ENVIRONMENT AGENCY
Anglian Region

SUFFOLK ESTUARINE STRATEGIES

RIVER BLYTH

STRATEGY REPORT
Volume 1 Main Report

November 1999

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ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES

PHASE II – REPORT A

BLYTH ESTUARY

Volume 1 – Main Report

November 1999

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INTRODUCTION

1.1 THIS REPORT

The Environment Agency have responsibilities for flood defence management under the Land Drainage, Water Resources and Environment Acts. In undertaking these responsibilities, to protect life and reduce risk to assets, the Environment Agency are keenly aware of their further obligations to the human and natural environment. Because of the close interaction and the possible far reaching impacts on the physical regime, the need for careful and co-ordinated flood defence management and the discharge of their other duties is nowhere more evident than within estuaries.

The Environment Agency, prompted by growing concern over several imminent problem areas on flood defence, commissioned the development of a long term strategy for three of the Suffolk estuaries; the Blyth, the Alde/Ore and the Deben[1]. Although each of the estuaries have very different characteristics, there is a need for a common and consistent approach in establishing the strategy.

The strategies, while concentrating on the policy for flood defence, necessarily take into account the broad diversity of interests associated with the estuaries. The development of a long term, high level, defence policy will provide an essential framework for the future physical management of each estuary; a framework from which other management plans for individual areas or for the management of specific aspects of estuary use can be developed with confidence.

This document is one of three reports, each report covering one of the three Suffolk Estuaries (Figure 1.1).

1.2 PROJECT BRIEF

The aim of an estuarine strategy as identified in the project brief, is to produce a sustainable and balanced framework for the future management of the estuary as a whole, reflecting natural processes, planning pressures, current and future land use, flood defence needs, and environmental issues.

The study areas in the three estuaries extend from the upstream tidal limits (as designated by the Ministry of Agriculture, Fisheries and Food) to the estuary mouths. The landward limits are provisionally identified as those lines following the limit of an approximate 1:200 year water level.

The key requirements in developing the strategies identified in the brief, are to:

- Assess the estuary morphology
- Consider the interaction with the management of the adjoining open coast, which is the subject of the Lowestoft to Felixstowe Shoreline Management Plan

[1] Consideration was given as to whether this strategy development should be extended to the estuary of the Orwell. It was decided against this on the grounds that the Orwell is a much larger estuary (of an order of magnitude greater than any of the three estuaries included within the study). This would have introduced significant differences in approach which might have resulted in obscurantism of what was already recognised as being a process of some complexity. The Environment Agency is involved with various detailed studies of the Orwell, and the development of a long term strategy for the estuary will be considered at an opportune time in the near future.

- Identify and quantify assets adjacent to the estuary shorelines that are likely to be affected by the estuary morphology and its management
- Identify and evaluate human and other environmental influences, aspirations, opportunities and potential conflicts which may affect or arise from policy recommendations
- **Produce an estuarine strategy – based on the generic flood defence policy options of Do Nothing, Hold the Line, Advance and Managed Realignment – that will provide a management framework for the estuary.**

In the process of developing the strategies, the following issues are considered:

- Estuarine processes
- The natural environment
- The human and built environment
- Economic benefits and costs
- Planning and land use
- Coastal and flood defence
- The Estuary/Open coast interface
- Future monitoring and studies
- Consultation.

1.3 CONTEXT

The Lowestoft to Felixstowe Shoreline Management Plan (SMP) adopted in 1998, provided recommendations for the management of defences along the open coast. These considered the generic defence policy options of Do Nothing, Hold the Line, Retreat and Advance. Although the SMP recognised the influence of the rivers flowing into the coast, no study of their physical processes or management was undertaken. The Suffolk Estuarine Strategies project is therefore required to produce a continuous and coherent management strategy for the whole of the Lowestoft to Felixstowe Shoreline.

The recommendations from both the Suffolk Estuarine Strategies and the SMP will be used by the Environment Agency (flood defence) and Local Authorities (coast protection) in their long term planning and budgeting. The strategies will identify specific areas which require attention. These areas will then be the subject of a detailed project appraisal, or similar study, and extensive consultation. It is only following this more in-depth investigation that specific schemes will be undertaken.

1.4 BASIS FOR RECOMMENDATIONS

The appraisal of potential flood defence policies has been based on the consideration and integration of three key factors. Policies for specific areas are assessed on the basis of:

i) Economic viability (to the Nation), considering tangible assets;
i) Environmental impacts and opportunities;
i) Social acceptability;
i) Technical feasibility.

These are then reviewed in the context of the adjacent length of river, and the estuary as a whole. In doing this it is possible to achieve a balance between the three key factors, on an estuary-wide basis.

1.5 BACKGROUND

Reclamation of mudflats and saltmarsh in the estuaries, for agriculture, probably began in Roman Times but most significantly expanded during the 16th and 17th centuries with the enclosure of the high marshes. This reclamation continued through to the mid 19th century, when, certainly in the case of the Alde/Ore and Blyth Estuaries, but far less so in the case of the Deben, the estuaries were effectively canalised channels over much of their length.

The physical constraint imposed upon the natural form of the estuaries by reclamation was maintained and, in areas, reinforced through to the 1930's. During the earlier part of this century there was greater questioning of the economic justification for defence; brought about, partly, by an increase in formal national funding of schemes. Even so the general attitude was still to safeguard coastal and estuarial land at almost any cost.

The catalyst for significant change was the storm of 1953. Many of the embankments within the estuaries were breached, in places exposing the instability of old defences which had been raised as the demand for defence standard increased. The 1953 storm exposed the vulnerability of the situation, demonstrating that some defences were being perpetuated on borrowed time. In spite of this, even after 1953 the philosophy was still to maintain the status quo. As a consequence there was a wholesale response of repair; an action which proved to be futile in several areas as significant lengths of defences had to be abandoned during the 1960's, predominantly on the Blyth and the Alde/Ore.

The 1953 storm had the effect of "weeding out" the more vulnerable defences. These defences, although sensible in relation to the specific local problems, were constructed with little apparent regard to the overall physical structure or environment of the estuaries.

Despite a conscientious programme of maintenance and repair to defences, undertaken by the Environment Agency and its predecessors the present situation is possibly as critical in some areas as it was in the early 1950s: although the nature of the problem is somewhat different.

The pressures on the estuaries have increased. There is a greater appreciation of the value of the natural environment, reflected in international and national legislation. There is increased use of the estuaries for recreation and sport, and coupled to this a greater reliance of local economies on this use and the tourism it generates. In addition, there has been continued investment in agriculture and infrastructure. In many instances these assets or areas of interest are only sustained by defences; agriculture and freshwater habitats being maintained metres below sea level, water sports being carried out in channels defined by defences. Despite this, solely in terms of present use, activity and interest, it is a situation which is seen, by those consulted, as being relatively in balance. Only in terms of maintaining these uses does conflict arise; a conflict with the physical processes and with the way in which the form of the estuary wishes to evolve in the future. It is, therefore, an inheritance of use and interest which is artificially maintained at a considerable cost; a situation which is inherently out of balance with the physical processes at work, an imbalance which may become worse as the estuaries continue to respond to past change and to the impact of sea level rise and other external change.

The Environment Agency, with their dual role of defending assets from flooding and having due regard for the conservation of the natural environment, have appreciated the need to manage these responsibilities in the context of each estuary as a whole.

The Environment Agency understands that the current situation must be reviewed. Rather than allow a new balance to be developed by default, there is a need to develop a

long term strategy which aims to maintain the balance between human and environmental interest while achieving a more sustainable balance with the physical processes. This must be done in conjunction with those who have interests in the estuaries.

The first phase of developing this strategy involved a detailed study of the physical nature of each estuary. This study, undertaken by ABP Research and Consultancy Ltd in 1996 collected and collated physical data. Through the use of modelling it established a basic understanding of the estuary processes at work. Phase 2 of the work has been undertaken by Posford Duvivier in association with HR Wallingford. This report draws upon the findings of both phases of work and, in conjunction with and working within the framework developed in the Shoreline Management Plan for the open coast, goes on to explain the manner in which a strategy for the estuary has been developed and how this strategy may be implemented.

The main report has attempted as far as is possible with such a complex issue, to remain concise concentrating on the development of the strategy. Specific and localised description of the estuaries and the technical workings of the project are included in appendices.

1.6 REPORT STRUCTURE

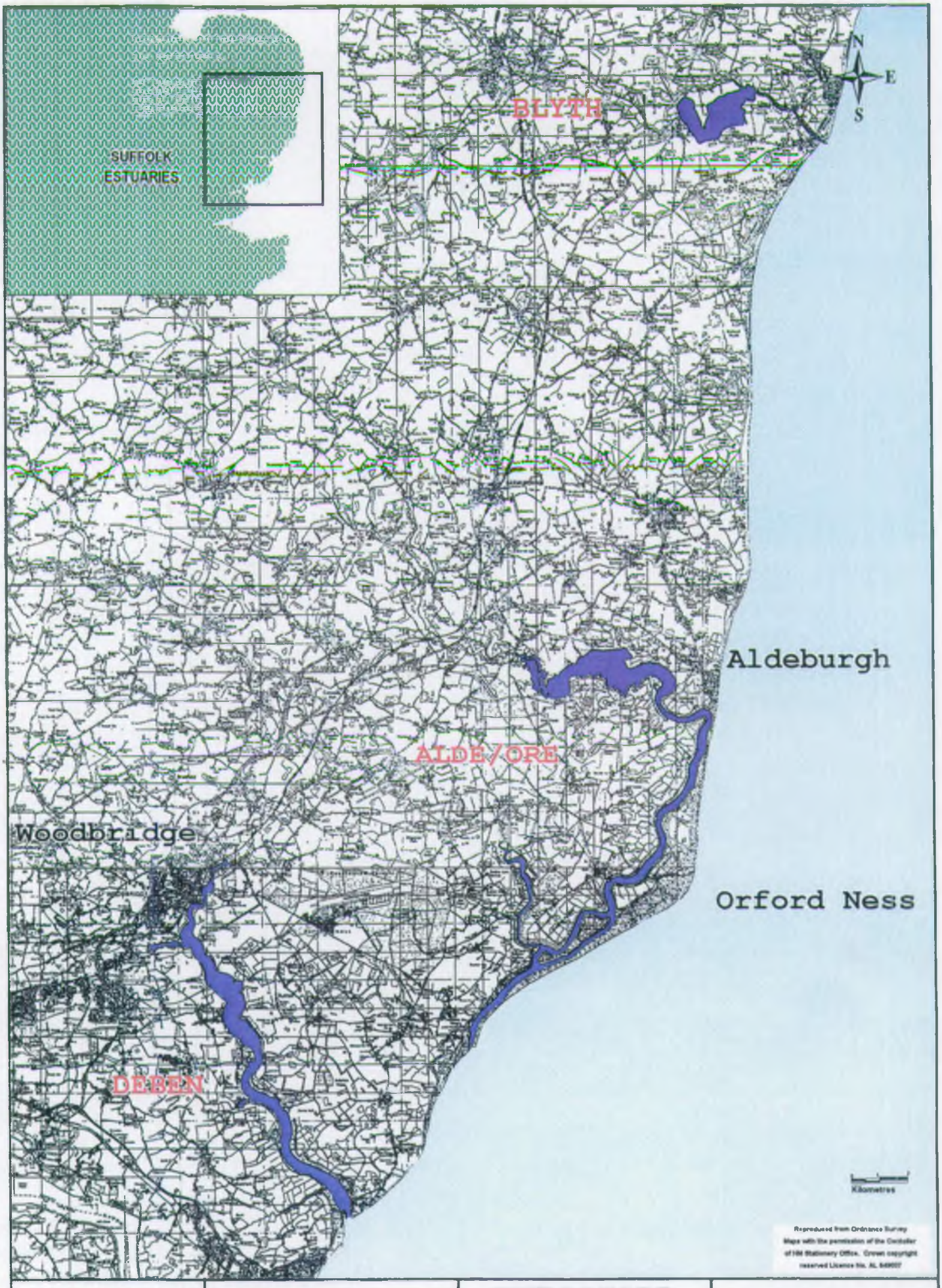
Section 2 provides an overall description of the estuary, drawing out key features of the physical, natural regime and other relevant issues. It then identifies the present and possible future problems.

Section 3 describes the human, built and natural environment in the estuary. In doing so it identifies the key habitats and species in the estuary, and the conservation designations protecting them.

Section 4 explains the basic principles, aims and objectives that have been formulated and used in the development of the strategy. Based on this, the section goes on to explain the manner in which the Estuary may be divided into zones and more local flood compartments. This process of division provides a framework for the development of the strategy. This ensures that local detail is considered during the development process. It also ensures that the overall appreciation of how each zone works, is influenced by or influences, the estuary as a whole is taken into account in developing the estuary's future management.

Section 5, drawing upon the results of the detailed analysis presented in the appendices, examines each section, or zone, of the estuary and explains the evaluation of a preferred policy for defence.

Section 6 sets out a number of requirements for the future management of the estuary, summarising the recommended strategy for each flood compartment, and identifying a programme and pathway of future work required to implement the strategic recommendations.



ENVIRONMENT AGENCY	SUFFOLK ESTUARINE STRATEGIES PHASE 2	POSFORD DUVIVIER In association with HR Wallingford	SUFFOLK ESTUARIES LOCATION PLAN FIGURE 1.1

ENVIRONMENT AGENCY	SUFFOLK ESTUARINE STRATEGIES PHASE 2	POSFORD DUVIVIER In association with HR Wallingford	BLYTH ESTUARY	FIGURE 2.1

SECTION 2

DESCRIPTION OF THE ESTUARY AND EXPLANATION OF THE PROBLEM

2.1 DESCRIPTION

2.1.1 General Description

Extent

The strategy area extends from Blyford Bridge to the mouth of the estuary at Southwold and Walberswick Harbour and covers all adjacent land below the 5m AOD contour. The study also considers all areas associated with or influenced by the use or regime of the Blyth Estuary. The basic area is shown on Figure 2.1.

General ownership
Land use around the estuary is predominantly agricultural and is largely in private ownership. Since the introduction of the Suffolk River Valleys ESA, some areas of previously arable farmland have been reverted to pasture, although around the southern half of the estuary arable farming still dominates.

General designations
The Blyth is located within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty and is a designated Heritage Coast. The Blyth estuary is also contained within the Minsmere-Walberswick SSSI, which is a Special Protection Area and Ramsar site. Counts of overwintering waterfowl on the estuary over the past decade confirm that the Blyth is now nationally important for overwintering black-tailed godwit and pintail and in some winters internationally important for overwintering avocet. Tinker's Marsh is an important area of grazing marsh and one of the best localities in Suffolk for breeding waterfowl.

Upstream boundary of estuary
The tidal limit of the River Blyth is at Blyford Bridge, near the village of Blyford. Upstream of this bridge, the river is freshwater.

2.1.2 Description of the Estuary

Upper Reach - Blyford Bridge to Blythburgh Bridge
Between Blyford Bridge and the A12 at Blythburgh Bridge, the estuary comprises a relatively narrow channel confined within flood banks and surrounded by low lying farmland (marginally below Mean High Water Spring (MHWS) tide level), typically 300 to 500m in width. There is a tributary valley running up towards Thorington. The overall shape of the main valley is dictated by the spur of high ground pushing down from Union Farm. Upstream of this the river channel is relatively uniform to the point of being canalised. Below Union Farm, to Blythburgh bridge the line of the banks follow more the twist and turn of a natural small river. While these banks do not completely constrain the main river channel, enclosing as they do backwaters and reed beds, they leave little room for natural development of the channel. The land is contained within the Suffolk River Valley's Environmentally Sensitive Area. Properties tend to be located around the edge of the flood plain within the 5m contour. Their position is often such that, without detailed land survey, it is difficult to judge what possibility there is of these properties being flooded. The flow within the river channel is slow, peaking at about 0.2m/sec for an hour on the later part of the ebb.

Blythburgh Village is built generally above the 5m contour on a ridge of high ground constraining the estuary valley between here and Spring Hill to the north. The estuary channel is further constrained by the flood banks protecting the A12, cutting across the floor of the valley and confining the channel through Blythburgh Bridge. Flows locally can be in excess of 0.75m/sec.

Central Reach - Angel and Bulcamp Marshes
Below the Blythburgh bridge the natural Estuary's intertidal valley has been reinstated by the abandonment of the Bulcamp and Angel Marsh defences in the 1960s. The old defences are still evident but are eroding. However, they still act to control the course of the low water estuary channel. As above the bridge, these old defences follow the meandering course the river adapted when the defences were constructed.

Seaward of the bridge, the estuary valley is forced southward by the ridge of high ground on which Bulcamp House is situated, before it expands to the north into Bulcamp Marshes. The main channel runs to the southern side of the valley following the old course of the New Cut. This is again an area where defences have been abandoned. The old agricultural drainage ditches of the Bulcamp Mashes may still clearly be seen cutting across this now large area of mud flat, indicating little sediment movement or accretion.

At the western end of this section of the estuary, as well as on the eastern side of Bulcamp House ridge are two small areas of land defended by embankments; the latter of these two areas containing Bulcamp House itself. Over the rest of the area tide runs up to natural high ground which in general rises steeply from the extreme tide level to the 5m contour. The A12 at the far western end of this area acts as a flood barrier but has a history of flooding under more extreme water level conditions.

Lower Central Reach – Reydon and Tinkers Marsh
To the eastern end of this open section of estuary the channel is again constrained, to the south by Tinker's Marsh and to the north by the Reydon Marshes. The old defences impose more control on the channel, the course being dictated by the old long and sweeping meanders adopted by the river when the original defences were first constructed. These defences force the channel north of Tinker's Marsh area and the flows within the main channel increase as the river becomes more constrained.

To the north of this area the spur valley of Wolsey Creek enters the main estuary; the Wolsey valley opening out upstream of the Wolsey Bridge to define a large area of low lying land stretching up towards Wangford and west back towards the A12. The actual entrance from the Wolsey Valley to the Blyth Valley is now confined by the western enclosures of the Reydon Marshes. Wolsey Creek itself hugs the defences of the Reydon Marshes, joining the main channel where the Blyth returns to a course fully constrained by defence banks.

The banks to either side of the Blyth over this Tinker's Marsh/Reydon section describe a series of wide bends down to the Squires Hill bridge. The land to either side, extending typically back from behind the defences some 500 to 700m, is generally below mid tide level (some 1.2m below MHWS) and is bounded by steeply rising land to the 5m contour and above.

The defence banks to the river are generally fronted by a 2 to 3m plateau of intertidal saltmarsh (at a level close to MHWS). These widths, important both as natural features and as an integral part of the defence system, have been significantly eroded in several places along this reach of the river. This erosion coupled with the fact that the channel bed over this section is more consistently deeper than anywhere else along the river has led to serious problems of instability resulting in the forward slumping failure of the defences. The problem has become acute in places along the Reydon frontage, but is clearly developing along the

Tinker's Marsh length as well. Typical flows within this reach peak over high water at about 0.7m/sec in an upstream direction and are in excess of 0.7m/sec for several hours shortly after the ebb.

To the south of the estuary channel Tinker's Marsh has been managed as a fresh water pasture habitat and is considered one of the most distinctive habitats of the estuary. This is reflected in its nature conservation designations. This area is divided by the Tinker's House embankment, potentially isolating the western section of the marsh from the main area towards Walberswick. At the eastern end of Tinker's Marsh the lowland cuts south in a valley along the eastern side of Squires Hill. This branch of the main marsh is of particular environmental interest due to the more gentle slope of the land and the progression of habitats from the heathland of Walberswick Common through to the fresh and brackish pasture of the river bank.

The Tinker's Marsh embankment most particularly along its western end, facing out to the Bulcamp Marsh area, is the lowest level of flood defence within the estuary; the crest is only marginally above MHWS.

The land to the north of the river is predominantly arable and is dissected by the slightly embanked Quay Lane and further west by a ditch and bank. These cross banks effectively divide Reydon Marshes into three areas. In addition to the important agricultural value of the land there are features of local historical significance such as the old wind pump.

Harbour Reach – Southwold and Walberswick Harbour
At the south eastern end of Reydon Marshes are the Busscreek Marshes leading into Botany Marshes and, between Reydon and Southwold, around to the open coast at the Easton Marshes north of Southwold. While of little agricultural value this valley is of significant environmental interest and houses the main sewage works for the area.

The pipe carrying sewage from Walberswick to the works runs through Woodsend Marsh crossing the river by a bridge and running in embankment to link to the high ground of Squires Hill north of Walberswick. The bridge spans the last major elbow in the course of the Blyth before the river runs in a virtually straight canal the final 1.5km to the sea.

The river through this final reach of the estuary is at first tightly constrained directly between the flood defence banks. Further downstream the defences on the northern flank are retired behind a 20m wide margin upon which are the buildings constructed around Southwold Harbour. An unmetalled access track runs the full length of the harbour, separating the various buildings and shacks from the river frontage and moorings.

On the southern side the flood defence fronts more directly on to the channel with only isolated and narrow patches of salt marsh where the line of the defence moves slightly back from the river channel. At Walberswick the main line of defence retreats from the river, leaving isolated buildings constructed on the wide supertidal margin just inside the harbour mouth.

On this southern side the harbour entrance is fixed by a piled breakwater, open where it protrudes from the coast and constructed as a closed structure along the face of the river. This section inside the river mouth is now in poor condition, being undermined and collapsed in places. The breakwater and inner harbour wall is supported on the southern side by a concrete seawall built within and along the line of the dunes at the entrance. This wall acts to prevent outflanking of the southern breakwater and inundation of the Walberswick Pool, the area bounded by flood defences to the south, the village of Walberswick and the few harbour buildings to the west, and the inner section of the breakwater to the north. Severe incursion

has been made into this pool area through the gaps in the southern harbour wall, and the pool has grown and deepened over the last few years.

Further upstream from the village, on the southern side, the bank protects Robinson's Marshes and comprises pastureland below mean tide level. This land is divided from Tinker's Marsh by Squire's Hill and the sewage pipe embankment to the bridge.

To the north of the river are three sections of land all below mean tide level. Starting at the bridge these are the Woodsend Marshes, the large area of the Town Marsh and the narrower neck of Havenbeach Marsh situated directly behind the Denes, the open coast dune system. All of the marshes are predominantly pasture. Woodside Marshes, divided from Town Marsh by the slightly embanked road to Southwold Common, includes areas used by Southwold Golf Club. The road is an important link to the properties and facilities of the harbour avoiding the need for harbour traffic to pass through the narrow streets of the town. Access to and through the harbour is one of the priority issues of the AONB management plan.

The Town Marshes are an important habitat used by migrant and breeding birds, whereas a major part of the Havenbeach Marshes are taken up with a caravan park. The Havenbeach Marsh area also includes a row of properties along the Denes Road which are below spring high water. Most of the other properties within this potential flood area, as with other property around the fringe of the estuary in general, are within the narrow band between the estimated extreme flood line and the 5m contour. The clear exception to this are the properties in Walberswick and the undefended properties lining Southwold Harbour.

The northern control of the Estuary mouth is the north breakwater. This structure was recently strengthened and repaired, but the quay section within the mouth of the river is still considered vulnerable due to scour, which is believed to be causing movement of the structure. This quay, in addition to forming the river-face protection to the flood bank to Havenbeach Marshes also acts in part to hold the dune frontage and stop potential outflanking of the seaward section of the breakwater. The two structures of the Estuary mouth severely constrain the width of this mouth, maintaining a well swept and deep entrance channel. Velocities in the entrance channel to the harbour are of the order of 0.8m/sec on the flood and almost 1.3m/sec on the ebb.

The general area behind the harbour, despite the presence of the caravan site, is considered of important visual value, counterpointing the high ground of Southwold itself and the amenity area of Southwold Common and Golf Course. The harbour of Southwold and Walberswick are of vital importance to the local fishing industry and to the tourism upon which the local economy heavily relies. The main harbour area and Walberswick are linked across the water and by the pipe bridge 1.5km upstream. This area of the Estuary, more possibly than any other, is an integral economic unit, closely aligned to the health of the Southwold/Walberswick economy. The unit provides direct employment, a cultural context, an important tourist and visual attraction as well as providing important visitor accommodation in the form of the caravan park.

The Shoreline

The coast to either side of the Estuary mouth has been the subject of the development of the Sub-Cell 3C Shoreline Management Plan. The Plan identifies the strong influence of the harbour breakwaters on the retention and passage of material along the coast, and this is developed and discussed further in Appendix B.

The shore to the north comprises a wide sand shingle beach backed by dunes extending south from the strongly defended headland of Southwold. The dune strip, the Denes is retained and has grown and stabilised since the construction of the north breakwater. The Denes forms the seaward flood barrier to the Havenbeach Marshes.

To the south the frontage consists of a narrow sand shingle beach backed initially over the first 500m south of the harbour, by dunes, but giving way to a narrow maintained shingle embankment. The dunes and the rear of the south breakwater are, as described earlier, supported against breach under extreme storm conditions by a concrete seawall. This wall is at present largely buried.

Behind the shingle bank, further south are Old Town Marshes and the Dingle Marshes, towards Dunwich. In terms of the direct link to the Estuary, the only connection between the flood compartment of Robinson's Marsh and the areas protected by the open coast is around the north and east-side of Walberswick. This low lying area is protected by retired flood banks around the village. Possibly the linkage of greater significance is the control the harbour mouth provides to the shape of the coast and the impact of the Estuary on sediment movement along the shore.

The SMP has defined management units along the coast which recognise this linkage. Management Unit BEN 7 is defined as extending over the Denes, the harbour mouth and the area immediately south of the harbour. Management Unit MIN 1 extends south from the limit of BEN 7 to just north of Dunwich. The policies defined for these units are Hold the Line (HTL) for BEN 7 and Managed Re-alignment (R) for MIN 1. The impact of this and a review of these policies is considered in the development of the Estuary Strategy.

The only other section of coast directly associated with the Estuary is to the north of Southwold where there is a potential flood route through to the Estuary north of Squires Hill pipe bridge. This coastal length is included within Management Unit BEN 6 and falls within the overall policy for Southwold of Hold the Line.

2.1.3 Physical Parameters

The Phase 1 report on the Estuary provides a thorough description of the results of modelling and measurement work undertaken and provides the fundamental assessment of the estuarine processes. During the work undertaken in Phase II further consideration has been given to these physical processes with particular regard to the continuing evolution of the estuary and the potential impact various scenarios for defence may have on the estuary as a whole and on individual sections in particular. A report on this is included as Appendix B. This sub-section of the report provides a key point summary of the physical parameters affecting the management of the estuary.

River Inflow

Fresh water input to the Estuary under normal conditions is minimal in relation to the saline input. (Mean river flow is $0.38m^3$/sec compared to peak tidal flow of the mouth of $200m^3$/sec). During spate, river flow may increase to $7m^3$/sec. The estuary processes are driven by the influx of tidal saline water (Appendix B).

Water Level

Tidal levels at the Estuary mouth are defined in Admiralty tide tables and high water levels are given below.

MHWS	1.2m AOD
MHWN	0.9m AOD

High water levels tend to decrease further up the estuary typically by a factor of 0.9 between the mouth and Blythburgh Bridge. This equates to a difference in level of between 0.1m and 0.2m.

There is considerable variance in the results of different techniques of determining extreme water levels (levels generated during surge conditions). Estimates extrapolated from a scant but local one year data set give the value of the one in one hundred year level as being 1.95m AOD at Reydon. In comparison extreme water level predictions at the coast give a one in one hundred year level of 3.42m AOD. The analysis presented in Appendix B provides best estimate values as set out in Table 2.1.

Table 2.1 Best Estimate of Water Levels For Various Return Periods (years)

	Water level (mAOD)			
	MHWS	Return Period (years)		
		1	10	100
Blythburgh		1.4 (1.9)	1.71 (2.2)	2.01 (2.5)
Bulcamp		1.55 (2.1)	1.83 (2.3)	2.13 (2.6)
Reydon		1.5 (2.0)	1.88 (2.4)	2.26 (2.8)
Southwold	1.2 (1.7)	1.6 (2.1)	1.93 (2.4)	2.26 (2.8)

Notes: All levels given in metres OD
(Figures in brackets denote corresponding level in 50 years)

Various estimates have been made of the rate of sea level rise over the next 50 years, ranging from relatively small values up to as much as a metre. The recommendations on assessing the impact of the possible rise highlight the importance of considering the sensitivity of the environment considered. An average "business as usual" rate of 6 mm per year is recommended on the open coast. The response of the regime of an estuary to sea level rise is likely to be more significant, due to the focussing effect of the narrowing channel on the propagation of the tidal inflow. In recognition of this a value of 0.5m over the fifty years of the strategy is used. The higher figure is taken throughout the report as being a realistic worse case. The impact on extreme water levels is shown in Table 2.1 as figures in brackets. In simple terms the fundamental effect will be to increase the volume of water moving into and out of the estuary and to raise the frequency of return of extreme water levels by a factor of 10 or greater. (The present day one in ten year level might even be anticipated to occur annually in fifty years time.)

Clearly there is still considerable uncertainty associated with the prediction of water levels and this should be addressed.

Tidal Volume

The present volume of water moving into and out of the estuary over a spring tide is of the order of 2.7 million cubic metres. The bulk of this volume is due to the filling of and emptying of the Bulcamp and Angel Marsh intertidal area.

The total tidal volume of the estuary, taking into account the areas below MHWS which are defended at present, would amount to some 3.7 million cubic metres.

A sea level rise of 0.5m acting solely over the present inter tidal area of the estuary would result in a increase from the present 2.7 Mm^3 to nearly 4.4 Mm^3 (159% of the present

volume). As a worst case where defences are abandoned, then in fifty years time, sea level rise would result in a total tidal volume of the estuary of some 11.1 million cubic metres, representing 404% of the present situation. Upstream of the Blythburgh Bridge the tidal volume, making the unlikely assumption that the bridge would not act to constrain flows, would be of the order of 2.3 million cubic metres, some 18 times greater than the flow at present going through the bridge.

Table 2.2 provides a summary of this assessment for a spring tide, both in terms of the whole estuary and broken down into specific areas. It may be seen that proportionally the areas above Blythburgh Bridge, Reydon and Tinkers Marsh and the Harbour Reach are most sensitive to abandoning defences. Angel and Bulcamp Marshes are more sensitive to sea level rise reflecting the wide intertidal area.

Table 2.2 Changes in Estuary Tidal Volumes

Zone	West of A12	Angel & Bulcamp Marshes	Reydon & Tinker's Marshes	Southwold Harbour	Totals
Existing conditions					
Existing tidal volume of river [Ver] (m^3)	128,000	2,273,000	139,000	210,000	2,750,000
Cumulative existing tidal volume [ΣVe] (m^3)	128,000	2,401,000	2,540,000	2,750,000	-
Area of flood compartment (m^2)	2,110,000	262,000	2,356,000	2,010,000	6,738,000
Volume of flood compartment below present Mean Sea Level [Vef] (m^3)	1,055,000	131,000	1,178,000	1,005,000	3,369,000
Potential Changes in Tidal Volumes, allowing for Sea Level Rise over 50 years					
Increase in River only [Vfr] (m^3)	76,000	1,350,000	82,500	125,000	1,633,500
Increase in flood compartment volume below future Mean Sea Level [Vff] (m^3)	1,055,000	131,000	1,178,000	1,005,000	3,369,000
Potential total tidal volume if all flood compartments are flooded [Vf = Ver + Vef +Vfr + Vff] (m^3)	2,314,000	3,885,000	2,577,000	2,345,000	11,121,000
Cumulative total tidal volume [ΣVf] (m^3)	2,314,000	6,199,000	8,776,000	11,121,000	-
Proportional increase in volume [ΣVf / ΣVe]	18.1	2.6	3.5	4.0	-

Summary of Potential Increases in Tidal Volume		
Future increase in Tidal Volume if all defences are held	[(Ver + Vfr) / Ver] (%)	159 %
Present increase in Tidal Volume if all defences are abandoned	[(Ver + Vef) / Ver] (%)	223 %
Future increase in Tidal Volume if all defences are abandoned	[(Ver + Vfr + Vef + Vff) / Ver] (%)	404 %

NOTE: Tidal volumes are indicative, based on Mean Spring Tides and surveys and modelling undertaken as part of Phase I of the Suffolk Estuarine Strategies.

The physical impact of changes in tidal volume due to sea level rise are considered in Appendix B. In summary these findings are:

- that there would be a significant increase in power dissipation over the constrained lower sections of the estuary.
- that there would be significant erosion of the channel bed over these lower sections of the estuary.
- that the mouth of the estuary would attempt to widen and deepen and that if constrained this would result in considerable increase in velocities.
- that the increased flow through Blythburgh Bridge, and at the Squires Hill pipe bridge, would result in substantial structural damage.

Interaction with the Coastal Regime

The interaction of the estuary with the coastline was considered in the SMP, and in ABP's Phase 1 strategy report. Appendix B developed upon this initial assessment, drawing upon additional material such as air photography and detailed reports on the estuary, and applying the improved understanding to specific issues of defence management.

The interaction depends to a large degree on the volume of flow into and out of the Estuary. The size of the ebb delta depends on this flow. The process regime is complex and at present indeterminate, potentially resulting in conflicting processes of erosion and accretion; the ebb delta provides local shelter to the adjacent coast whilst also holding up longshore drift of sediment which may result in erosion further afield.

In the more extreme situation of very large increases in flow through the estuary mouth the impact would be to substantially increase the amount of material trapped in the delta regime. This could most probably increase the protection immediately to the south and north of the entrance. This would be at the expense of material feeding to the southern frontage generally and might in the worst extreme result in sediment being lost to the offshore area.

2.2 THE PROBLEM

The use of the estuary; the activities it supports and the important environmental and economic interests within the estuary, is at present reasonably in balance. The extensive agricultural use of the land supports the local economy; the estuary is a focal point for tourism and provides recreational opportunity both for local residents and visitors, while at the same time containing nationally and internationally important features of the natural environment. These aspects are all underpinned by the flood defence structure of the estuary.

These interests and uses have been developed from a situation where there was near total control of the estuary channel over the last two centuries. This control was relaxed through the loss of defences. While the return to a more natural condition around the Angel and Bulcamp Marshes has added considerably to the diversity of the natural estuary environment, it has also created a pattern of change to which the estuary regime is still responding.

Symptomatic of these changes are the increased pressure on areas of defence at Reydon and Tinker's Marsh and possibly the increasing scour action on the structures at the mouth of the estuary.

In addition to this there are two further factors which are, or have the potential to accelerate the pressure on maintaining a balance in the management of the estuary. First, despite a programme of maintenance and repair, the integrity of several lengths of defence are reported to be deteriorating. In particular there is long term concern for the condition of defences upstream of Blythburgh, the western defences of Tinker's Marsh, the defence of Reydon and Tinker's Marsh and the bank protecting Robinson's Marsh. Managed Re-alignment from any of these defences would potentially result in the increased cost of maintaining other defences.

Secondly, the natural process of sea level rise would increase flows into and out of the estuary. In addition to the increased cost, and in some areas the technical difficulty, of raising embankments to maintain the same level of defence, the increased flows would tend to increase pressure on defences and in certain areas result in the channel attempting to change its position.

Because of the changes that have occurred over the last fifty years and possibly due to the first symptoms of sea level rise the estuary has become out of balance and is attempting to rectify this. The cost of defence is increasing and is likely to continue to increase. Doing Nothing to defences in response to this pressure and in response to increasing costs may make the situation worse, further increasing the pressure to abandon more areas of defence. There is the potential for a "domino effect" resulting in the estuary being allowed to revert to its natural unconstrained condition.

This would result in:

- the flooding of all low lying areas. In most cases, due to areas typically being at mid tide level, this would result in land reverting to mud flat and loss of internationally designated habitats.

- the loss, again due to the low level of defended land, of the embankments and any habitat peripheral to the channel.

- the continuation of coastal squeeze (loss of peripheral habitat) against the relatively steep slope of the land around the edge of the estuary.

- substantial loss of agricultural land with the consequential economic, social and cultural loss.

- damage and possible loss of the two bridges on the estuary and the need to reroute or reconstruct bridges for the A12 and the sewer.

- loss of use of Southwold and Walberswick harbour, with the consequential damage in terms of use of the estuary and tourism to the surrounding areas.

- massive increase in flow into and out of the estuary, increasing with time, with the likely disruption to sediment drift along the coast and resulting in increased difficulty in managing the retreat of the frontage to the south (SMP policy for units MIN 1 and MIN 2).

The problem is one of increasing costs of maintaining defences, associated with the very real threat that this will be exacerbated by sea level rise, to the point where the value and fabric of use and interest of the estuary will suffer. Furthermore the problem is that a piecemeal approach in response to these threats will lead to unsustainable management of the estuary.

SECTION 3

ENVIRONMENT

3.1 OVERVIEW OF THE BLYTH ESTUARY

The Blyth is the smallest and perhaps the least estuary-like of the Suffolk estuaries. This is largely due to the history of land reclamation that has been undertaken around the estuary. In the lower part of the valley, the Blyth is closely contained in a narrow channel by the flood defences that protect Southwold Town Marshes, Reydon Marshes and Tinker's Marsh. Upstream of Tinker's Marsh the estuary suddenly opens out into a large expanse of mudflats, the result of inundation of former reclaimed agricultural land following collapse of the flood defences. In its upper reaches (upstream of the A12 bridge) the tidal Blyth River is contained in a narrow channel flanked by grazing marshes.

The Blyth is located within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty and is a designated Heritage Coast. The Blyth estuary is also contained within the Minsmere-Walberswick SSSI, which is a Special Protection Area and Ramsar site. This internationally important site comprises a mosaic of coastal, wetland and heathland habitats that support a very diverse flora and fauna, including many nationally scarce and rare species. Counts of overwintering waterfowl on the estuary over the past decade confirm that the Blyth is now nationally important for overwintering black-tailed godwit and pintail and in some winters internationally important for overwintering avocet. Tinker's Marsh is an important area of grazing marsh and one of the best localities in Suffolk for breeding waterfowl.

Agricultural land predominates around the Blyth with arable production, grazing and outdoor pig rearing being the main activities. A large area of the inter-tidal mudflats and saltmarsh, together with heathland and grazing marsh (Tinker's Marsh) on the southern side of the estuary, forms part of the Walberswick National Nature Reserve and is managed by English Nature.

Recreational activity is largely limited to the coastal end of the estuary, centred on Southwold and Walberswick. Southwold Harbour is used for a mix of inshore fishing and sailing boats which tie up to jetties along both sides of the river. Waveney District Council manages the harbour through a users committee. Traditionally there has been little recreation activity upstream of the Bailey Bridge, but water skiing takes place and there is occasional use by jet skis and canoeists.

Figures 3.1 and 3.2 show details of habitats and conservation designations, and tourism and recreation throughout the estuary.

3.2 HUMAN AND BUILT ENVIRONMENT

3.2.1 Land Use

As with much of the Suffolk coast, the land surrounding the Blyth is largely undeveloped and uncommercialised lending the estuary and its environment an isolated and relatively undisturbed feel. Agricultural land use dominates with large open arable fields sweeping down to the reclaimed drained marshland of the valley floor. Mixed farming predominates with grazing and arable on the valley floor and arable and outdoor pigs on the slopes. The agricultural landscape is interrupted by the wooded slopes and heathland along the southern side of Angel Marshes and Bulcamp Marshes, which form part of the Walberswick National Nature Reserve.

Development has been restricted to spurs or promontories of land, the location of which provided protection from flooding. Examples of these include. Blythburgh at the head of the estuary, and Southwold and Walberswick at the mouth of the estuary.

3.2.2 Residential Development and Industry

The main residential areas are the historic settlements of Southwold and Walberswick, situated towards the mouth of the estuary on the north and south banks respectively. Southwold particularly acts as a service centre for the local population. The only other residential area is the village of Blythburgh, situated approximately 5 km from the estuary mouth at the foot of the A12 road bridge. In addition to these settlements there are numerous farm houses and cottages located on the slopes overlooking the estuary.

Apart from agriculture, industrial and commercial activity on and around the estuary is restricted to the fishing industry and small-scale light works such as boat building at Southwold Harbour. The Harbour is considered to be an important local economic asset to the town of Southwold, providing employment for fishermen, boat builders and associated activity, and the Harbour Inn.

3.2.3 Recreation and Tourism

Compared with the other Suffolk estuaries recreational activity on the Blyth is relatively low-key. Activities centred on the estuary include water sports such as sailing, canoeing and yachting, along with wildfowling, walking and birdwatching from the estuary shores. There is a sailing club located at the harbour. Unlike the other Suffolk estuaries, however, the Blyth has no swinging moorings. Due to the relatively narrow channel and presence of old flood walls, navigation in the upper part of the estuary is difficult, which tends to restrict boating activity to the lower estuary or more generally the open sea. Some waterskiing and jet skiing takes place in the lower part of the estuary between Southwold and Reydon. There are, however, occasional problems with jetskis moving into the upper part of the estuary, where disturbance to roosting and feeding birds as well as erosion of estuary vegetation can result. The secluded and calm nature of the Blyth make it popular with canoeists and is well used all year round by novices and very experienced sea and inland paddlers, including touring canoeists.

The footpath network in the area is relatively extensive, is well used and is an important recreational resource. The flood defences on either side of the estuary form the main footpath routes, except in the upper estuary where breach of the flood walls has effectively destroyed the original route. The footpaths on either side of Southwold Harbour (via the Bailey Bridge) form part of the Suffolk Coast long distance path. The paths across Southwold Town Marshes are particularly well used by birdwatchers and local walkers.

The historic and picturesque settlements of Southwold and Walberswick are popular tourist destinations. Much of their appeal is centred on their attractive setting alongside the estuary and the sandy beaches on the open coast. Southwold Harbour, with its traditional waterside character is a well visited area, although access and car parking can be problematic. The maintenance of a high quality environment, both natural and human, is viewed as of great importance to the tourism industry. Tourist facilities immediately adjacent to the estuary are limited. There is a camping and caravan park at Havenbeach Marshes on the Southwold side of the estuary. This is the main site for the area and makes an important contribution towards the local economy. A restricted use (summer only) campsite occupies part of The Flats amongst the dunes and grassland at the eastern end of Walberswick.

3.2.4 Commercial and Recreational Fishing

There are shellfish layings in the Blyth, for which the council has issued approval under the Shellfish Directive (91/492/EEC). There is a small but thriving Pacific oyster (*Crassostrea gigas*) fishery at Wolsey Creek, where the shellfish are grown in trestles and purified in tanks prior to marketing. There is limited cultivation of the Pacific oyster near Bulcamp Marshes, and evidence of historical mussel and native oyster cultivation in the area.

Fishing activity comprises pleasure angling and some commercial netting for bass and mullet by small fishing vessels. Eel fishing also takes place in the river, notably by line fishing. Approximately 30 licensed inshore vessels are based at Southwold and Walberswick, although only half of these are currently considered to be active. The existence of a right to fish in tidal waters means that most angling takes place on an informal basis. This occurs from the shore in almost any location where access is possible. The extensive saltings and mudflats that occur along the estuarine areas can, however, inhibit access at low water.

Many different types of fish are caught by recreational anglers fishing on the estuaries and the coast. Flatfish such as plaice, dab, flounder and sole are regularly caught by beach anglers. Cod and whiting are commonly caught in autumn in winter, whereas bass tend to be caught in the summer and autumn.

3.2.5 Agriculture and Forestry

Agricultural land use dominates the slopes surrounding the Blyth estuary. The free-draining and acidic soils of the area are developed from glacial sands and gravels overlying Crag sands and pebble beds. These soils are relatively infertile giving rise to agricultural land which, without irrigation is largely unproductive (classified as Grade 4). The light sandy soils are, however, conducive for the raising of outdoor pigs.

Grazing marsh predominates on the valley floor. This land represents former intertidal estuary mudflats and saltmarsh which has been reclaimed and drained. The majority of reclamation took place in the 16th and 17th centuries. By 1842, 1100 ha of agricultural land had been reclaimed from the Blyth, resulting in the estuary being confined to a narrow meandering channel in the centre of the valley. Following the exceptional coastal flooding of 1953 a large area of the Blyth was submerged and lay neglected for a number of years. The floods provided the impetus to begin large-scale agricultural improvement with strengthening of the flood walls, field levelling and under-drainage taking place. Further breaches of the flood defences in the upper part of the estuary (Angel Marshes and Bulcamp Marshes) in the 1960s have since returned some 250 ha of grazing marsh to mudflat. Most of the grazing marsh is improved and semi-improved for cattle and sheep grazing.

All of the agricultural land surrounding the Blyth is included within the Suffolk River Valleys Environmentally Sensitive Area (ESA).

There are only small areas of woodland and wooded hedgerows on the valley slopes surrounding the Blyth. The largest woodland block is an area of coniferous plantation (Hill Covert) on the southern side of the estuary which forms part of the Walberswick National Nature Reserve. There are no designated areas of ancient woodland near the Blyth.

3.2.6 Historic and Archaeological Heritage

The archaeological resource of the Suffolk estuaries is relatively unknown. From survey work in similar situations e.g. the Essex estuaries, it is clear that over the past 4000 years the sheltered interface between the land and the sea found along estuary shores has provided an important area for settlement and food gathering. The estuaries have also provided safe

havens for ships and their cargoes for at least two thousand years. No systematic survey has been undertaken of the archaeological interest of the estuaries, but there is no reason to doubt their importance given the significant finds that have been made from the Essex estuaries. Near the Blyth, dredging work at Buss Creek in 1990 led to the chance discovery of the remains of two 10th century boats.

The Royal Commission on the Historical Monuments of England has identified only one charted foul which is situated at the mouth of the estuary. However, considering its past maritime influence, it is likely that there are more wrecks in the area which remain undiscovered.

There are several Grade II listed buildings situated adjacent to the estuary. These comprise the Harbour Inn at Southwold Harbour, an old water tower to the east of Southwold, and the Blackshore wind pump at Reydon Marshes.

Three Scheduled Ancient Monuments occur in the immediate area. These are the remains of an Augustinian Priory at Blythburgh (TM 4520 7540) and two round barrows near Tinker's Walks (TM 4710 7480 and TM 4700 746).

3.2.7 Water Quality

Water quality targets can be divided into those that are statutory and non-statutory. Statutory standards in the East Suffolk Local Environment Agency Plan (LEAP) Consultation Report (Environment Agency, 1997) are set by the following EC Directives: the EC Freshwater Fish Directive (78/659/EEC), the EC Bathing Waters Directive (76/160/EEC), the Shellfish Waters Directive (79/923/EEC) and the EC Dangerous Substances directive (79/464/EEC).

The best indication of estuarine water quality is provided by the CEWP Target Classes for Saline Waters. This incorporates both biological and chemical parameters. In 1995, this system classified 7km of the Blyth estuary as Class A (Good), with no stretches of the estuary classified as Class B to D. Traditionally estuaries have been used for the dilution of domestic sewage derived from adjacent towns and villages. There are currently two sewage outfalls that discharge into the Blyth, located at Blythburgh Hospital, approximately 2km upstream of the A12 bridge and the final effluent from the Sewage Treatment Works at Southwold.

Blooms of suspended microscopic algae can occur in estuaries rivers and may impact on the dissolved oxygen levels in the estuary waters. During periods of prolific algal growth the reduced levels can result in fish mortality. Factors which interact to result in the formation of algal blooms are numerous and complex, but it is known that algal growth is promoted by high levels of nutrients, in particular nitrogen and phosphorus. The principal source of these is often sewage treatment works (point source discharges) and run-off from agricultural land (diffuse inputs). Suspended algal populations are determined on some watercourses by the concentration of *chlorophyll a* in the water. *Chlorophyll a* monitoring is regularly carried out on the Blyth estuary, although the estuary is not classified as a candidate Sensitive Area (Eutrophic) under the Urban Waste Water Treatment Directive (91/271/EEC).

3.3 NATURAL ENVIRONMENT

3.3.1 Geology and Geomorphology

The solid geology of the Suffolk Coast is comparatively simple and is dominated by rocks formed by sedimentary processes. These soft, generally undisturbed rocks are responsible for creating the area's gently rolling landscape. North of the Deben estuary the solid geology is dominated by shelly marine sands and clays, known as Crags. These were deposited under

shallow marine conditions during the late Pliocene to Pleistocene, some 2 million years ago. Around the Blyth, and throughout East Suffolk, much of the Crag outcrop is overlain by a series of sands and gravels deposited as outwash material as the last ice sheet retreated from Britain. These sediments give rise to the deep, free-draining acidic soils characteristic of the area.

In geological terms the Suffolk estuaries are of recent origin having formed as sea-level rose following the end of the last Ice Age approximately 7,000 years ago. Coupled with the subsidence of the North Sea Basin this rise in sea-level flooded the river valleys of east Suffolk. All of the Suffolk estuaries, with the exception of the Ore, have been formed by this process. The calm conditions that prevailed in the newly formed estuaries allowed sediment to settle and formed extensive areas of intertidal mudflat fringed by salt tolerant vegetation.

The present day morphology of the Blyth estuary largely reflects human influence over the last three hundred years. The original intertidal area of the Blyth was in the region of 1300ha. By 1842 the extent of reclamation was such that approximately 1100ha of the intertidal zone had been converted to agricultural land, restricting the estuary to a thin channel extending 10 km inland to Blyford Bridge. Today, due to a series of breaches in the defences during this century, 250ha have been returned to the intertidal zone.

3.3.2 Landscape

The landscape of the Blyth, more than perhaps any of the other Suffolk estuaries, documents a history of reclamation and marshland drainage. The present estuary occupies about a third of its former (pre-reclamation) valley floodplain. In general, the valley of the Blyth is relatively uniform in width (700-1000m) with gently sloping sides up to the surrounding plateau surface at 5-10m OD.

Above Blythburgh the upper reaches of the estuary consist of a narrow tidal channel enclosed by flood banks and flanked by extensive grazing marshes. Downstream of the A12 at Blythburgh as far as Reydon, the estuary fully occupies the valley floor, with extensive inter-tidal mudflats extending up to the break in slope. The course of the main channel across the mudflats is in places marked by former river walls which originally constrained the estuary until they were breached during the 1950's. The tributary valley of the River Wang enters the Blyth at Wolsey, downstream of which the estuary is again contained within a relatively narrow channel to its mouth at Southwold Harbour. Along this section the channel is flanked by treeless grazing marshes and arable land, rising to the north to form the low hill on which Southwold is located and to the south to form the low promontory on which the village of Walberswick is situated. Between the two, at the mouth of the estuary, Southwold harbour is characterised by wooden-built jetties which line either side of the channel and a variety of huts and sheds which reflect the general informal and uncommercialised character of this section of the coast.

3.4 HABITATS AND SPECIES

3.4.1 Saltmarsh and Mudflats

The intertidal area of the Blyth represents the most significant habitat type within the study area and is particularly important as a feeding and roosting area for waterfowl. The mudflats regularly support large flocks of avocet (*Recurvirostra avosetta*), with up to 400 being recorded in recent winter months. Significant populations of pintail (*Anas acuta*), avocet and black-tailed godwit (*Limosa limosa*) have wintered on the Blyth only during the past ten years, during which time numbers have generally increased annually. The Blyth now

supports nationally important populations of these species and at times internationally important numbers of avocet.

Thirteen saltmarsh and two swamp communities have been identified (Suffolk Wildlife Trust, 1993) on the Blyth estuary covering a total of 86 ha. The majority of the saltmarsh fringes the southern side of Bulcamp Marshes and Angel Marshes. There has been very limited development of saltmarsh on the main bulk of the mudflats and northern side of these areas following breach of the estuary defences in the 1950-1960s. This suggests that the inundated land was at a low-level relative to mean high water and that, in addition, the overall rate of sediment accumulation is low.

Saltmarsh vegetation can be split into four basic community types, each with a suite of different species adapted to varying tidal and substrate conditions. Pioneer saltmarsh accounts for approximately 13% of the total habitat, a relatively high component compared with the other estuaries. Low-marsh communities make up about 29% on the Blyth and is dominated by extensive stands of rayed sea aster (*Aster tripolium)* particularly on the southern side of the mid-estuary. These stands are species-poor, having an underlayer of glasswort (*Salicornia* spp.) and cordgrass (*Spartina anglica)* and are comparable to those growing along the mid section of the Deben estuary. One notable difference is that the stands on the Blyth are apparently more stable and do not show the extensive erosion seen in the stands on the Deben. Low-mid and mid-marsh communities make up the bulk of the well-established saltmarsh blocks, comprising 37% of the total. This is often a complex community comprising a variety of species, but on the Blyth tends to be dominated by species such as common saltmarsh grass (*Puccinellia maritima)* and sea lavender (*Limonium vulgare)*. The upper marsh community comprises various grass species, notably sea couch (*Elytrigia atherica)*. This species generally occurs on old flood banks and often forms a strip between the lower communities and the vegetation of higher ground. On the Blyth it is prevalent on the northern side of Bulcamp Marshes where there are no flood defences, forming a fringe between the mudflats and the neighbouring agricultural land.

Survey work undertaken by Suffolk Wildlife Trust in 1993 indicates that saltmarsh erosion along the seaward-edge is relatively widespread throughout the estuary, particularly on the southern side of Bulcamp Marshes. There are some very small areas where accretion appears to be taking place. The overall loss of this habitat on the Blyth is difficult to estimate, but has been put at about 0.5-1% annually of the total area (i.e. 0.4-0.8ha).

3.4.2 Vegetated Shingle

There are no significant areas of this habitat present within the Blyth estuary. On the open coast at Southwold Denes, immediately to the north of the estuary mouth, a linear strip of partially vegetated shingle occurs fronting the sand dune system.

3.4.3 Grazing Marshes

Grazing marsh occupies much of the original estuary valley floodplain, particularly on both the northern and southern side of the channel between the estuary mouth and Wolsey Bridge. Upstream of the A12 extensive areas of grazing marsh occupy the floodplain of the Blyth. The majority of the marshes are improved and semi-improved cattle grazing with some areas of unimproved grazing located upstream of the A12 and at Tinkers Marshes. Botanically these areas are generally species-poor with very few "pockets" of diversity. The internal dyke systems are often of more interest particularly if the cycle of dyke management has not been too harsh. Slightly brackish dyke systems are characteristic of many of the coastal grazing marshes, often showing a transition to freshwater along their more landward stretches. These salinity variations provide a range of habitat niches and often support rich aquatic communities as at Tinkers Marshes and Southwold Town Marshes.

Where water levels within the internal dyke systems are raised to near surface level, the marshes support important breeding and overwintering bird populations. Tinker's Marsh on the southern side of the Blyth is particularly important and represents one of the more important wet grassland wader and waterfowl breeding sites in Suffolk. The Suffolk Wildlife Trust survey in 1997 recorded 23 pairs of redshank (*Tringa totanus*), 20 pairs of lapwing (*Vanellus vanellus)* and notably 8 pairs of avocet. In contrast only three pairs of oystercatcher (*Haematopus ostralegus*) were recorded from the larger block of Reydon Marshes on the northern side of the estuary. These differences reflect the specific management of Tinkers Marshes for its wildlife interest and the improved and drier nature of the marshes at Reydon.

Historically Southwold Town Marshes has been an important breeding site for waterfowl although in recent years the number of pairs of species such as lapwing and redshank has markedly declined. The Marshes are, however, an important overwintering and landfall site for waterfowl.

3.4.4 Reedbeds

Reedbeds are an important habitat for a number of rare birds and invertebrates. In Suffolk, there are 550 hectares of reedbed remaining, which amounts to almost 25% of the national resource. Large reedbeds have developed on the coast either in estuaries or on former coastal grazing marshes and their dykes, or fringing brackish lagoons. The large brackish coastal reedbeds, tend to be species-poor plant communities almost entirely composed of common reed (*Phragmites australis*). Approximately 12ha of reedbed occurs on the Blyth, the vast majority of it occurring along the southern shore of Angel Marshes. This area supports a small colony of the nationally rare marsh sowthistle (*Sonchus palustris*).

3.4.5 Conservation Designations

The Suffolk coast is recognised nationally and internationally as an area of unique landscape, wildlife and historic interest. This is reflected in the large number of statutory and non-statutory designations that have been applied to the area. Further information regarding these designations is provided in Section E5 of Appendix E.

The Blyth and surrounding land falls within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB). The primary purpose of the designation is to conserve and enhance the natural beauty of the area and to protect its flora, fauna, geological interest and landscape features. However, in pursuing the primary purpose account should be taken of the needs of agriculture, forestry and the economic and social needs of local communities.

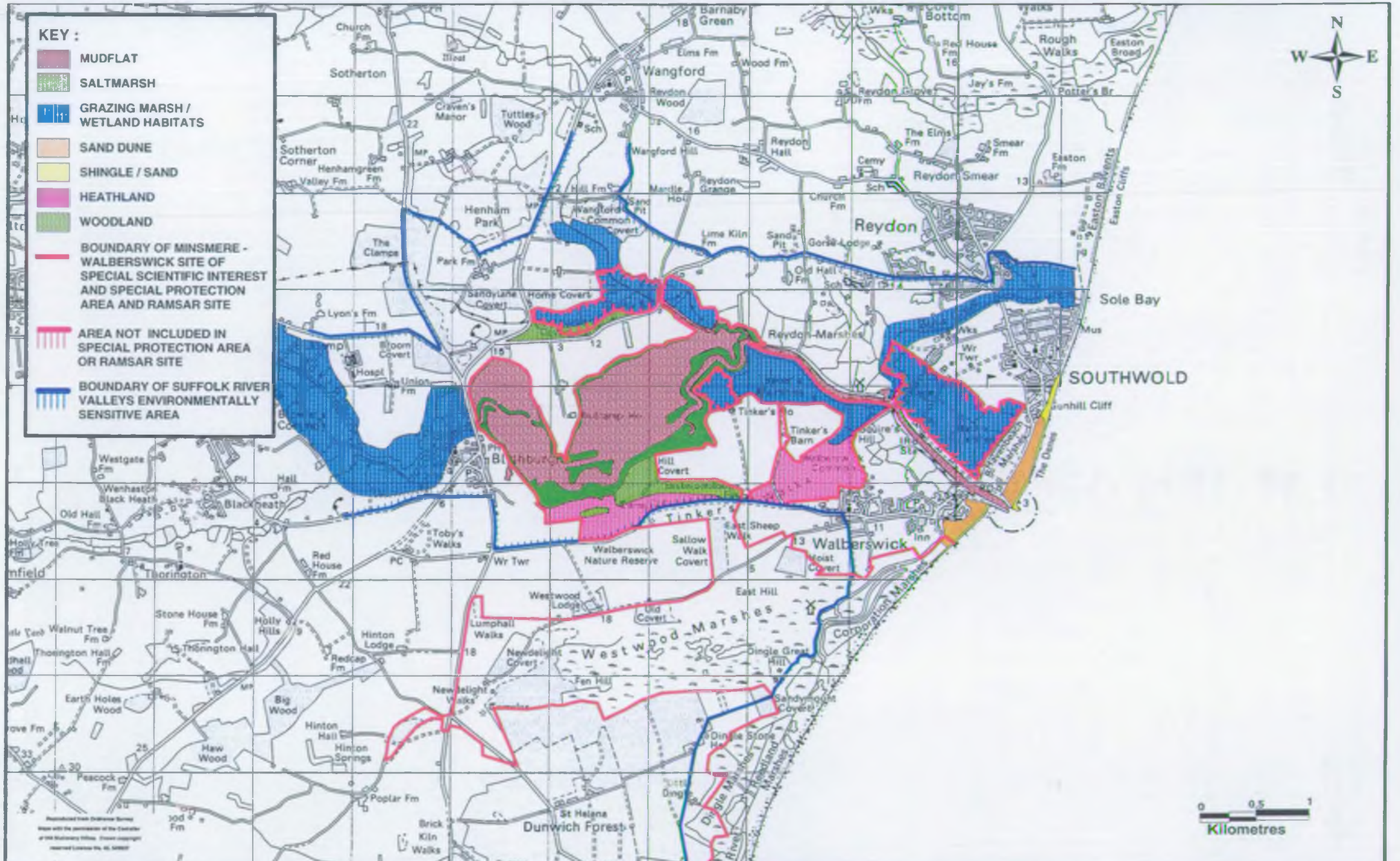
The Blyth estuary is also contained within the Suffolk Heritage Coast (designated in 1973). The 1992 Heritage Coast Policy sets national targets for all Heritage Coasts, namely the provision of a semi-natural strip along the coast accommodating a coastal path, the clearance of eyesores and meeting standards for water and beach cleanliness.

A large part of the intertidal estuary, the grazing marshes and wetlands of the River Hen and lower part of the Wang valley, Southwold Town Marshes and significant areas of grazing marsh and heathland to the south of the estuary are contained within the Minsmere to Walberswick Heaths and Marshes Site of Special Scientific Interest (SSSI). The main estuary channel east of Tinkers Marshes and the extensive grazing marshes upstream of Blythburgh are not included within the SSSI. The SSSI (apart from Southwold Town Marshes) is also a designated Special Protection Area (SPA) and Ramsar Site for its internationally important breeding bird populations. Heathland on the southern side of the Blyth, notably Walberswick Common, is included within the Minsmere-Walberswick Special Area of Conservation (SAC). In addition, Tinkers Marshes and Angel Marshes, together with heathland and

woodland on the southern side of the estuary, form part of Walberswick National Nature Reserve (NNR). The boundaries of the SSSI, SPA and SAC are shown in Figure 3.1.

Buss Creek, Busscreek Marshes, Southwold Denes, the shingle and saltmarsh to the west of Walberswick, the grazing marshes of the River Wang, Blythburgh Marshes and marshland on the northern side of the river near Blyford are all County Wildlife Sites (CWS). The Suffolk Wildlife Trust own an area of wet woodland and grazing marsh upstream of Wolsey Bridge (the Norman Gwatkin Nature Reserve). In addition, the Suffolk Wildlife Trust is in the process of acquiring a 37 ha site alongside its current 10 ha landholding to create a new reedbed as part of a European Union project to create and manage reedbeds for bittern and other wetland fauna and flora.

The entire estuary and much of its hinterland is contained within the Suffolk River Valleys Environmentally Sensitive Area (ESA), which was designated in 1988 and extended in 1993 by MAFF.



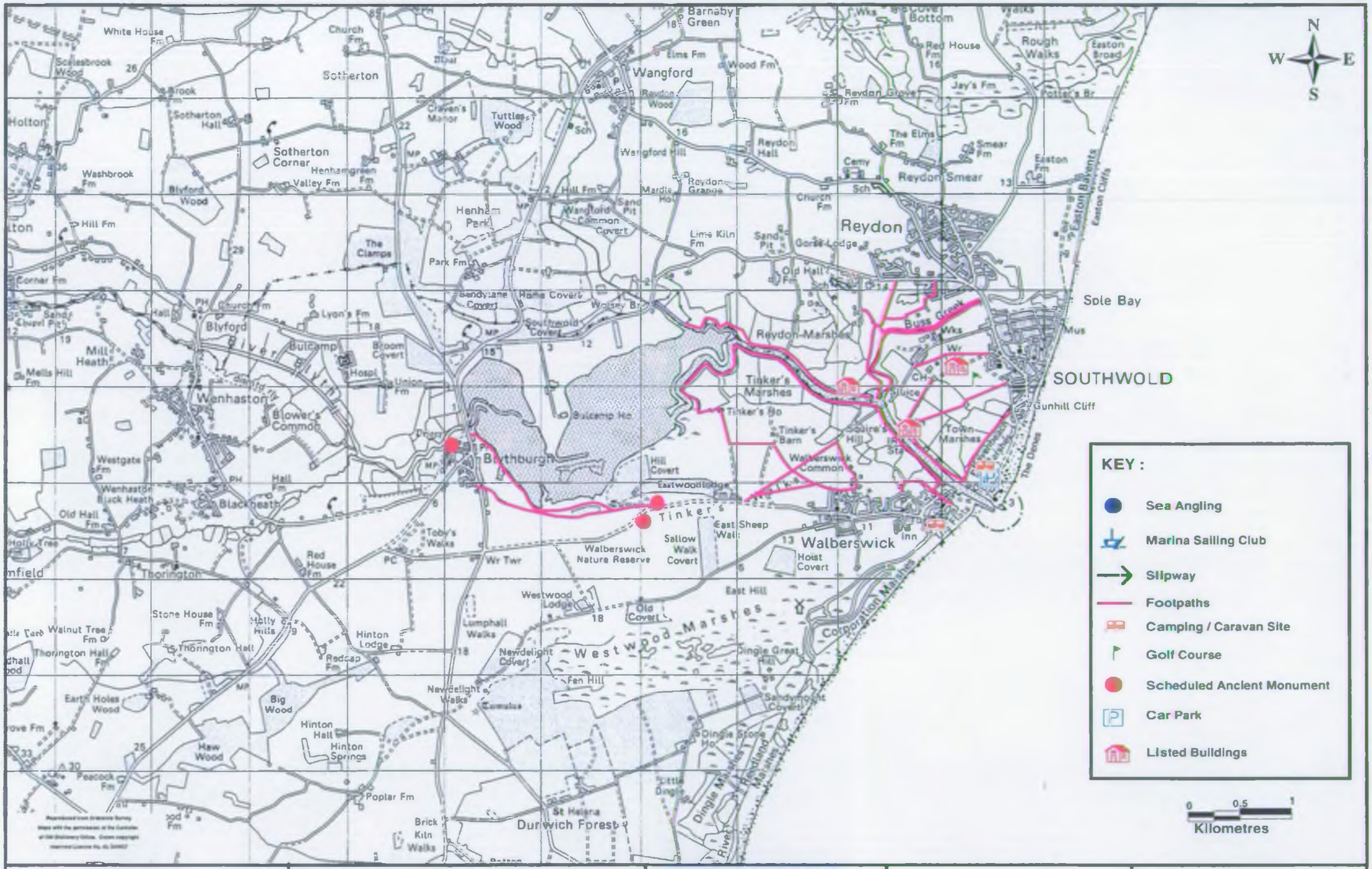
ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES
PHASE 2

POSFORD DUVIVIER
In association with
HR Wallingford

BLYTH ESTUARY
HABITATS
AND CONSERVATION

FIGURE 3.1



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES
PHASE 2

POSFORD DUVIVIER
In association with
HR Wallingford

BLYTH ESTUARY
TOURISM
AND RECREATION

FIGURE 3.2

SECTION 4

AIMS OF THE STRATEGY AND THE DIVISION OF THE ESTUARY

4.1 STRATEGY AIMS AND OBJECTIVES

4.1.1 Consultation

As part of the Phase 2 strategy development, organisations were consulted to identify their interests and involvement with the estuary. A list of those consulted is included in the section on Consultation Details at the rear of this report. The interest and the various comments made have been collated as a report on the environment presented as Appendix E. Key issues have already been summarised in Section 2. Based on these issues and based on the Environment Agency policy and MAFF guidance on defence, general and specific objectives for the estuary strategy have been drawn up and are presented below.

4.1.2 Aim

The strategy must take on board all aspects of estuary use, interest and expenditure. Distilling the intent of the detailed objectives set out below (Section 4.1.3) an overall aim has been developed. This is:

"To develop a strategy for flood defence which maintains or, where possible, improves the overall balance of the estuary in terms of its natural and human environment, its use and recreational value and economic interests, while minimising the dependence of this balance on flood defence expenditure."

4.1.3 General Objectives

i) Defence Management Objectives

To provide sustainable defence policy options that avoid tying future generations into inflexible and expensive defence requirements.

To ensure that defence policy options are compatible with the preferred options identified in the open coast Shoreline Management Plan (subcell 3c) for the mouths of the estuaries.

To select defence policy options that take into account the impact on the estuary as a whole and minimise the overall defence burden.

To provide sustainable defence options that are technically appropriate and environmentally sound.

Where economically justifiable and technically viable, to provide and maintain sustainable defence schemes that protect human life and property and maintain environmental interests.

i) Nature Conservation

To ensure that the flood defence strategy takes account of the implications of the Habitats Directive and contributes towards the maintenance of a favourable conservation status for the estuaries

To ensure that wild species and wildlife habitats are conserved and enhanced in line with the UK biodiversity Action Plan.

i) Planning

To provide defence from flooding and erosion in a manner consistent with the policies and objectives established within the planning framework.

To take account of, and co-ordinate with, the objectives of the relevant guidance and management planning initiatives beyond the statutory requirements for both the built and natural environment.

Where economically and technically feasible, to provide sustainable estuary and tidal defence schemes to protect agricultural land from flooding and erosion.

i) Fisheries

To take into account the requirements of the fishing industry in formulating and implementing defence policies.

i) Recreation

Ensure that recreational activities and amenity areas are fully considered, and opportunities to enhance existing facilities are taken, in the development of the strategy.

i) Landscape

To conserve and enhance the natural beauty of the estuaries in particular the varied landscape, wildlife and historic value.

To take account of the existing landscape character of the area and the Character and Natural Area objectives. To take account of both Heritage Coast and Area of Outstanding Natural Beauty objectives.

i) Water Quality

To ensure that defence policy does not detrimentally impact upon the water quality of estuarine waters.

i) Archaeology

Ensure that potential areas at risk from flooding and/or erosion are identified in order to allow surveys to be undertaken to assess whether archaeological interests could be damaged or destroyed.

To recognise the national and local importance of archaeological sites and historic buildings.

There will be a presumption in favour for the protection of Scheduled Ancient Monuments and Grade 1 listed buildings or a large number of well preserved sites.

To ensure that wherever possible that areas of known archaeological interest are conserved and to minimise and mitigate against any adverse impacts that defence policy may have on them, up to and including recording and excavation.

4.1.4 Blyth Estuary Specific Objectives

To ensure that the strategic defence policies:

- contribute towards maintaining the internationally and nationally important overwintering waterfowl and breeding populations that occur in the upper estuary
- maintain the navigable access to, recreational use of and local economic importance of the harbour facilities at Southwold/Walberswick
- recognise the recreational importance of the estuary for both water based and land based activities
- allow the existing transport network to function effectively and in particular that the A12 at Blythburgh, is not adversely affected by increased flood risk
- are compatible with maintaining its nationally important landscape character
- do not compromise coastal process movements and increase the likely risk of flooding and/or erosion at Southwold and Walberswick

4.1.5 Blyth Estuary Specific Issues

During the course of the Phase 2 consultation certain specific issues were raised by consultees. These are commented on below.

One of the main concerns expressed involved the loss of saltmarsh. This habitat is very specific in its position in relation to high water. It is vulnerable to erosion due to increase flow within the channel and will die off if excessively submerged (due to sea level rise). This habitat is at present being lost in all three estuaries. Although some of this loss may well be due to other factors such as pollution, the die back of saltmarsh is considered to be a major indicator of sea level rise. This is discussed for each estuary in more detail in both Appendix B and Appendix E. There is a need to monitor the behaviour of this habitat not only from the environmental view point but also in relation to the frontline protection it provides to defences and as an earlier indicator of change within the estuary.

The ability for saltmarsh to migrate to higher ground in response to rising tide levels is dictated by the nature and slope of the ground behind, the rate of increase of sea level and by the availability of sediment. These issues are discussed with reference to each estuary in Appendices B and E. The development process of the strategy has recognised that there is and is likely to be a continuing loss of salt marsh. Within the proposed strategy there is an attempt to maintain the balance of this habitat and this has been an important factor in considering the suitability of strategy options.

Other points raised include the abstraction of fresh water from some of the low lying marshes. This water supply is important in providing irrigation to higher ground. Although difficult to evaluate at a strategic level, recognition of this resource has been allowed for in the economic assessment.

Studies have in the past looked at constructing barrages across the river Blyth with the specific intent of improving the freshwater supply to the area. The benefits of this were unproven. During the recent scoping consultation, however, the question of barrages has been raised in relation to all of the estuaries, in part as a means of controlling flows throughout the estuaries but also as a means of producing hydroelectric power. The scale of construction

works needed is likely to make this impractical. It is only in the upper reaches, such as on the Blyth, that the scale of works required for flow control is likely to be commensurate with the benefit that could be derived from flood defence. Having demonstrated, in the case of the Blyth, a benefit in this regard, it would now be sensible to re-examine the additional benefit which may be achieved from improvement of fresh water supplies.

4.2 PRINCIPLES

In addition, in developing the strategy certain guidelines are applied. These are:

- That the estuary and its environs are considered as a whole in terms of environmental interests, recreational use and in assessing the economic case for specific options.

- That economic value is considered on a national basis, but that the local social and cultural impacts of decisions are recognised.

- That where possible decisions on defence should encourage the development of use or interests in areas appropriate to that use or interest. (e.g. Developing freshwater habitats significantly below sea level creates an artificial and dependent situation. Where opportunity exists to relocate such habitat to a more appropriate location then the defence policy should encourage this.)

- That economic and environmental impacts remote from specific lengths of defence must still be taken into account in developing the overall strategy.

- The strategy is a long term, 50 year, plan for the management of flood defences. The policies developed aim to redress the imbalance in the present conditions but recognise that this is a long term process. There may therefore be a need temporarily to adopt a policy which may change over the fifty years either because:

    - There is some inherent uncertainty which is critical to a decision and which must be measured over time
    - There is a need to develop mitigation measures before a preferred policy can be fully implemented.

4.3 DIVISION OF THE ESTUARY

An essential part of the overall strategy development process is examining how each and every section of the estuary would respond to the possibility of change somewhere else within the system. Fundamental to this is understanding the behaviour of each area; the pressures currently imposed on the area, its capacity to accommodate further physical pressure, the impact this would have on the interests within that area and the consequence that might arise from any subsequent response.

This understanding may be seen to relate to two aspects:

- The physical regime (the driving forces, the response and the consequence).

- The use (the activity, the economic value, the defence costs and the interests).

4.3.1 Division by Physical Regime

Despite the need, ultimately, for all aspects to be considered equally over the whole geographical extent of the estuary, the practical development of the strategy requires that smaller sections of the estuary are examined individually, but in such a way as to assist in building towards the larger picture. This only works if the division into smaller units is based on characteristics which reflect the interaction or linkage as a whole. The principal physical process in this respect is tidal flow, and the possible response to increased flow or the control of that flow.

Based initially upon the division of the estuary made in the Phase I study (by geomorphological characteristics) the estuary has, for the purpose of assessing various defence strategy options, been divided into four zones. The basic criteria for division is how the estuary works and how, therefore, it responds to the pattern of flow through the zone. In essence:

- To what degree at any point in the estuary is the estuary width constricted? (i.e. Are defence banks hard up to the edge of the channel, so that there is little scope for the channel to adapt to change by change in its width, or, conversely, is the flow through a wide open plain, where significant change in tidal volume upstream may be accommodated without significant change in the regime of the zone?)

- To what degree is change in the alignment of the channel at any location restrained? (i.e. Will change in flow result in a wish for the estuary channel to change its alignment? If so, will this conflict with the position of defences, or if resisted, result in increased pressure to opposing banks and defences?)

For the Blyth Estuary, four zones have been identified, each having different attributes, as follows:

Zone 1 – Blyford Bridge to Blythburgh Bridge
The channel through this zone is relatively narrow, being confined to an historical meandering course. The channel is constricted by defence banks to either side. The flow through the zone is, however, slow and there is only local pressure for the channel to change its course.

Zone 2 – Angel and Bulcamp Marshes
The estuary is wide and the meandering low water channel is only partly restrained by the old, now abandoned, defences. It is only as the estuary narrows at the eastern end of the zone is there and significant pressure on the current defence line. Change in sea level would result in a substantial increase in tidal volume of the estuary.

Zone 3 – Reydon and Tinkers Marsh
The channel width is constricted and change in position of the channel is restricted by flood defence banks. Any increase in flow through the area will result in increased erosion of both the channel bed and the edges of the channel. The channel flows through a series of curves which because of the present constraints means that there is significant interaction between he two sides of the estuary. The flood banks to both sides of the estuary are already under pressure from erosion.

Zone 4 – Southwold and Walberswick Harbour
Flow through the channel is constricted by the flood banks to either side and at the eastern end of the channel by the harbour entrance works. The channel is relatively straight, although turning into the zone through a relatively sharp bend. Downstream flow around the bend and into the outfall straight is partly controlled by the pipe bridge and partly by the reinforced

embankment on the northern side. The width of the channel is further constricted by moorings and landing stages.

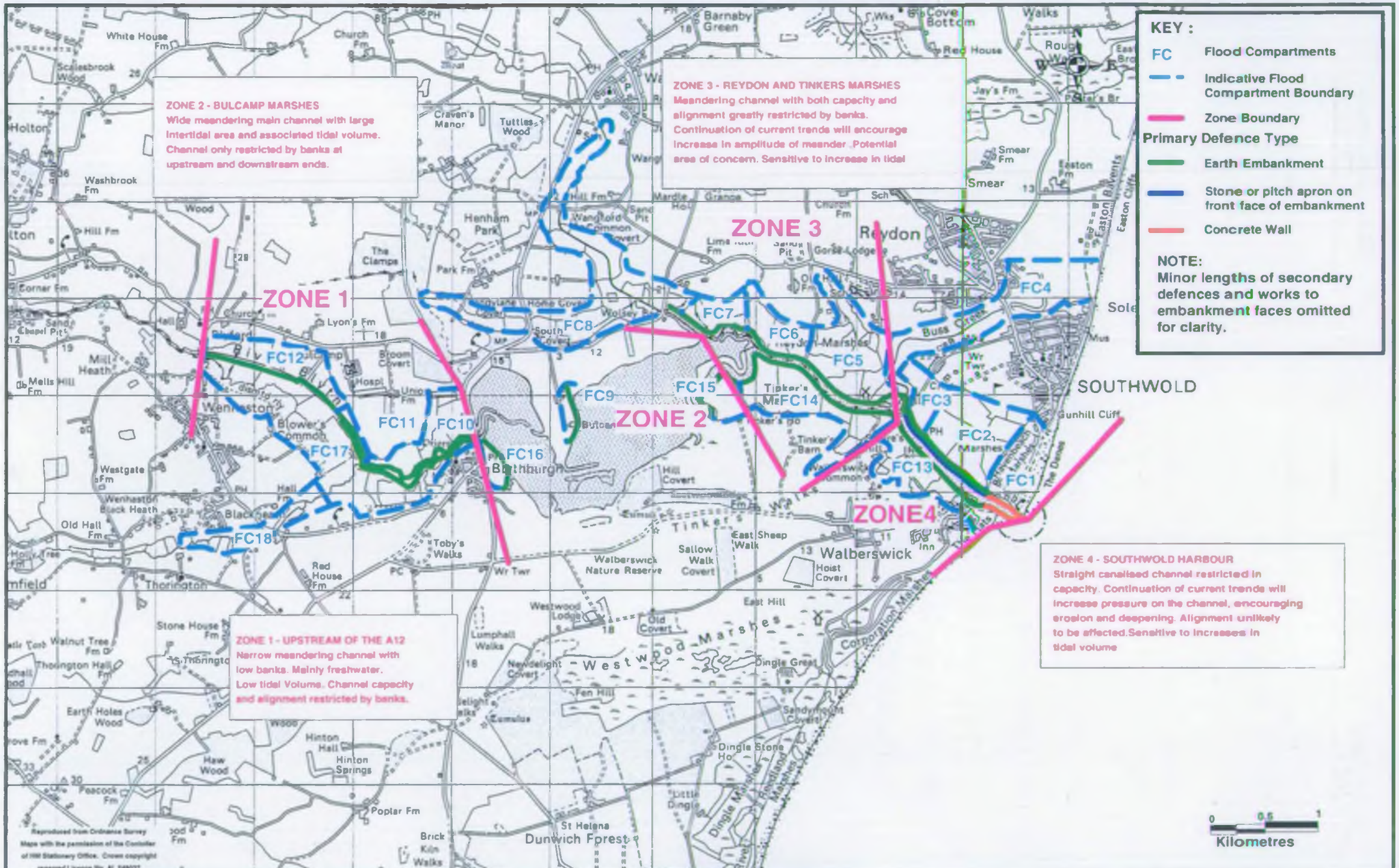
4.3.2 Division by Use

In examining the economics of flood defence and use and interest of the estuary, and assessing how this is affected within any scenario for flood defence, two areas have to be recognised:

- The assets contained within the estuary channel.
- The assets within the potential flood plain which are currently defended against flooding.

For convenience, the former are generally considered on a zone by zone basis. The latter are divided by flood compartment so as to relate the cost of defence against the assets protected. There are 18 flood compartments identified.

The flood compartments (FC) and the zones are shown on Figure 4.1



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES
PHASE 2

POSFORD DUVIVIER
In association with
HR Wallingford

BLYTH ESTUARY
FLOOD COMPARTMENTS
AND ZONES

FIGURE 4.1

SECTION 5

STRATEGIC APPRAISAL

5.1 GENERAL

The strategic appraisal process follows a general procedure. The implications of various options at a local level (the options for specific flood compartments (FC)) are examined. Consideration is then given as to how these may combine as options for each zone[2] (zone options). Finally, the interaction and implications of different zone options are examined to see how they work together to produce a workable strategy for the estuary.

The process is, therefore, one of predicting the future evolution of the estuary, examining how this is affected by the choice of defence options at the local level and, at an estuary level, examining the consequences of this on other areas. This Integrated Predictive Process is shown schematically in figure 5.0.

The rest of this subsection identifies specific issues relating to the overall process.

5.1.1 Options

The individual flood compartment is the basic building block of the strategy. For each flood compartment the cost of maintaining defences has been assessed and the damages, which would occur should defences be allowed to fail, has been determined (Appendices C and D). The current value of these damages - to property, land, and the agricultural production thereon - has been assessed, and Treasury discount rates applied to arrive at present values of damage occurring in the future. The assessment of costs and damages has been carried out following the principles identified in MAFF's Project Appraisal Guidance Notes[3]. Other factors such as amenity or environmental value have also been identified (Appendix E). For each flood compartment consideration is given to the generic defence policy which could be adopted. The standard strategic options considered in the Shoreline Management Plan process are described below:

- "Do Nothing" (DN). Doing Nothing to the existing defences and undertaking no defence work to minimise or restrict any associated damage. This option should always be considered and must at least form the basis for comparison with other options.

- "Hold the Line" (HTL). Retaining the existing defence line and undertaking necessary maintenance, repairs or reconstruction as required. This option assumes that the current standard of defence is retained, rather than the current level. This option is always considered in detail.

- "Managed Re-alignment" (R). Managed Re-alignment may take different forms. A new line of defence may be chosen, protecting key assets within the larger area of the flood compartment. Alternatively, the line of defence may be realigned or the standard of defence may be allowed to decrease. In some cases Managed Re-alignment may not be feasible because there is no sensible line to retreat to.

[2] The rationale behind the division of the estuary into zones is discussed in section 4.3. This division allows impacts of options to be considered at a local level while ensuring that the broader implications of the various options for defence management are considered throughout the estuary

[3] Further detailed assessment will be required to implement the strategy findings

- "Advance the Line"(ATL). This has only limited application to the estuary situation. Considering an estuary is different from considering the open coast, most obviously because the regime is confined between two shores; there is no open offshore boundary and there is often a high degree of interaction between the two sides of the estuary. Clearly in most situations Advancing the Line would increase this interaction and further constrict flows and increase the velocities. Advance the line is, therefore, not normally considered sensible.

In addition to the four standard options it is also important to consider other approaches:

- Where "Do Nothing" is a possible or probable option in the long term, then the cost of maintaining the existing defence in the short term has also been considered. The end result would still be to "Do Nothing" but this abandonment of defences would be triggered by the maintenance costs becoming excessive or impractical. This option is "Delay Do Nothing"(DDN). Such an approach, if found to be economically sensible, acknowledges the residual value of the existing defence and does allow better information to be obtained on the cost of maintaining the defence before a final decision is made. This cost of maintenance is generally the main area of uncertainty within the analysis presented. DDN would allow strategic decisions to be reviewed in light of better information. It would also in certain circumstances give advance notice of the intent to abandon a defence and allow time to plan how such a policy may be managed in the most advantageous manner.

- There are other options, which are appropriate to the individual nature of the estuaries but which are not easily classified under the four "SMP" generic headings, these are described and considered as appropriate in the local zone appraisals. Among these is the possibility of barrages or barriers. This possibility has been discussed with the Environment Agency and based on previous studies into such an approach the option of closing off major sections of the estuaries has been dismissed.

5.1.2 Transfer of Costs and Impacts

The decision to abandon, or hold, a defence in one area may result in additional cost or damage elsewhere. This may be due to an increase or redirection of the flow, more rapid erosion, and the need to install more costly forms of protection or the need to extend the defended length. Equally, it may create an opportunity for, or cause the loss of, habitat or use, which may detract from, or add, to the value of the estuary as a whole. Underlying the strategic analysis of the estuary is the need to add together these costs, benefits and other impacts across the whole area of the estuary. A mechanism has been set up by which this process of transfer can be assessed. The approach taken in achieving this is discussed below.

Each zone of the estuary contains various flood compartments. For each flood compartment, there are several possible defence management options (FC option). This results in several possible management options for the zone as a whole; based on the different logical combinations of FC options within the zone.

For any FC option, it is possible to assess the present value cost[4] (PVc) and present value

[4] Present value costs (PVc) are the discounted costs associated with maintaining, and where necessary rebuilding defences. Present value damages (PVd) are the discounted value of assets lost as a result of a specific option. The present value benefits (PVb) of an option is the difference between the damages which would still occur under that option and those that would arise if defences were abandoned (PVd "Do Nothing" - PVd "Option" = PVb). The Net Present Value (NPV) is the value of adopting a specific option; the difference between the value of benefits and the cost of that option (PVb – PVc = NPV). The time over which these values are discounted is linked to the residual life of defences. Further information is provided in Appendix D.

benefit (PVb) and, depending on the physical characteristics of the zone, the influence that an option may have on adjacent or opposite defences within the zone. The costs and benefits for each option may then be aggregated to provide a combined PVc and PVb for the zone under that particular combination of flood compartment options.

Under normal rules for economic appraisal the benefit cost ratio would be determined (the ratio of PVb/ PVc) and this would provide a comparative economic indicator of how worthwhile a particular option is. This method does not, however, provide any means of assessing the actual value of the option, neither in terms of its net economic advantage nor its net economic disadvantage (its deficit). If the benefit or burden of an option is to be assessed throughout the estuary, a different economic indicator has to be used.

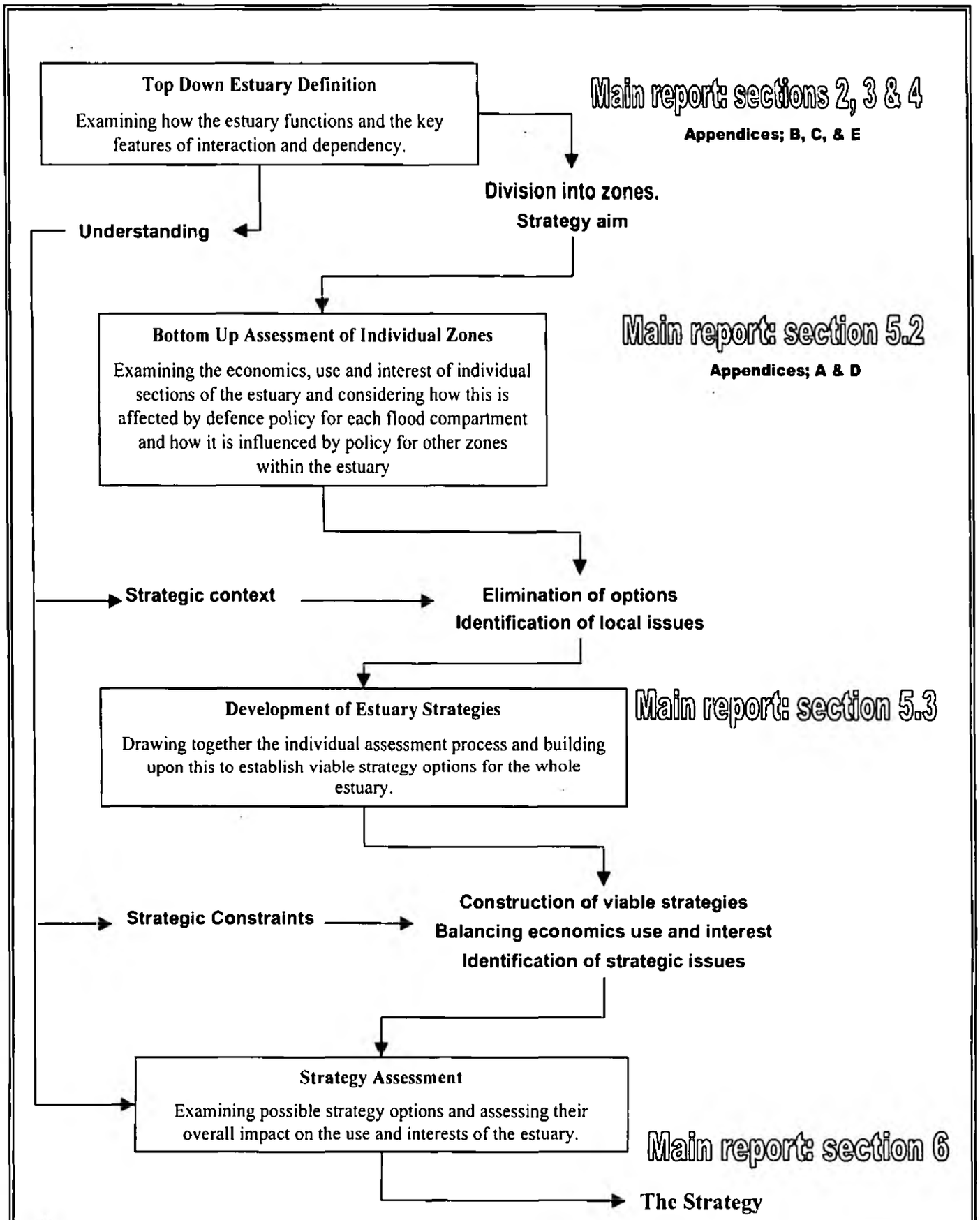
The difference between the PVc and PVb is the net present value (NPV). If positive then the NPV demonstrates that there is an economic benefit in adopting an option; if negative the NPV demonstrates a deficit between the cost of defending a section of the estuary compared to the value of assets protected. This indicator provides directly the value of benefit or deficit for any zone option considered. It also allows the physical impact of an option in one zone to be reflected in the economic analysis of a zone elsewhere. The NPV provides a means of tracking the economic consequence of an option throughout the estuary. Summing the NPVs for compatible options for each and every zone provides a means of assessing the economic case for the various estuary wide strategic options.

The environmental loss or gain, or the loss or gain in specific use of the estuary, may be assessed directly for any zone option and for the consequence of that zone option on other zones. In this way, and consistent with the approach adopted for the economics, a balance sheet can be maintained of loss, gain and opportunity, as the physical effect of any local option feeds through the estuary. In addition, an allowance for the cost of habitat management or recreation has been made where necessary.

In summary, therefore, the strategy appraisal starts by examining each flood compartment, considering how options for associated flood compartments may be put together to generate options for each zone. It then proceeds to examine how the zone options may be combined to create various strategy scenarios for the estuary as a whole. Throughout this process, the economic consequences are monitored by the cumulative NPV and the impact of the scenario tracked to ensure that the overall balance of interests in the estuary is maintained.

5.1.3 General Strategic Policy.

The appraisal undertaken for the Estuary is at a strategic level. The outcome of the analysis for some isolated flood compartments may not be critical to the overall strategy and, because of this, may potentially distort the strategic economic analysis. Such isolated flood compartments are identified. Neither the potential damages, benefits nor cost associated with the preferred option for these compartments are considered in the overall economic summary of the strategy. Furthermore, it would be inappropriate in such cases for the strategy to be overly prescriptive. While a preferred option is given, this should be seen as guidance, recognising the level of confidence in the strategic economic appraisal.



ENVIRONMENT AGENCY	SUFFOLK ESTUARINE STRATEGIES	POSFORD DUVIVIER In Association with HR Wallingford	INTEGRATED PREDICTIVE PROCCESS
			Figure 5.0

5.2 ZONE APPRAISALS

The following sub-sections work through the appraisal process zone by zone. In each case a standard format is adopted.

a) Zone Title Page

A brief description of the zone is given together with a list of zone options discussed in more detail further on within the sub-section and within Appendix A. The zones are shown in Figure 5.1.

a) General Overview

A general overview is given in tabular form. The table identifies:

- The physical nature of the zone, highlighting changes that would, as a result of action in other parts of the estuary, have a critical bearing on the defence management of the zone.
- Existing areas of concern.
- A headline assessment of the significance of the zone in relation to the estuary and the interaction within the zone.
- Other aspects of the zone which are important in the context of the estuary as a whole. Particularly those assets or features which are associated with the river channel rather than individual flood compartments.
- The potential threat to features within the zone and the potential opportunities which might arise from certain management scenarios.

For each flood compartment the table includes:

- The nature and condition of the defence works associated with each flood compartment.
- The actual value of assets protected by the defences, which would be lost should the defence be abandoned.
- The possible defence options considered, with brief description of potential local impacts and an explanation of why some options are clearly inappropriate.

a) Summary and Preliminary Conclusions

Preliminary (or local) conclusions for the zone are summarised, defining what conditions should be taken forward, from the possible options for the zone, when examining other zones. These preliminary conclusions form the basis for pulling together an overall estuary strategy at the end of Section 5. The detailed discussion upon which the above summary and conclusions are based is presented in Appendix A.

The manner in which the economic analysis has been derived is discussed in the Appendix A but is presented in more detail in Appendix D. A summary of the economic assessment for the relevant zone is presented in a table at the end of sub-section. This table is copied in Appendix A for convenience of reference.

ZONE 1. UPPER REACH
Blyford Bridge to Blythburgh Bridge

This zone, situated at the head of the estuary, comprises 4 main flood compartments, FC10 (Union Farm 1), FC11 (Union Farm 2), 12 (Blyford) and 17 (Blowers Marsh), with a secondary compartment, FC18 (Thorington) behind FC17. This is shown on Figure 5.1.

Table 5.2.1a provides a general overview of key information and an initial screening of flood compartment options.

Seven options are considered for the management of this zone.

1. **Do Nothing throughout the zone.**

1. **Hold the Line throughout the zone.**

1. **No longer protect the flood compartments adjacent to the river but continue defend flood compartment 18.**

A further three options test the economic sensitivity of maintaining defences in the short term but with the intention of Doing Nothing to defences when maintenance is no longer viable:

1. **Delay Do Nothing throughout the zone,**

1. **Delay Do Nothing for FC17 and 18**

1. **Delay Do Nothing for FC17 and Hold the Line in FC18**

One final option considers how the zone may be defended at a reduced economic cost.

7. **Maintain the present level of defence but excluding the tide with a sluice at Blythburgh bridge.**

Table 5.2.1b provides a summary of the economic assessment for this zone.

Table 5.2.1(a): General Summary of Zone 1

Zone 1 — **Blyford Bridge to Blythburgh Bridge** — **Ch 4.0 – 8.3 km**

Physical Description

Relatively narrow channel confined between flood defences banks over much of the zone. Some wider backwaters generally in-filled with reeds. The flows are generally sluggish (0.2m/sec); power dissipation indicates the channel is not under excessive stress.

Critical Influences: Increased flow through narrow meandering channel will increase pressure on defences.

Controls and Constraints Direction of flow is controlled by bridges at the head and lower end of the zone. In between, the defences confine flow into historical course of channel. Blythburgh Bridge potentially constrains volume of water moving into and out of zone. Present velocity through bridge is 0.75 m/sec.

Present Pressures Local areas of erosion and pressure on defences.

Potential Impacts Potential significant increase in tidal volume should defences fail and defended land be allowed to flood.

Internal Interaction The constraint of the banks direct flow against opposite side of the channel. Flood compartment 18 protected by defences of flood compartment 17.

General Attributes

Large areas of agricultural land protected. Land included within SRVESA. Footpaths along either side of the channel. Reed beds within channel.

Threats Banks in relatively poor condition and set at a low level.

Opportunities Sustainable area for fresh water habitat development.

Local Assessment

Flood compartment (FC)		Length	Area (ha)	Value of Assets	Defence Type	Defence Condition	Adjoining
10	Union farm 1	2000m	39	£199k	Clay banks	poor	FC11, A12
11	Union farm 2	350m	2	£14k	Clay banks	poor	FC10,FC12
12	Blyford	1500m	35	£224k	Clay banks	poor	FC11
17	Blowers marsh	3850m	112	£1,477k	Clay banks	poor	FC18
18	Thorington	300m	23	£437k		fair	FC17

FC	Option	Comment
10	*Do Nothing*	Loss of assets, change of habitat. Feasible and considered further..
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Retreat line is the same as high ground behind (Do Nothing). Assets are uniformly distributed within compartment, with no natural line either to re-align to or about which to divide compartment. As Do Nothing. Not considered further
11	*Do Nothing*	Loss of assets, change of habitat. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Narrow compartment. As Do Nothing. Not considered further.
12	*Do Nothing*	Loss of assets, change of habitat. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Retreat line is the same as high ground behind (Do Nothing). Assets are uniformly distributed within compartment, with no natural line either to re-align to or about which to divide compartment. As Do Nothing. Not considered further
17	*Do Nothing*	Loss of assets, change of habitat. Feasible and considered further.
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Retreat line is the same as high ground behind (Do Nothing). Assets are uniformly distributed within compartment, with no natural line either to re-align to or about which to divide compartment. As Do Nothing. Not considered further
18	*Do Nothing*	Dependent on FC17. Loss of assets, change of habitat. Feasible and considered further.
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Retreat line is the same as high ground behind (Do Nothing). Assets are uniformly distributed within compartment, with no natural line either to re-align to or about which to divide compartment. As Do Nothing. Not considered further

Summary and Preliminary Conclusions for Zone 1:

In isolation the policy for Zone 1 would be to abandon the defence of FC10, 11 and 12 immediately; maintaining FC17, while only minor repairs are required, but eventually Doing Nothing to these defences in favour of defending FC18 only (option 6). The economic case for this policy is strong (the case for Hold the Line having a negative NPV of -£747k).

The consequence of this policy on the rest of the Estuary would be considerable. This effective Do Nothing option would result in an increase in tidal volume of some 1.5Mm^3 within the next three to five years, increasing due to sea level rise to a potential value of 3.2Mm^3. Major works would eventually be required to the A12 Bridge and strengthening works would be required in the interim. However, this effective Do Nothing approach for Zone 1 has to be carried forward in the assessment of other zones.

As an alternative, consideration is given to constructing a sluice barrier at the A12 (Option 7). This option would avoid any increase in tidal volume but would at a local level still have a considerable economic disadvantage. The NPV is still negative (-£146k). However, this local disadvantage must be considered in the context of the increased cost elsewhere within the estuary, which might accrue under the Do Nothing scenario.

The option to construct a tidal barrage and exclude salt water from this upper part of the estuary has potentially significant benefits for the environmental interest of the estuary. It creates a genuinely sustainable freshwater environment opening up opportunities for habitat relocation which may be required if more sustainable options are to be allowed in other parts of the estuary. This option would actually reduce the tidal volume of the zone. As far as the impact this would have on the estuary further downstream, constructing a sluice at Blythburgh bridge would, in effect, be the same as Hold the Line. This version of the HTL option for the zone is therefore taken forward in the assessment of other zones.

Table 5.2.1b Summary of Zone 1 Economic Assessments

Option		1[3]	2	3[3]	4[3]	5[3]	6[3]	7
Flood Compartments	10	DN	HTL	DN	DDN	DN	DN	HTL[2]
	11	DN	HTL	DN	DDN	DN	DN	HTL[2]
	12	DN	HTL	DN	DDN	DN	DN	HTL[2]
	17	DN	HTL	DN	DDN	DDN	DDN[1]	HTL[2]
	18	DN	HTL	HTL	DDN	DDN	HTL	HTL[2]
Associated options	None							
PVc Costs £ x1000		0	2740	257	566	283	427	2139
PVd Damages £ x1000		2035	0	1668	1377	1500	1255	42
PVb Benefits £ x1000		0	2035	367	658	535	780	1993
NPV £ x1000		0	-705	110	92	252	353	-146
Notes	1	No appreciable increase in maintenance due to Do Nothing on opposite bank.						
	2	Hold the line associated with construction of barrage at the A12 Blythburgh Bridge						
	3	Increase in tidal volume of estuary, damages allow for cost of repair to A12 bridge.						

ZONE 2. CENTRAL REACH
Angel and Bulcamp Marshes

This zone comprises 3 flood compartments, FC9 (Bulcamp House), FC16 (Blythburgh East) and FC15 (Tinkers Marsh West). These are shown in Figure 5.1. FC9 and FC16 are both relatively small areas. FC15 adjoins FC14 (Tinkers Marsh East) in zone 3.

Table 5.2.2a provides a general overview of key information and an initial screening of flood compartment options.

The main external impact on this zone is from the policy adopted in Zone 1; an abandonment of the defences in Zone 1 would significantly increase flow through Zone 2. Only in the case of FC15 is this impact material to the cost of defence. Clearly, at a more local level, the policy for FC14, in Zone 3, would have an impact on the management of the defence of FC15, abandonment of the defence of FC14 would substantially increase the cost of maintaining the defence of FC15.

Because of the relatively minor impact either FC9 and FC16 would have on the estuary as a whole, these compartments may be assessed independently.

Nine options are considered for the management of this zone. The selection of these is explained further in *Appendix* A. Dealing first with FC9 the options are:

1 **Do Nothing in FC9** (irrespective of options for other Flood Compartments)
1 **Hold the Line in FC9** (irrespective of options for other Flood Compartments)

Then considering FC16:

1 **Do Nothing in FC16** (irrespective of options for other Flood Compartments)
1 **Hold the Line in FC16** (irrespective of options for other Flood Compartments)

(Because in neither case is the option for FC9 or FC16 going to have a material effect on the choice of options elsewhere in the estuary these two flood compartments are not considered further in this section of the report. The local conclusion drawn from examining these compartments is, however, taken forward to the overall summation of the estuary strategy, discussed in *Section* 5.3 of the report.)

And finally considering in a more strategic way options for FC15:

1 **Do Nothing in FC15** (associated with Do Nothing in Zone 1)
1 **Hold the Line in FC15** (associated with Do Nothing in Zone 1)
1 **Hold the Line in FC15** (associated with Hold the Line in Zone 1)
1 **Delay Do Nothing in FC15** (associated with Hold the Line in Zone 1)
1 **Delay Do Nothing in FC15** (associated with Do Nothing in Zone 1)

Table 5.2.2b provides a summary of the economic assessment for this zone.

Table 5.2.2(a): General Summary of Zone 2

Zone 2 — Angel and Bulcamp Marshes — Ch 8.3 – 11.6 km

Physical Description

Wide intertidal area with narrower low water channel meandering relatively freely through zone. Channel confined in some locations by the remnants of old flood banks, particularly towards the seaward (easterly) section of the zone. Much of the defence in this area was abandoned during the 1960's and these areas have generally reverted to mud-flats. Flow through the area tends to be sluggish (0.2 to 0.3 m/sec) increasing at the downstream end.

Critical Influences: Increased flow would increase pressure on defences at the eastern end of the zone.

Controls and Constraints Direction of flow is controlled by the Blythburgh Bridge at the upstream end and by the orientation of flow from the Reydon/ Tinkers marsh channel in the east. The shape of the estuary is dictated by the high ground behind Bulcamp House. The older, now abandoned defences, influence the course of the low water channel.

Present Pressures Along the western defences of Tinkers Marsh FC15.

Potential Impacts Increased tidal volume and thus increased flow if defences are abandoned. Impact is relatively small in comparison to the total volume of the estuary.

Internal Interaction Virtually no interaction between defence of flood compartments within this zone.

General Attributes

Relatively minor agricultural areas. Intertidal mud flat is an important environmental feature. Flood compartment 15 forms part of SPA and Ramsar site with particularly important fresh water grazing marsh habitat. Footpaths along either side of the channel.

Threats Sea level rise would require raising of banks if standard of defence is to be maintained. Erosion of banks to FC15 is a concern at present.

Opportunities Limited opportunity to develop saltmarsh around fringes of flood compartments.

Local Assessment

Flood compartment (FC)		Length	Area (ha)	Value of Assets	Defence Type	Defence Condition	Adjoining
9	Bulcamp House	500m	7.8	£576k	Clay banks	poor	High ground
16	Blythburgh East	260m	6.9	£233k	Clay banks	poor	High ground
15	Tinkers Marsh West	1000m	11.5	£170k	Clay banks	poor	FC14

FC	Option	Comment
9	*Do Nothing*	Loss of Bulcamp House. No significant creation of new habitat. Feasible and considered further.
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Limited width. Possible to re-align to protect house (local consideration). Not considered further at a strategic level.
16	*Do Nothing*	Loss of agricultural land and housing, No significant creation of new habitat. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Limited width with diverse assets and no sensible line of re-align. As Do Nothing. Not considered further.
15	*Do Nothing*	Loss of minor agricultural assets. Significant change of habitat and potential reduction in favourable conservation status of the SPA. Imposes increased cost on defence of adjoining flood compartment 14. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Retreat line is the same as high ground behind (Do Nothing). Assets are uniformly distributed within compartment, with no natural line either to re-align to or about which to divide compartment. As Do Nothing. Not considered further

Summary and Preliminary Conclusions for Zone 2:

There is marginal value in holding the existing line of defence to FC 9 and 16. These compartments have no significant effect on the estuary and are not considered further in this process of developing the strategy.

There is a strong economic case for Doing Nothing to the defence of FC15, the western end of Tinkers Marsh. The main implication of this policy would be the loss of habitat which would result in a substantial reduction in favourable conservation status of the SPA. This conflicts with the legal presumption in the Habitats Directive in favour of protecting European sites "in situ". However, this approach may be changed where protection is not sustainable over a reasonable period of time, as would probably be the case for FC15. There would also be a break in the footpath running along the crest of the existing defences. Considered at a local level this loss might outweigh other arguments, leading to the need to Hold the Line (options 6 or 7); despite the considerable expenditure necessary on defence.

If a Do Nothing option were to be adopted then there would be a need to examine how suitable conditions may be created within the estuary, as part of the strategy, to provide replacement habitat. It may be necessary to accept the need to delay a Do Nothing approach while such measures were put in place. A suitable area for fresh water grazing marsh is potentially available in Zone 1, if a Hold the Line option were adopted in this upper section of the estuary. Considering the zones examined so far, it would be more economical to maintain the habitat at Tinkers Marsh rather than accept the additional cost of Holding the Line in Zone 1.

The impact of Doing Nothing to the defence of FC15 on the regime of the Estuary would be significant but not critical in terms of the proportional increase in tidal volume. There would, however, be an increase in the defence cost of FC14.

In terms of options to be considered in association with options for zones elsewhere in the estuary, only Do Nothing in FC15 is taken on from this zone. Hold the Line option for FC15 is only truly relevant in association with the assessment of FC14 in Zone 3. Delay Do Nothing, is in most senses the equivalent of the Do Nothing option and only needs to be considered as an alternative, in that the delay before loss of habitat would allow management of the creation of alternative areas of habitat

Table 5.2.2b Summary of Zone 2 Economic Assessments

Option		1	2	3	4	5	6	7	8	9
Flood Compartments	9	DN	HTL							
	16			DN	HTL					
	15					DN	HTL	HTL	DDN[1]	DDN[2]
Associated options	Zone 1	DN	DN	DN	DN	DN	DN	HTL	HTL	DN
PVc Costs £ x1000		0	123	0	72	0	507	415	74	63
PVd Damages £ x1000		242	0	198	0	151	0	0	54	72
PVb Benefits £ x1000		0	242	0	198	0	151	151	97	79
NPV £ x1000		0	119	0	26	0	-356	-264	23	16
Notes	1	Based on delay of 10 years								
	2	Based on delay of 5 years								

ZONE 3.
The Reydon and Tinkers Marshes

This zone, shown in figure 5.1, comprises 5 flood compartments; 4 on the northern side of the estuary, FC8 (Wolsey Bridge), FC7 (Reydon Marsh West), FC6 (Reydon Marsh Central) and FC5 (Reydon Marsh East) and 1 on the southern side FC14 (Tinkers Marsh).

FC8 is set back partially behind FC7. All three compartments making up Reydon Marshes (FC7, FC6 and FC5) have common boundaries, with FC 5 adjoining Botany Marsh, (FC4 of Zone 4). Tinkers Marsh adjoins FC15 in zone 2 but is separated from Robinson's Marsh in Zone 4 by the embankment leading to the Squires Hill Pipe bridge.

With the narrow meandering channel this section is very sensitive to change in flow (tidal volume or sea level rise) increases in the estuary upstream. From the existing problems of erosion at several locations along both sides of the estuary, it is evident that there is quite considerable interaction between the two banks.

In total fifteen options are examined in assessing the local options for the zone. These are divided into two groups.

- An examination of the defences on the northern shore, including an examination of how these defences are affected by the policy for the southern shore (FC14). The eight options considered are:

1 **DN for all compartments (FC8, 7, 6 & 5).** (With DN for Zones 1, FC15 and FC14)
1 **HTL to FC8 but DN elsewhere.** (With DN for Zone 1, FC15 and FC14)
1 **HTL along the northern bank.** (With DN for Zone 1, FC15 and FC14)
1 **HTL along the northern bank.** (With DN for Zone 1 and FC15 but HTL FC14)

Then testing the sensitivity of dividing up units on the northern bank:

1 **DN to FC6 but HTL elsewhere.** (With DN for Zone 1 and FC15 but HTL FC14)
1 **DN to FC6 and FC5 but HTL elsewhere.** (With DN for Zone 1 and FC15 but HTL FC14)

And finally examining the effect of HLT in Zone 1

1 **HTL along the northern bank** (With DN in FC15 but HTL to Zone 1 and FC14)
1 **HTL along the northern bank** (With DN in FC15 and FC14, but HTL to Zone 1)

Table 5.2.3b provides an economic summary for the northern part of the zone.

- An examination of the defences on the southern shore (FC14), including an examination of how these defences are affected by the policy for the northern shore (FC8, 7, 6 & 5). The seven options considered are:

1 **DN to FC14** (With DN for Zone 1, FC15, and the northern side of Zone 3)
1 **HTL to FC14** (With DN for Zone 1, the northern side of Zone 3 but HLT to FC15)
1 **HTL to FC14** (With DN only along the northern shore of Zone 3, HLT to Zone 1 and FC15)
1 **DDN to FC14** (With DN along the northern side of Zone 3, HTL in Zone 1 and DDN to FC 15)

Having assessed the merits of treating the compartment as one, the following options examine the possibility of Managed Re-alignment:

1 **Managed Re-alignment FC14** (With DN for Zone 1, FC15, and north side of Zone 3)
1 **Managed Re-alignment FC14** (With DN for Zone 1 and FC15, but HLT to north side of Zone 3)
1 **Managed Re-alignment FC14** (With DN to FC15, but HLT to in Zone 1 and north side of Zone 3)

Table 5.2.3c provides an economic summary for the southern part of the zone.

Table 5.2.3(a): General Summary of Zone 3

Zone 3	Tinkers and Reydon Marshes

Physical Description

Narrow meandering and constricted channel, restrained by defences hard against both sides. Extensive flood compartments to either side of the estuary. Flow through the channel reaches typical velocities of 0.7m/s on spring tides.

Critical Influences: Increased flow would result in increased general erosion as well a more severe erosion at specific points as the channel attempts to widen and change its course.

Controls and Constraints Direction of flow tends to be funnelled into the zone by old abandoned defences at the western end. The direction of flow and the position of the channel is controlled by the Pipe Bridge at the downstream end.

Present Pressures Defences to Reydon are being undermined by erosion. Erosion is occurring to the outside of the bends along the Tinkers Marsh defences.

Potential Impacts Large increase in tidal volume and flow if defences were abandoned. This would have a major impact on the estuary downstream and on the interaction with coastal processes at the mouth.

Internal Interaction Considerable interaction between defences to either side of the channel.

General Attributes

Major agricultural areas. Limited fringe saltmarsh which is in any event being eroded. Flood compartment 14 forms part of SPA and Ramsar site with particularly important fresh water grazing marsh habitat generally through out the area and transitional habitat at the eastern end. Foot paths to either side of the estuary.

Threats This area is particularly threatened by increases in flow due to tidal volume increase upstream.

Opportunities Limited opportunity to develop saltmarsh around the fringes of flood compartments. Doing Nothing to defences would provide extensive areas of mud flats

Local Assessment

Flood compartment (FC)		Length	Area (ha)	Actual Value of Assets	Defence Type	Defence Condition	Adjoining
8	Wolsey Bridge	100	86.1	£544k	Piled	Fair	FC7
7	Reydon West	1200	20.7	£132k	Reveted clay bank	Fair	FC8,FC6
6	Reydon Central	500	17.9	£115k	Clay bank piling	Moderate	FC7, FC5
5	Reydon East	1000	58.2	£471k	Clay bank, concrete	Fair	FC6, FC4
14	Tinkers Marsh	1625	52.7	£332k	Clay bank	Poor	FC15

FC	Option	Comment
8	*Do Nothing*	Substantial loss of agricultural land. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further.
	Managed Re-alignment	No advantageous retreat line. Not considered further
7	*Do Nothing*	Substantial loss of agricultural land Imposes additional cost on adjacent compartments.. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
6	*Do Nothing*	Substantial loss of agricultural land. Imposes additional cost on adjacent compartments. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
5	*Do Nothing*	Substantial loss of agricultural land. Imposes additional cost on adjacent compartments. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
14	*Do Nothing*	Loss of agricultural land, Significant change of habitat and potential reduction in favourable conservation status of the SPA. Imposes increased cost on defence of adjoining flood compartment 15. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Possible line of retreat defending eastern section of compartment. Feasible and considered further

Summary and Preliminary Conclusions for Zone 3:

The Reydon marshes should be held as a unit (FC5, 6, and 7) or not at all. FC8 is worth maintaining regardless but may be held more economically overall in conjunction with the other three units.

It is only economically beneficial to hold the Reydon Marsh if Zone 1 is HTL or, if Zone 1 is abandoned, FC14 is also abandoned. The difference in NPV is of the order of £50k in favour of Holding the Line in Zone 1 and Doing Nothing to FC14.

Holding the line in FC14 would result in an negative NPV for Zone 3 north of some £124k if Zone 1 is HTL and some £361k if Zone 1 were abandoned.

Regardless of whether the northern section is HTL or DN, Holding the Line to FC14 is not economically sound

There is a general conflict between holding the line on both sides of the river. This would be exacerbated by the increased flows resulting from Doing Nothing to the defences to the west of the A12. Doing Nothing to the defence of the southern frontage would make it possible to maintain the northern frontage in an economic manner. Loss of FC14 would, however, result in the loss of important habitat, which may be in conflict with the preferred approach in the Habitats Directive of protecting European sites "in situ". There would be a need to examine how suitable conditions may be created within the estuary, as part of the strategy, to provide replacement habitat in a more sustainable manner. This is likely to be a prerequisite for accepting this option.

This option would result in some increase in tidal volume of the order of 570M m^3, resulting in increased pressure on defences downstream. Some mitigation in terms of both environmental and regime impact might be possible locally in re-aligning the defence of FC14 rather than wholesale abandonment. This Managed Re-alignment, to the eastern end of Tinkers Marsh, would reduce the tidal volume increase to some 530M m^3 and would protect some of the most unique habitat of the Tinkers marsh area, also ensuring the continuity of the riverside footpath. It would, however, result in a marginal negative NPV of the order of £55k.

Under the Managed Re-alignment option there would be a NPV benefit of the order of £50k in favour of holding the line in Zone 1. Holding the line in Zone 1 by means of a sluice barrage also, potentially, provides the option for freshwater pasture habitat creation.

No other options sensibly present themselves; to Do Nothing both north and south of the river would result in a decrease of NPV by some £100k while increasing the tidal volume of the estuary by some 1.3M m^3 , Holding the Line both north and south of the river would result in an incremental decrease in NPV of the order of £400k and for all reasonable purposes must be considered unsustainable.

Table 5.2.3b Summary of Zone 3N Economic Assessments – Northern bank only.

Option		1	2[1]	3	4	5	6	7	8
Flood Compartments	8	DN	HTL	HTL	HTL	HTL	HTL	HTL	HTL
	7	DN	DN	HTL	HTL	HTL	HTL	HTL	HTL
	6	DN	DN	HTL	HTL	DN	DN	HTL	HTL
	5	DN	DN	HTL	HTL	HTL	DN	HTL	HTL
Associated options	Zone 1	DN	DN	DN	DN	DN	DN	HTL	HTL
	FC15	DN	DN	DN	DN	DN	DN	DN	DN
	FC14	DN	DN	DN	HTL	HTL	HTL	HTL	DN
PVc Costs £ x1000		0	108	863	1224	1320	488	987	863
PVd Damages £ x1000		1172	904	57 [2]	57 [2]	154	793	0	0
PVb Benefits £ x1000		0	268	1115	1115	1018	379	1172	1172
NPV £ x1000		0	160	252	-109	-302	-109	185	309
Notes	1	Increases tidal volume by 680M m^3 due to contribution from northern flood compartments and a further 570M m^3 due to contribution from FC14 and 15. Total 1250M m^3 .							
	2	Additional protection required to maintain the bridge.							

Table 5.2.3c Summary of Zone 3S Economic Assessments - Southern bank only.

Option		1	2	3	4	5	6	7
Flood Compartments	14	DN	HTL	HTL	DDN[1]	R[2]	R[2]	R[2]
Associated options	Zone 1	DN	DN	HTL	HTL	DN	DN	HTL
	Zone 3N	DN	DN	DN	DN	DN	HTL	HTL
	FC15	DN	HTL	HTL	DDN	DN	DN	DN
PVc Costs £ x1000		0	730	579	120	315	315	260
PVd Damages £ x1000		399[3]	0	0	242[3]	194[4]	190[4]	194[4]
PVb Benefits £ x1000		0	399	399	157	205	209	205
NPV £ x1000		0	-331	-180	37	-110	-106	-55
Notes	1	Maintain defences for ten years						
	2	Managed Re-alignment to defend the eastern section of Tinkers Marsh only.						
	3	Loss of important habitat and increase in tidal volume by 570M m^3						
	4	Loss of important habitat and increase in tidal volume by 530M m^3. Safeguards habitat unique to estuary.						

ZONE 4 LOWER REACH
Southwold and Walberswick Harbour.

This zone, shown in figure 5.1, comprises five flood compartments; four on the northern side of the estuary, FC4 (Botany Marsh), FC3 (Woodsend Marsh), FC2 (Town Marshes) and FC1 (Haven Beach Marsh), and one on the southern bank FC13 (Robinson's Marsh and Walberswick). This marsh on the southern side is divided into two areas with different characteristics; to the west is the low lying pasture land and to the east is the town and harbour of Walberswick.

The channel through the harbour reach is relatively straight, once clear of the sharp bend through the Squires Hill Pipe Bridge. The eastern end of the reach is confined between the harbour works, training the channel out to sea. On the northern bank much of the harbour development is forward of the flood defence works, many of the buildings being raised above the general level of the narrow track at the edge of the estuary. Flow through the harbour is quite strong and there are moorings and landing stages along both banks further concentrating flows. On spring tides the channel is flowing at capacity, any increase in flow will attempt to widen or deepen the channel.

In total eighteen scenarios are examined in assessing the local options for the zone. These are divided into two groups looking first at the northern side (10 options) and then at the southern compartment (7 options).

Northern Bank

1, 2, 3 & 4 **Do Nothing to Northern bank.** (The first four options consider the Do Nothing within this section of the zone and examine the impact of various combinations of zone options from elsewhere in the estuary; the main variation being the reduction in residual life of defence structure due to change in flow conditions through the zone.)

5. **HTL to FC 4** (FC4 contains the largest concentration of assets. This option tests the importance of this to the assessment process.)

6. **HTL throughout the section** (This option examines the most onerous case for Holding the Line along the whole of the northern bank.)

7. 8, 9, & 10 **HTL throughout the section** (The final four options consider the merits of HTL under different scenarios of zone options elsewhere in the estuary.)

Table 5.2.4b identifies the specific details of each option and summaries the economic assessment for this northern bank.

Southern Bank

1 & 2 **Do Nothing** (The first two options consider DN to FC13 and examine the impact of various alternative scenarios of zone options elsewhere in the estuary.)

3, 4, 5 & 6 **Hold the Line** (These four options consider Holding the Line to FC13 and examine the impact of various alternative scenarios of zone options elsewhere in the estuary.)

7 & 8 **Managed Re-alignment** (The final two options consider the merits of Managed Re-alignment under different scenarios of zone options elsewhere in the estuary.)

Table 5.2.4c identifies the specific details of each option and summaries the economic assessment for this southern bank.

Table 5.2.4(a): General Summary of Zone 4

Zone 4 — Southwold and Walberswick Harbour.

Physical Description

Relatively narrow but straight channel from the Pipe Bridge to the Sea. Sharp corner through Pipe Bridge. Extensive areas of low lying marsh land to either side of channel. Potential flood route through Botany marshes behind Southwold to coast. Coastal flood compartments partially protected by natural sea defence. Peak spring tide velocity of 1.2m/s.

Critical Influences: Increased flow would result in pressure for channel to widen and deepen. If resisted velocities would increase. Increased flow would impact on sediment transport at coast.

Controls and Constraints Direction of flow is dictated by orientation of Pipe Bridge and hard defences immediately down stream, and by the harbour piers at the estuary mouth. Within the reach flow directed by banks and influenced by moorings and landing stages.

Present Pressures. Need for hard defence along northern side of channel. Erosion along the southern side and to the harbour structures.

Potential Impacts Large increase in tidal volume and flow if defences were abandoned. This would have a major impact on the adjacent defences and on the coastal regime.

Internal Interaction Dependence of adjacent defences. Conflict in terms of channel width between the two sides of the channel.

General Attributes

Significant agricultural areas. Important habitat to northern marshes. Golf course extends into Woodsend Marsh. Sewage works in Botany Marsh. Harbour development, moorings and landing stages and important fishing interests. Caravan Park and tourism development in and around Havenbeach marsh. Part of Walberswick within FC13. General landscape and tourism interests.

Threats This area is threatened by increases in flow due to tidal volume increase upstream. This may impact both on flood defence and on the use of the river.

Opportunities Limited opportunity to develop saltmarsh around the fringes of flood compartments.

Local Assessment

Flood compartment (FC)		Length	Area (ha)	Value of Assets	Defence Type	Condition	Adjoining
4	Botany Marsh	100	56.6	£2,060k	Reveted clay bank	Good	FC5, FC3
3	Woodsend	300	21.6	£734k	Reveted clay bank	Fair	FC4,FC2
2	Town Marsh	800	52.9	£1,195k	Reveted clay bank	Fair	FC3, FC1
1	Havenbeach Marsh	500	18.8	£1,427k	Clay bank, concrete	Fair	FC2
13	Robinson's Marsh	1500	51.1	£944k	Clay bank	Poor	FC14

FC	Option	Comment
4	*Do Nothing*	Substantial loss of assets. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further.
	Managed Re-alignment	No advantageous retreat line. Not considered further
3	*Do Nothing*	Loss of assets. Additional cost on adjacent compartments.. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
2	*Do Nothing*	Loss of harbour. Additional cost on adjacent compartments.. Feasible and considered further.
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
1	*Do Nothing*	Loss of harbour, caravan park and possibly beach. Additional cost on adjacent compartments. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	No advantageous retreat line. Not considered further
13	*Do Nothing*	Loss of agricultural land and property in Walberswick. Feasible and considered further
	Hold the line	Maintains existing use and interest. Feasible and considered further
	Managed Re-alignment	Possible line of retreat defending eastern section of compartment. Feasible and considered further

Summary and Preliminary Conclusions for Zone 4

The economic analysis has demonstrated a conflict in defending both the north and southern side of the Harbour reach. A strong case can be made for continuing the defence of all the flood compartments to the northern side of Southwold Harbour. The economic case for protecting the full length of the southern bank is weak. Furthermore, if this southern bank is maintained, this could result in an increase of the order of £200k in the cost of defending the Southwold side.

The northern frontage is worth defending with an NPV of the order of £2M, depending on the defence of the southern frontage. This even assumes that the flows through the estuary are increased by Doing Nothing to defences in Zone 1. Holding the line in Zone 1 does, however, reduce the cost of maintaining defences along this northern frontage by some £500k. Even under the most severe scenario it is worth defending the northern frontage. It is, however only worth defending the whole of the southern frontage if Zone 1 is HTL and the northern section of Zone 4 is abandoned.

Loss of FC13 would result in damage to properties in Walberswick, as well as the loss of income generated by the adjacent land and the use of the riverside footpath. It would also result in increased flow through the entrance channel of the harbour, and incur the loss of moorings to this southern side of the estuary. An alternative approach has been considered, that of re-aligning the defence of FC13 so as to protect properties around Walberswick. This option is economically worthwhile with an NPV of the order of £380k. This would impose some additional cost on the defence of the northern side amounting to an difference in NPV of the order of £190k. This option does therefore make economic sense while still preserving important assets on the southern side of the river.

Under a Managed Re-alignment option for FC13 and HTL for FC1, 2, 3 and 4 there is significant benefit if the increase in the tidal volume of the estuary is minimised by defending the flood compartments to the west of the A12. The differential NPV in favour of Holding the Line in Zone 1 is of the order of £653k.

Table 5.2.4b Summary of Zone 4N Economic Assessments – northern bank only.

Option		1	2	3	4	5	6	7	8	9	10
Flood Compartments	1	DN	DN	DN	DN	DN	HTL	HTL	HTL	HTL	HTL
	2	DN	DN	DN	DN	DN	HTL	HTL	HTL	HTL	HTL
	3	DN	DN	DN	DN	DN	HTL	HTL	HTL	HTL	HTL
	4	DN	DN	DN	DN	HTL	HTL	HTL	HTL	HTL	HTL
Year of failure /construction [1]		7[2]	5[2]	10[3]	8[2]	7[2]	15[2]	10[2]	20/25[3]	18/23[2]	20/25[2]
Associated options	Zone 1	DN	DN	HTL	HTL	DN	DN	DN	HTL	HTL	HTL
	Zone 3N	HTL	HTL	HTL	HTL	HTL	HTL	HTL	HTL	HTL	HTL
	Zone 3S	DN	DN	DN	DN	DN	DN	DN	DN	DN	DN
	FC13	DN	HTL	DN	HTL	DN	DN	HTL	DN	HTL	R
PVc Costs £ x1000		0	0	0	0	396	1052	1201	678	791	706
PVd Damages £ x1000		3742	4062	3190	3584	2362	105[4]	201[5]	0	105[4]	0
PVb Benefits £ x1000		0	-320	552	158	1380	3637	3541	3742	3637	3742
NPV £ x1000		0	-320	552	158	984	2585	2340	3064	2846	3036

Notes		
	1	The residual life of defences or the period during which the existing defences can be maintained depends, to a large degree, on the tidal volume of the estuary and the degree of constraint imposed by maintenance of both sides of the channel. Increased tidal volume or increased constraint increases the cost of maintenance and decreases the time that maintenance may be sustained.
	2	The general residual life of structures is given. The need for works to safeguard the quay in FC1 is taken as 5 years.
	3	The general residual life of structures is given. The need for works to safeguard the quay in FC1 is taken as 7 years.
	4	Partial loss of moorings due to increased flows and erosion of the frontage.
	5	Loss of moorings due to increased flows and erosion of the frontage

Table 5.2.4c Summary of Zone 4S Economic Assessments – Southern bank only.

Option		1	2	3	4	5	6	7	8
Flood Compartments	13	DN[1]	DN[1]	HTL	HTL	HTL[2]	HTL[2]	R[3]	R[3]
Associated options	Zone 1	DN	HTL	DN	HTL	DN	HTL	DN	HTL
	Zone 3N	HTL	HTL	HTL	HTL	HTL	HTL	HTL	HTL
	Zone 3S	DN	DN	DN	DN	DN	DN	DN	DN
	Zone 4N	DN	DN	DN	DN	HTL	HTL	HTL	HTL
PVc Costs[5] £x1000		0	0	654	582	789	654	253	163
PVd Damages[5] £x1000		708	633	52[4]	0	104	52[4]	222	165
PVb Benefits £x1000		0	75	656	708	604	656	486	543
NPV £x1000		0	75	2	126	-185	2	233	380

Notes

1. Loss of the embankment is assumed to occur in seven years.
2. Reconstruction costs are assumed to be needed in years 10 and 15 for options 5 and 6 respectively.
3. Managed Re-alignment would occur in year 5 or in year 10 for option 7 and 8 reflecting the difference in tidal volume between the two options. Managed Re-alignment would be to the defence of the village of Walberswick.
4. Damages are the loss of moorings due either to the excessive increase of tidal volume or due to constrain of the channel.
5. Neither costs nor damages take into account the additional cost or damage associated with coastal defence due to estuary options.

THE SHORELINE

The predominantly natural defence to either side of the estuary mouth and to the south of the estuary relies on a continued supply of sediment. Increased flows from the estuary are likely to result in an increase in the ebb shoal delta of the estuary. This will tend to have a twofold effect.

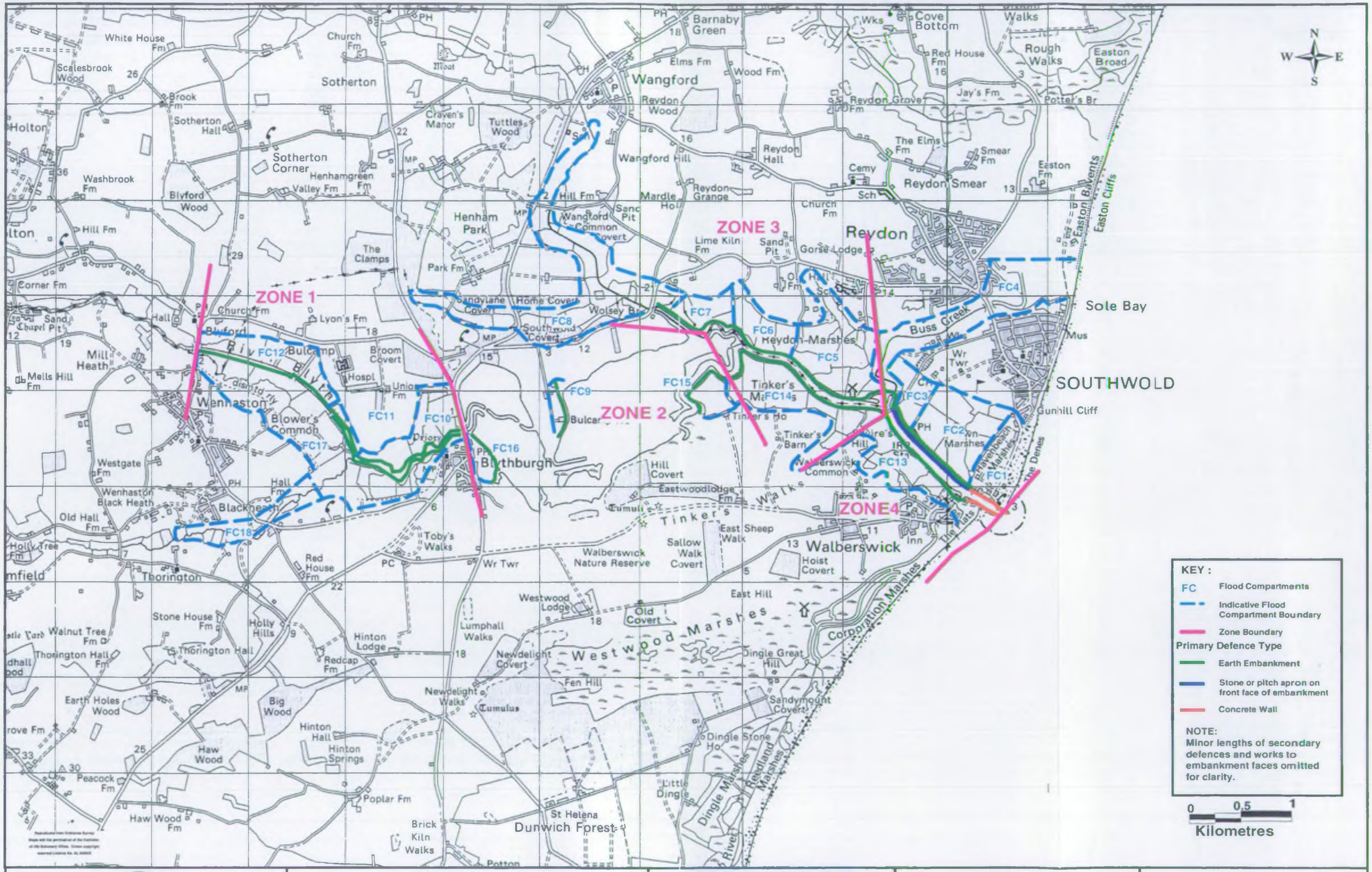
- The increase in the delta formation will tend to entrap material resulting in some, possibly temporary, disruption to the southerly drift reported for the area.

- The ebb shoal delta may provide a degree of shelter to the coast immediately adjacent to the estuary mouth.

On balance the principal impact will be to the coast to the south, beyond the area of dunes in front of Walberswick. This may increase the difficulty of maintaining the shingle bank in this area and resulting in a faster retreat of the frontage than at present anticipated.

These process changes are likely to take place over the period of the strategy, due to the increase in sea level rise. Any option involving Managed Re-alignment or abandonment of existing defences will make a more immediate impact and will amplify the impact of the longer term sea level rise. Of the options considered in the various scenarios described above, the most significant change in tidal volume would result from the abandonment of the defences to the west of the A12. This would result in an increase of approximately 1.5M m^3, a factor of 1.55 on the present tidal volume of the estuary, and probably in excess of the increase in volume anticipated due to sea level rise based on the existing situation. Managed Re-alignment of defences to Tinkers Marsh and Robinson's Marsh, the other potential candidates could potentially add a further 600,000m^3. These impacts are difficult if not, with our present technology, impossible to quantify, not least because of the present uncertainty associated with the sediment drift rates and patterns.

Certainly should all the above areas be abandoned then the impact on the coast and the sediment supply would be significant. The increase of volume due to Doing Nothing to Zone 1 is likely to be significant and even more so in the future with sea level rise increasing volumes within the abandoned area. In the case of the Tinkers Marsh and Robinson's Marsh areas the immediate increase of some 22% would not be expected to create a substantial difference in the rate of drift, although it would have some impact.



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES
PHASE 2

POSFORD DUVIVIER
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HR Wallingford

BLYTH ESTUARY
FLOOD COMPARTMENTS
AND ZONES

FIGURE 5.1

5.3 DEVELOPMENT OF ESTUARY STRATEGY

5.3.1 Vision for the Estuary

The analysis in Section 5.2 has been developed on the basis of individual estuary zones. This section (5.3) of the report draws together the local conclusions, building up a strategy for the estuary as a whole. This recognises that impacts can extend over much of the estuary; a local option can give rise to a substantial increase in tidal volume or result in the loss of a specific feature of use or environmental interest, which then may be of significant strategic importance for the estuary's overall management.

Various issues have been identified, such as the loss of habitat or the opportunity for habitat gain or the importance of the harbour, and the transfer of cost from one area of the estuary to another. These issues need to be balanced to achieve a strategy in-line with the overall aim for the estuary:

"To develop a strategy for flood defence which maintains or, where possible, improves the overall balance of the estuary in terms of its natural and human environment, its use and recreational value and economic interests, while minimising the dependence of this balance on flood defence expenditure."

The estuary is at present heavily managed, and it is clear that the interests and uses of the estuary cannot be sustained unless a strong degree of management is continued. With care this is feasible over the fifty years of the strategy (and beyond), given the probable rate of sea level rise assumed in the study and assuming a recognition that areas of stress within the estuary must be appropriately dealt with.

There is little scope for allowing a fully "natural" evolution of the estuary, without total disregard for its use. This cannot, however, give "carte blanche" for maintaining defences wholesale throughout the estuary. Such an approach would ignore the increasing areas of pressure and would erroneously encourage an evolution of use, with a false sense of security, reliant upon defences and a form of estuary which could not be sustained into the future.

A balance must be struck and the key factors, apparent from the analysis for the Blyth, are that:

The volume increase of the estuary must be controlled, together with the way in which this impacts upon and is influenced by the interaction with the coast.

The pressures, both man made and natural, on the environment must be recognised and a balanced and adequate habitat resource must be built into the strategy in a sustainable manner.

The significant social, cultural and economic value of the estuary must be maintained, in particular with respect to the harbour and the settlements.

Endeavouring to achieve this balance encapsulates the vision from which to examine and develop the strategy for the estuary and provides intent in the subsequent implementation guidance presented in this report.

5.3.2 Approach

In section 5.2 various options were considered looking at how specific policies for individual flood compartments work and interact within a zone. These zone options are developed and discussed on the assumption of certain policies being adopted in other zones of the estuary. In this section various generic strategies are considered looking initially at different wholesale approaches to the management of the estuary and honing in on variation to specific options within individual flood compartments. Although the zones have provided a pragmatic means to analyse these combinations of options, in essence, in developing the strategy it is necessary to build up again from the way in which each flood compartment interacts with other flood compartments and with the whole management framework for the estuary as one entity.

In total, four estuary strategy options are presented, the first being Do Nothing throughout the estuary. Although Do Nothing is not compatible with the aim for the estuary, it does, provide the benchmarks from which to compare other options.

As with the approach adopted in assessing options for the flood compartments and the zones it is neither sensible nor constructive to range through every possible alternative option for the overall strategy. Some zone options are mutually exclusive, others have been shown to be less advantageous than others at the local level. In strategic terms, as briefly indicated earlier, the main areas of contention focus around:

- The need to ensure that any increase in tidal volume in the estuary as a whole does not result in a major disruption of the coastal processes and that the costs associated with the increase in velocities is considered with respect to each and every zone.

- The need to ensure first, that where strategically important habitat (such as at Tinkers Marsh) is threatened then there is a feasible mechanism whereby such habitat may be re-created and secondly, that the overall balance of habitat throughout the estuary is maintained. In this latter respect it is appreciated that there is a continuing loss of salt marsh. The strategy needs to compensate where possible for this.

- The need to minimise the economic damage whilst also reducing the cost of future work on defences.
- The need to ensure as far as is practical that the use of the harbour in maintained, predominantly by limiting increases in velocity through the area.

5.3.3 Strategy Options

Four estuary strategy options are considered.

S1 **Do Nothing throughout the estuary.** (This option considers Do Nothing in the flood compartments that are likely to have an impact on the overall strategy. It provides the economic baseline for the comparison of other options.)

S2 **Strategic Hold the Line.** (Considering each zone individually, this option takes the most economically favourable result.)

S3 **Maximised environmental balance, incorporating the Do Nothing option in Tinker's Marsh.** (This option considers how S2 may be modified to achieve a better environmental balance.)

S4 **Maximised environmental balance, incorporating the Managed Re-alignment option in Tinker's Marsh.** (This option considers how S2 may be modified to achieve a more balanced strategy.)

Table 5.3 summarises the policies which would apply to each flood compartment based on these four options. Table 5.4 considers the environmental impacts and opportunities in each option, and carries out an environmental audit. Table 5.5 summarises the economic assessment for each option.

Table 5.3 Summary of Strategic Options

Strategy Options	S1	S2	S3	S4
Zone 1 (zone option)	1	6	7	7
FC10 Union Farm 1	DN	DN	HTL	HTL
FC11 Union Farm 2	DN	DN	HTL	HTL
FC12 Blyford	DN	DN	HTL	HTL
FC17 Blowers Marsh	DN	DDN	HTL	HTL
FC18Thorington	DN	HTL	HTL	HTL
Zone 2 (zone options)	2/4/5	2/4/9	2/4/8	2/4/8
FC9 Bulcamp House	HTL	HTL	HTL	HTL
FC16 Blythburgh	HTL:	HTL	HTL	HTL
FC15 Tinker's West	DN	DDN	DDN	DDN
Zone 3 N&S (zone options)	1n/1s	3n/1s	8n/4s	8n/7s
FC8 Wolsey Bridge	DN	HTL	HTL	HTL
FC7 Reydon West	DN	HTL	HTL	HTL
FC6 Reydon Central	DN	HTL	HTL	HTL
FC5 Reydon East	DN	HTL	HTL	HTL
FC14 Tinkers Marsh	DN	DN	DDN	R
Zone 4 N&S (zone options)	1n/1s	6n/1s	10n/8s	10/n/8s
FC4 Botany Marsh	DN	HTL	HTL	HTL
FC3 Woodsend Marsh	DN	HTL	HTL	HTL
FC2 Town Marshes	DN	HTL	HTL	HTL
FC1 Havenbeach Marsh	DN	HTL	HTL	HTL
FC13 Robinson's Marsh	DN	DN	R	R
Net Present Value (NPV)	0	£3,011,000	£3,444,000	£3,352,000

Option S1	Widespread economic damage. Massive increase in tidal volume and consequently velocities. Substantial and significant impact on coastal processes calling into question viability of SMP policies for coastline to the south. Severe environmental consequences with loss of important habitat. This option is unacceptable.
Option S2	Large economic damages including substantial loss of use of the harbour. Significant increase in tidal volume and increase in velocities. Significant impact on coastal processes with particular effect on shingle bank to south. Severe environmental consequences with loss of important habitat without scope for re-creation.
Option S3	Loss of important fresh water marsh habitat including specific transitional habitat, but with the opportunity for re-creation of general freshwater marsh in a more sustainable location. Loss of some mooring area to harbour and possible increased difficulty of use. Some impact on coastal processes.
Option S4	Loss of important fresh water marsh habitat excluding specific transitional habitat. Opportunity for re-creation of general freshwater marsh in a more sustainable location. Loss of some mooring area to harbour and possible increased difficulty of use. Some impact on coastal processes.

Key

DN — Do Nothing

DDN — Delay Do Nothing

R — Managed Re-alignment

HTL — Hold the Line

Zone Options refer to the number of the option described in Section 5.2

Table 5.4 Summary of Environmental Impacts

Likely Habitat Change due to Implementation of Strategy (as % +/- of existing resource)				
Strategy Options	**S1**	**S2**	**S3**	**S4**
Intertidal Habitats	+ 625	+ 269	+82 ha	+82 ha
Wetland habitats (inc. grazing marsh)	-414	-200 ha	-65 ha	-65 ha
Other Habitats	+ coastal sand/shingle;- ve wetland habitats to south	Limited loss of coastal sand/shingle	same	same

Summary of Environmental Impacts	
Option S1	This strategy would have large-scale ecological consequences. The overall area of intertidal habitat would more than double due to the inundation of the former estuary floodplain. The potential division between saltmarsh and mudflat habitats is difficult to establish, but it is more than likely that the vast majority of the area would become intertidal mud. Existing areas of wetland habitat, including freshwater grazing marsh, on the former floodplain would be lost. Re-creation of these habitats would only be possible upstream of the tidal limit and outside of the estuary floodplain. The large increase in tidal volume would also alter coastal habitats on the open coast. Widening of the estuary mouth could lead to the loss of sand dune habitat at Southwold Denes. Potentially, the development of an ebb delta would lead to the formation of relatively extensive shingle/sand beaches and dunes (depending on sediment supply) in the vicinity of the mouth of the estuary. Coastal erosion to the south of the ebb delta could lead to the tidal inundation of low-lying grazing marsh and reedbed habitats.
Option S2	Eventual doubling in the area of intertidal habitat, but also considerable loss of grazing marsh and wetland habitat including the majority of the area designated as of national or international nature conservation importance. The inundation of the former estuary floodplain upstream of the A12 would significantly limit the potential for the re-creation of freshwater wetland habitats in the lower section of the Blyth valley. Some limited loss of coastal habitats in the vicinity of the estuary mouth could occur if it is not feasible to hold the training walls in their current position.
Option S3	Moderate increase in the area of intertidal habitat (approximately 40%), and loss of approximately 15% of existing floodplain wetland habitats (53 ha designated SPA, 12 ha SSSI). Defence of floodplain upstream of the A12 would enable enhancement of existing wetland habitats and creation of new areas to be undertaken (potential 210 ha).
Option S4	As for option S3, except that the greater extent of area under the managed realignment option could allow measures to be taken to enhance the potential for saltmarsh habitat development as opposed to intertidal mudflat.

Table 5.5 Summary of Economic Assessments

Strategy Options		S1	S2	S3	S4
COSTS					
Zone 1	FC10 Union Farm 1 FC11 Union Farm 2 FC12 Blyford FC17 Blowers Marsh FC18Thorington	0	[illegible]	2,139,000	2,139,000
Zone 2	FC9 Bulcamp House	123,000	123,000	123,000	123,000
	FC16 Blythburgh	72,000	72,000	72,000	72,000
	FC15 Tinker's West	0	[illegible]	[illegible]	[illegible]
Zone 3 N&S	FC8 Wolsey Bridge FC7 Reydon West FC6 Reydon Central FC5 Reydon East	0	863,000	863,000	863,000
	FC14 Tinkers Marsh	0	0	[illegible]	260,000
Zone 4 N&S	FC4 Botany Marsh FC3 Woodsend Marsh FC2 Town Marshes FC1 Havenbeach Marsh	0	1,052,000	706,000	706,000
	FC13 Robinson's Marsh	0	0	163,000	163,000
	TOTAL	**195,000**	**2,600,000**	**4,260,000**	**4,400,000**
DAMAGE					
Zone 1	FC10 Union Farm 1 FC11 Union Farm 2 FC12 Blyford FC17 Blowers Marsh FC18Thorington	2,035,000	[illegible]	42,000	42,000
Zone 2	FC9 Bulcamp House	0	0	0	0
	FC16 Blythburgh	0	0	0	0
	FC15 Tinker's West	151,000	[illegible]	[illegible]	[illegible]
Zone 3 N&S	FC8 Wolsey Bridge FC7 Reydon West FC6 Reydon Central FC5 Reydon East	1,172,000	57,000	0	0
	FC14 Tinkers Marsh	399,000	399,000	[illegible]	194,000
Zone 4 N&S	FC4 Botany Marsh FC3 Woodsend Marsh FC2 Town Marshes FC1 Havenbeach Marsh	3,742,000	105,000	0	0
	FC13 Robinson's Marsh	708,000	708,000	165,000	165,000
	TOTAL	**8,207,000**	**2,596,000**	**503,000**	**455,000**
BENEFIT		**0**	**5,611,000**	**7,704,000**	**7,752,000**
NET PRESENT VALUE		**0**	**3,011,000**	**3,444,000**	**3,352,000**

5.3.4 Description Of Strategy Options

Option S1 presents the basic Do Nothing case throughout the Estuary, considering the abandonment of all of the strategically important flood compartments in the estuary. This would result in the loss of the order of £8,207,000. This option would not meet the objectives for the strategy defined in Section 4. In particular there would be:

- Loss of important habitat significantly reducing the favourable conservation status of the SPA. There would be gain of mud flats and initially reestablishment of salt marsh around the edge of the estuary. However, due to the steepening of the shore at higher tide levels this potential increase in salting would again be subject to squeeze as sea level continues to rise.

- The use of the estuary would be totally disrupted, the Harbour area would be lost, having not only a devastating effect on the local fishing industry but also on the local tourism economy of Southwold and Walberswick.

- A massive impact on the local agricultural community, reflected also in the loss in terms of the national economy.

- Water quality would be damaged due to the loss of the sewage works at Southwold and the loss of the sewer from Walberswick.

- There would be considerable change in the shoreline regime. Initially flows into and out of the estuary would increase by a factor in excess of 2.5. With sea level rise this could result in an increase in flows of the order of a factor of 3.6.

This option is clearly unacceptable, but provides the basis for comparison, in economic terms, of other options.

Option S2 presents the economic case for maintaining those areas where there is at a local level shown to be a strong economic case. This option has an NPV of the order of **£3,011,000** making it economically sensible to pursue. The option would result in the defences west of the A12, with the exception of FC18, being abandoned, the eventual abandonment of FC15, Holding the Line along the northern section of Zone 3 (Reydon Marshes) but Doing Nothing to the southern defences of this zone (Tinkers Marsh), defending the northern section of Zone 4 (Southwold Harbour) and Doing Nothing to the southern defence of Zone 4 (Robinson's Marsh and Walberswick).

This option in effect is the minimal Hold the Line option. There would be significant loss of environmental assets, going against the preferred approach of the Habitats Directive. The high flows through the estuary would result in some damage to the Harbour making access along the frontage more difficult and potentially damaging the visual aspects of this area. Almost certainly, this option would reduce the value of the Harbour area as a tourist attraction, thereby having indirect detrimental impacts on the Southwold economy and potentially on the national economy as a result. Water use of the estuary would be hampered by the significant increase in flow along the channel.

This increase in flow, nearly doubling the existing volume of the estuary would have a substantial impact on the coastal processes at the mouth of the estuary. It is probable that this would result in accelerating the retreat of the coast to the south, potentially increasing the loss of assets in this area.

On the basis of the impact on the coastal regime, but possibly more significantly due to the damage to the existing natural environmental interest this option fails to meet the objectives for the strategy and this option is rejected.

Option S3 One of the principal factors resulting in the unacceptability of Option S2 is the very high flows generated by the policy of Do Nothing for the defences west of the A12 (Zone 1). Option S3 is based on Holding the Line in this zone.

In isolation from economic considerations for the rest of the estuary, Holding the Line in zone 1, by means of a Sluice Barrier, was found not to be economically justified. However, Holding the Line in this area reduces costs in the defence of areas further down the estuary. In economic terms as an Estuary Strategy based upon Holding the Line in Zone 1, option 3 has an NPV of **£3,444,000**. The option allows a slightly more gradual approach to be taken in adopting policies throughout the estuary and provides the opportunity to minimise the loss of assets. Most significantly, this option provides the opportunity to re-establish habitat lost through the flooding of Tinkers Marsh in a "fresh water" area of the estuary. The option also significantly reduces the impact on the coastal regime. There would be losses, principally in terms of agricultural land and in terms of damage to the Harbour through the Managed Re-alignment of FC13. However, the option aims to keep increased flow to a minimum and the Managed Re-alignment of the southern bank of the harbour reach aims to reduce further the impact of this flow impact by allowing the channel to widen on its southern side.

Option S3 would still result in loss of important specific habitat in the area of Tinkers Marsh. This impact could be reduced by re-aligning from the defence of FC14 rather than Delaying Do Nothing.

Option S4 The economic cost of re-aligning the defence to Tinkers Marsh is shown in Option S4 with an NPV of **£3,352,000**. Although this option has a shortfall in NPV of some £92,000 compared to Option S3. The option provides the opportunity to maintain the transitional habitat of eastern Tinkers Marsh and, even though of marginal benefit, further limits the increase in tidal volume. Although the Habitats Directive states a preference for protecting European sites "in situ", the sustainability of Tinkers Marsh defences over a reasonable period of time, and the burden they place on the Reydon defences, is a key issue.

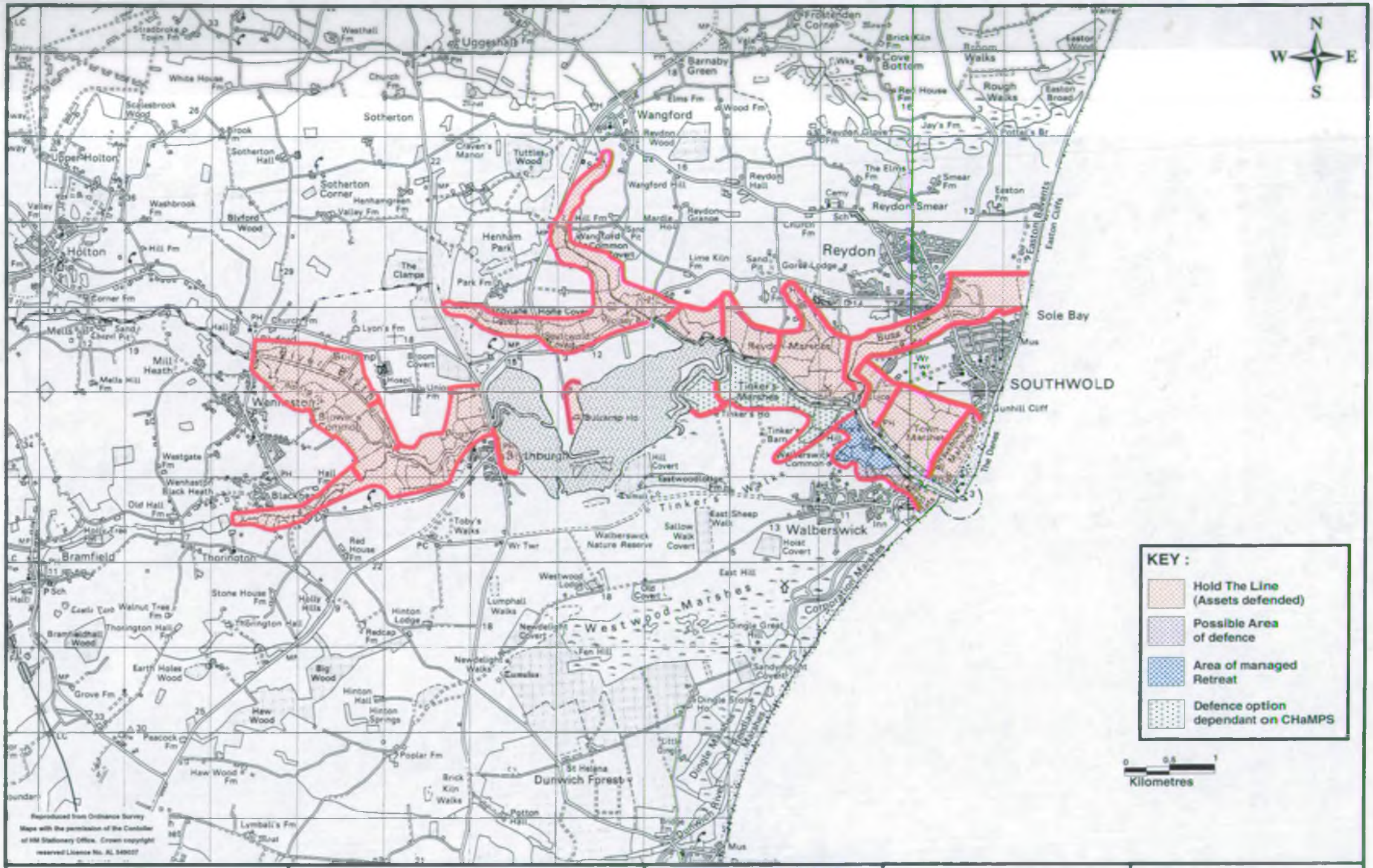
5.3.5 Comparison of Options

In summary of the above discussion of options, it can be seen that neither Do Nothing, option S1, nor a minimal Hold the Line Option S2 provide a realistic means of meeting the aims of the strategy.

Option S3, by limiting the increase in tidal volume, does, however, substantially achieve this aim and provides a future framework for defence which would allow the estuary to adjust to the threat of sea level rise.

There would be several areas where further detailed discussion would be needed to confirm the mechanics of achieving this strategy; in particular with regards to the management of habitat relocation and allowing the continuation of rights of way around the estuary. Option S3 does provide for habitat relocation, incorporating a policy of delaying do nothing. Although Option S3 to a large degree matches the aim of the strategy, as well having an NPV equivalent to the economically most efficient solution, it does incur the loss of quite specific habitat of the east end of Tinkers Marsh. Option S4, however, addresses this aspect.

Option S4 is considered to achieve the best balance of economics, environment and use is the preferred strategy for the estuary. This proposed strategy is shown schematically on Figure 5.2.



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES
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BLYTH ESTUARY
RECOMMENDED
MANAGEMENT STRATEGY

FIGURE 5.2

SECTION 6

CONCLUSIONS AND IMPLEMENTATION

6.1 CONCLUSION

The study has examined the physical nature of the estuary, its use and the assets potentially at risk from it. There has been a strong message that with respect to its use and interest the estuary is in relative balance. It is clear, however, that that is not the case with respect to the physical behaviour of the estuary. There are several areas under extreme stress, with defence works hard up to the channel being undermined and other areas being severely eroded. Failure of defences, with the additional tidal volume this would create, together with sea level rise will increase pressure not only on the defences but also on the use of the channel for mooring and general boat use and on the coastal processes at the mouth of the estuary.

The principal issue has been shown to be the difficulty the estuary would have, in its present form, to respond to any substantial change in tidal volume, or indeed to be maintained effectively under the present pressure. This may be a result of the estuary adjusting following abandoning defences up to thirty years ago.

There are other issues relating to the high cost of maintaining certain areas of defence where, based solely on a local assessment of the economics, it would be hard to justify continuing to defend the potential flood areas.

There are, therefore, two main areas of concern. The first being that further Managed Re-alignment from lines of defence, particularly to some of the larger defended areas at the head of the estuary, would increase the tidal volume to such an extent that other areas lower down, as well as the bridges over the estuary may become excessively expensive to maintain.. The second is being the very real threat of rise in sea level. This phenomenon has the potential to increase tidal volumes generally through out the estuary by nearly 50% over the fifty year period of the strategy. Sea level rise will increase costs as the height of defences have to be raised in order that standards of defence are maintained.

The Strategy Study concludes that if a piecemeal approach is taken to the defence policy of flood compartments within the estuary then, by default, there will progressively be more difficulty in maintaining defences. Potentially, this will lead to abandonment and unmanaged change to the whole regime of the estuary and its interaction with the coast. The important natural environmental and human use interests of the estuary would suffer. Similarly, attempting to hold the line of defence throughout the estuary would be expensive and will also have a detrimental impact on the use and interest of the estuary. A mid course has to be struck.

The most cost effective option for dealing with defences throughout the estuary (based on the economic assessment of each estuary zone in isolation) would result in undue pressure on the entrance to the estuary, the harbour and the coast. As such this approach to a strategy has had to be rejected.. This strategy option would also have serious implications on the use and environment of the estuary. Various other options have been considered, and a strategy devised which, while still having some adverse impact is considered to achieve the best balance. This option, Option S4 discussed in Section 5, is only marginally disadvantageous in economic terms but provides a framework whereby the key interests and uses of the estuary can be sustained.

There are still areas of uncertainty or areas where further discussion or investigation is needed, and in the light of this it is concluded that there needs to be a cautious approach to progressing the recommended strategy. The study presents a means by which policies can be

adopted that are both flexible and in line with the overall strategy for the estuary. In this way the future policy for each area can be assessed, in a timeframe allowing for further investigation of the long term sustainability of the estuary and its defences.

6.2 IMPLEMENTATION OF STRATEGY

As identified above there are certain areas where further work or discussion will be required to confirm, and if necessary, modify the preferred strategy for the long term management of defences throughout the estuary. It is, however, important, that in principle, the strategy is accepted so that future planning of estuary use and management of environmental interests can be progressed without compromising a sustainable approach to defence management. This section sets out, first in general terms, the main requirements for progressing the strategy, and then examines the way in which, at a more local level, it is proposed that the strategy be implemented.

6.2.1 General Implementation

It is recognised that there are certain areas of study being progressed at present, or that are likely to be undertaken in the near future, which may have an influence on the approach to the estuary. These include estuary research (such as the "Emphasys" programme), the survey of flood defences and CHaMPS. In addition, there are the planned updates or reviews of the Shoreline Management Plan. The proposed manner in which this information, and review of policies on allied issues, should be incorporated into the estuary strategy, both in the short term and over time, is shown in the overview programme presented in Figure 6.1a. The most immediate information will be that from the defence survey, the results of which must be used to update the anticipated programme for the strategy, and output of CHaMPS. In the latter case, there is a need for CHaMPS to take on board the findings of the estuary strategy and then to develop upon this a strategy for management of the estuary as a viable and sustainable eco-system. This, it is anticipated, will provide a more detailed audit of the ecological resource and provide a more specific target against which the environmental acceptability of the strategy outcome can be judged.

The strategy will need to be reviewed and potentially refined in light of this additional information.

The output of CHaMPS, and the defence survey, together with other factors potentially influencing the strategy will need to be monitored. The general policy for monitoring is discussed below.

Monitoring
The Environment Agency undertakes regular monitoring of the shoreline. It also undertakes regular inspection of its flood defences throughout the estuary. There are two critical areas of monitoring which must be continued to provide improved data on:

- The condition and maintenance requirement of defences. A sensitive factor in assessing the economics for the defence of each flood compartment has been the cost of maintenance. An increase in maintenance requirements is a good indication of increasing pressure on defences and provides the most accurate way in which to determine the residual life of structures;

- The condition of the beaches to the north and south of the harbour mouth. There will inevitably be change in this area due to the impact of sea level rise; from both the effect this will have on the natural "soft" frontages and also from the gradual increase in tidal volume of the estuary. The degree to which the process of increasing the ebb tide delta

will impact upon the coastal drift regime is difficult to quantify. Monitoring is an essential element assisting the understanding of this mechanism.

In addition to the above, there is a critical need for improving monitoring of tide level within the estuary particularly on more extreme events. It is recognised that at present there is a considerable degree of uncertainty how extreme levels may vary within the estuary. Associated with this is the need to support monitoring of general sea level. The assumptions made within the report as to possible rates of sea level rise are critical to the findings of this study; an increasing rate beyond that already assumed would require the strategy to be reviewed with the intent of possibly reducing further the areas of defence which may be abandoned or re-aligned. A lower rate of sea level rise, while still being important, would be less critical in assessing the appropriate strategy. Other factors such as the present difficulty and expense of maintaining defences dictate, as much as the threat of sea level rise, the need to implement the proposed strategy. However, the rate of sea level rise in conjunction with improved information on the condition of defences will determine the time scale for implementing individual schemes within the strategy framework.

Sea level rise will also have a marked impact on coastal squeeze. Better monitoring procedures need to be put in place to track the loss or conversion of intertidal habitat. This needs to be carried out on a more regular basis than at present and needs to be related to a specific monitoring of CHaMPS targets.

In all these areas there needs to be a co-ordination of information with a regular review process.

6.2.2 Strategy Implementation and Programme

Table 6.1 provides a summary breakdown of the recommended strategy and how this is implemented, both in the short and longer term in relation to individual flood compartments. This is expanded upon in the implementation guidance sheets included as Attachment 1 at the end of this section of the report. These sheets deal with each flood compartment, or coherent management group of flood compartments, on an individual basis, highlighting the strategic context from which the management of each compartment is derived. It also highlights local issues that have been raised during consultation and which must be considered when implementing the proposed policies of the strategy.

Figure 6.1b and Figure 6.2 present the strategy programme and a strategy decision pathway respectively. These attempt to draw together and highlight the main complexity of interactions discussed in section 5 and appendix A and define the basis for implementing the strategy at a local level. As stated earlier there is a recognition that the strategy must continue to evolve as further external information is incorporated. In addition, it is recognised, and shown in the figures, that at each stage there is a need to take stock of the way in which the strategy is developing and use the principals and constraints identified and discussed throughout the report to possibly redefine the next step.

The strategy programme (Figure 6.1b) is divided into two sections; the Strategic Development and the Detailed Appraisal. The former of these is subdivided into a section on Establishing Agreements and a section headed Strategic Studies. The various items identified are discussed below.

Ongoing Consultation

There are many parties involved with, or with interests in, the defence management of the estuary. These include, obviously, the Environment Agency, the Local Authorities and English Nature but extend to the parish and community councils, the internal drainage boards,

individual land owners, RSPB and other environmental groups as well as various other societies. Management of the estuary, as stressed throughout the report, is a question of balance and fundamental to this is an understanding of issues and priorities. On going consultation and involvement is, therefore, a prerequisite for developing and implementing the strategy.

Establishing Agreements

Resolving the problems of the Blyth has called for quite a radical approach to the way in which benefits and impacts need to be viewed, and in the way in which aspects of the estuary ideally need to be re-organised so as to provide a more secure and sustainable framework for the future.

Certain assumptions, based on existing information and analysis and upon the results of the consultation process and therefore felt to be realistically robust, have had to be made in developing the strategy. In particular, assumptions have had to be made in connection with the management of the natural environmental resource within the estuary, but also with respect to issues such as social acceptability and compliance of landowners. In addition the strategy has brought out such issues as compensation where strategic benefit is gained at the loss to the individual. (Such issues as this are developed in the Addendum on consultation issues.)

The strategy provides a pragmatic way forward whilst still recognising that these issues can have a fundamental bearing on the strategy, potentially overturning certain decisions.

In the case of the Blyth, the key issue surrounds the interrelationship proposed between the defence of the area west of the A 12, the ability to create important freshwater habitat in this area and the consequential ability to allow Tinkers marsh to be converted to compensatory intertidal area. From this comes the management of the estuary volume and flow, the reduction in existing defence pressure and the sustainability of the harbour and its entrance channel. Associated with this is the policy for Robinsons marsh.

There are, immediately, several important issues identified, which must be addressed, at least in principal if the strategy is to progress along its proposed path. These issues are summarised on the programme (figure 6.1b) and in corresponding areas of the decision pathway (figure 6.2).

The programme reflects the order both in which aspects need to be addressed, and the fact that negotiating agreements takes time. It identifies the priorities, which are driven by the need to confirm strategic policy before the condition of defences dictates a purely reactive response:

- There must be sufficient confidence that the proposed management of defences will generate the anticipated benefit west of the A12 (e.g. the proposed habitat if managed correctly will be acceptable, landowner agreements and an acceptable route to re-designation of the land) prior to making various decisions elsewhere in the estuary. This negotiation, although overseen and facilitated by the Environment Agency, will rely predominantly upon the co-operation of other estuary users.

- The next priority has to be examining, in a similar way, the basic agreements necessary for Robinson's Marsh. This is less urgent in terms of the overall strategy, and in many respects is out of sequence with the way in which the strategy would be ideally progressed, but is urgent in terms of achieving an acceptable way forward before default decisions are forced by the deteriorating condition of the defence. Because of the time scale it will be necessary to take indicative results from negotiations over the area west of

the A12 as in some respects (e.g in relation to intertidal marsh development) aspects of this remote policy are important to local decisions about Robinson's Marsh.

- The third key area where agreements have to be established is over Tinkers Marsh. Clearly it is important that negotiations with respect to the areas west of the A12 are progressed sufficiently such that agreements on Tinkers Marsh can be developed with a degree of confidence regarding the final outcome in this other area.

Throughout this process it is important that sufficient flexibility is maintained within the implementation of the strategy so that the strategy, if necessary can be adapted to reflect further issues raised or opportunities created.

Strategic Studies

There are four main areas where further detailed information is required concerning the physical processes of the estuary. These are:

- The interaction with the coast and the works at the harbour mouth. The Environment Agency, together with the Coast Protection Authorities are undertaking a strategy study for the coast in this area. The condition of the harbour entrance structures and the impact they have on the coastal process must be examined. The strategy has assumed these structure will be maintained and has been designed in part on the basis that flow conditions within the estuary will kept to a level where this is possible. This issue should be considered in more detail. The SMP made certain assumptions as to coastal processes and on the basis of this arrived at certain policies for the coast. The strategy has, again, worked on the basis that it should not work counter to these policies. However, it must be anticipated that flow from the estuary will increase and that. as a minimum, this will have an impact on the drift regime. This needs to be taken into account in the proposed coastal strategy and in future review of the SMP.

Of these four, more directly related to the local implementation of the strategy are:

- The detailed examination of the proposed Managed Re-alignment of the Robinson's Marsh area. The intent of this Managed Re-alignment, in addition to concentrating defence expenditure on areas which may be economically justified, is to relieve pressure on the more developed northern side of the Harbour reach. The existing and potential flow pattern in these areas needs to be examined in more detail. This investigation should also consider how the opportunities for intertidal habitat creation could be realised.

  This study would take into account the agreements likely to be established (see above), with respect to policy in other sections of the estuary.

- Outline design and detailed investigation for a sluice at Blythburgh Bridge. Preliminary details provided in earlier reports have been used in the strategic assessment of this issue. These need to be properly tested and the more detailed results incorporated within the strategic analysis. This study would be undertaken based on the interim results of agreements being established for Tinkers marsh and the area west of the A12, incorporating any specific constraints in the areas identified.

- The detailed examination of the proposed Managed Re-alignment of Tinkers Marsh. The strategy study has demonstrated the difficulty of maintaining both side of the Tinkers Marsh/ Reydon reach. It has been indicated that substantial benefit can be achieved if the Tinkers Marsh area defences are re-aligned. However, it is recognised that there is a legal presumption in the Habitats Directive in favour of protecting European sites "in situ", subject to the sustainability of the site over a reasonable period of time. Also,

within the strategy there is a recognition that for this to be effective there is a need for detailed examination of how best to manage the retreat. It would be anticipated that there is a need to actually realign the main channel. This need is to be considered in detail, together with an examination of how best to manage a realignment of defences to enhance environmental resource.

The programme and the pathway diagram aim to resolve this inevitable "chicken and egg" situation inherently associated with implementation of the strategy.

The strategic Development then feeds into the mechanism for detailed appraisals.

6.2.3 Application of Strategy to Local Areas

Before examining the programme presented in figure 6.1b, there is a need to consider the practical mechanism by which the strategy can be implemented at the local level. Three mechanisms present themselves, of which two may be dismissed:

- **Detailed strategic appraisal.** This approach would attempt to progress the strategy directly to a detailed project appraisal for the whole estuary. Such an approach is considered to be impractical, failing to recognise the complexity of local issues, the time based uncertainties and the limitations of strategic level of analysis so far undertaken. In effect total (as in one off) management of the estuary is considered to be indeterminate. This approach to progressing the strategy is rejected.

- **Isolated local appraisal.** This approach, while appropriate where the strategy has identified a good degree of independence for certain defences, runs counter to the whole management concept; it is rejected. .

- **Detailed appraisal within the context of an iteratively developing strategy.** This approach is proposed as the only sensible way forward. It is based on the understanding that the strategy itself will probably change over time as more detailed information is obtained externally, from the studies undertaken as part of the strategic development and from the detailed appraisals themselves. The approach therefore accepts the need to make decisions based on the concept of what the strategy provides at any particular time, even though that concept may change significantly. Accordingly, this approach accepts the need to consider, in some degree "what if" scenarios, so as to maintain as much future flexibility as possible, while still, however, making decisions rather than accepting a default of inaction.

The basic principle behind this approach is that in undertaking a detailed project appraisal, and in examining the technical, economic and environmental issues:

a) The strategic policies defined for each defence within the estuary are assumed to apply in the future unless shown, by more detailed investigation, to be inappropriate. (e.g. When undertaking a detailed appraisal of compartment A, it is assumed that the strategic policy for defence B is as defined by the strategy, even though ultimately it may be shown that some other policy should be apply at B.) The sensitivity of key decisions as to the overall estuary management should, however, be examined.

b) Local issues, those relating specifically to the defence in question, should be examined in detail at a local level (i.e in the detail normally associated with a scheme based project appraisal).

c) Impacts (beneficial or detrimental, ie. transfer impacts identified within the report) identified as potentially resulting from some specific defence policies should be

revisited during a detailed project appraisal but at a strategic level and on the basis that the overall strategy applies. Again, this would be subject to any new more detailed information being available and to consideration of likely possible outcomes from any on going study or negotiation.

d) Finally it is assumed rather obviously that the result of a detailed project appraisal and any information from an associated detailed examination is fed back into the strategy and if contrary to the anticipated strategy policy then the strategy is reviewed and, if necessary, revised.

Considering the programme in figure 6.1b it may be seen that the first project appraisal anticipated is that for Robinsons Marsh. Unless, there is evidence to the contrary, it would be assumed that the policies in the two remote areas most influencing the defence would be Hold the Line for the area above the A12, and Re-alignment for Tinkers Marsh. In neither case for these remote areas would this actually prescribe their future policy.

The policy for Robinsons marsh would draw upon the detailed information provided by the study of the local area and upon the local discussion and consultation undertaken as part of the process of establishing agreements.

A similar situation arises when looking at the Reydon, the Tinkers Marsh frontage and the area above the A12. However, clearly in these cases the programme assume that negotiation of agreements has actually been concluded and with respect to possible impact down stream the policy for Robinsons Marsh has been confirmed.

In this way, as summarised in Table 6.1 and discussed in more detail in the guidance sheets of Attachment 1, the strategy proposed by this report is allowed to develop and strengthen, while still providing flexibility and a sound framework from which to undertake proactive sustainable defence management of the Blyth estuary.

Table 6.1 Application of Recommended Strategy (S4) to Individual Flood Compartments

Flood Compartment	Short Term Policy	Key issues	Long Term Policy	
			Policy	Time scale
FC10 Union Farm 1	Hold the Line	Monitor maintenance requirement. Investigate with landowner possibility of environmental enhancement as compensation for loss of freshwater marsh. Investigate construction of sluice at Blythburgh Bridge	Hold the Line	10 years
FC11 Union Farm 2	Hold the Line	Monitor maintenance requirement. Investigate with landowner possibility of environmental enhancement as compensation for loss of freshwater marsh Investigate construction of sluice at Blythburgh Bridge.	Hold the Line	10 years
FC12 Blyford	Hold the Line	Monitor maintenance requirement. Investigate with landowner possibility of environmental enhancement as compensation for loss of freshwater marsh. Investigate construction of sluice at Blythburgh Bridge	Hold the Line	10 years
FC17 Blowers marsh	Hold the Line	Monitor maintenance requirement. Investigate with landowner possibility of environmental enhancement as compensation for loss of freshwater marsh Investigate construction of sluice at Blythburgh Bridge.	Hold the Line	10 years
FC18 Thorington	Hold the Line		Hold the Line	10 years
FC9 Bulcamp House	Hold the Line	Monitor defence costs.	Hold the Line	25 years
FC16 Blythburgh	Hold the Line	Monitor defence costs.	Hold the Line	20 years
FC15 Tinkers Marsh west	Maintain	Monitor defence costs. Undertake detailed study of estuary regime and examine most advantageous manner for abandoning defences. Investigate appropriate means of managing new habitat creation.	Dependant on CHaMPs.	10 years
FC14 Tinkers Marsh	Maintain	Monitor defence costs. Undertake detailed study of estuary regime and examine most advantageous manner for re-aligning defences and encouraging re-alignment of channel. Investigate appropriate means of managing new habitat creation	Dependant on CHaMPs	10 years
FC8 Wolsey Bridge	Hold the Line	Monitor defence costs.	Hold the Line	10 years
FC7 Reydon West	Hold the Line	Monitor defence costs.	Hold the Line	20 years
FC6 Reydon Central	Hold the Line	Monitor defence costs	Hold the Line	10 years
FC5 Reydon East	Hold the Line	Monitor defence costs	Hold the Line	10 years
FC4 Botany Marshes	Hold the Line	Monitor defence costs.	Hold the Line	20 years
FC3 Woodsend Marsh	Hold the Line	Monitor defence costs	Hold the Line	20 years

Flood Compartment	Short Term Policy	Key Issues	Long Term Policy	
			Policy	Time scale
FC2 Town Marsh	Hold the Line	Monitor defence costs.	Hold the Line	25 years
FC1 Havenbeach Marsh	Hold the Line	Monitor defence costs.	Hold the Line	10 years
FC13 Rohinson's Marsh	Maintain	Monitor defence costs. Undertake a detailed investigation of flow pattern within Harbour reach. Examine most advantageous manner to re-align defences, in particular how this would effect the use of the harbour and how re-align could be managed to encourage intertidal marsh development.	Managed re-alignment	5 years
The Shoreline	As SMP	Monitor beaches and consider within review of SMP impact due to the inevitable increase in tidal volume from the harbour mouth.	As SMP.	

NOTES: The time scale shown within the table is generally based on anticipated residual life, either with or without maintenance depending on the proposed long term strategy. The time scale indicates the MAXIMUM time likely to be available in which to have made a final decision as to the long term future of the defence or before more major works are required to refurbish defences for the future. This time scale needs to be reviewed against defence monitoring.

Overview Programme

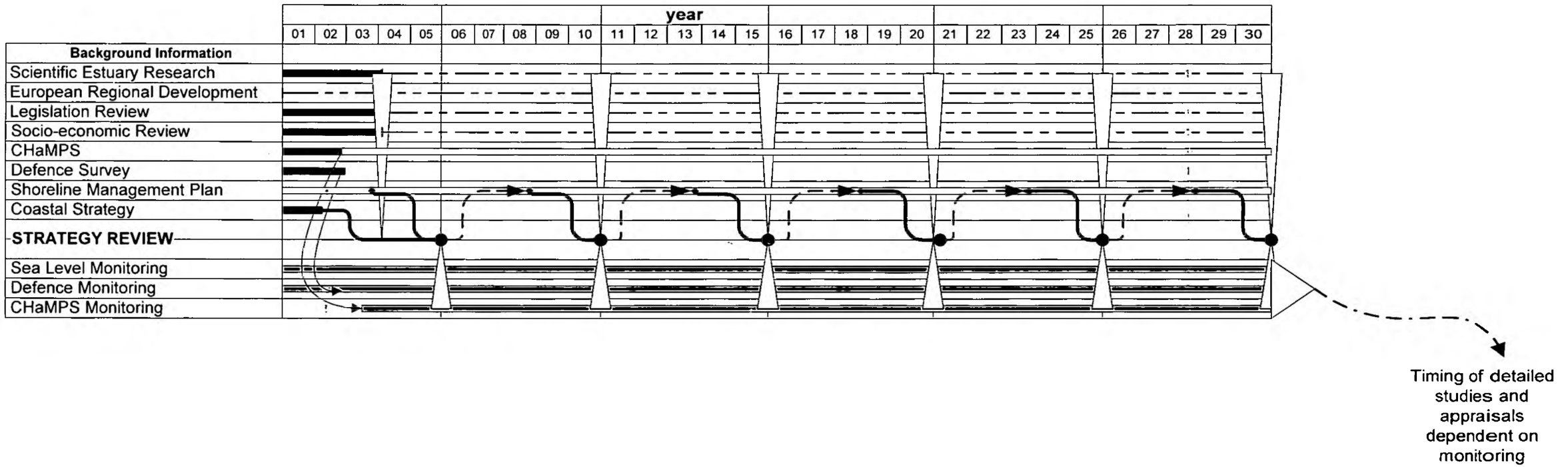
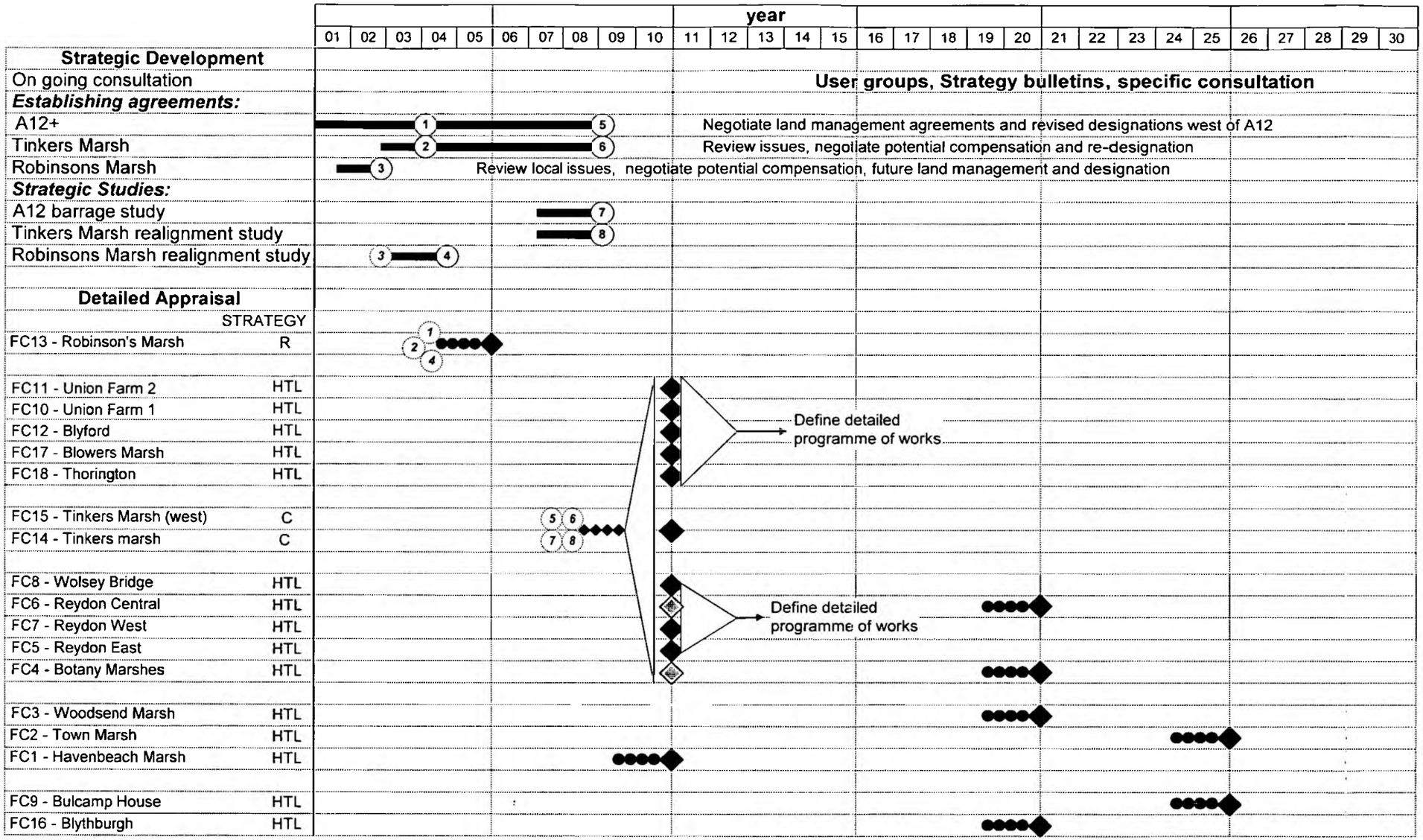


Figure 6.1a

Strategy Programme - Blyth



KEY

- Anticipated deadline for works on flood compartment
- Policy for flood compartment confirmed
- Anticipated failure of abandoned defences
- Linked zone appraisal lead in
- Local appraisal lead in
- 6 — Reference Point (outcome): *The outcome of this process will be **used to influence other processes.*** [also shown on Figure 6.2]
- 6 — Reference Point (input): ***This process will be influenced by the outcome of other processes** as identified.*

Strategy Key:

DN	Do Nothing
DDN	Delay Do Nothing
HTL	Hold the Line
R	Re-align defences
RD	Reduce defence standard
C	Defence option dependant on CHaMPs

Figure 6.1b

STRATEGY DECISION PATHWAY - Blyth

Additional Data

Blyth Strategy

OK?

No

Review Strategy

Yes

A12 + (1)
Negotiate land management agreements and revise designations

Tinkers Marsh (2)
Review issues, negotiate potential compensation and re-designation

Robinson's Marsh (3)
Review local issues, negotiate compensation, future land management and designation

A12 + provisionally meets requirements

No

Review Strategy

Yes

A12 + (5)
Continue establishing agreements

Tinkers Marsh (6)
Continue establishing agreements

Issues:
Ecological integrity
Social /Community
Physical
Hydrological

A12 (7)
Barrage Study

Tinkers Marsh (8)
Realignment Study

Confirms strategic assessment

No

Review Strategy

Yes

A12+, Tinkers Marsh, Reydon
Linked zone appraisal

FC10 Scheme

FC11 Scheme

FC14 Scheme

FC..... Scheme

Programme of Works

Acceptable outcome

No

Review Strategy

Yes

Assume strategy inputs

Issues:
Harbour use
Ecological integrity
Social /Community
Physical

Robinsons Marsh (3)
Re-alignment Study

Confirms strategic assessment

No

Review Strategy

Yes

Robinson's Marsh
Local appraisal

Robinson's Marsh
Scheme

CHaMPS

Legislation / socio-economic review

CHaMPS

Legislation / socio-economic review

Defence survey & monitoring

Figure 6.2

ATTACHMENT 1

FLOOD COMPARTMENT IMPLEMENTATION
Guidance Sheets And Maps

ATTACHMENT 1

Explanation and Discussion Of Guidance Tables.

The following tables are designed to provide guidance in identifying key issues relating to each flood compartment or group of flood compartments. The tables are based upon the strategy and strategy programme (Figure 6.1b) and decision pathway (Figure 6.2). The tables attempt also to assist in explaining the processes which are deemed necessary to further develop the strategy to implementation.

The tables are divided into three principal sections covering: the primary information on the compartment or group of compartments, the strategic context of these compartments and finally the management of local considerations (and implementation). All of these are supported with a plan of the specific geographical area under consideration.

Each section is explained and discussed below:

1. Primary information

This section identifies the compartment or group, provides a simple description and identifies the length of defence and the extent of the area defended. These latter two attributes are important in appreciating such aspects as the typical magnitude of defence costs and the significance of impacts on the estuary, in terms of potential habitat change or increase in volume.

This section of the table also identifies, in terms of a simple priority indicator, the importance of dealing with the issues related to the compartment, raised by the strategy:

- **Priority three** indicates that the compartment or the impacts as a result of the policy for that compartment are not of major significance to the overall strategy. It may be that decisions can be deferred without influence on other areas of the strategy or that the policy for the compartment may in effect be considered in isolation from other decisions relating to the strategy as a whole.

- **Priority two** indicates a degree of importance as to the long-term policy for a compartment, in strategic terms, but indicates that the strategy may be progressed initially without this decision having been tested in detail. Typically, this priority is given in the situation where the policy is likely to be secure, where any detailed project appraisal is almost certain to confirm the strategic assessment and where the impacts, although potentially large, can be reasonably assumed to apply, when dealing with other areas of the estuary.

- **Priority one** indicates an urgency in addressing issues raised by the strategy; either because several other local policies may hang on the outcome of these issues or because defences are in poor condition or, ultimately, because the issue relating to the policy of defence is fundamental to the way in which the overall strategy has been developed.

2. Strategic Context

This section, which is itself subdivided into three sections, attempts to elucidate on the thinking behind the strategy policy and upon the way in which issues relevant to the compartment, when examined in more detail, may influence the future implementation of the strategy.

2.1 Strategy Policy identifies the recommended future policy for the compartment (or group of compartments) based on the current understanding of the estuary and its interactions. The key issues, from a strategic point of view, are listed, together with flood compartments where there is interaction. The significance of this issue in strategic terms is assessed and notes provided supporting this. This explanation may best be expanded by examples:

- One of the principal areas of concern in developing the strategies is that of increased volume of the estuary as a result of abandoning defences. In smaller flood compartments this may not be a critical issue. In a larger compartment, or where there may be a significant cumulative effect, this issue becomes critical to the whole strategy of managing the estuary and the decision to hold the line of a defence becomes an essential factor in developing the policy for the compartment. The zones most affected by an increase in volume are where there is some constraint on the way in which the channel can evolve. These issues, summarised in the table, are discussed in more detail in the main text of the report and in Appendix A assessing each zone.

- The strategy attempts to establish a balance of defence investment, use and environmental resource. In table 5.4, in section 5 of the main report, an outline audit of habitat loss and gain under the preferred strategy is shown. This is based on a summation of the change in habitat resulting from the strategy policy for each compartment. It is recognised that an ideal balance is not always achieved and this whole balance has to be redefined as part of the CHaMPs process. This process will take account of the legal presumption in the Habitats Directive in favour of protecting European sites "in situ", subject to the sustainability of the site over a reasonable period of time. In the case of the Blyth there is an apparent surfeit of intertidal habitat creation and deficit of grazing marsh under the preferred option. Addressing the deficit depends on the suitability of the area west of the A12. One of the key issues identified in the table in holding the line in this area is, therefore, the potential to create this new fresh water marsh ; this is critical if the strategy is to work. The potential surfiet of intertidal habitat gain comes from the re-alignment in Tinkers Marsh and Robinsons Marsh. If either policy were reversed the other area would still provide adequate intertidal gain, if neither area were re-aligned there would be insufficient intertidal gain to match the anticipated loss of this habitat. This issue is therefore identified as being conditionally critical.

- Economics and social impacts are also clearly important. On an individual basis, the defence of a compartment may , or may not, be economically sustainable. This issue may be economically significant but may not be critical to the development of the whole strategy; such a situation is identified in the table. It may, however, in the case of large productive compartments or in the case of compartments enclosing important cultural or social assets, be fundamental (or critical) to the aims of the achieving the correct balance within the estuary.

In each example given above the intent of the table is to highlight the key issues driving the policy recommended in the strategy. In implementing the strategy, and inevitably when some of these initial policies are questioned and reviewed, as more detailed information is obtained, these issues are the ones which must still be addressed. Where the decision to retreat a defence is made purely on economic grounds, there may be an argument that defence may still be undertaken, but not at public expense. Where a policy is conditionally critical to the overall aims of the strategy, then a final decision may have to be based upon the outcome of other negotiations or upon a choice between pursuing a policy in one area at the expense of some where else. Clearly, under such circumstances the question of strategic compensation may have to be addressed.

2.2 Influence on Strategy identifies issues which, if not satisfied, will almost certainly require either local or total review of the strategy. In this, it is recognised that the strategy relies on co-operation between various parties, as well as upon detail which has only been identified as part of the process of developing the strategies. This subsection identifies basic constraints relating to the individual compartments. Again by example:

- It would be unacceptable to re-align the defence of Tinkers Marsh if, through the failure to re-create equivalent habitat, the necessary environmental balance of the estuary was not maintained.

- The corollary of the first example is that, if a policy of maintaining the defence of an area is based, even in part, upon the opportunity this creates to re-establish important habitat (as is the case for west of the A12), then there is a constraint in managing this compartment such that that habitat should be re-created. Failure to allow this, or the unacceptability of an area, may result in the need for the strategy to be reviewed.

- Constraint issues can also apply to the use of the actual channel area of the estuary, or to areas were there is perceived to be significant impact on less tangible values such as landscape or cultural aspects of managing the estuary. In fact, to any area where there is a fundamental factor about which there is some degree of uncertainty or need for testing and clarification.

Clearly these constraint issues imply a degree of urgency in their resolution, as they are important in determining the direction in which the strategy is heading. They are also recognised as often being areas where there will need to be further consultation, between the Environment Agency and interested groups, or between others with responsibilities for specific aspects of the estuary. The table identifies actions required to resolve these issues, and the programme and pathway diagrams (Figure 6.1 and 6.2) indicate where this fits into the overall programme, such that other aspects of the strategy can still be progressed.

2.3 Dependence on the Strategy identifies issues where there tends to be some remote factor influencing the local policy for a flood compartment. While at the level of the project appraisal, for any defence scheme ,the detailed economics and impacts relating to a section of defence can be, and needs to be, examined at a local and detailed level, there are other factors which need to be incorporated in some other manner. Such factors may be the possible additional defence burden imposed on remote defences, or the impact remote defence policy may have on the local defences. As identified in section 6 of the main report, the general principal proposed is that in such cases, and until further investigation or information is obtained, the strategic assumptions should be held true. By example:

- In carrying out a detailed project appraisal on a defence such as Robinsons Marsh (in year 5), it should be assumed that the policy for west of the A12 is Hold the Line. This, despite the fact that a detailed project appraisal will not yet have been undertaken on this other area and despite the fact that agreements may only be in place in principle.

The table highlights key issues of this type and identifies the probable approach which can be adopted. Where the programme indicates that further relevant information should be available this is identified and the approach is to incorporate this data. Where no further information is likely to be available then the approach has to be that the assumptions made in the strategy should apply.

3. Management

This final section of the table highlights issues identified during the study or raised during consultation, which have a bearing on the management of the flood compartment but which are not strictly of a strategic nature. Such issues may for example relate to the need for archaeological survey work to be undertaken prior to loss of land, or to the need to consider important assets at the rear of a flood compartment, and hence the probable need to consider local defence action if the main line of defence is to be re aligned. It is unlikely that the list is exhaustive, detailed consultation would still be required to properly scope local concerns.

The section also briefly states the short term and longer term policy for the compartments. In both cases the table aims to highlight certain issues, referred to elsewhere in the table, which may dictate at

what point the final policy would be confirmed. Even though in the short and long term a policy of do nothing may be considered appropriate, it may in reality be necessary to monitor defences and undertake some repair or maintenance work until some critical aspect of the strategy is confirmed.

FC(s): 13	*FC(s) Name/Location:* **Robinson's Marsh**	*Figure* B1	*ZONE:* 4
Assessed critical time: 5 years		*Strategy Implementation – Priority*	
Physical Characteristics:			
Description: Relatively narrow but straight channel from the Pipe Bridge to the sea. Extensive areas of low lying marsh land to either side of channel. Flood compartment, which includes village, partially protected by natural and man made sea defence.		*Defence length:*	1500 m
		Defended area:	51.1 ha

Strategic Context

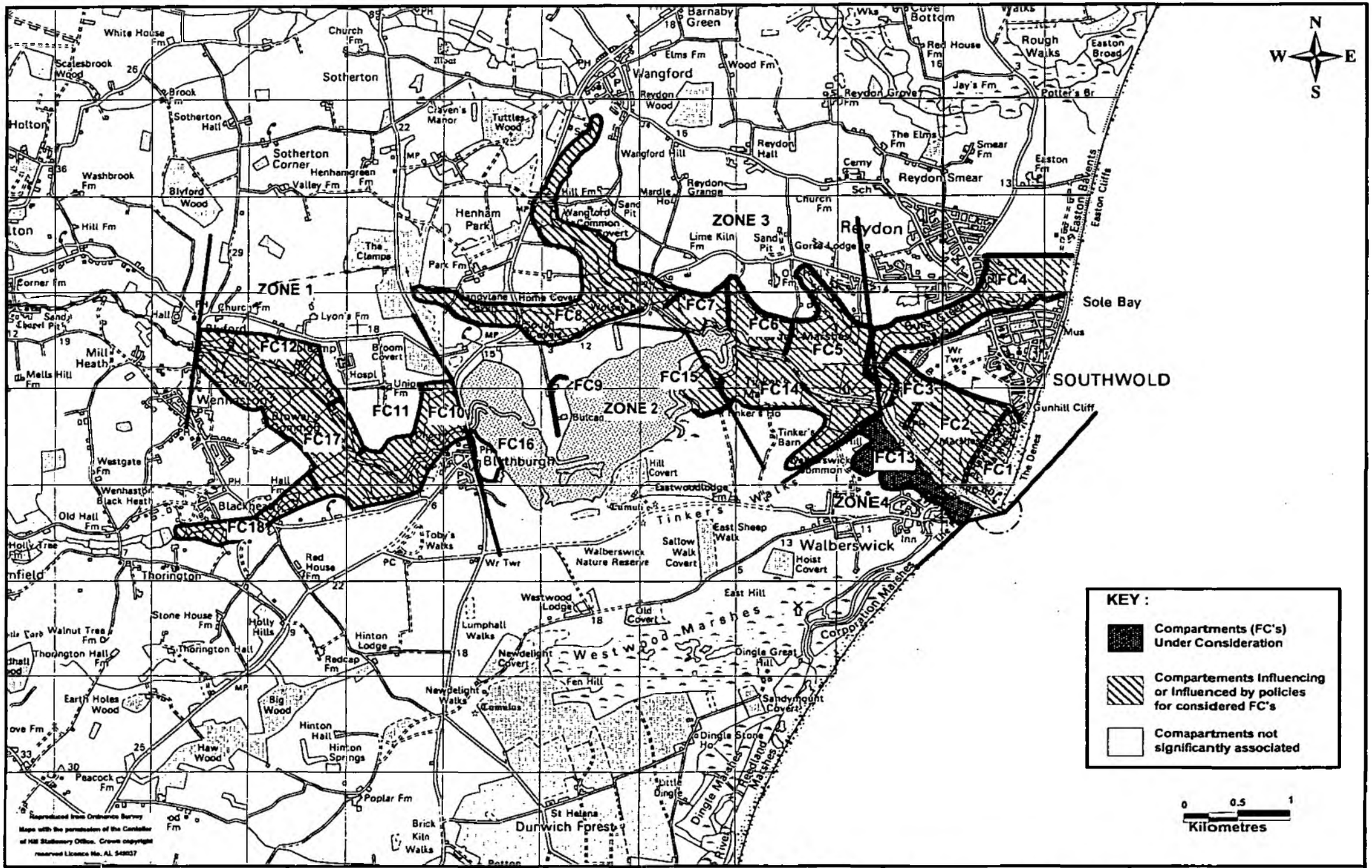
Strategy Policy:	*Key Strategic Issues*			
	Issue	*Associated FC(s)*	*Significance*	*Notes*
Realign defences to relieve pressure within harbour channel while protecting village.	-Pressure on defences on opposite bank.	FC1, 2 and 3.	Economically significant	Holding the line of defence would significantly add to the future cost of defence on the northern flood compartments.
	-Intertidal habitat.	FC14 &15	Conditionally critical to strategy	The marsh would contribute a significant element of the new intertidal area necessary to balance the habitat of the estuary under the strategy. This would be critical if FC14 and 15 were not retreated.
	-Pipe bridge and village.	None	Critical to strategy	Protecting the village and maintaining the link with the northern shore are fundamental elements of the strategy. Hence the need for realignment not DN.

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	*Significance and Response*	*Action*
Influence on harbour use and creation of intertidal area.	Maintaining the harbour is important to the overall strategy. Realigning defences would influence this. A reduction in intertidal gain could influence policies elsewhere and call for the strategy to be re-examined.	Undertake a study of the realignment of the defences.

Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	*Notes*	*Approach*
Estuary volume	Increase in volume from SLR or abandoning defences elsewhere in the estuary will increase cost of defence of these compartments.	Detailed consideration of critical areas elsewhere in the estuary will be carried out concurrent with the detailed appraisal of defences at this section. This information will be fed into the realignment study.
Intertidal balance.	The need for specific additional intertidal area may be determined by policies elsewhere.	Feed back from concurrent studies. (see programme on Figure 6.1)

Management

Local Issues:	Walberswick village	Bailey Bridge	Harbour use
Short term approach (on adoption of Strategy):	Maintain existing defences, monitoring defence costs.		
Long term approach (to be applied before critical time elapses):	Managed re-alignment.		



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES PHASE 2

POSFORD DUVIVIER
In association with
HR Wallingford

BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: ROBINSONS MARSH

FIGURE B1

FC(s): 10,11,12,17,18	*FC (s) Name/Location:* **Above the A12**	*Figure* B2	*ZONE:* 1
Assessed critical time:	10 years	*Strategy Implementation - Priority*	
Physical Characteristics:			
Description: Relatively narrow channel confined between flood defences banks over much of the zone. Some wider backwaters generally in-filled with reeds. Large areas of agricultural land protected. Land included within SRVESA. Footpaths along either side of the channel. Reed beds within channel.		*Defence length:*	8000 m
		Defended area:	211 ha

Strategic Context

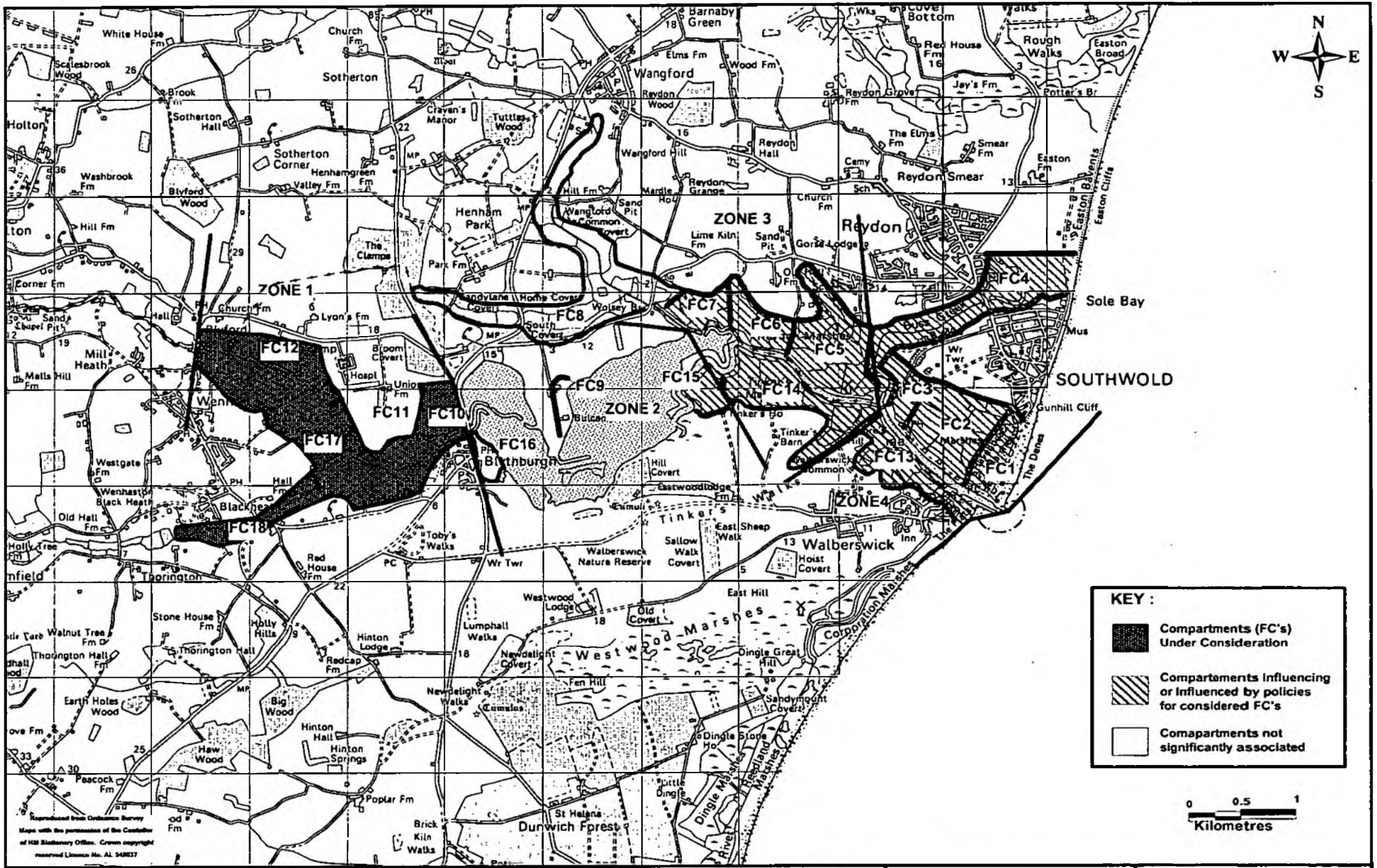
Strategy Policy:	*Key Strategic Issues*			
Construct a barrier (sluice) at the A12 bridge and hold the line throughout the unit.	*Issue*	*Associated FC(s)*	*Significance*	*Notes*
	-Increased flow in the event of Do Nothing.	All in zones 3 and 4.	Critical to strategy.	Abandoning defences above the A12 would introduce a substantial increase in pressure on defences throughout the estuary.
	-Potential freshwater habitat.	FC13, 14 and 15.	Critical to strategy.	The defence of these compartments potentially provide compensatory habitat for the loss elsewhere in the estuary.

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	*Significance and Response*	*Action*
Feasibility of barrage.	Critical to the strategy. Strategy needs to be reviewed in light of results of investigation.	Hydrological and engineering feasibility study to confirm strategy assumptions.
Acceptability of potential habitat re-creation.	Critical to strategy. Strategy needs to be reviewed in light of on-going responses.	Negotiations with land owners, Environmental opportunity study.

Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	*Notes*	*Approach*
Transferred defence costs.	The economic justification of the policy relies upon the additional costs assessed elsewhere.	Monitor costs throughout the estuary and input more detailed information as it becomes available from detailed appraisals.

Management

Local Issues:	Fresh water sources in all compartments. Potential benefit in terms of reduced flooding to A12.
Short term approach (on adoption of Strategy):	Maintain existing defences.
Long term approach (to be applied before critical time elapses):	Maintain existing defences and construct barrage incorporating the bridge at the A12.



ENVIRONMENT AGENCY

SUFFOLK ESTUARINE STRATEGIES PHASE 2

POSFORD DUVIVIER
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HR Wallingford

BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: ABOVE THE A12

FIGURE B2

FC(s): 14 & 15	*FC(s) Name/Location:* **Tinkers Marsh**	*Figure* B3	*ZONE:* 2 & 3
Assessed critical time:	10 years	*Strategy Implementation – Priority*	1
Physical Characteristics:			
Description: Narrow meandering and constricted channel, restrained by defences hard against both sides. Limited fringe saltmarsh which is being eroded. Forms part of SPA and Ramsar site with particularly important fresh water grazing marsh habitat generally through out the area and transitional habitat at the eastern end. Foot paths along banks.		*Defence length:*	2625 m
		Defended area:	64.2 ha

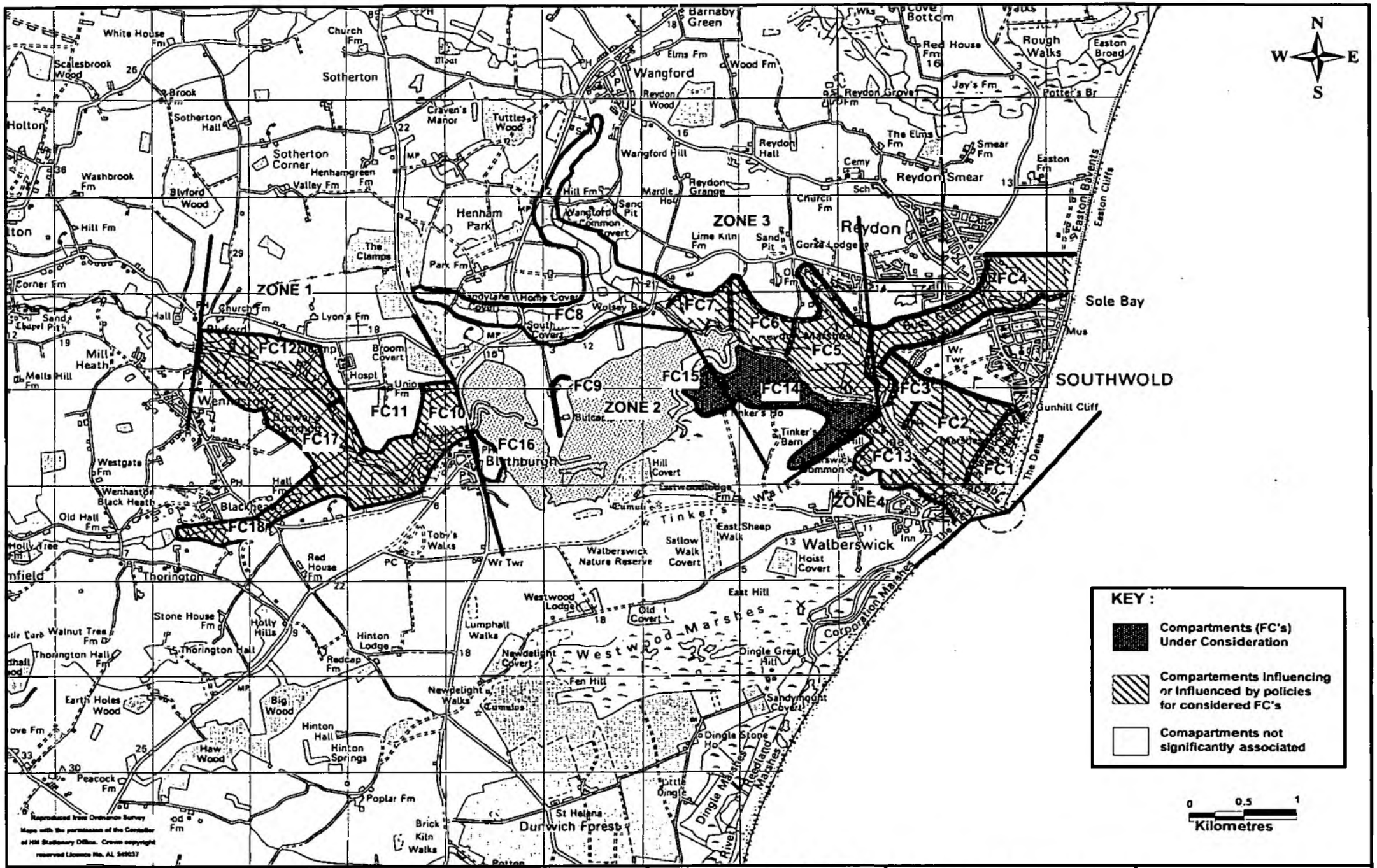
Strategic Context

Strategy Policy:	***Key Strategic Issues***			
Defence option subject to the outcome of CHaMPs	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	-Relief of pressure on opposite bank.	FC 4, 5, 6, 7	Economically significant	Holding the existing line to FC 14 imposes significant cost on defence of FC6 and Reydon marsh in general. This would not however overturn the strategy so long as above the A12 were defended.
	-Intertidal habitat	FC 13	Conditionally critical to strategy	The marsh would contribute a significant element of the new intertidal area necessary to balance the habitat of the estuary under the strategy. This could be critical depending upon the detailed realignment of FC13.

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	***Significance and Response***	***Action***
Re-creation of habitat.	Before retreat from this defence could be considered there would need to be, in place, all necessary agreements for and acceptance of re-created habitat.	Progress negotiations and environmental opportunity study.
Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	***Notes***	***Approach***
Feasibility of barrage.	Important with respect both to potential for more sustainable habitat re-creation and with respect to pressure on defences.	Incorporate results of detailed study. (see programme Figure 6.1)
Policy for the northern bank of zone 3.	The detailed decisions with respect to this frontage depends on the confirmation of policy for the northern section of zone 3.	A linked zone appraisal would be undertaken to ensure this issue is properly co-ordinated.

Management

Local Issues:	Environmental compensation Local assets to rear of compartment	Protection to bridge and embankment to bridge Maximise intertidal habitat creation
Short term approach (on adoption of Strategy):	Maintain existing defences to a standard that does not preclude future holding of the defence.	
Long term approach (to be applied before critical time elapses):	Defence option subject to the outcome of CHaMPs	



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: TINKERS MARSH

FIGURE B3

FC(s): 8	*FC(s) Name/Location:* **Wolsey Bridge**	*Figure* B4	*ZONE:* 3
Assessed critical time:	10 years	*Strategy Implementation - Priority*	3
Physical Characteristics:			
Description: Large flood compartment set back from the main line of the channel.		*Defence length:*	100 m
		Defended area:	86.1 ha

Strategic Context

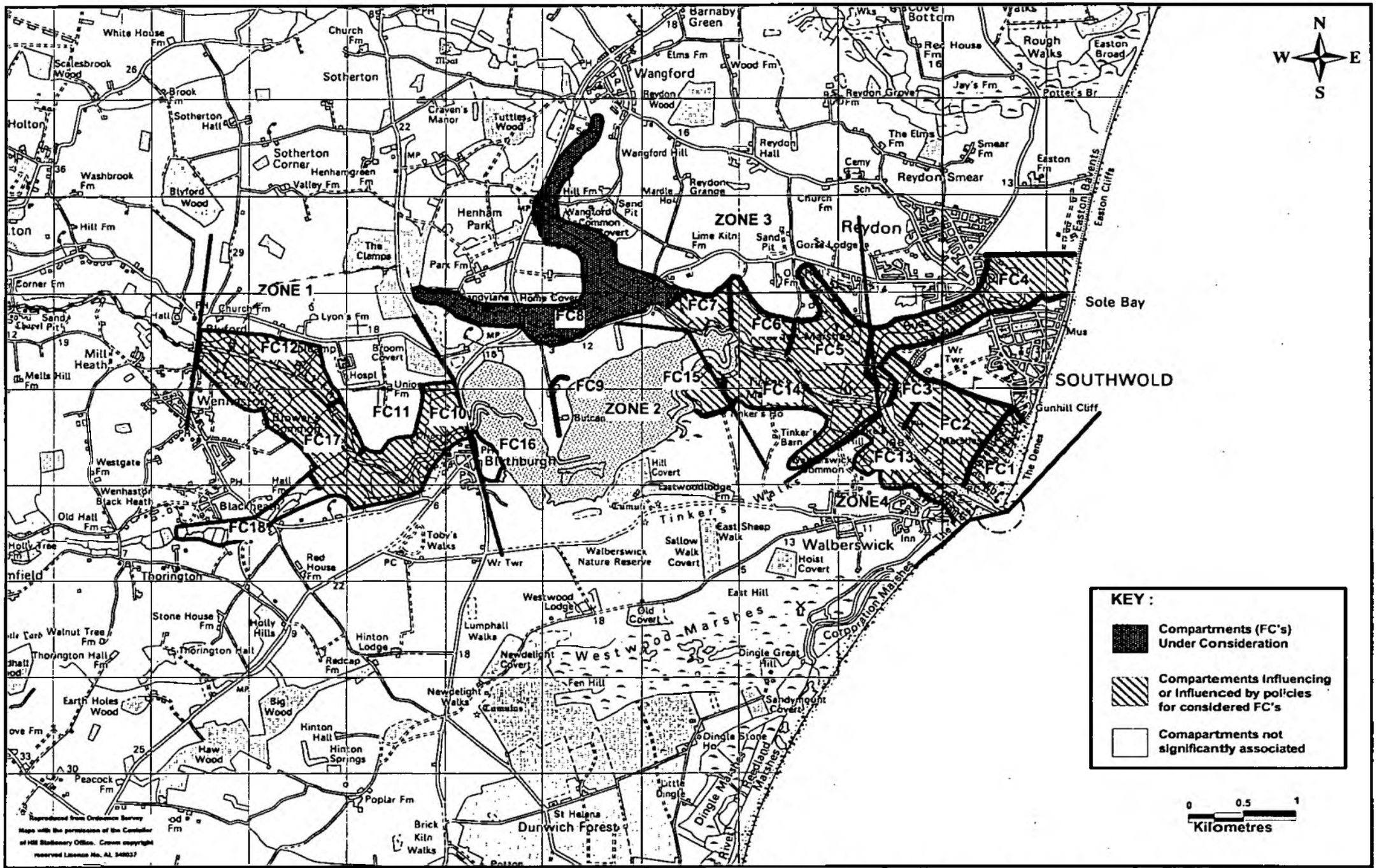
Strategy Policy:	***Key Strategic Issues***			
Hold the Line.	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	Large defended area.	All defences in zones 3 & 4.	Potentially critical to strategy.	Failure to hold the line would increase pressure on defences.

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	***Significance and Response***	***Action***

Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	***Notes***	***Approach***
Continuity of defence.	Although not critical the outcome of a detailed project appraisal would be influenced by policy for FC7.	Strategically this will have been addressed at the anticipated time when a project appraisal is undertaken for FC8.

Management

Local Issues:	
Short term approach (on adoption of Strategy):	Maintain existing defences.
Long term approach (to be applied before critical time elapses):	Maintain existing defences.



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: WOLSEY BRIDGE

FIGURE B4

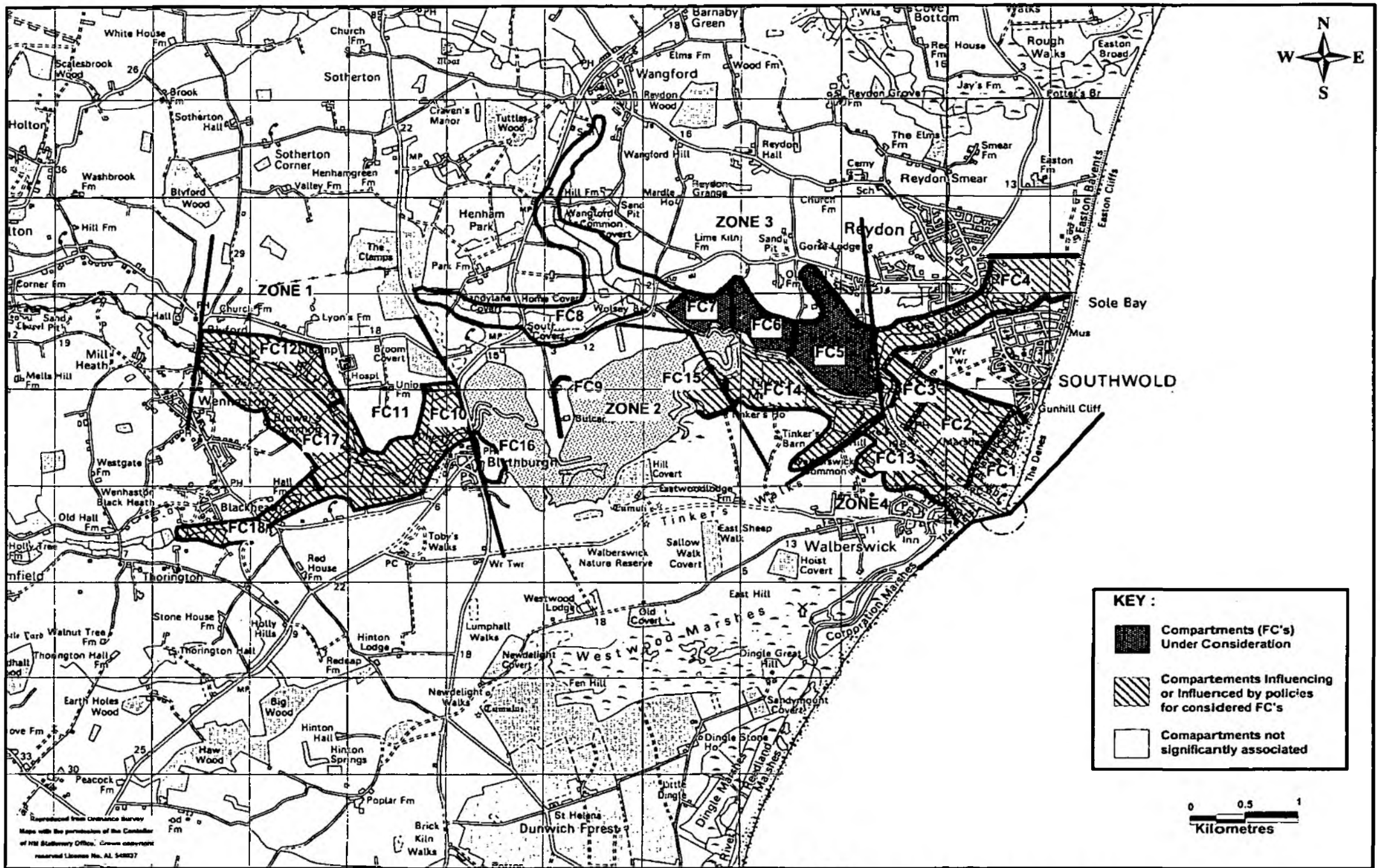
FC(s): 5, 6, 7	*FC(s) Name/Location:* **Reydon Marshes**	*Figure* B5	*ZONE:* 3
Assessed critical time:	10 years	*Strategy Implementation – Priority*	1
Physical Characteristics:			
Description: Narrow meandering and constricted channel, restrained by defences hard against both sides. Limited fringe saltmarsh which is being eroded. Large agricultural area. Footpaths along banks.		*Defence length:*	2700 m
		Defended area:	96.8 ha

Strategic Context

Strategy Policy:	***Key Strategic Issues***			
Hold the Line	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	-Increased flow in the event of do nothing.	FC 14, All FCs in zone 4.	Economically significant and conditionally critical.	Abandoning defences would have a significant impact on the lower estuary. In combination with abandoning defences in other area this additional volume might be critical at the estuary mouth.
	-Increased cost of defence.	FC 4.	Economically significant.	Continuity of defence needs to be maintained.
	-Maintained pressure on opposite bank	FC14	Economically significant	Holding the line to FC5 and 6 increases the pressure along part of FC14. This is not critical to the policy decision for FC14.
Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)			
Issue affecting Strategy	***Significance and Response***		***Action***	
Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)			
Issue affected by Strategy	***Notes***		***Approach***	
Feasibility of barrage.	Important with respect both to potential for more sustainable habitat re-creation, and creating the opportunity to relieve pressure on the defence.		This will have been addressed by the time decisions are required on FC5, 6 and 7 (see programme Figure 6.1). Incorporate results of detailed study.	

Management

Local Issues:	Archaeological interests. Pumping station at back of defences.
Short term approach (on adoption of Strategy):	Maintain existing defences.
Long term approach (to be applied before critical time elapses):	Maintain and refurbish existing defences.



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: REYDON MARSHES

FIGURE B5

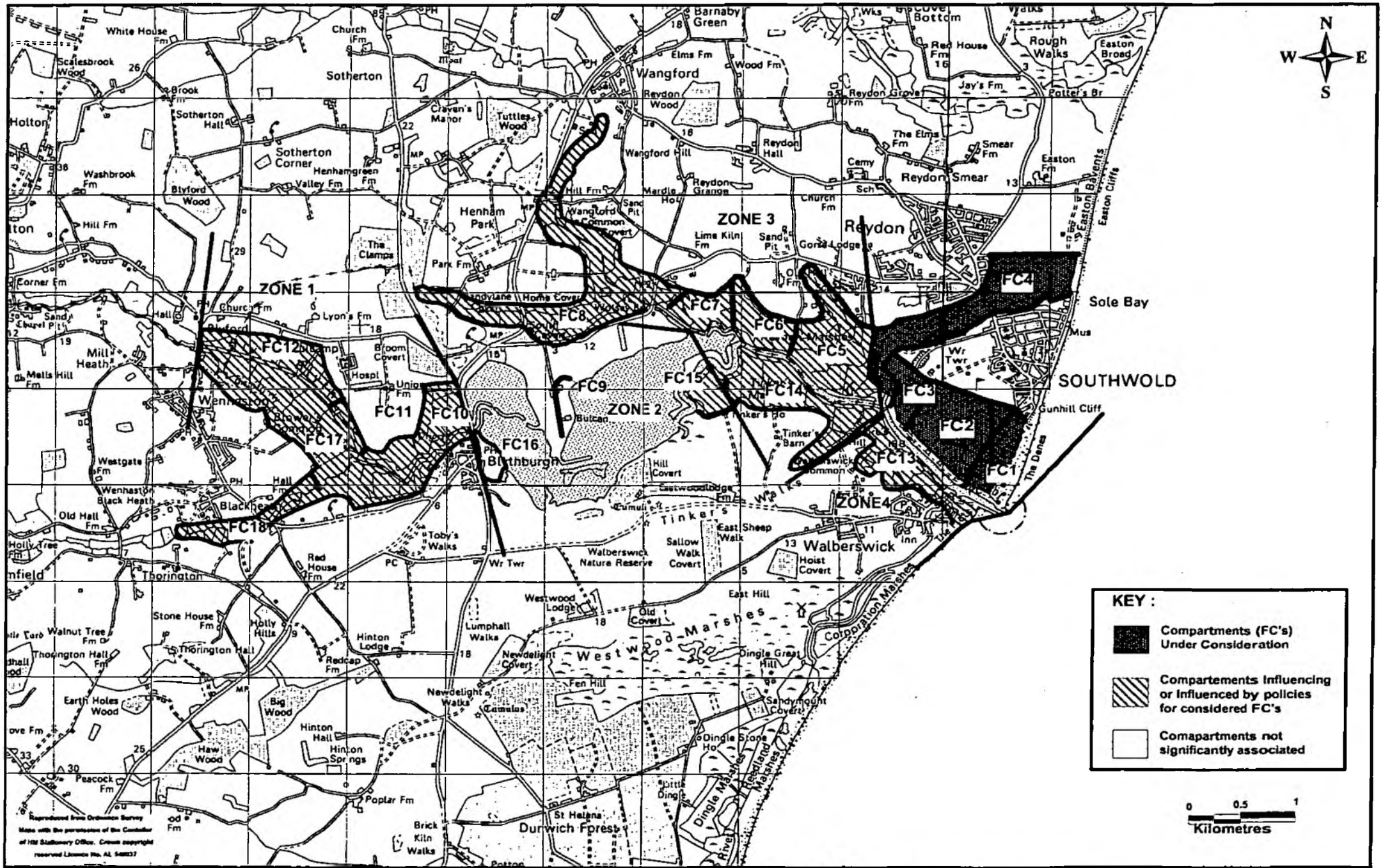
FC(s): 2, 3, 4	*FC(s) Name/Location:* **Botany, Woodsend and Town Marshes**	*Figure* B6	*ZONE:* 4
Assessed critical time:	20/25 years	*Strategy Implementation - Priority*	2
Physical Characteristics:			
Description: Relatively narrow but straight channel from the Pipe Bridge to the Sea. Sharp corner through Pipe Bridge. Extensive areas of low-lying marshland to either side of channel including: significant agricultural areas, important habitat to northern marshes, golf course, sewage works and harbour.		*Defence length:*	1200 m
		Defended area:	131.1 ha

Strategic Context

Strategy Policy:	***Key Strategic Issues***			
Hold the Line	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	-Increased flow in the event of do nothing. Continuity of defences.	FC 1 and coast.	Economically significant.	Very large increase in volume would result in abandoning Zone 1, together with loss of important economic assets and bridge.
	-Maintaining harbour.	FC 1.	Critical to strategy.	The use of the harbour is a key economic and cultural importance.
Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)			
Issue affecting Strategy	***Significance and Response***			***Action***
Hold the Line Costs.	It has been assessed that in holding the line there would be a substantial increase in cost should certain other areas (most notably above the A12) be abandoned. These transferred damage form part of the justification of strategy policies further up the estuary. Although critical the argument is robust.			Monitor cost of defence and re-assess potential economic impact at a strategic level when undertaking project appraisals for other flood compartments. These appraisals will have to be undertaken before there is any local need to do more detailed appraisal on these harbour area defences.
Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)			
Issue affected by Strategy	***Notes***			***Approach***
Estuary volume.	Increase in volume from SLR or abandoning defences elsewhere in the estuary will increase cost of defence of these compartments.			It is anticipated that options for critical compartments will have already been resolved by the time detailed appraisals are required for the harbour area. Incorporate updated information.

Management

Local Issues:	Harbour assets in front of main line of flood defence. Protection to the edge of channel critical to the long term maintenance of the flood banks.	Use of harbour. Water level management plans for compartments. Protection to bridge and embankment to bridge.
Short term approach (on adoption of Strategy):	Maintain existing defences.	
Long term approach (to be applied before critical time elapses):	Maintain existing defences.	



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: BOTANY/WOODSEND/TOWN MARSHES

FIGURE B6

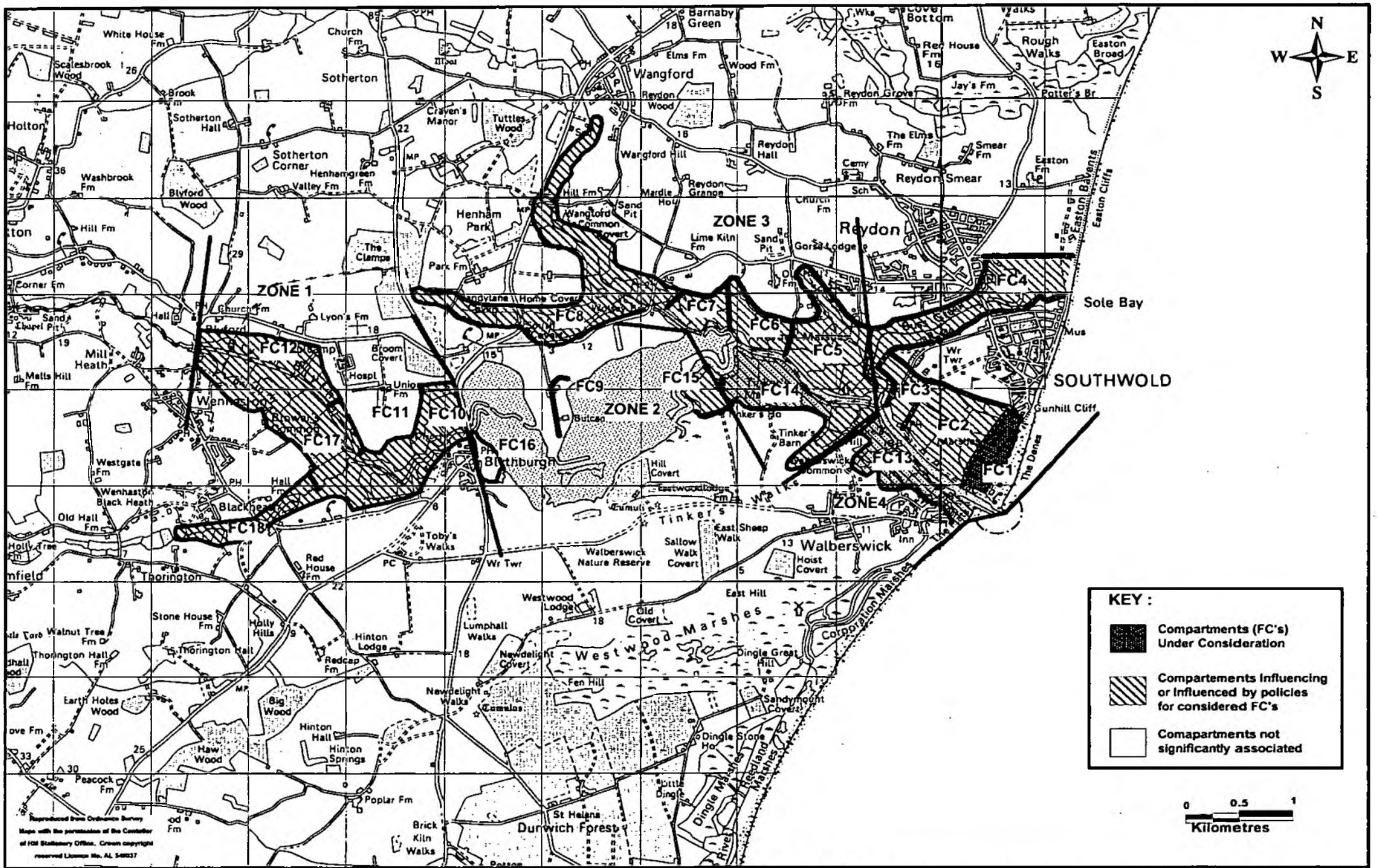
FC(s): 1	*FC(s) Name/Location:* **Havenbeach Marsh**	*Figure* B7	*ZONE:* 4
Assessed critical time:	10 years	*Strategy Implementation – Priority*	3
Physical Characteristics:			
Description: Flood compartment includes entrance to the harbour and is partially protected by natural sea defence.		*Defence length:*	500 m
		Defended area:	18.8 ha

Strategic Context

Strategy Policy:	***Key Strategic Issues***			
Hold the Line	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	-Maintain coastal processes.	Coastline.	Critical to strategy and SMP.	Abandoning flood compartment would abandon control of estuary entrance, critically altering entrance configuration and pressure on defences.
	-Maintaining harbour.	FC 2 and 3.	Critical to strategy.	The use of the harbour is a key economic and cultural importance.
Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)			
Issue affecting Strategy	***Significance and Response***			***Action***
Hold the Line Costs.	It has been assessed that in holding the line there would be a substantial increase in cost should certain other areas (most notably above the A12) be abandoned. These transferred damages form part of the justification of strategy policies further up the estuary. Although critical the argument is robust.			Monitor cost of defence and re-assess potential economic impact during project appraisal. Feed this information back into appraisals for other areas which are likely (see programme 6.1) to be being undertaken concurrently.
Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)			
Issue affected by Strategy	***Notes***			***Approach***
Estuary volume	Increase in volume from SLR or abandoning defences elsewhere in the estuary will increase cost of defence of these compartments.			Detailed consideration of critical areas elsewhere in the estuary will be being carried out concurrent with the detailed appraisal of defences at this section.

Management

Local Issues:	Use of harbour and maintenance of harbour structures. Tourism
Short term approach (on adoption of Strategy):	Maintain existing defences and review required works on North Pier.
Long term approach (to be applied before critical time elapses):	Maintain existing defences.



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: HAVENBEACH MARSH

FIGURE B7

FC(s): 9	*FC(s) Name/Location:* **Bulcamp House**	*Figure* B8	*ZONE:* 2
Assessed critical time:	25 years	*Strategy Implementation - Priority*	3
Physical Characteristics:			
Description: Wide intertidal area with narrower low water channel meandering relatively freely through zone.		*Defence length:*	500 m
		Defended area:	7.8 ha

Strategic Context

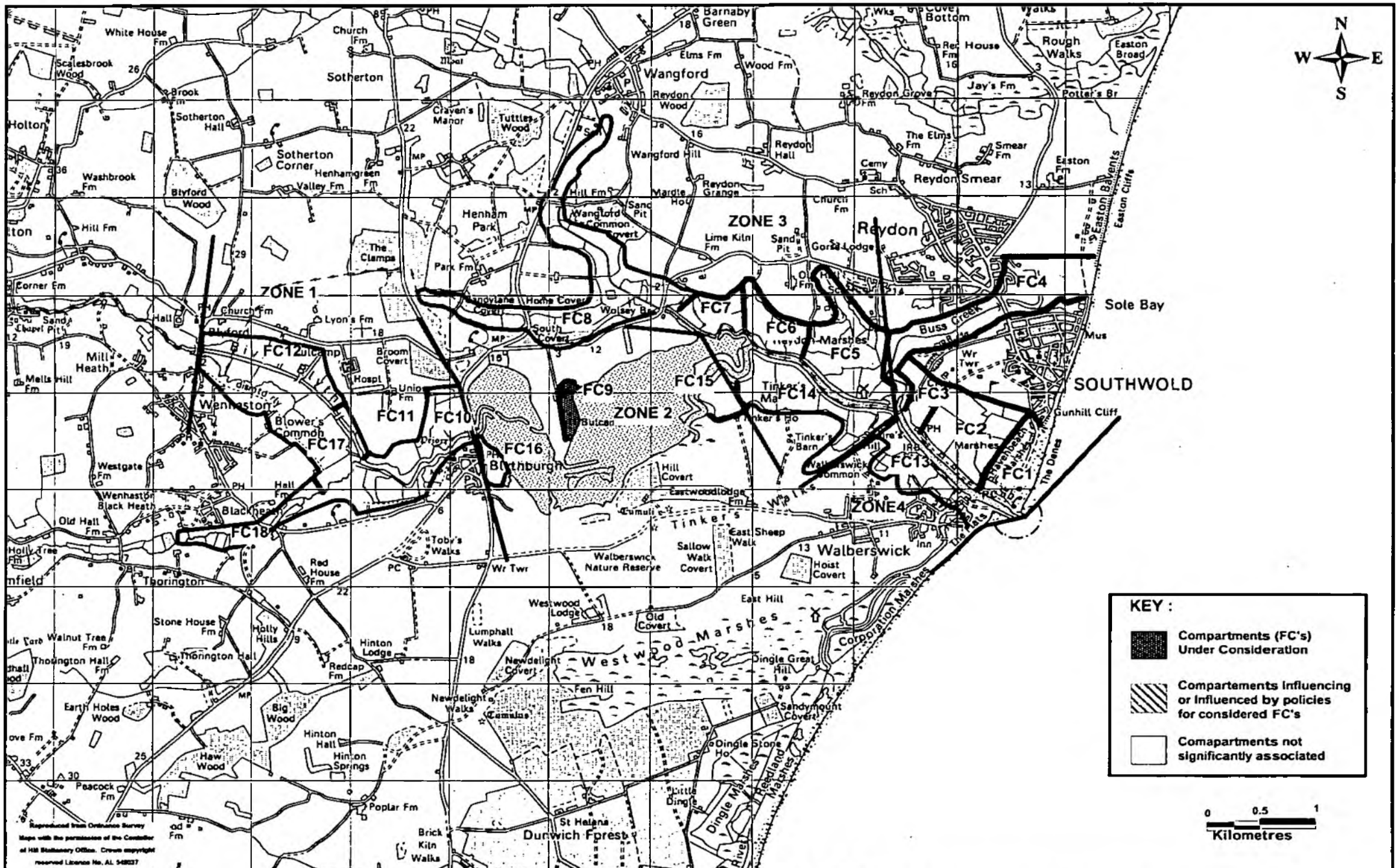
Strategy Policy:	***Key Strategic Issues***			
Hold the Line	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	None	None	Low	Relatively independent compartment

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	***Significance and Response***	***Action***
None	None	None

Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	***Notes***	***Approach***
None	None	None

Management

Local Issues:	The principal asset is the house. Future management of the unit needs to be reviewed locally in due course.
Short term approach (on adoption of Strategy):	Maintain defences.
Long term approach (to be applied before critical time elapses):	Maintain defences subject to detailed project appraisal.



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: BULCAMP HOUSE

FIGURE B8

FC(s): 16	*FC(s) Name/Location:* **Blythburgh**	*Figure* B9	*ZONE:* 2
Assessed critical time:	20 years	*Strategy Implementation – Priority*	3
Physical Characteristics:			
Description: Wide intertidal area with narrower low water channel meandering relatively freely through zone.		*Defence length:*	260 m
		Defended area:	6.9 ha

Strategic Context

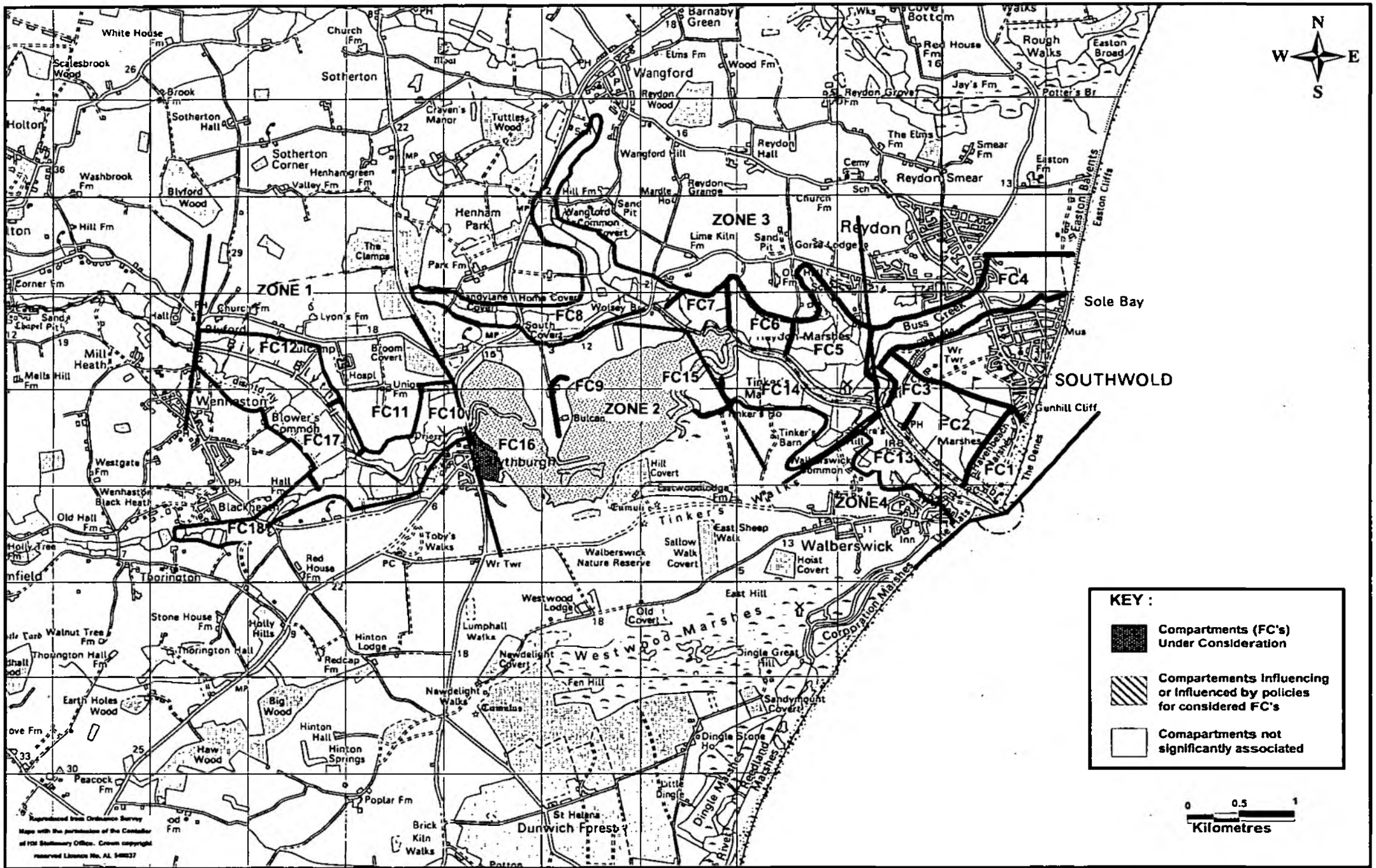
Strategy Policy:	***Key Strategic Issues***			
Hold the Line	***Issue***	***Associated FC(s)***	***Significance***	***Notes***
	None	None	Low	Relatively independent compartment.

Influence on Strategy	(Potential constraints which may have a significant bearing on the overall strategy for the estuary)	
Issue affecting Strategy	***Significance and Response***	***Action***
None	None	None

Dependence on Strategy	(Strategic assumptions upon which the detailed project appraisal of this compartment depends)	
Issue affected by Strategy	***Notes***	***Approach***
None	None	None

Management

Local Issues:	None specifically identified.
Short term approach (on adoption of Strategy):	Maintain defences.
Long term approach (to be applied before critical time elapses):	Maintain defences subject to detailed project appraisal.



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BLYTH ESTUARY IMPLEMENTATION GUIDANCE SHEETS: BLYTHBURGH

FIGURE B9

ADDENDUM

DISCUSSION OF FLOOD DEFENCE POLICY, AND ENVIRONMENTAL AND ECONOMIC ISSUES RAISED DURING THE CONSULTATION PROCESS

CONTENTS

1. INTRODUCTION

The response to the second phase of consultation (Consultation on the draft strategies) has been comprehensive and wide ranging. Much useful additional information, material to the development of the strategies, has been forthcoming, allowing an initial review of the policies making up the strategy.

In addition, a considerable amount of detailed information has been obtained which, although not directly relevant to the strategy development, provides valuable data for future detailed examination of specific areas and helpful background to the current higher level study.

A third element of the responses identify issues and concerns relating to fundamental policy, legislation and matters of management with respect to interest other than these directly associated with flood defence.

These third category responses are, of necessity, outside the scope of the strategy study, in that the strategy must be developed within existing policy and legislative framework and should not attempt to dictate management of interest beyond flood defence. However, these issues clearly have a significant bearing on the strategy, and the strategy has thrown up areas open to interpretation.

Furthermore, it has to be appreciated that higher level policy may change with time and with circumstance. It is essential that the strategy recognises this and is developed in such a manner as to maintain adequate flexibility into the future.

It is, therefore, felt to be helpful to discuss the main issues raised and to examine how these might possibly influence the strategy development on how the integrated approach promoted by the strategy potentially opens fresh interpretation of some of these higher level policies.

This addendum provides this discussion and is divided into three main subject areas; those of defence policy (legislation, compensation and private investment), environment (legislation, mitigation and management) and economic (PAGN, asset evaluation and sensitivity to variations). These discussions are not intended to be definitive but rather to highlight questions, provide guidance and primarily to set the context of strategy recommendations within the higher level framework. Whether having a critical bearing on the strategy or not, it is felt that further investigation of these issue will be necessary in the medium to long term if correct overall management (management over and above flood defence) of the estuary is to be achieved and if detailed project appraisals are to be successfully accomplished.

2. FLOOD DEFENCE POLICY

Defence policy has a fundamental impact on virtually all aspects of use and interest within the estuaries; from agriculture and other land use, recreation, water quality, ecological function and interest, to the way in which the estuary behaves, and hence the interaction with other areas or other defences within the estuary.

This is in addition, of course, to the actual role of defence in protection of life and assets.

Reflecting this is a plethora of legislation both directly relating to duties and functions of those responsible for defences and drainage works and indirectly relating to impacts associated with management of defences. **The confusion surrounding this has generated one of the main areas of concern during consultation.**

The Environment Agency ("the Agency") has permissive powers to undertake flood defence works. The Agency also has a mandatory duty to exercise a general supervision over all matters relating to flood defence. In this latter regard, the Agency performs its duty through its "consenting" powers, either directly, as in the case of its statutory consultee role under the Coast Protection Act, or through the planning consent procedures.

A consent to a person undertaking works on a defence cannot reasonably be withheld, but in judging this the Agency must be guided by its principle aim to contribute towards attaining the objective of achieving sustainable development.

In addition to the above aim, the Agency is guided in the performance of its permissive powers, to undertake defence, by the need for economic worthwhileness, and for the scheme to be technically sound and environmentally acceptable.

Against this background, principal areas of concern raised by consultees relate to:

- what constitutes positive action in relation to the Agency performing its permissive role?
- what powers does the Agency have to prevent a private person undertaking works to protect their own land?
- what compensation would be available in the event of the Agency's actions, inaction or prevention of action?
- How would compensation be determined, and would equitable payments be available to address both strategic and non-strategic area defence recommendations?

Although tested to a degree on individual schemes, these questions in relation to strategies and strategic management of estuaries are still unresolved. The intention, therefore, is to highlight some of the issues so as to provoke further discussion, rather than provide definitive answers.

A strategy may comprise several elements but provides, overall, a coherent approach to the management of defence to all assets and interest within the estuary. As such, it could be argued that the strategy, if it involves any works, could, in its entirety, be taken as an active works scheme. Any damages arising from undertaking, or locally not undertaking, works could result in compensation being payable for injury, loss or damage sustained as a result of the strategy as a whole. Such an attitude seems extreme, potentially creating unacceptable precedent well beyond estuary management and therefore is likely to be unacceptable.

However, there is a general principle within this which should arguably be considered; that the strategy anticipates loss to the individual for the benefit of better management of the estuary in

general. In particular, it allows the Agency to perform its duties, under such legislation as the Habitats Directive, and in achieving a more economically acceptable solution to the problems of defence.

From this it becomes more sensible to examine individual elements making up the strategy. Four cases may be considered:

i) & ii) relating to individual flood compartments that are either justifiable or unjustifiable economically;
iii) & iv) relating to estuary-wide strategic decisions which result in local loss to benefit the estuary as a whole or result in conflict between lengths of defence.

These are discussed in detail in Sections 2.1 and 2.2 below.

2.1 Individual Flood Compartments

The strategies have identified that **there are some areas where there is little strategic interaction with other areas of the estuary**, whether the defence is maintained or not.

In the traditional situation; the unit is evaluated in terms of the cost of defence compared to potential loss of assets. Two cases, apart from hold the line, may arise.

i) There is no economic justification for defence. The Agency has a discretion whether or not to protect a particular area and if protection were shown not to be in the nation's benefit, it would be reasonable to abandon the defence. In exercise of this discretion, if the Agency decides to abandon or no longer maintain an existing defence, it would generally not be liable for any damages.

ii) There is economic or environmental justification in defending only part of an existing flood compartment. If the action were taken to protect the residual area, rather than actively to cause flooding of the area between the new and existing defences, then it seems probable to assume that damages would not occur as a result of action taken by the Agency. This would assume that the front line defences were not actively breached; set back or retreat would have been for local reasons not for strategic benefit.

    In this local situation there would, under normal procedures, be a need to compensate landowners for land taken or damaged in association with the construction of the new defences.

In both cases i) and ii), since there is no strategic benefit in abandoning or retreating defences, it would be arguably inappropriate for the Agency to withhold consent if a landowner wished to undertake private defence works. (This would presume that such proposals were environmentally and technically sound). This then raises the question as to whether a contribution offered by the landowner balancing the economic disadvantage between abandoning and maintaining the existing defence should reverse the decision to abandon the defence.

2.2 Strategic Decisions

In general there is a high degree of physical interaction and interdependence throughout the estuaries, and a need to maintain the overall ecological integrity and comply with the Habitats Directive. Decisions are being made for the national benefit, not on a purely local level.

iii) One of the most difficult areas is where it is proposed to abandon defences specifically to meet the strategic needs of the strategy to maintain the favourable conservation status of the estuary. It may be argued that, in such a case, regardless of whether physical action is taken or not, the Agency is actively causing the abandonment of the defence in that consent for private works to maintain the defences might be withheld. On the basis that in implementing such abandonment, the Agency is exercising its powers under the Water Resources Act 1991, compensation would be payable for any injury, loss or damage sustained. This is certainly not Government Policy at present, although grants are being made available through set aside projects, ESAs and Countryside Stewardship Schemes to encourage such decisions.

Consultation responses indicate that, while such initiatives are welcomed in many circumstances to encourage or facilitate co-operative enhancement of the environment, they are seen as inadequate to cover enforced retreat. This resistance reflects the concern over possible irretrievable loss of ownership (eg. land reverting to Crown ownership as sea level rises), possible loss of irrigation sources and the potential result in inefficient use of existing plant and facilities due to the reduction of farmed land area. On this latter point it is argued that landowners have made investments based on their existing areas of land, which could not be justified if the total area of land was substantially reduced.

iv) Conflict Between Defences. The strategies identify interdependence between the cost of defence of two or more flood compartments. In many areas the transferred defence burden actually justifies, in economic terms, the continued defence of compartments, which at a local level are indicated as being uneconomic.

The Agency's powers, and the nation's subsequent responsibilities to individual landowners, is really, however, called into question where holding the line in one area places additional burden onto other defences.

In the extreme situation, and following the MAFF guidance in properly assessing whole life costs, this can result in a decision to abandon or retreat one line of defence so as to create a sustainable condition with respect to another defence line. This is potentially more complex where, assessed individually, both areas might be economically defendable but where viewed together a more sustainable and economic solution is to retreat one line.

This situation cannot be equated to the situation on the open coast, where work on an updrift area may deprive an area downdrift of sediment. In an estuary the economic argument results from a conflict between two sides of a channel and the combined impact on flows resulting in increased pressure. **Decisions relating to both defence lines must arguably be seen as one scheme. The decision to retreat one side, but maintain the defence opposite is, therefore, logically all part of an active exercise of the Agency's powers.**

Furthermore, the Agency would, in attempting to implement the strategy, logically withhold consent to any private landowner proposing to undertake defence work.

Any attempt by a landowner to maintain his defence, where it can be demonstrated to cause damage to another defence could be construed as a nuisance. Especially in the case where the physical regime is altered in such a way that the other defence no longer becomes economic to maintain and is subsequently abandoned.

The above attempts to outline the key issues raised by the consultees, setting them in the context of the strategy. Clearly there are no definitive answers at present and there is an urgent need for matters to be considered further.

The real option must be for all those with a stake or interest in the estuary to recognise the need for a strategy providing the basis for more detailed examination of these and other issues.

At present the general expression of consultees is that compensation, by way of environmental improvement grants, is based on too short a timescale and does not truly relate to the loss that may occur.

Concern has been expressed that the economic damages evaluated in the main report, reflecting as they do only the loss to the nation also fail to recognise the true value of land and assets to the landowners. Other opinion considers that substantial benefit has already been gained by landowners at considerable expense to the nation over many years through the provision of defences and that there should therefore now be no compensation for loss.

Finally, two aspects which have been raised several times are those of EU human rights and social benefit. The former is due to be addressed by legislation in the near future, and certainly the strategies will need to be reviewed in light of this.

The latter relates to the unevaluated damages to the local communities and regional (as opposed to national) economy. There is recognised to be little guidance on this matter and it is strictly outside the scope of the strategy study. It is, however, clearly important and must be considered when examining, in more detail, the implementation of the strategy framework.

3. ENVIRONMENTAL ISSUES

3.1 Implications Of The Habitats Directive

All three of the estuaries considered as part of this strategy are of international importance for nature conservation, with the Deben, Alde-Ore and Blyth being designated as Special Protection Areas (SPAs) under the Birds Directive and much of the Alde-Ore designated as a Special Area of Conservation under the Habitats Directive. The Conservation (Natural Habitats etc.) Regulations 1994, transpose the Habitats Directive into UK law and also apply specific provisions to existing and future SPAs. The Regulations impose restrictions on development likely to significantly affect a SPA or SAC, and which is not directly connected with or necessary to the management of the site. These restrictions apply to plans or projects, including those that would be implemented through a strategic approach, and therefore in effect the strategies themselves have to be compliant with the Habitats Directive.

Concerns have been raised during consultation from various organisations and individuals including English Nature, RSPB and the Suffolk Wildlife Trust regarding the implications of some of the proposed strategic options with respect to nature conservation interests and compliance with the Habitats Directive. These concerns essentially revolve around proposed retreat or Do Nothing options that would result in the loss of freshwater grazing marsh designated as SPA. Specific examples include Tinkers Marsh on the Blyth Estuary and Hazelwood Marsh on the Alde-Ore. Implementation of these options would result in the loss of these freshwater habitats, which could constitute an adverse effect on the ecological integrity of the designated site. Without adequate compensation to offset these potential losses it is considered that the strategies run counter to the Habitats Directive. The line presently taken by MAFF with regard to the protection of internationally designated habitats from flooding or erosion is that the feature should be maintained in situ. However, the alternative of habitat re-creation could be entertained where to maintain a feature *in situ* would either:

- Cause damage or loss to other European or other internationally important features; OR
- Require a scheme that failed to pass one or more of the following tests: that it be either technically, economically or environmentally sustainable in the long term.

As stated in the Strategies the overall aim is to maintain or improve the overall balance of the estuaries in terms of both the natural and human environment. To do so requires that future flood defence policy (and works) take account of, and work with, the dynamic environment that the estuary itself creates. This is reflected in the view put forward in the Strategies that where the maintenance of defences to flood compartments is not sustainable in the long term then alternative solutions to defence should be sought e.g. managed realignment or do nothing. In some cases this approach leads to the situation where the most sustainable option is to realign the estuary over existing areas of nature conservation interest in order to enable dynamic change in the form of the estuary to occur. In other cases realignment over agricultural land is clearly the most suitable option. Tinkers Marsh, in particular, is located within a particularly dynamic section of the Blyth Estuary that is under intense and increasing pressure from estuarine processes and the likely effects of sea-level rise. In addition, the marsh surface occurs below mean high water level and is already prone to saline seepage and occasional overtopping. The habitats present at Tinkers Marsh could be sustained within their present location. However, to do so would be economically unjustified, the works themselves to provide the level of protection required to the existing habitat could be damaging in their own right and perhaps most importantly, this policy would continue to support the maintenance of a habitat that is ecologically 'isolated' from the rest of the estuary system, and clearly unsustainable in the longer term (over 50 years)

In isolation realignment over existing SPA designated grazing marsh at Tinkers, or other sites, would constitute significant effect with regard to the Habitats Directive and could be viewed as an adverse affect on the integrity of a European site. However, Strategic policies have been proposed that provide a defence framework that can accommodate for the loss of existing freshwater habitat and

which could promote its creation in more ecologically fitting and sustainable locations e.g. towards the heads of tributary rivers. It may therefore be possible to propose the loss of part of an existing European designated habitat as long as measures are taken to ensure its replacement within an estuary system. As such the interests for which the European site was designated would be maintained, and possibly enhanced, and therefore integrity would not be compromised. This approach is being advocated through the production of Coastal Habitat Management Plans for coastal, dynamic sites of European interest. In some cases, the Strategies indicate potential areas where habitat recreation or enhancement could be undertaken in order to offset habitat loss e.g. replacement for Tinkers Marsh on the Blyth Estuary could be undertaken upstream of the A12. For some potential areas where SPA habitat could be lost e.g. Hazelwood Marsh, suitable areas for habitat re-creation have not been identified. However, the Strategies provide a defence policy framework that would allow the establishment of new habitat to take place within locations that are sustainable from a physical process and economic perspective.

Realignment or do nothing policies within the estuaries also enables the issue of 'coastal squeeze' to be dealt with. This represents the effect whereby existing flood defences prevent lateral saltmarsh migration in response to sea-level rise. With no scope for compensatory development landwards, the width of saltmarsh is becoming progressively narrower as the seaward edge of the marsh is eroded. Under the Habitats Directive, the loss of saltmarsh through maintaining the existing line of defence in its entirety could constitute a significant effect and potentially have an adverse affect on the integrity of the SPAs. If this is the case then realignment within the estuaries would be required in order to compensate for saltmarsh loss. Undertaking such realignment specifically in relation to the needs of the Habitats Directive would constitute a piecemeal approach to flood defence and habitat recreation. The Strategies, as proposed, provide the means to offset saltmarsh habitat loss, and therefore meet the requirements of the Habitats Directive, within a strategic framework for flood defence.

At the present time, there is a danger that interpretation of the Habitats Directive will lead to the protection of valued sites for nature conservation in locations within the estuaries where their maintenance is clearly ecologically and economically unsustainable. Taking this approach could have two significant consequences. Firstly, the dynamic evolution of the estuary system could be hindered resulting in adverse effects elsewhere in the estuary and secondly opportunities for habitat creation could be missed or become economically less viable. Maintaining and enhancing the overall ecological interests of the estuaries and ensuring compliance with the Habitats Directive is a difficult and complex task. The entire issue has to be viewed as an integral part of the long term management of the wide range of estuary uses and interests. **As such, it should be accepted that in the face of external forcing mechanisms, such as sea-level rise, there may well have to be a redistribution of habitats through landuse change in order for ecological function to be maintained and potentially enhanced. Adopting a static approach to the management of flood defences is not an option.**

3.2. Coastal Habitat Management Plans

The following text represents draft guidance on the likely content, development and scope of Coastal Habitat Management Plans (CHaMPs). This information has been drawn up by English Nature and the Environment Agency. It is intended that CHaMPs will assist in the development of sustainable coastal defence strategies in those areas where coastal defence measures have implications for internationally important wildlife sites. The guidance has been prepared in consultation with MAFF and the Department of the Environment, Transport and the Regions and will be revised following comments received from consultation with various organisations and interest groups.

Coastal Habitat Management Plans (CHaMPs) are intended to provide a framework for managing sites of European importance and Ramsar sites that are located on or adjacent to dynamic coastlines, including estuaries. They are intended to provide a way of fulfilling the UK Government's obligations under the Habitats and Birds Directives to avoid damage and deterioration to Natura 2000

sites, and its obligations under the Ramsar Convention, where the conservation of all the existing interests *in situ* is not possible due to natural or quasi-natural changes to shorelines. Their two primary functions are:

- to act as an accounting system to record and predict losses and gains to the Habitats and Species of European or international importance within a Natura 2000 or Ramsar site subject to shoreline change
- to set the direction for habitat conservation measures to address net losses.

By doing this they will ensure that damage to or deterioration of Natura 2000 sites from either changes to estuaries and the open coast or, from the sea/flood defence response to such changes, is avoided or compensated for. The plans will therefore contribute to maintaining the coherence of the Natura 2000 and Ramsar site network.

3.2.1 Scope of Coastal Habitat Management Plans

It is intended that each CHaMP will cover a site complex. This will normally consist either of a single coastal SAC or SPA, or more commonly a complex of overlapping or contiguous coastal SACs and/or SPAs and Ramsar sites. However, in order to encompass areas where replacement habitats can be created and sustained, CHaMPs will often also have to take in areas immediately adjacent to those currently designated as of international interest e.g. coastal or estuarine flood plain, and which could reasonably be predicted to achieve a similar ecological function with appropriate management.

CHaMPs will provide a framework for managing site complexes over a relatively long period. It is anticipated that this would normally be between 30 and 100 years depending on the type of coastline involved. Habitat creation and other works should however be planned with a view to their sustainability for the foreseeable future.

3.2.2 Application of CHaMPS to the Suffolk Estuarine Strategies

The Strategies as developed are not a CHaMP or replacement for a CHaMP. However, the basic sentiments and ideas that CHaMPs will cover have been considered and where appropriate incorporated into the Strategies.

As with CHaMPs, the basis for the development of the strategies is the physical processes operating within each of the estuaries and consideration of the likely evolution of the estuary systems in response to sea-level rise and continued operation of these processes. The proposed defence options have been put forward to enable the estuary to respond to the pressures which it is currently experiencing and to enable a more sustainable approach towards the management of defences to be advanced. In all three of the estuaries taking this approach requires that decisions have to be made about the sustainibility of existing defence policies in relation to the likely evolution of the system and the habitats that the system supports. In certain instances it is clear that the defences currently protecting some areas of habitat are under pressure either due to processes, likely change in processes (e.g. sea-level rise) or strategic location. Continuing to protect such sites, whilst enabling obligations under the Habitats Directive to be met, does not enable dynamic evolution of the system to take place, is economically unjustified and perhaps most significantly is ecologically unsustainable.

3.2.3 Predicted changes to estuaries and the shoreline

CHaMPs will be based upon a 'best guess' model for how the shoreline within each management plan area is likely to change over the next 30 to 100 years. This will be informed by, review of coastal processes, the preferred defence options set out in the Shoreline Management Plans, detailed strategic

plans for flood and coastal defences, but also building in other available data and expert opinion. This review of predicted changes to the shoreline will in turn feed back into the next revision of SMPs and to any strategies produced subsequently. The aim will be to integrate CHaMPs into Estuary and Shoreline Management Plans.

From consideration of likely estuary and shoreline changes for each CHaMP a list of the European and other internationally important features and parts of features which can be maintained *in situ* under conditions of dynamic coastal change and a list of those which are unlikely to be sustainable in the face of coastal change over a 30 to 100 year period will be derived. Maintenance of a feature *in situ* will be the choice of preference (existing MAFF policy). The alternative option of habitat re-creation will only be entertained where to maintain *in situ* would either:

a. Cause damage or loss to other European or other internationally important features.

Or b. Require a scheme that failed to pass one or more of the following tests: that it be either technically, economically or environmentally sustainable over a 30 to 100 year period. Technical and economic sustainability are not easy to define, but a working definition of where maintenance *in situ* might be unsustainable might be where this course of action would require continued, excessive and increasing input of natural resources and money.

3.2.4 Assessment of effect on site integrity

The list of features which cannot sustainably be maintained in situ will be used to inform an assessment of whether or not the scope and scale of habitat loss and/or change likely to result from shoreline change and the management response to it over a 30 to 100 year period has the potential to cause adverse effect on site integrity.

3.2.5 Programme of measures

Where it is predicted that an adverse effect on integrity would occur, the CHaMP would then go on to set out the targets to, either avoid an adverse effect on integrity, or to compensate for it. There would then be a programme consisting of the measures considered essential to meet these targets through the development of replacement habitats. These should be located within or immediately adjacent to the site complex wherever possible, though it may sometimes be necessary to look more widely within the natural area. The CHaMP would also assist this part of the process by identifying potential sites for replacement habitat within the proposed rolling five year time frame.

3.2.6 The iterative nature of the plan

It is recognised that the targets for habitat replacement will initially be set on the basis of some fairly broad assumptions, both on the likely scale of habitat loss, and on the likely response. The plan will therefore need to be a living document. The figures for anticipated habitat loss, and the targets for habitat replacement derived from them will need to be adjusted each time a scheme goes forward, after detailed consideration of the different options for that scheme, or as and when other new information becomes available. The CHaMP will need to identify monitoring requirements to keep the inventory of habitat losses and gains up to date.

3.2.7 Anticipatory replacement of habitat

Once plans have been prepared and agreed, it will be desirable to start to replace the habitats and the habitats of species of international importance in advance of the loss occurring. The ability to replace in advance also offers the pragmatic and ecological advantages of economies of scale that may be achieved by combining several smaller habitat replacement schemes.

However, bearing in mind the uncertainties surrounding the prediction of future changes, and the need for an iterative approach within CHaMPs, it is proposed that the loss predictions and the habitat replacement targets should be profiled as best as is possible within the 30 to 100 year life of the plan. Advance habitat replacement should then normally be limited to that predicted as necessary within a rolling five year time horizon, though this limit will need to be applied with a considerable degree of flexibility so as not to preclude otherwise sensible and economic solutions.

3.2.8 Legal basis for the Coastal Habitat Management Plan

It is proposed that a CHaMP will be a Management Plan as mentioned in Article 6.1 of the Habitats Directive. Where the site complex includes or overlaps with a European marine site, the ChaMP will be written so that it can be integrated with the Scheme of Management provided for in the 1994 Habitats Regulations, so that they can together fulfill the requirement in the Regulations for a single Management Plan for each Natura 2000 site. A CHaMP is viewed as an aid to the application of the Habitats Regulations to particular schemes. It is envisaged that they will be particularly helpful in making the judgements required by the Habitats Regulations in relation to the assessment of effects in combination with other plans and projects and in relation to whether there will be an adverse effect on the integrity of a site. It must be stressed that a CHaMP does not offer an alternative regulatory pathway to the Habitats Regulations.

Because the purpose of a CHaMP is essentially to manage long term natural or quasi-natural changes to the coast it may be the case that works required to maintain site integrity are 'necessary for or connected with site management for nature conservation'. As such they need not be subject to the tests of significant effect and adverse affect on integrity required under the Habitats Regulations for 'plans or projects'. Such a view would be most likely to be applicable where the habitat modification took place within the existing boundaries of the site or sites and was essentially facilitating a natural process.

Where a plan or project is envisaged, habitat conservation may not be possible within the current boundaries of a European or Ramsar Site. In such a case, where an adverse effect on integrity is unavoidable, the CHaMP is intended to provide the context for a subsequent decision which could lead to the conclusion that the scheme was required for imperative reasons of over-riding public interest. Each case will have to be decided individually, but it could be considered that the action was necessary for environmental as well as flood defence reasons, ie the action being the best environmental solution which allows coastal habitats to adapt to changes in the coastline. The plan will be so constructed that the flood defence management responses, combined with the habitat replacement measures set out in the plan, will demonstrate the environmental justification for the project and set out what compensatory measures would be taken to ensure that overall the network of Natura 2000 and Ramsar sites in the area remained coherent.

3.2.9 Management of site boundaries

CHaMPs will need to include a procedure for adjusting the formally designated boundaries of the European sites making up the site complex. This is necessary to ensure that the provisions of the Directive are complied with, and that areas of recreated habitat receive legal protection against development and other man-made threats. Formal adjustment of boundaries to include areas of

recreated habitat will need to wait until the appropriate interest has developed. The plan will however need to set at the outset a 'Site Envelope' within which habitat replacement works are likely to be required during the lifetime of the plan. Local Authorities will need to be given a policy steer to integrate the management plan, and the implications for these 'Site Envelopes' in structure and local plans.

3.3. Mechanism for Saltmarsh Creation

The development of Saltmarsh vegetation can be seen within all of the estuaries where former flood defences have been abandoned. However, it cannot be guaranteed that saltmarsh would develop within any one particular area, particularly given the potential implications of sea-level rise. As such if realignment is viewed as a means of creating a specific quantity of saltmarsh, either to maintain overall site integrity or possibly to contribute towards biodiversity targets then detailed consideration will need to be given as to how this is achieved.. This would require engineering, timing and potentially modelling to ensure that the aims can be achieved and that the process itself does not have adverse effects eleswhere in the estuary system.

Currently, the MAFF Habitat Scheme pays landowners to undertake saltmarsh creation through the realignment of existing flood defences. This scheme is presently under review and it is likely that intertidal habitat creation rather than just the creation of saltmarsh habitat will be eligible for payment. Payment levels are being considered as part of the review. However, there has been criticism in the past that the scheme does not provide for the loss of the capital value of any land and that the overall payment levels are below that which agricultural production might achieve. There has therefore been a reluctance to enter into the scheme, as evidenced by the rate of uptake, particularly by landowners with agricultural rather than nature conservation interests. Further details of the scheme, once the review process has been completed, should be available from MAFF.

3.4 Recreation and Tourism

Tourism and recreation are now the main economic providers in the Suffolk Coast and Heaths area. The landscape of the estuaries and their recreational use is viewed as of critical importance in ensuring that the overall interest of the area to tourism is maintained. There are increasing demands on the area from this sector that have implications with regard to the flood defence strategies and several issues have been raised through consultation.

3.4.1 Public Rights of Way

This issue specifically relates to potential managed realignment and do nothing options for flood compartments where existing rights of way are routed along the tops of flood defences or through areas likely to be affected by inundation. It is considered that the implementation of these options could lead to the loss of access to certain areas or changes to existing routes that currently provide aesthetic views or form part of the Suffolk Coast and Heaths long distance footpath. There are legal obligations against damage to or loss of public rights of way. In most instances the loss of part of a footpath would not affect the ability to utilise the existing network to obtain access to the estuaries or as through routes to other sections of the coastline. However, there would be a reduction in the overall extent of available rights of way and changes in the accessibility to particular areas e.g. Aldeburgh Marshes. The legislation with regard to public rights of way is complex, but essentially, and with reference to the proposed Estuarine Strategies, the issue of loss or need for diversion can be addressed through existing legislation.

By virtue of Section 130(1) of the Highways Act 1980, county councils have a duty, as highway authorities, to assert and protect the rights of the public to use and enjoy those public rights of way for

which they are responsible. This applies to the vast majority of the footpath network apart from those that are privately maintainable. The Highway Authorities also have a similar duty to prevent, as far as possible, the stopping-up or obstruction of those public rights of way for which they are responsible and to safeguard public enjoyment of those highways for which they are not responsible.

The Town and Country Planning Act 1990 enables local planning authorities to make orders to stop up or divert footpaths to enable either development for which planning permission has been granted or development by a government department to be carried out. In the case of the loss of a footpath due to the implementation of a managed realignment scheme it is likely that planning permission would be required and therefore issues related to footpath diversion or stopping-up would fall to the local authority. In addition to enabling a footpath or bridleway to be diverted along another route the Act also enables orders to include provision for the creation of an alternative highway, or the improvement of an existing one, for use as a replacement for one being stopped up or diverted. Where the diversion or alternative right of way is proposed to be provided and dedicated over land not owned by the developer, the consent of the landowner(s) to the proposed dedication should be obtained before an order is made.

Section 26 of the Highways Act 1980 empowers local authorities to make orders for the creation of footpaths and bridleways if it appears to them that there is a need for such facilities in their area. Under the same Act it is also possible for a local authority to make orders to extinguish footpaths and bridleways or divert routes in the interest of the public. The diversion or creation of a right of way may require consent from other statutory undertakers. Consultation with these organisations and the general public is therefore viewed as an integral and important part of the process.

Based on this information the following points can be made with relation to the Strategies:

- Implementation of the proposed policies contained within the Strategies requires further and detailed consideration including assessment of how rights of way may be potentially affected. The local authority, Environment Agency, landowner(s) and general public will need to be closely involved in the assessment of rights of way issues and the required decision making process.
- Where a Do Nothing option is proposed that could result in the loss of part of a right of way the local authority has powers to create a new footpath or enhance part of the existing network to replace the loss. Consent from other statutory bodies may be required as could compensation for any loss of interest in the land affected by diversion or creation of a path.
- Under a re-alignment option where planning permission was required the diversion or stopping-up of a footpath would be a material consideration as part of the planning process. Through this process it may be determined that a replacement footpath or diversion is required and the gaining of orders to undertake this would have to be considered as part of the overall scheme.
- Where defences are set back on a new line then the new defences could provide the route for a new right of way.

3.4.2 Navigation

The maintenance of navigable channels for boating activity within all three estuaries, but in particular the Alde-Ore and Deben is a key issue. One area of concern is that through policies of realignment and/or do nothing the tidal volume and current velocities within the estuaries will increase to the extent that moorings and navigation will be adversely affected. For all three estuaries, implementation of the Strategies would lead to an increase in tidal volume. However, it is considered that this increase could be accommodated within the estuaries without adverse impacts on boating and navigation interests. **The increase in tidal volume due to realignment or do nothing policies has to be viewed in relation to potential volume increase due to sea-level rise**. Within the existing estuary form an increase in tidal volume due to sea-level rise would result in increased current

velocities in some sections of the estuaries with potential adverse impact on navigation and boating activity. However, realignment may actually enable any increase in velocities due to sea-level rise to be offset through an increase in the tidal cross section of the estuary. This would be most apparent at existing pressure points within an estuary e.g. the neck of the Alde just upstream of Aldeburgh Marshes.

Siltation within the upper estuaries, notably the Deben and parts of the Alde-Ore may well be a function of response to sea-level rise. While it is unlikely that the defence policies put forward in the strategies would alleviate this natural response, it is not considered that implementation of the Strategies would contribute further to this problem.

3.4.3 Landscape and Aesthetics

Whilst not a central driver behind the production of the Strategies, it is clear, given the location of all three estuaries within an Area of Outstanding Natural Beauty, that maintaining the aesthetic qualities of the estuarine landscape is an important issue. This is particularly so in relation to the role that the estuaries and the general coastal landscape have in attracting visitors and tourists to the area.

The flood defence strategies if implemented as presented would lead to change within the estuaries. Inundation of some areas of land that are currently in agricultural production or former flood plain grazing marsh would lead to the creation of areas of intertidal habitat. Some of these would be created through a do nothing option and would therefore not require any additional construction works to be undertaken. Re-alignment would probably involve the construction of new defences, which could be viewed as having an impact on the landscape. However, as they would invariably be replacing existing structures this is not considered to represent a significant issue at the strategic level. In addition, the creation of additional intertidal areas by realignment could offset the potential loss of saltmarsh habitat through coastal squeeze. There may also be a requirement, through the Habitats Directive to create additional areas of freshwater grazing marsh to replace any areas lost through realignment. Without these proposed measures there could be a general degradation in the overall quality of the estuarine landscape through the loss of significant amounts of saltmarsh vegetation. Taking into account these habitat creation opportunities, it is considered that implementation of the proposed policies would maintain the overall character and balance of the existing estuarine and coastal landscape.

4. ECONOMIC ISSUES

4.1 Introduction

The aim of the Suffolk Estuarine Strategies is to provide a long term strategy for the management of flood defences within the estuaries of the Rivers Blyth, Alde/Ore and Deben. Inherent to this is the need to examine the potential economic benefits from and costs of defence for a number of different scenarios. The economic assessments for the estuaries has been carried out in accordance with MAFF's Project Appraisal Guidance Notes (PAGN). Some of the basic premises upon which the assessments have based are discussed below:

The normal approach to the initial comparison of options set out in PAGN is through their respective benefit cost ratios. This does not, however, reflect the fact that increased investment may result in substantially better benefits and hence the need to consider incremental benefit cost analysis (PAGN decision rule step III) especially when examining whole life strategies. Nor does the benefit cost ratio provide a simple means identifying the transfer of cost, which is fundamental in taking an integrated view of the estuary defences.

The approach, therefore, adopted is to compare options on the basis of their Net Present Value (NPV). This is both a measure of incremental benefit and highlights the deficit or overall economic benefit which may be derived from a specific approach to defence. For each option considered, the NPV is a measure of either the economic advantage or disadvantage in adopting that option compared to a Do Nothing approach.

The calculation of the NPV for each option is:

$$NPV = PV_{(damage\ avoided)} - [\ PV_{(capital\ costs)} + PV_{(maintenance\ costs)} + PV_{(residual\ damage\ caused)}]$$

For a scheme to be economically viable, the NPV must be greater than zero.

The decision to abandon, or hold, a defence in one area may result in additional cost or damage elsewhere. This may be due to an increase or redirection of the flow, more rapid erosion, and the need to install more costly forms of protection or the need to extend the defended length. Equally, it may create an opportunity for, or cause the loss of, habitat or use, which may detract from, or add, to the value of the estuary as a whole. Underlying the strategic analysis of the estuary is the need to add together these costs, benefits and other impacts across the whole area of the estuary. The mechanism that has been set up enables this process of transfer to be assessed.

4.2 Asset Evaluation

The assets generally comprise the inherent value of the land within the flood plain, specific assets such as individual properties and, in some cases, the added economic value of land supported by irrigation using freshwater supplies within the flood zone. A detailed identification of assets has been undertaken on a field by field basis. However, average values have been used in attributing value.

Agricultural land within the flood compartment:

This category considers land that has being identified as lying within the estuary's flood plain. It includes land which is, or may potentially in the future be, used for agricultural production. The value of the land is assessed in accordance with PAGN Annex G. PAGN identifies three categories of land, the first of which (Scenario I) considers agricultural land that will be permanently under water, or sufficiently affected so as to prevent any future agricultural production. Such would be the case in the flood plains of the Suffolk Estuaries. In this scenario, the prevailing market price of the land is taken and multiplied by a factor of 0.4, to indicate the value of the land to the nation.

For the Suffolk estuaries, a market value of £8,065 per hectare was ascertained from Nix's Farm Management Pocketbook (1999 edition). This value is towards the top of the acceptable range of values, and recognises the general high quality of land in the Suffolk area. This market value is then multiplied by a factor of 0.4 to give an adjusted value of £3225 per hectare.

Agricultural land remote from the flood compartment:

This category considers land that is influenced by flooding of the low-lying land in the flood compartments. Throughout the estuaries there are a large number of licences allowing the abstraction of water from specified points such as wells, boreholes, surface streams, for the purpose of irrigating the surrounding higher land. This irrigated highland typically produces a high crop output, and so must be considered in assessment of the economic assessment. Flooding of the lowland would result in the saline contamination of these abstraction points, and therefore greatly reduce the agricultural output from the highland.

Two possible methods of assessing the impacts of lowland flooding on the adjacent higher land, may be considered, depending on the degree of information available – based on either a proportion of lowland impacts, or gross margin of specific crops.

For an holistic strategic study such as the Suffolk Estuarine Strategies, detailed information on crop types, land quality and irrigation rates throughout the estuaries may not be obtainable on a wide scale. In this case, it is more practical to apply a factor to the cost of flood damage to the lowland which has been calculated in accordance with Scenario I of PAGN. Considering the great reliance which is placed on irrigation around the Suffolk estuaries, a multiplication factor of 2 was adjudged to be appropriate. This models a situation where gross margins achieved on the higher land may be double those in the flood plain, but the areas affected by individual abstraction points will not be as great as the areas of the flood plains. It also makes allowance of the fact that non-irrigated high land will not be lost but merely have a reduced gross margin imposed on it.

Properties and other structures:

Damage to properties due **frequent flooding or surrender** was based on typical property values obtained from local land valuers and landowners.

Table D.2 Valuation of Assets

Degree of flooding Asset	Frequent flooding OR surrender of land
Land	
Agricultural – direct flooding	£ 3,225 / Ha
Agricultural – contamination of abstraction point	£ 3,225 / Ha of adjacent flood compartment #
Forest, scrub or woodland	£ 3k / Ha
Residential or industrial	Up to £ 10k / Ha
Properties	
Residential or public	£ 96k / property
Industrial	£ 100k / property
Agricultural	£ 144k / property
Other	Varies

Note: # this assumes that the land irrigated by the low lying abstraction points is similar in area and gross margin productivity to the flood compartment containing the abstraction points

Using these evaluations an assessment of assets within each estuary was made, on a FC basis.

4.3 Defence Costs

In all cases, apart from the case of "Do Nothing", the cost of defence includes an element of maintenance and an element of reconstruction. Reconstruction may be required because maintenance has become too onerous, because the pressure on the defence is such that more substantial defences would be required or because the level of the defence will need to be raised to match sea level rise.

The derived costs are based on discussion with the Environment Agency's operational staff and upon recent works undertaken within the region. They are, however, necessarily averaged over a period of time for each defence length.

The cost of future works carried out on existing defences is largely dependant on the form of these defences. For the purposes of this assessment it is envisaged that, in most cases, defences will be replaced 'like with like' at the end of their residual life, unless changes in estuarine processes would make this impractical.

It is recognised that, in reality, entire lengths of defence are unlikely to be totally reconstructed or be the subject of minor repairs. A more realistic scenario at the end of a residual life will involve the building up or reinforcement of discrete lengths of the existing defence. Similarly, maintenance is more likely to occur at different discrete locations each year. For the purposes of this study, however, both of these costs can be equated to values per metre run of defence.

For the majority of the Suffolk Estuaries the primary flood defence consists of earth embankments. There are also short lengths of blockwork, concrete wall and sheet piling throughout the estuaries. Standard costs have therefore been developed for each of these types of construction, based on typical values taken from a number of recent projects and schemes of a similar nature.

It is recognised that variations to the cost of defence re-construction and maintenance may also occur, depending on the forces against which such a structure must be designed. Reducing the pressure on an embankment will result in less onerous design requirements on future works, allowing a relative reduction in capital costs. Similarly, an increase in pressure will necessitate higher capital costs. A range of costs for specific structures has been determined. The costs calculated are summarised in Table D.3:

Table D.3 Typical Defence Re-construction and Maintenance Costs

	Re-construction		Maintenance	
Defence Type	Standard Costs (£ per m run)	Range of Costs	Standard Costs (£ per m run)	Range of Costs
Earth embankment	500	300 – 900	10	5 – 20
Concrete wall	1000	-	10	-
Sheet pile wall	900	-	10	-

4.4 Application Of Costs

The costs of damage to assets and of rebuilding defences are generally incurred as a single sum at the end of the residual life of the defence. Maintenance costs will occur throughout the life of the defence – both existing and future – as long as an option of Do Nothing has not been adopted.

Damages with a scheme are always related to the damages which would occur for the Do Nothing case, and so the cost of a defence scheme may be compared with the value of damages avoided.

For the purposes this assessment, it is assumed that currently active farmland will only become unworkable, and currently occupied properties will only become uninhabitable at the end of the residual life. Damage occurring before this time is deemed to be temporary. "Do Nothing" damages may, therefore, consist of a series of discounted single sums representing loss of, or damage to, land, crops or property.

4.5 Sensitivity

The economic assessments in the strategy reports represent a "best estimate" of the costs and benefits throughout the estuary. It is, however, recognised that there are a number of potentially significant factors within the calculations which could influence the outcome of the assessment. It is therefore necessary to carry out sensitivity studies on some of the main components of the assessment, as follows:

- Agricultural value
- Irrigation value
- Defence costs

Individual option and cost estimate "sensitivities", and hence overall strategy assumptions, were requested by several of the major stakeholders and their representatives as part of the consultation feedback. The following observations address these requirements:

4.5.1 Sensitivity to Agricultural value

These are considered to be robust. Values are taken from Nix's Farm Management Pocketbook (1999 edition), which is a well used source of information. The range of values obtained from Nix is not dependent on land quality or grading. However, use of the higher values within it reflect the high quality of the Suffolk land. Values used in the assessment, before adjustments in accordance with PAGN, correspond well with values obtained from landowners around the estuaries during the consultation period.

4.5.2 Sensitivity to Irrigation value

The calculation of the value of irrigated land at a strategic level considered a broad approach , applying a multiplication factor of 2 to the value of land within the flood plain. If more detailed information is available, it is possible to develop this assessment. With data obtained during the consultation period, a sensitivity analysis may be carried out.

A review of abstraction licences, crop production and irrigation requirements around the Suffolk estuaries allows the development of a more detailed assessment procedure. **An average value for the gross margin of a unit volume of abstracted water for irrigation may be assigned to all abstraction points throughout the estuaries.**

For such a detailed study at a local level, PAGN identifies a category of land (Scenario III) in which agricultural output falls, as would be the case in the contamination of irrigation sources. In such a case it is necessary to calculate the difference in gross margins before contamination and after. This net margin is then multiplied by a factor of between 0.1 and 0.35 depending on the type of commodity being produced. The production of cereals and vegetables has an associated factor of 0.1. This factor

allows for the fact that the land in question is not lost as is the case in PAGN's Scenario I. Instead, the use of the land will be changed. It also recognises the fact that repositioning of the abstraction point may be possible.

For the Suffolk estuaries, a number of crops were investigated in terms of their gross margin (obtained from Nix Farm Management Pocketbook 1999 edition) and their irrigation requirements (obtained from the Environment Agency). The location and permitted volumes of licensed abstraction points was then used to determine the area of land, and therefore the gross margin it produces, which is affected by each abstraction point. From this calculation, gross margins per unit volume of abstracted water ranging from £0.43 (carrots) to £3.93 (early potatoes) per m3 per year were arrived at, and an average gross margin of £0.96/Ha/year carried forward. A multiplier of 0.1 was applied to the average, to arrive at an adjusted gross margin of £0.096/Ha/year. For assessment purposes it was conservatively assumed that no gross margin would be achieved once irrigation has been contaminated.

Loss of output due to contamination of irrigation sources will only occur after the defences currently defending the lowland fails. The majority of flood defences throughout the estuaries have a residual life of over ten years. The average loss of £0.096/Ha/year may therefore be applied annually between years 10 and 50 of the strategy life. Using Treasury discount rates at 6% interest, this gives a discount factor of 8.4. The final adjusted gross margin was therefore taken as £0.80/Ha/year. Taking the highest irrigation value of £3.93 for early potatoes, the final adjusted gross margin would be £3.30/Ha/year. It can be seen, therefore, that a detailed knowledge of farming practices in the area is essential if this approach is to be used.

A sensitivity study, comparing the strategic and the detailed approaches for the three Suffolk estuaries produces the following results:

If the highest value of the range is taken, then net present values will be increased. However, applying the higher value throughout each estuary gives a similar relationship between the various strategy options, as demonstrated in the table below:

Sensitivity of Net Present Values of Strategy Options to Irrigation Rates

Estuary	Irrigation Assessment	Net Present Value of Strategy Options					
		S1	S2	S3	S4	S5	S6
Blyth	Strategic	0	3,011	**3,444**	3,352		
	Detailed (average)	0	2,233	**2,267**	2,161		
	Detailed (max)	0	2,642	**2,784**	2,678		
Alde/Ore	Strategic	0	6,939	9,356	10,412	**10,701**	10,368
	Detailed (average)	0	3,365	5,815	7,341	**7,630**	7,225
	Detailed (max)	0	6,486	8,794	10,083	**10,372**	10,101
Deben	Strategic	0	7,008	8,052	**8,181**		
	Detailed (average)	0	5,643	6,721	**7,031**		
	Detailed (max)	0	9,234	10,079	**10,381**		

Notes: All NPVs in £1,000s
Preferred strategy (in economic terms) shown **in bold**

From the above table it can be seen that, although the net present value varies in the detailed assessments, the relationship between strategy options remains the same. **This indicates that, whilst, the strategies must make allowance for irrigation value, they are not solely dependent on irrigation for their justification.**

4.5.3 Sensitivity to Defence Costs

The cost of maintaining and replacing defences throughout the estuaries has been based on a standard cost per unit length (related to the nature and location of the defence) derived from previous experience and discussions with the Environment Agency. These basic costs for particular defence types have then been adjusted to model changes in physical conditions and erosional forces throughout the estuaries. It is recognised that these costs are estimated only, and indeed one of the findings of the strategies has been that detailed records of defence costs are required if the strategies are to be used to their full potential

The economic assessment of strategy options is carried out on a zone-by-zone basis. Various options are then carried forward for combination with options in subsequent zones. There is therefore a possibility that variations in defence costs could change the preferred option for a specific zone, and thereby radically change the subsequent development of the estuary-wide strategy.

This potential impact on the overall strategy may be illustrated by considering the Blyth estuary:

- The strategic assessment concludes that holding the existing defences upstream of the A12 (Zone 1) is not economically viable. This immediately influences the directions of the strategy development. The possibility of abandoning the zone 1 defences must be considered when assessing the costs and economic viability of defence in the rest of the estuary. If, however, holding the existing defences in zone 1 was made economically viable – due to a reduction in defence costs – then their abandonment need be considered no further.

- The strategic assessment also concludes that construction of a barrage at the A12 is only marginally unjustified considering zone 1 in isolation, and in fact becomes justifiable when considering the estuary as a whole. If, however, the cost of defence increase dramatically then the option of a barrage may not be justifiable, even when considering the estuary as a whole. In this case, the only option for zone 1 that would be carried forward would be that of Do Nothing. Further down the estuary this would significantly reduce the viability of holding the line, regardless of local variations in defence costs within industrial zones.

The sensitivity of defence costs has therefore been assessed separately for each estuary, with the **key zones being considered on an individual basis, before the overall strategy options are compared**. For this exercise, variations in defence costs of +20% and –20% have been considered.

Blyth Estuary:

Zone 1

The strategic assessment highlighted that it is not economically viable to hold the existing defences when considering the zone in isolation (option 2). This is still the case if defence costs are increased or reduced. The alternative of constructing a tidal barrier at the A12 road bridge (Option 7) would, however, become viable if costs were reduced. This option is, however, sensitive to variations in cost. In strategic terms, the main sensitivity, however, is whether the benefits of minimising the increase of tidal volume on other areas of the estuary are still sufficient to warrant the defence of Zone 1 through the construction of a tidal barrier. The following table shows the variation in NPV for each option for Zone 1 discussed in the strategy report:

Zone 1 Defence Costs	Net Present Value of Zone Options						
	1	2	3	4	5	6	7
Strategic	0	-747	110	92	252	353	-146
Reduced 20%	*0*	*-199*	*161*	*205*	*309*	*438*	*282*
Increased 20%	0	-1,295	59	-21	195	268	-574

Notes: All NPVs in £1,000s

Zone 3N

The strategic economic assessment concluded that holding the line along the whole of the Zone 3N frontage (Reydon Marshes) is fundamentally sustainable. It is, however, sensitive to the management options adopted in Zones 1 and 3S (Tinkers Marsh). This is extended to the point where, by abandoning Zone 1 and holding Tinkers Marsh, then the continued defence of Reydon Marshes is no longer economically justifiable. The sensitivity study shows a similar pattern of option outcomes, regardless of variations in defence costs. Therefore there is no fundamental change in the zone options taken forward in developing the strategy options. The following table shows the variation in NPV for each option for Zone 3N discussed in the strategy report:

Zone 3N Defence Costs	Net Present Value of Zone Options							
	1	2	3	4	5	6	7	8
Strategic	0	160	252	-109	-302	-109	185	309
Reduced 20%	*0*	*182*	*425*	*136*	*-38*	*-11*	*382*	*482*
Increased 20%	0	138	79	-354	-566	-207	-12	136

Notes: All NPVs in £1,000s

Zone 3S

The strategic assessment identified that there is no justification, in economic terms, for holding the defences at Tinkers Marsh. This is still the case, even allowing for variations in defence costs. As with Zone 3N, there is therfore no fundamental change in the zone options taken forward in developing the strategy options. The following table shows the variation in NPV for each option for Zone 3S discussed in the strategy report:

Zone 3S Defence Costs	Net Present Value of Zone Options						
	1	2	3	4	5	6	7
Strategic	0	-331	-180	37	-110	-106	-55
Reduced 20%	*0*	*-185*	*-64*	*61*	*-47*	*-47*	*-3*
Increased 20%	0	-477	-296	13	-173	-173	-107

Notes: All NPVs in £1,000s

Zone 4S

The strategic assessment of Zone 4S concluded that, on economic grounds, the preferred solution was to retreat the line of defence at Robinsons Marsh. Varying the cost of defence does not change this preference for retreat, although if costs were to be less then there would be an economic argument for holding defences to minimise other social impacts – albeit reduced compared to that for the retreat option. The following table shows the variation in NPV for each option for Zone 4S discussed in the strategy report:

Zone 4S Defence Costs	Net Present Value of Zone Options							
	1	2	3	4	5	6	7	8
Strategic	0	75	2	126	-185	2	233	380
Reduced 20%	*0*	*75*	*133*	*242*	*-27*	*133*	*284*	*413*
Increased 20%	0	75	-129	10	-343	-129	183	347

Notes: All NPVs in £1,000s

Overall Estuary Strategy

From this study of the sensitivity of the individual zones, it is apparent that variations in defence costs do not change the component elements of each strategy option. The four Strategy Options identified in the strategy therefore remain applicable. The variation of defence costs throughout the whole estuary, as illustrated below, has no effect on the selection of preferred the Strategy Option, or on the ranking of the remaining options. The following table shows the variation in NPV for each Strategy Option for the Blyth discussed in the strategy report:

Sensitivity of Net Present Values of Strategy Options to Defence Costs

Blyth Estuary	Net Present Value of Strategy Options			
Defence Costs	S1	S2	S3	S4
Strategic	0	3,011	**3,444**	3,352
Reduced 20%	*0*	*3,531*	*4,296*	*4,233*
Increased 20%	0	2,491	**2,592**	2,473

Notes: All NPVs in £1,000s
Preferred strategy (in economic terms) shown **in bold**

Alde/Ore Estuary

Zones 1 and 2 have relatively little influence on the rest of the estuary, in terms of physical processes and changes thereto. The estuary may therefore be considered to be independent to variations in defence costs in these zones.

Zone 3

The strategic assessment identified that, at the zone level, the preferred economic option for Zone 3 is to hold the line at High Street (FC10b), and retreat at Aldeburgh Marshes and the northern tip of Sudbourne Marshes (FC16 and FC8a respectively), shown by Option 5. There is an overwhelming economic benefit in doing this compared to holding all the defences in the zone, amounting to some £1,449,000 (Option 5 compared with 2). The sensitivity study confirms that a similar situation exists if defence costs are varied, with an NPV differential of between £1,074,000 if defence costs are less, and £1,802,000 if defence costs are more. Similarly, the strategic assessment indicated that there is a benefit of £654,000 in retreating at Aldeburgh Marshes whilst holding High Street and retreating Sudbourne (Option 5 compared with 3). This remains the case in the sensitivity study, with the NPV differential ranging between £453,000 to £833,000. Thus the fundamental impracticality and unsustainability of continuing to defend Aldeburgh Marshes is clearly shown to be robust. The following table shows the variation in NPV for each option for Zone 3 discussed in the strategy report:

Zone 3	Net Present Value of Zone Options				
Defence Costs	1	2	3	4	5
Strategic	0	-481	314	817	968
Reduced 20%	*0*	*215*	*836*	*1,177*	*1,300*
Increased 20%	0	-1,177	-208	457	636

Notes: All NPVs in £1,000s

Zone 4

The strategic assessment concluded that, solely considering the impacts within Zone 4, economic benefits are maximised by either retreating or merely delaying the abandonment of King's and Lantern Marshes (FCs 6 and 7), shown in Options 10 and 11. It was observed, however, that the exact manner and timing of what is effectively managed retreat is sensitive to standards of protection required to control the retreat process. This clearly affects defence costs. The sensitivity study confirms that it is only economically justifiable to hold the west bank of this zone, along Sudbourne Marshes and the Orford frontage, regardless of variations in defence costs. The following table shows the variation in NPV for each option for Zone 4 discussed in the strategy report:

Zone 4	Net Present Value of Zone Options							
Defence Costs	1	2	3	4	5	6	7	8
Strategic	0	2,714	2,523	2,321	2,865	2,388	2,369	2,736
Reduced 20%	*0*	*3,792*	*3,639*	*3,478*	*3,835*	*3,454*	*3,498*	*3,750*
Increased 20%	0	1,636	1,407	1,164	1,895	1,322	1,240	1,722

Zone 4 Defence Costs	Net Present Value of Zone Options			
	9	10	11	12
Strategic	2,712	2,891	2,958	2,569
Reduced 20%	*3,561*	*3,839*	*3,816*	*3,652*
Increased 20%	1,863	1,943	2,100	1,486

Notes: All NPVs in £1,000s

Zone 6

The strategic assessment identified that, although the continued defence of Gedgrave Marshes is fundamentally justifiable on economic grounds, that the probability is that Boyton Marshes is not. The sensitivity study demonstrates that, should costs be reduced, the case for retreating Boyton is weakened but not overturned. Under the strategy values, and taking into account the additional defence to Zones 5 and 7, the NPV deficit of defending Boyton is in the order of £300,000. If defence costs were less, then this deficit would be in the order of £80,000. Conversely, increased defence costs would increase the deficit to some £500,000. The analysis, therefore, demonstrates the robustness of the economics at a strategic level, but highlights the need for local consideration prior to implementing strategy recommendations. The following table shows the variation in NPV for each option for Zone 6 discussed in the strategy report:

Zone 6 Defence Costs	Net Present Value of Zone Options							
	1	2	3	4	5	6	7	8
Strategic	0	-2,175	-133	344	204	204	64	-168
Reduced 20%	*0*	*-1,081*	*538*	*764*	*652*	*652*	*539*	*354*
Increased 20%	0	-3,269	-804	-75	-243	-243	-412	-689

Notes: All NPVs in £1,000s

Overall Estuary Strategy

From this study of the sensitivity of the individual zones, it is apparent that variations in defence costs do not change the component elements of each strategy option. The six Strategy Options identified in the strategy therefore remain applicable. The variation of defence costs throughout the whole estuary, as illustrated below, has no effect on the selection of preferred the Strategy Option, or on the ranking of the remaining options. The following table shows the variation in NPV for each Strategy Option for the Alde/Ore discussed in the strategy report:

Sensitivity of Net Present Values of Strategy Options to Defence Costs

Alde/Ore Estuary Defence Costs	Net Present Value of Strategy Options					
	S1	S2	S3	S4	S5	S6
Strategic	0	6,939	9,356	10,412	**10,701**	10,368
Reduced 20%	0	10,690	12,592	13,088	**13,296**	13,021
Increased 20%	0	3,188	6,119	7,735	**8,105**	7,715

Notes: All NPVs in £1,000s
Preferred strategy (in economic terms) shown in bold

Deben Estuary

Zones 1 and 2 have relatively influence on the rest of the estuary, in terms of physical processes and changes thereto. The estuary may therefore be considered to be independent to variations in defence costs in these zones.

Zone 3

The strategic assessment concluded that, although it is economically viable to hold the line throughout the majority of the Lower Reaches (FCs 1,7, 8, 9, 10 and 11), the optimum solution is to hold the line along the east bank (Option 10) and retreat defences along Nursery Wood (FC10) on the west bank (Option 16). The sensitivity study indicates that if defence costs vary, there is still a massive

economic argument for holding the east bank. On the west bank a reduction in costs would reduce the burden imposed by defending Nursery Wood, with retreat still being marginally preferable (Option 16 compared to Option 14). It may be seen that even at the strategic level of examination, there is a degree of robustness in the economic argument. However, it also highlights the level of confidence within which the strategies are defined, and the consequent need for detailed appraisal prior to implementing the strategy recommendations. The following table shows the variation in NPV for each option for Zone 3 discussed in the strategy report:

Zone 3 Defence Costs	Net Present Value of Zone Options			
	9	10	11	12
Strategic	0	1,497	1,631	875
Reduced 20%	*0*	*1,758*	*1,865*	*1,054*
Increased 20%	0	1,236	1,397	696

Zone 3 Defence Costs	Net Present Value of Zone Options							
	13	14	15	16	17	18	19	20
Strategic	0	2,963	3,022	3,092	2,907	2,249	2,213	2,027
Reduced 20%	*0*	*3,402*	*3,449*	*3,427*	*3,299*	*2,516*	*2,487*	*2,453*
Increased 20%	0	2,524	2,595	2,757	2,514	1,982	1,939	1,689

Notes: All NPVs in £1,000s

Overall Estuary Strategy

From this study of the sensitivity of the individual zones, it is apparent that variations in defence costs do not change the component elements of each strategy option. The four Strategy Options identified in the strategy therefore remain applicable. The variation of defence costs throughout the whole estuary, as illustrated below, has no effect on the selection of preferred the Strategy Option, or on the ranking of the remaining options. The following table shows the variation in NPV for each Strategy Option for the Deben discussed in the strategy report:

Sensitivity of Net Present Values of Strategy Options to Defence Costs

Deben Estuary Defence Costs	Net Present Value of Strategy Options			
	S1	S2	S3	S4
Strategic	0	7,008	8,052	**8,181**
Reduced 20%	0	8,567	9,306	**9,331**
Increased 20%	0	5,449	6,798	**7,031**

Notes: All NPVs in £1,000s
Preferred strategy (in economic terms) shown in bold

4.5.4 Sensitivity to Maintenance Costs

The above section illustrates the robustness of the strategies in terms of sensitivity to variations in defence costs. A further facet of defence costs which must be reviewed is the degree of maintenance undertaken. The strategies have made an allowance for the progressive increase in the cost of maintaining all defences, and earth embankments in particular. A sensitivity analysis shows that, should the required maintenance effort be considerably less than expected in the Blyth estuary (taking a typical cost of £1 per metre per year instead of £10), the viability or order of preference of the strategy options is not significantly affected. On the Alde/Ore such a reduction would, on first inspection, strengthen the case for holding Aldeburgh marshes. However, this is clearly the most vulnerable and unsustainable length of defence in estuary, and so the likelihood of a reduction of maintenance costs along it is extremely low. On the Deben, a reduction in maintenance costs would increase the argument for holding Nursery Wood (FC10) to the extent that it is preferable to retreating these defences. This once again highlights the level of confidence within which the strategies are defined, and the consequent need for detailed appraisal prior to implementing the strategy recommendations.

Sensitivity of Net Present Values of Strategy Options to Maintenance Costs

Option	Defence Costs	Net Present Value of Strategy Options					
		S1	S2	S3	S4	S5	S6
Blyth	Strategic	0	3,011	**3,444**	3,352		
	Reduced	0	3,870	**4,291**	4,139		
Alde/Ore	Strategic	0	6,939	9,356	10,412	**10,701**	10,368
	Reduced	0	12,014	13,655	13,897	14,280	**14,312**
Deben	Strategic	0	7,008	8,052	**8,181**		
	Reduced	0	9,682	**10,385**	10,310		

Note: all NPVs in £1,000s
Preferred strategy (in economic terms) shown in **bold**

CONSULTATION DETAILS

Organisation	Contact	Consulted on				Written Response	Meeting Held
		Alde/Ore	Blyth	Deben	Exec Sum		
127 Hendslow Road, Ipswich	Mr R Davies	✔					
19 Lee Road, Aldeburgh	Mr D Andrews	✔					
27 Broadley Terrace, London	Sir Michael Hopkins	✔					
4 Nightingale Mews, Netley Abbey	Mrs V Fenwick	✔	✔	✔		✔	
4 Thellusson Lodge, Aldeburgh	Mr M Good	✔					
40 St Andrews Place, Melton	Mrs P Bond			✔			
52a Chelsea Park Gardens, London	Mrs F Herford	✔					
82 Seaton Road, Felixstowe	Mr Naulls			✔			
Alde & Ore Association	Nicholas Bushill	✔				✔	✔
Alde & Ore Wildfowlers Association	Mr P Litten	✔				✔	
Aldeburgh Gazzette	Mrs J McNeill				✔		
Aldeburgh Golf Club	Mr Simpson	✔				✔	
Aldeburgh Library	Mrs Wiseman	✔					
Aldeburgh Productions	Mr J Reekie	✔				✔	
Aldeburgh Town Council	Mr A Harris	✔				✔	
Aldeburgh Yacht Club	Mr Michael Steen	✔					
Aldeburgh Yacht Club	Mr V N Bromage						
Alderton Hollesley and Bawdsey IDB	Mr P Mann	✔		✔		✔	
Anglian Water plc		✔	✔	✔			
Anglian Wildfowler's Association	Mr A S A Judge			✔		✔	
Anglian Wildfowler's Association	Mr D W Algar						
Barker Gotlee	Mark Horvath	✔	✔	✔		✔	
Barker Gotlee	R E Barker					✔	
Bawdsey Haven Yacht Club	Mr N Rose			✔		✔	
Bawdsey Parish Council	Mr R F Hazell	✔		✔		✔	✔
Bawdsey Parish Council	Mrs A J I Mawford			✔		✔	
Bawdsey Quay	Mr P Wain			✔			
Bawdsey Quay Water Sports Centre	Ms Heather Patrick			✔			
Bell House, Orford	Mr Allen	✔					
Bidwells	Ruth Lamb			✔		✔	✔ ❹
Blois Farms	Sir Charles Blois		✔			✔	
Blyth Fishing Society	Mr Purdy				✔		
Blythburgh Parish Council	Mr G Newson		✔				
Boyton Hall Farms	Richard Pipe	✔				✔ ❶	❸
Boyton Parish Council	Mrs R Clarke	✔				✔	
British Ass^{n} for Shooting & Conservation	Helen Doe	✔	✔	✔			
British Canoe Union	C E Quaife				✔	✔	
Broadside Farms	Mr D Ball		✔				
Bromeswell Parish Council	Mrs Joan Richold			✔			
Butley Parish Council	Mrs M Allen	✔					
c/o County Highways Depot	Simon Hooton	✔	✔	✔			
Capel St Andrew Farm	Mrs Greenwell	✔				✔ ❶	❸
CEFAS	Dr S Lockwood				✔		
Chair Alde & Ore Users' Association	Alan Coombes						
Chillesford Lodge	Mr M Watson	✔				✔	
Chillesford Parish Meeting	Mr A J Massey	✔				✔	

Organisation	Contact	Consulted on				Written Response	Meeting Held
		Alde/Ore	Blyth	Deben	Exec Sum		
Church Farm	Mr D A Glossop			✔			
Country Landowners Association	Mr P Long	✔	✔	✔		✔	✔
Countryside Commission	Sarah Skinner	✔	✔	✔			
Crag Farm	Mrs Black	✔					
Crag Farm	Mr C M Rope	✔				✔	
Dairy Farm	Mr & Mrs Cole			✔		✔	
Deben Farms	Mr Douglas Inglis			✔		✔❶	❸
Deben Farms Estate Office	James Adeane Esq			✔		❶	❸
Decoy Farm	Mr D J Bye			✔			
Defence Estate Organisation	Mr A C Hawkins				✔		
Dunwich Parish Meeting	Mr Charles Barnett		✔			✔	✔
Dunwich Town Trust	Mr Michael Clark		✔			✔	✔
Durrants	Mr Rudge		✔				
East of England Tourist Board	Mr N Warren				✔	✔	
East Suffolk Water Ski Club		✔	✔	✔			
Eastern Electricity	Mr McCarthy	✔	✔	✔		✔	
Eastern Sea Fisheries Joint Committee	S C Amos Esq.	✔	✔	✔			
English Heritage	Ronni Bridgett	✔	✔	✔		✔	
English Nature	Helen Smith	✔	✔	✔			✔❷
English Nature	Nick Sibbett						
English Nature	Tim Collins	✔	✔	✔			
Environment Agency	Merle Leeds	✔	✔	✔			✔❹
Environment Agency	Mr P Marjoram		✔			✔	✔❷
Falkenham & Kirton Parish Council	Mr C A Shaw			✔		✔	
Felixstowe Ferry Boatyard	Mr R Dutton			✔			
Felixstowe Ferry Fairways Committee	Mr W J Barr			✔			
Felixstowe Ferry Preservation Society	Mrs A J Ratcliffe			✔		✔	
Felixstowe Ferry Sailing Club	Mr Guy Pearce			✔		✔	
Felixstowe Ferry Yacht Club	Mr G. M. Henderson			✔			
Felixstowe Society	Mrs B Reid			✔			
Felixstowe Town Council	Mrs S Robinson			✔			
Ferry Farm	Mr R B Skepper	✔				✔❶	✔❹
Fir Tree Farm	Mr P Waring			✔			❶
Fisheries Office	Nr Neil Welham	✔	✔	✔			
FRCA	Mr Alan Bullivant	✔	✔	✔			
FRCA	Tim Sloane	✔	✔	✔			
Friston Parish Council	C D Edwards JP	✔					
Frostenden, Eccles	Mr J N Holmes				✔		
GH and JP Paul	Mr Michael Paul			✔		❶	❸
Granary Yacht Harbour and Leisure Centre Ltd				✔			
Great Glemham House	The Countess of Cranbrook				✔		
Green Lane House	Mr Flint	✔				✔	
Hall Farm	Mr Andrew Haiste	✔					
Harwich Area Sailing Association	Mr L P Catton				✔		
Hasketon Grange	Mr Cambridge				✔		
Hemley Parish Meeting	Mr P D H Bowden-Smith			✔			
Hill Farm	Mr J A Symes			✔			

Organisation	Contact	Consulted on				Written Response	Meeting Held
		Alde/Ore	Blyth	Deben	Exec Sum		
Hill Farm	Mr N G Mayhew			✔		✔	
Hill Farm	Mr R W Mann	✔				❶	❸
Hollesley Bay Colony	Mr J Forster			✔			
Hollesley Parish Council	Mrs K Davies	✔				✔	
Horsey Island, Essex	Mr J L Backhouse	✔					
House of Commons	The Rt Hon John Gummer MP	✔	✔	✔			❹
Iken Parish Council	Mrs L Lloyd	✔				✔	
Iken Parish Council	P N R Cooke	✔					❸
Ipswich	Mr Davis	✔					
Jesters, Woodbridge	Mrs Healey			✔			
Kings Fleet	Mr Frank Brown		✔	✔		✔	
Knoll Fairways Committee				✔			
Kyson Fairways Committee	Mrs S Maystom			✔			
Lime Kiln Farm	Exors G Stammers Decd		✔				
Little Haugh	Mr I Hooper			✔		✔	
Long Reach	Mr T Wilkinson	✔				✔	
Long Reach, Aldeburgh	Mr Wilkinson	✔					
Low Farm, Bromeswell	Mr James Foskett			✔			
Lower / Middle Alde & Lower Deben IDB's	Ian Hart	✔		✔		✔	✔
Marine Estates	Tauhid Rahman	✔	✔	✔	✔		
Marine Estates	Mr N Jacobson				✔		
Marsh Hill	Col Besly						❸
Martlesham Parish Council	Mrs Lynne Lodge			✔		✔	
Melton Lodge Farm House	Mr P W Warburg			✔		✔	
Melton Parish Council	Mr T C D Brown			✔		✔	
Mils and Reeve	Mr T Brainbridge		✔	✔			
Ministry of Agriculture, Fisheries and Food	Dr Lindsey Murray	✔	✔	✔			
Ministry of Agriculture, Fisheries and Food	Geoff Bowles	✔	✔	✔			
Ministry of Agriculture, Fisheries and Food	Mr David Collins	✔	✔	✔			
Ministry of Agriculture, Fisheries and Food	Mr G Sexton	✔	✔	✔			
Mssrs R Desborough & Sons	Sirs		✔				
National Farmers Union	Mr J A Hodge	✔	✔	✔			✔
National Farmers Union (East Anglian Region)	Paul Hammett	✔	✔	✔			✔
National Monuments Record Centre	Mr B Ferrari				✔		
National Trust	Mr K Turner	✔		✔		✔	
Naunton Hall	Sir Michael Bunbury				✔		
New Oak Tree Farm	Mr D E Parken			✔			
Newbourne Parish Council	Mr Joe Finch			✔			
Norfolk & Suffolk LFDC	Mr Ben Steward	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr David Price	✔	✔	✔		✔	❷
Norfolk & Suffolk LFDC	Mr Ian Battey	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr Richard Rockcliffe	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr David Adams	✔	✔	✔		✔	✔❷
Norfolk & Suffolk LFDC	Mr David Bracey	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr David Papworth	✔	✔	✔		✔	❷
Norfolk & Suffolk LFDC	Mr Graham Gouldby	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr Henry Cator	✔	✔	✔		✔	❷

Organisation	Contact	Consulted on				Written Response	Meeting Held
		Alde/Ore	Blyth	Deben	Exec Sum		
Norfolk & Suffolk LFDC	Mr James Stansfield OBE	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr John Sheppard	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr Neville Chapman	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr Peter Baldwin	✔	✔	✔			❷
Norfolk & Suffolk LFDC	Mr Peter Monk	✔	✔	✔			✔❷
Norfolk & Suffolk LFDC	Sir Edward Greenwell	✔	✔	✔			✔❷
Old Rookery House	Capt R Sheepshanks CBE DL				✔		
Old School Farm	Mr Hayward	✔		✔			
Orford & Gedgrave Parish Council	Mr S Caley	✔				✔	
Orford Town Trust	Mr R Roberts	✔					
Orwell Settlement Trustees	R. A Gosling			✔			
P Adams & Sons (Farms) Ltd	D C Adams			✔		✔	
Plunketts Farms	Mrs V French	✔					
Potash Farm	Mr H J Chapman				✔		
Ramsholt Fairways Committee	Mrs P R Doran			✔			
Ramshot Parish Meeting	Mr & Mrs R Simper			✔		✔	✔
River Blyth & Southwold Harbour Users Assⁿ			✔				
River Deben (Lower) IDB	K A Buckley Edq.			✔		✔	
River Deben Association	Mr A H Mason				✔		
River Deben Association	Mr Denzil Cowdry			✔			✔
Round Hill, Aldeburgh	Mr Wheeler	✔				❶	✔❶
Royal Yachting Association	Mr F Power	✔					
RSBP	John Sharpe	✔	✔	✔			✔❷
Shingle Street Association	Mr D Williams	✔				✔	
Shottisham Parish Council	Mrs C Bax			✔			
Simper Agricultural	Mr J. R Simper			✔		❶	❸
Sluice Farm	Messrs Johnson			✔			
Smear Farm Ltd			✔				
Snape Parish Council	Mrs Melanie Thurston	✔					
Snape, Saxmunden	Mr Jonathan Gooderham	✔					
Sole Bay Cottage	Mr Shurman		✔				
Southwold Town Council	Mrs J L Hursell		✔			✔	✔
Spring Farm	Mr G H Steele			✔			
Strutt and Parker	Mr Fiddes	✔					
Sudbourne Parish Council	Mr H J Nash			✔			
Sudbourne Parish Council	Mr Parker	✔				✔	
Suffolk Coastal District Council	Mr J Schofield	✔	✔	✔		✔	
Suffolk Coastal District Council	Mr R Stoddard	✔	✔	✔			✔
Suffolk County Council	Mr Don Ayre	✔	✔	✔			
Suffolk County Council	Mr J T Hindle	✔	✔	✔			
Suffolk Preservation Society	R Whittaker	✔	✔	✔			
Suffolk River Valleys ESA	Tim Sloane						✔
Suffolk Underwater Studies Group	Mr Stuart Bacon				✔		
Suffolk Wildlife Trust	Julian Roughton	✔	✔	✔			
Sutton Hall Farms	Mr Guy Quilter			✔		✔❶	✔❶
Sutton Parish Council	Mrs J R King			✔			✔
The Aldeburgh Society	Mrs P Vernon				✔	✔	

Organisation	Contact	Consulted on				Written Response	Meeting Held
		Alde/Ore	Blyth	Deben	Exec Sum		
The Bungalow, Sutton Hoo	K Drury			✔			
The Cloisters	Mrs Alderson	✔					
The Ramblers Association	Anne Moore				✔	✔	
The Woodbridge Society	Mrs P Austin-Brown			✔			
Valley Farm	Mr T Darby						❸
Walberswick	Mrs Edwards		✔				
Walberswick Common Lands Charity Trust	Mrs Priestman		✔		✔	✔	✔
Walberswick Parish Council	Mrs Vivien J Hunt		✔			✔	
Waldringfield Fairways Committee	Mr F A Brown			✔			
Waldringfield Parish Council	Miss Jackie Townley			✔		✔	✔
Waldringfield Parish Council	Mr Mace			✔		✔	✔
Water Mill Farm	J E B Hill		✔			✔	✔
Waveney District Council	Mr R Bell		✔				
Waveney District Council	Mr J Walker		✔		✔		
Woodbridge Cruising Club	R.A.S. Sampson	✔		✔		✔	
Woodbridge Town Council	Mrs C B Walker			✔			

Key: ❶ Contributed to a joint response with other consultees
❷ Consulted as a Steering Group Committee or Local Flood Defence Committee member
❸ To be represented in a meeting
❹ Meeting to be arranged

REFERENCES

ABP Research & Consultancy, 1996, *Suffolk Estuaries Estuarine Process Assessment – Blyth Estuary Strategy*

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Ministry of Agriculture, Fisheries and Food, 1993, *Project Appraisal Guidance Note*

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Suffolk Coastal District Council / Waveney District Council / Environment Agency, 1998, *Shoreline Management Plan for Sediment Sub-cell 3C – Lowestoft to Harwich*

LIST OF ABBREVIATIONS

AGHV	Area of Great Historic Value
AGLV	Area of Great Landscape Value
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
BGS	British Geological Society
CCA	Coastal Conservation Areas
CEWP	Classification of Estuaries Working Party
CMP	Catchment Management Plan
CPA	Coastal Protection Area
CWS	County Wildlife Site
cSAC	Candidate Special Area of Conservation
DDN	Delay Do Nothing
DN	Do Nothing
EA	Environment Agency
EC	European Community
EMP	Estuary Management Plan
EN	English Nature
ESA	Environmentally Sensitive Area
EU	European Union
FC	Flood Compartment
FCDD	Flood and Coastal Defence Division of MAFF
FEPA	Food and Environment Protection Act (1985)
GCR	Geological Conservation Review
GDO	General Development Order
HMIP	Her Majesty's Inspectorate of Pollution
HR	HR (Hydraulics Research) Wallingford
HTL	Hold The Line
IPCC	Intergovernmental Panel on Climate Change
LEAP	Local Environment Agency Plan
LNR	Local Nature Reserve
MAFF	Ministry of Agriculture, Fisheries and Food
MNR	Marine Nature Reserve
NCC	Nature Conservancy Council
NCZ	Nature Conservation Zone
NPV	Net Present Value
NNR	National Nature Reserve
NT	National Trust
NRA	National Rivers Authority
OD	Ordnance Datum
PAGN	Project Appraisal Guidance Notes
POL	Proudman Oceanographic Laboratory
PPG	Planning Policy Guidance
pSAC	Possible Special Area of Conservation
PV	Present Value
RNLI	Royal National Lifeboat Institution
RSPB	Royal Society for the Protection of Birds
RIGS	Regionally Important Geological/Geomorphological Site
pSSSI	Proposed Site of Special Scientific Interest
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument
SMA	Sensitive Marine Area
SMP	Shoreline Management Plan
SMR	Sites and Monuments Register
SNCI	Site of Nature Conservation Importance
SPA	Special Protection Area
SRVESA	Suffolk River Valleys ESA
SSSI	Site of Special Scientific Interest
VMCA	Voluntary Marine Conservation Area
WRA	Water Research Council