consulting in alliance with Halcrow Group Ltd.
8. Environment Agency (2005). Planning For the Rising Tides- The Humber Flood Risk Management Strategy, Consultation Document, August 2005.
9. English Nature, May 2004. European Sites Guidance - Internal Guidance to Decisions on 'Site Integrity': A Framework for Provision of Advice to Competent Authorities.
10. Humber Forum (2004). Humber Trade Zone: World Class Opportunities. Business Plan.