Project Appraisal Report

Authority Scheme Reference	IMAN000737
Defra / WAG LDW Number	LDW 40245
Promoting Authority	Environment Agency – Anglian Region
Scheme Name	Ipswich Flood Defence Management Strategy

Date	June 2005

CONTENTS

FIGURES

PHOTOGRAPHS

EA APPROVAL HISTORY SHEET			
Project Title: Ipswich Flood Defence Management Strategy		Agency Project Code:	IMAN000737
Agency Project Manager: Rod Hicks		Date of PAR:	June 2005
Consultant Project Manager: Sarah Sinclair		Consultant:	Black & Veatch
AGENCY STAFF INVOLVEMENT			
Position	Name	Signature	Date
"I have reviewed this document and confirm the project meets EA and Defra/WAG investment appraisal criteria and recommend approval in the sum of £ 44.84 million. "			
Originator (PM)	Rod Hicks		
Reviewer (Project Executive)	Chris Allwork		
"I confirm I am content for the project as described in this document to proceed to design and construction, that funding is available and that strategic/project level risks have been identified"			
Client Representative	Mark Johnson		
NEAS Team Leader	Dermot Smith		
"I have reviewed this document and confirm that it complies with the current PAR guidelines"			
PAR Reviewer	Lance Dawkins		
"I confirm the project is ready for submission to PAB/NRG"			
Operations Manager	David Pelleymounter		

NRG – National Review Group (Projects greater than £1.5 million)		
Date of Meeting:	Chairman:	PAR Amendment No:
Project Presenter(s):		
Detailed record of any comments/actions required/additional information provided, to be appended to the PAR for onward transmission		
Recommended for approval: In the sum of £:		Date:

PROJECT APPROVAL		
AGENCY	Officers in accordance with the Agency's SoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Agency Board	
PAR Submitted		Date:
Project Approval	By: In the sum of: £	Date:

Defra or WAG APPROVAL (Delete as appropriate)	
Submitted to Defra / WAG or Not Applicable (as appropriate)	Date:
PAR Amendment No. (if different):	
Defra/ WAG Approval: or Not applicable (as appropriate)	Date:
Comments:	

SoD COVERSHEET

Region	Anglian	Project Executive	Chris Allwork
Function	Flood Defence	Project Manager	Rod Hicks
Start year	2005		
Project Title	Ipswich Flood Defence Management Strategy	Code	IMAN000737

FORM A AUTHORISATION

Reg.SoD Ref		H.O.SoD Ref	
Date		SoD Category	

	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)
Cost for which SoD Authorisation was Obtained	30	216	246

PID RECOMMENDATION AND AUTHORISATION (LARGE PROJECTS)

	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)
Actual Cost of PID Preparation	101	375	476
Total Project Cost (inc PID prep'n cost)	977	44,342	45,319

PAB/NRG Recommendation		Date	

We are assured that this project fully complies with the Agency's Environmental Policy

Reg.SoD Ref		H.O.SoD Ref	
Authorisation: Signed		Date	
Job Title			
Consultation			

				Authorised Project Cost (£K)			
Form G No.	Date	Region SoD Ref	HO SoD Ref	Agency Staff Costs	External Costs	Total	Re-app.? Y/N
1							
2							
3							
4							
5							

1 EXECUTIVE SUMMARY/RECOMMENDATIONS

Ipswich is a town situated at the confluence of where the fluvial River Orwell becomes the tidal River Gipping in Suffolk. It comprises a high-density urban area with considerable residential, commercial and industrial development. It also has an active port and docklands area. Large areas of the port, docklands and urban area are low lying and are at risk from flooding. The Strategy study has embraced an area with upstream and downstream limits at Norwich Railway Line Bridge and the A14 Orwell Road Bridge, respectively.

The town has a long history of flooding both from high fluvial flows and surge tide effects. Flood protection at Ipswich is provided by an improved river channel, which has increased the river flow capacity, and comprises 15km of floodwalls and 5 water control structures along the length of the urban waterway. 882 residential and 261 commercial properties have been identified as being at risk from flooding.

In recent years 3 lengths of defence in Ipswich have failed. One has been fully repaired; the other two have only been temporarily repaired. The need for a full Flood Defence Management Strategy was identified in order to determine the condition of all existing defences and to formulate a long term strategic plan for future improvements.

The Strategy Study has been undertaken in accordance with the FCDPAG series of documents, and with cognisance of local statutory and non statutory planning documents. The Study boundaries are considered appropriate and the area has been compartmentalised using local features, which will be strengthened as necessary, to implement the strategy. The Strategy will link with existing Flood Management (FM) Strategies for Ipswich and Felixstowe and the Stour and Orwell FM Strategy Study which commenced recently.

The Environment Agency proposes to carry out these works under the Powers granted in the Water Resources Act 1991 / Land Drainage Act 1991. Procurement of these works will involve the same team of Agency personnel with framework consultants (Black & Veatch) and a framework contractor. The Engineering and Construction Contract (ECC 2nd Edition) will be used for procuring consultancy and construction services to ensure the delivery of an integrated service.

The works recommended within the Strategy are based on the provision of a barrier in the New Cut, to protect properties to a 1 in 300 standard of protection (SoP) against tidal flooding. This will be combined with river frontage improvements to provide a 1 in 300 SoP against fluvial flooding. Wall improvement works will also be undertaken in compartment B to provide a 1 in 100 standard of protection, which will be along a partial realignment around the back of the port owned land. The number of properties to be protected is 1086 (840 residential and 246 commercial), within post code areas IP1, 2, 3, 4 and 9. In addition to this the port area within compartment H will also be protected.

The calculated Priority Score, based on Defra guidance, is shown below. Implementation of the Strategy will comply with the Agency's Vision targets in respect of Reduction of Flood Risk, Adapting to Climate Change and leading to a Better Quality of Life for some of the residents due to regeneration opportunities

The PV cost, over the 100 years strategy period is £ 43.66 million. The projected 6-year spend (Years 0 to 5) is £45.32 million including optimism bias. The whole life cash cost of the strategy (without maintenance) is £70.70 million.

The Barrier option will assist in stimulating urban regeneration and partnership funding will be pursued.

The following have been identified as possible major residual risks – (1) Unforeseen ground conditions, (2) Cost variations, (3) Inappropriate design/change in scope, (4) Existing defences failing earlier than anticipated and (5) Strategy not accepted/failure to meet the programme and (6) need for Public Inquiry. These risks have been considered in developing the study; cost implications have been incorporated in sensitivity analyses, adequate contingencies have been provided and actions have been identified for addressing mitigation actions. The base cost for the barrier was amended after sensitivity analysis, to include a sum for Public Enquiry costs, as this was seen as a significant risk to the barrier option.

The preferred option has very little beneficial or adverse environmental impacts other than localised construction impacts. The barrier option is preferred for technical, economic and environmental aspects and it provides opportunities to support the regeneration of Ipswich town centre, the implementation of regional plans, and the avoidance of a significant adverse impact on the historic and visual setting of the town.

Approval is not being sought for works in Compartment A, however the opportunity for environmental enhancements in this area has been identified – this will be developed in a further study.

It is proposed that major works identified within the Strategy should be implemented over the next 6 years. The next stage of works will be separated into 3 elements pertaining to the barrier, existing control structures and wall works.

KEY INFORMATION

Defra Priority Score	Barrier Economics: 15.9; People: 3.2; Environment: 2.0 TOTAL: 21.0 CompB Economics: 7.3; People: 5.0; Environment: 2.0 TOTAL: 14.3 Overall Economics: 15.1; People: 3.4; Environment: 2.0 TOTAL: 20.5
	No. of residential properties protected: 840 No. of other properties protected 246 Infrastructure Roads and services to above properties Areas of habitat protected /enhanced: Nil Other assets protected: Port land (comp H)
Asset condition improved	Total length of defences embraced within the strategy is approx. 15km – this also includes 5 water control structures.
Efficiencies	Damage avoided: £352.5 million
Current threshold of flooding	(Return Period) Varies from 4 years to >150 years at present time for area where defences are proposed. Lowest in overall area is <2.
Standard of protection for proposed option:	300 years for the barrier compartment. 100 years for Compartment B (Indicative range: 50 to 300 years)
Key programme dates:	This document relates to a strategy which will embrace multiple projects with differing criteria . The barrier study will need to commence within 6 months to meet construction targets.

Summary of Estimated Costs[1]

Item	Economic appraisal (with Optimism Bias)	Whole Life Gross Cost (with Optimism Bias)	SoD Approval (with Optimism Bias)
Costs pre PAR (outline design)	N/A – sunk costs	476,000	476,000
Costs post PAR			
Agency costs	719,238	1,371,628	876,074
Fees	2,915,489	5,014,885	3,885,534
Investigations (inc. public enquiry)	758,202	823,052	1,139,403
Construction	22,085,370	36,511,520	31,350,350
Compensation	1,360,726	2,109,977	2,226,739
Contingency	14,791,586	24,865,652	5,364,803
Inflation *(state rate assumed)*	N/A	N/A	5%
Future costs (maintenance etc)	*1,025,078*	*3,348,756*	N/A
Other (specify)			
TOTAL	**43,655,690**	***74,045,472***	***45,318,902***

	Barrier Compartment	Compartment B	Overall
PV Benefits	£ 336,362 k	£ 16,187 k	£ 352,549 k
PV Costs	£ 39,743 k	£ 3,912 k	£ 43,819 k
NPV	£ 296,619 k	£ 12,275 k	£ 308,730
Benefit-cost ratio	8.46	4.14	8.05
Cost per property protected	£ 46.16 k (overall) or £ 63.18 k (per residential property).	£ 17.38 k (overall) or £ 18.54 k (per residential property).	£ 40.20 k (overall) or £ 51.97 (per residential property).
Base date for costs and benefits:	August 2004		
Planning costs of the project	£ 486 k		

Recommendation

The Environment Agency is recommended to approve a Strategy for flood risk management in Ipswich based on Option 4a – Tidal Barrier with raised defences downstream and fluvial defences upstream – and to approve expenditure of £45.32M over a 6 year period.

2 BUSINESS CASE

2.1 Introduction and Background

2.1.1 Geography and Topography

Ipswich is situated at the confluence of the Rivers Orwell and Gipping in Suffolk. The rivers run through the centre of the town, through industrial and residential areas and the port. The Study area extends downstream from Norwich Railway Line Bridge upstream to the Orwell Bridge where the estuary widens, as shown in Figure 1.

Ipswich lies within a valley. The land to the south of the river rises relatively near to the river, leaving a small developed area within the flood plain. To the north of the river, the ground is flatter and the floodplain is larger, covering a significant proportion of the town centre before rising to higher ground.

Ipswich is a high-density urban area with considerable residential, commercial and industrial development. It also has an active port and docklands area. Large areas of the port, docklands and urban area are low lying and are at risk from flooding.

2.1.2 History and Impact of Flooding

Ipswich has a long history of flooding both from high fluvial flows and surge tide effects. Records show that Ipswich has suffered significant flooding on eighteen occasions, on fourteen occasions due to tidal surges and on four occasions due to river flooding. The most significant of these events are the 1939 fluvial flood and the 1953 surge tide flood.

882 residential and 261 non-residential (referred to as commercial) properties have been identified as being at risk from flooding.

In addition, several roads would be affected. However, in the main, increased flood risk would affect the commercial viability of the town centre in its current location, and would also slow down or halt the current regeneration and urban renaissance which Ipswich is in the throes of. A considerable amount of public money, including that from local government and development agencies has been spent to effect this regeneration.

The River Gipping Comprehensive Scheme implemented between 1971 and 1983 was intended to address flood risk. The effectiveness and lifespan of these defences is considered in the study.

2.1.3 Need for Strategic Planning

The majority of the defences in Ipswich were put in place 25-30 years ago and are nearing the end of their effective life. In 1996 a section of flood wall at The Island site (Figure 1) failed, due to failure of the older, masonry wall it was founded on (Photograph 1). This exposed a large area of the centre of Ipswich to increased flood risk. Although temporary works were immediately put in place, given the likely residual life of the other flood defence structures, a flood risk management strategy was needed to plan for the ongoing management of the defences.

Photograph 1 Failed wall at The Island in 1996, with temporary bank landward

The Environment Agency (the Agency) commissioned Black & Veatch (BV) in 2001 to undertake a phased strategy study into the long term management of the flood defences to the town of Ipswich. A Flood Defence Strategy is a long term plan for flood defence management to ensure an integrated and sustainable approach. It is designed to provide a framework for decision-making and action, related to both the provision and the management of sustainable flood defence policies. This enables the whole flood defence system to be managed effectively. The Strategy identifies all necessary work to meet defined flood defence objectives.

Since the procurement of the Strategy Study, a wall failed at Horseshoe Sluice (Figure 1) in 2003, and urgent works were undertaken to effect repairs. A PAR was submitted to Defra seeking funding for this work, within the context of the ongoing Strategy. More recently, in January 2004 a second wall on the Island was undermined by subsidence (Photograph 2). Repairs have been undertaken and the structure is being monitored for further movement; however flood risk would be reduced by implementing strategic replacement of both failed walls.

A strategy plan is needed to prioritise replacement works, as well as to ensure that the appropriate standard is offered to flood risk areas, for both tidal and fluvial flooding.

Photograph 2 Failed wall at The Island in January 2004

2.1.4 Legal and Planning Context

There is a range of European and national legislation which provides the legal context to this Strategy and which relates to features within the study area. Full details are provided within the Strategic Environmental Assessment (SEA) document, (Appendix B). It should be noted that the SEA does not fall within the remit of the recently issued Environmental Assessment of Plans and Programmes Regulations (2004) due to the timescale of the study. However, the context of the SEA Directive and forthcoming UK Regulations was taken into account during the SEA process.

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The Suffolk Coasts and Heaths Coastal Habitat Management Plan (CHaMP) encompasses the southern part of the study area for the Strategy. There is currently no formal defence policy for the Orwell Estuary and the intent is stated as 'to allow natural change to occur'. The Stour and Orwell Flood Management Strategy Study has recently commenced with the aim of identifying strategic options for the delivery of effective flood risk management in the Stour and Orwell estuaries over the next 100 years. The Strategy will link with existing Flood Management Strategies, including the Ipswich Strategy and one for Felixstowe.

Central government, regional and local planning policy has been reviewed during the development of this strategy. Of particular note are the Ipswich Borough Council Local Plan, Ipswich One-Area Action Plan (relating to the future development of Ipswich town centre) and the Tourism Strategy for Ipswich (which seeks to maximise the benefits of sustainable tourism to the Ipswich economy).

The Strategy Study has been undertaken in accordance with the FCDPAG series of documents. This Strategy Study considers the defences over a 100-year period, taking into account the predicted impacts of climate change over this period.

2.1.5 Boundaries, Flood Compartments and Scope of Problem

Ipswich is at risk from both tidal and fluvial flooding. The boundary at the upstream end of the study area is Norwich Railway Line Sluice (Figure 2). This is a vertical gate which can be operated to reduce fluvial flows into Ipswich. Although the impacts of flooding upstream may be exacerbated by this, this is being examined in a separate fluvial study (the Gipping Strategy) – since this is at Strategy level, this study has considered a worst case scenario, which may be reviewed when the upstream strategy is well developed, to see if there is scope for significant savings. Therefore the upstream boundary is appropriate for this Strategy.

Ipswich has been proven through modelling to be more vulnerable to tidal surges than fluvial flooding (i.e. tidal surge levels are higher than the equivalent frequency of fluvial event). The upstream tidal limit during extreme surge events is downstream of Norwich Railway Line Sluice; therefore the boundary of tidal flooding is within scheme boundaries.

The shape of the river within the study area is unusual – the New Cut imposes a sudden restriction on the tide, effectively ending estuary behaviour at that point. Modelling has shown that the construction of a tidal surge barrier within the new cut would not affect the existing regime when in operation, i.e. there would be no impact on water levels downstream - no doubt due to the existing constraint. However, the urban area of Ipswich extends into the Orwell estuary. Therefore, although it has no hydrodynamic impact, the downstream boundary has been taken as the Orwell Bridge (Figure 1), which acts as the visual gateway to Ipswich. High ground on the left bank ensures that the area upstream is hydrodynamically independent of the area downstream. Wherstead Road, on the right bank by the bridge, is separated from the lower estuary by low man-made barriers. It is however linked with the rest of the Ipswich floodplain, and should be considered with the rest of Ipswich. Therefore the downstream boundary is appropriate.

The flood plains for a 1 in 300 year event (highest Indicative Standard) if the defences were not present, or if they failed, for the year 2002 and 100 years later (year 2102), are shown in Figures 2 and 3 respectively, to demonstrate the area at risk. The flood plain has been divided into twelve flood compartments, labelled A to L, shown in Figure 4. LiDAR data was used to identify natural high ground flood compartment boundaries. A site visit was made to confirm the presence of high ground creating a suitable compartment boundary. The flood compartments are hydraulically independent, except for the J/H, H/G and C/B compartment boundaries which are only effective at lower flood levels. At these locations, flow from one compartment to another has been allowed for in the analysis of Do Nothing. However, the boundaries are considered to confer full hydraulic independence for Do Something options. Compartment features are summarised in Table 3.

2.1.6 Environmental Designations and Constraints

Within, and in the vicinity of the study area there are a number of sites and features designated for their nature conservation, heritage and landscape value, as described in the following sections.

Natural environment:

Nature conservation

Figure 5 illustrates the location and extent of sites which have been designated for nature conservation value within the study area; these sites are described below commencing with those sites designated at an international level, those of national importance and leading to those designated on a regional or local basis. Nature conservation features are summarised in Table 1.

Table 1 Summary of nature conservation features

Site	Important Features
The Stour and Orwell Ramsar site / Special Protection Area	Wetlands of International Importance especially as Waterfowl Habitat (Ramsar site), and as a Special Protection Area (SPA). The Stour and Orwell SPA qualifies as a European Marine Site; the boundary of the European marine site is concurrent with that of the SPA. The estuaries include extensive mudflats, low cliffs, saltmarsh and small areas of vegetated shingle in the lower reaches, and provide wintering habitats for important wetland bird species, particularly wildfowl and waders. The south-east corner of the study area, in the vicinity of the Orwell Bridge, falls within these designated areas.
Orwell Estuary Site of Special Scientific Interest	The site includes the Wherstead Flats and adjacent river channel. The SSSI is a nationally important site which supports intertidal mudflats and an assemblage of wintering wildfowl.
Alderman Canal Local Nature Reserve and CWS	A tributary of the River Gipping, it supports a broad range of plants (over 120 species) and numerous fauna, including a range of interesting marginal plants.
River Orwell County Wildlife Site (CWS)	This site includes the stretch of water in front of Cliff Quay, along the New Cut as far as Station Bridge, and the area of water in the Wet Dock, is a sanctuary area for birds, including nationally significant populations of wintering redshanks.
Other County and Local Wildlife Sites	• The River Gipping CWS • Pipers Vale CWS • Bourne Bridge Grassland CWS • Stoke Hill, Ancaster LWS

Landscape

Suffolk Coast and Heaths Area of Outstanding Natural Beauty

The Suffolk Coast and Heaths AONB covers 151 square miles of the Suffolk coast between Kessingland and the Stour estuary. The AONB boundary is located downstream and beyond the study area, although does extend along the Orwell Estuary up to the Orwell Bridge. The area has been designated an AONB due to its heaths, reedbeds and estuaries.

Protected species

A data search identified evidence of a number of protected species within the study area (water vole, badger, various birds) and some protected species within the vicinity of the study area (otter). It is anticipated that further data collection and location-specific species surveys may be required during the implementation of the Strategy.

In relation to national Biodiversity Action Plans, habitats for which targets have been set that are present in the Ipswich study area include salt marsh and mudflats. On a local level the Suffolk Local Biodiversity Action Plan (2000) contains Species Action Plans (SAPs) and Habitat Action Plans (HAPs) that are likely to be relevant in the study area.

Built environment:

Archaeology and cultural heritage

The town of Ipswich, the main settlement in the study area, was founded in the seventh century and is one of England's oldest towns and is rich in cultural heritage. The designated areas and features are shown in Figure 6.

Designated areas

Ipswich Borough Council (IBC) has designated a number of Conservation Areas within the study area. Of particular relevance are the Wet Docks Conservation Area and the Stockton Conservation Area located on the west side of the River Gipping, in the vicinity of the Wet Dock. These areas are designated to provide protection to and enhancement of their character and appearance. A large part of Ipswich is also designated by IBC as an Area of Archaeological Importance (AAI), which indicates that there is a likelihood that any excavation within this area could reveal archaeological remains.

Designated features

There are a number of Scheduled Monuments (SMs) within the study area of which four are within the AAI, primarily encompassing the town centre and the Wet Dock, and the flood plain north of the A137 bridge over the River Orwell. There are also a number of Sites and Monuments Records (SMRs) in Ipswich, especially within the AAI, and which are within the modelled flood plain. There are 53 streets with Listed Buildings that fall within the modelled flood plain, 16 streets of which contained five Grade I and 15 Grade II* Listed buildings; Bourne Hill, within Babergh District Council's area contains two Grade II Listed Buildings.

Recreation and leisure use

Within the Borough of Ipswich there are no formally recorded Public Rights of Way [PRoW], but maps of potential PRoWs were obtained from IBC. The potential PRoWs within the 1 in 300 year modelled floodplain are as follows and are shown on Figure 7:

- through Pipers Vale, straddling Orwell Bridge and in close proximity to the Orwell Estuary; and
- northwards from Stoke Bridge following adjacent to the River Gipping, as part of the Gipping Valley River Path.

Beyond IBC boundaries there are two recorded PRoWs (number 7 and 9) that form a combined route through the water meadows adjacent to Belstead Brook, past Bourne Bridge and south alongside the Orwell Estuary to Orwell Bridge. The IBC Draft Deposit Local Plan 2001 indicates a river walk along the riverbank around the Wet Dock and alongside the New Cut.

There are a number of formal recreation areas within the study area which are indicated on Figure 7 and include a Country Park at the downstream end of the study area, and protected open space. The river is also used for leisure boating and has moorings along the New Cut, in the Wet Dock and at Fox's boatyard downstream.

2.2 Problem

2.2.1 Condition and Lifespan of Existing Defences

Flood protection at Ipswich is provided by an improved river channel, which has increased the river flow capacity, and a series of floodwalls and water control structures along the length of the urban waterway. These flood defences were constructed under the River Gipping Comprehensive Scheme that was implemented between 1971 and 1983, with the aim of providing a one hundred year standard of defence through Ipswich.

The existing defences, built some 25-30 years ago, are now nearing the end of their effective life. As part of the Strategy Study a condition survey of the existing flood defences was carried out to facilitate analysis of the existing situation and to predict future behaviour. The condition survey report (Appendix C) concluded that the majority of the flood defences in Ipswich are in good condition with a residual life of approximately 20 years. However, in a number of locations works were recommended to be carried out in the next five years due to impending or actual failures (see the Condition Survey Report for further details). The estimated residual life of the walls within the study area have been assessed in the condition survey. The wall/walls with the lowest residual life in each compartment are listed in Table 2.

A detailed inspection of the water control structures was undertaken in 2001 by BV and Kenneth Grubb Associates as part of the scoping study to determine the condition of the structures and to develop options for their refurbishment. The report (Appendix D) concluded that the structures would need works within the next 5 years in order to operate effectively. However, generally the structures were not close to imminent failure; thus the report recommended that the Strategy Study should be completed before making decisions on refurbishment of the structures, in case a new flood management regime changed the need for or design of one or more structures.

2.2.2 Recent flood defence works in the study area

In 1996 a short length of defence failed near the velocity control structure and temporary secondary defence works were installed to protect the flood compartment. An appraisal of the defences in 1997 identified the justification for improvements to the defences on the left bank, including the failed length. The proposed work secured Defra Agreement in Principle at the time. Given the timescale since the Gipping Comprehensive Scheme has been implemented, and the change in use of much of the defended area, it was agreed that a strategic review of the future of the flood defence system was needed. Therefore work was deferred pending the outcome of a Flood Defence Strategy for the whole of Ipswich.

Flood defences are carried across the entrance to Ipswich Wet Dock by hydraulically operated floodgates. The gate operating mechanism proved inadequate to operate the gates safely and underwent urgent repair work during the Strategy Study. Works were completed in 2003.

In January 2003 it was discovered that a 15m section of the defences to the Right bank of the River Orwell, approximately 40m downstream of Horseshoe Sluice, had failed. A dive

survey identified a large scour hole directly in front of the failed section and a smaller scour hole was also found in front of the sheet piled wall on the opposite (left) bank. Black & Veatch were appointed to undertake a PAR for Urgent Works to repair and stabilise the defences in this area. This work was completed in November 2003 and the PAR was submitted to Defra for grant aid funding in January 2004.

More recently, in January 2004 a second wall on the Island was undermined by subsidence. Deterioration in condition of the river wall on which the flood defence rested caused wash-out of material which caused the masonry wall to fail and the flood wall to rotate and settle slightly. Repairs have been undertaken by ABP as Port Authority.

2.2.3 Existing Standard of Defence and Probability of Flooding

The existing defences in Ipswich were constructed with the aim of providing the town with a 100 year standard of defence.

The defence standards calculated as part of the Strategy Study are based on the assumption that existing defences have a freeboard allowance of 150mm for hard defences and 300mm for soft defences, which has been removed from the existing crest level to assess effective standard of defence provided.

Modelling showed that the current flood defence levels protected all bar Compartment K from a 100 year fluvial event – Compartment K being lower. The protection against tidal flooding was found to be significantly lower than for fluvial events, except for compartments F and L which are at the upper limit of the study area and are unaffected by tidal surges. The results of the modelling are shown in Table 2. At Horseshoe and Handford sluices the tidal surge peak prevents the discharge of fluvial flows causing increased water levels upstream. The structures were found to be overtopped from surges above the current 1 in 50 year event.

Table 2 Residual life of existing defences existing and future (in 100 years time) standard of protection for each compartment

Compartment	Residual Life	Existing Standard 2002	Future Standard 2102
A	5 – 10 years	<2 years	0 years
B	10 – 15 years	4 years	0 years
C	5 – 10 years	74 years	4 years
D	15 – 20 years	165 years	15 years
E	10 – 15 years	46 years	5 years
F	25-30 years	193 years	64 years
G	N/A	98 years	8 years
H	0 – 5 years	29 years	0 years
I	10 – 15 years	77 years	5 years
J	0 – 5 years	128 years	10 years
K	10 – 15 years	14 years	5 years
L	10 – 15 years	193 years	92 years

NB An isolated low point in Compartment B results in the low existing standard of defence of four years. If defence 4105/0101R04 was raised then the standard of defence would increase to 49 years. The new low point would be wall 4105/0101R09 (see location map appended).

2.2.4 Impacts of climate change

The anticipated impacts of climate change are expected to increase fluvial flows by 20% over 100 years and increase sea levels by 6mm per year on average based on Defra guidance.

Ipswich has a gently rising topography from the river edge. As expected the application of these anticipated impacts over the project life of 100 years, with a 20% increase in fluvial flows and 600 mm rise in sea levels, increased the extent and depth of flooding from tidal and fluvial events, as shown in Table 2.

The impacts of climate change will be to extend the flood plain to a wider area, increasing the number of properties (residential and commercial) at risk from flooding from 1116 to 1143. Properties already located in the floodplain will flood to a greater depth, incurring higher clean-up costs. The frequency of flooding will increase over time; as sea levels rise higher surges will occur more frequently. The net effect will be that what is currently considered to be a 100 year surge water level could occur as often as once every 4 years in 100 years time[1].

2.2.5 Aims and objectives

Policy and Strategy

A Strategic analysis will identify long term solutions (or options) for managing flood risk in the context of the lifespan of existing defences, the natural and human and built environment and natural change. A Strategic assessment of flood defences must have a number of objectives, against which the policy options can be measured to ensure that the Strategy meets the objectives of managers and funders. Overarching objectives that apply to the whole strategy were developed, and must be achieved for the Strategy to be appropriate. These are discussed below. More local supporting objectives, which apply to specific areas or specific interested parties were also developed. These supporting Strategy objectives have been used to ensure that the policy options do not significantly affect the other uses and interests of the frontages, but it may not be possible to achieve all the supporting objectives, as part of a Multi Criteria Analysis. These supporting Strategy Objectives are appended to the PAR (Appendix 5) in Section 5.5.

Policy Aims

The adoption of a series of targets provides a framework for ensuring and demonstrating delivery of the Government's stated policy aims and objectives for flood and coastal defence, as set out in the 1993 Strategy for Flood and Coastal Defence in England and Wales. The stated policy aim of Defra is:

- "*To reduce the risk to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, economically and environmentally sound and sustainable defence measures*."

Overarching Objectives

The overarching objectives below have been derived based on Defra high level objectives for strategic flood defence management. They have been subject to consultation with stakeholders, and apply to the whole study area. These objectives will be used in the assessment of strategy options to ensure that the options meet the general requirements for sustainable, cost-effective flood defence

- *Provide appropriate protection for people and property from flooding, through the development of strategic flood defence options that:*

  - Are based on the principle of sustainable development and the precautionary approach in view of:
    - the natural environment and biodiversity
    - the built environment and archaeology
    - the economic and social environment.

  - Are compatible with natural processes as far as possible.
  - Take account of future changes as a consequence of sea level rise and climate change.
  - Take account of adjacent river and estuary strategies and other management plans.
  - Are 'owned' and adopted by stakeholders, and used to implement best practice
  - Facilitate the development and usage of guidance on appropriate development within the flood plain.

- *In line with the above ensure that all proposals arising from the strategy:*

  Avoid, as far as possible, tying future generations into inflexible and expensive options for defence, by ensuring that they are::
  - technically feasible
  - economically viable
  - socially and environmentally acceptable

- *To develop long and short term plans:*

  - To develop strategic flood defence management policy for the next 100 years.
  - To facilitate future development of a fully integrated 5 year plan of works.

2.3 Options Selection

2.3.1 The Problem

The problem to be addressed in the Strategy is that the defences in Ipswich are reaching the end of their useful life, and that a plan is needed which justifies any long term flood risk management within Ipswich. There are a range of options which can be implemented as part of flood risk management.

2.3.2 Do Nothing option (Option 1)

Prior to investigating strategic options for flood defence, it is important to understand the implications of not maintaining or improving the flood defences at Ipswich - the 'Do Nothing' approach. The Do Nothing scenario is a walk away option where by no active intervention is taken to maintain the flood defences to Ipswich.

This option would involve withdrawing all intervention and allowing the flood defences to fall into a state of disrepair. The defences would eventually fail and the areas currently protected from flooding would no longer be protected. This process would happen gradually over a long period of time. The existing control structures (sluices and weirs) would also be

allowed to fail. This may alter the river levels both upstream and downstream of the structures. Within the Strategy methodology, this option must be considered as a baseline against which the benefits and disadvantages of all other options will be assessed. The area currently protected from flooding is shown in Figure 4.

Do Nothing Flood Risk

Under the Do Nothing scenario, flooding will at first occur by overtopping of the existing defences. However, eventually the existing defences will be breached causing a greater degree of flooding. Compartments H and J, which contain high proportions of the overall assets in Ipswich, would both be vulnerable now, due to the poor condition of some of the defences (Figure 4). The number of properties at risk from flooding are shown in Table 3.

Table 3 Summary of compartment features

Compartment	Frontage Length (km)	Benefit Area (km2)	Residential properties	Commercial properties	Total properties
A	1.18	0.072	35	2	37
B	1.68	0.287	211	14 & Port	225 & Port
C	1.00	0.206	56	40	96
D	0.61	0.014	17	3	20
E	2.27	0.143	11	12	23
F	0.34	0.022	0	0	0
G	2.11	0.458	0	Port	Port
H	1.20	0.303	42	37 & Port	79 & Port
I	1.42	0.057	0	18	18
J	1.57	0.650	206	110	316
K	1.18	0.226	304	15	319
L	0.41	0.026	0	10	10
Total	**14.97**	**2.464**	**882**	**261**	**1143**

Note: the Port valuation is detailed separately on basis of total projected damages based on assessment by ABP. The approach to protection of port land has been discussed with the Port Authority

Findings of the environmental assessment of a Do Nothing approach

The assessment of the key impacts resulting from the 'Do Nothing' approach has been undertaken at a high level, in accordance with the FCDPAG series and Agency guidelines for environmental appraisal, and general good practice. Within each flood compartment the potential impacts, whether adverse or beneficial, of the 'Do Nothing' approach and the level of significance have been assessed against a suite of environmental aspects. Some impacts may be restricted to a specific compartment whilst others are of a more generic nature throughout the floodplain. A summary of the potential impacts of the Do Nothing approach is provided in Table 4.

Table 4 Summary of potential impacts resulting from a Do Nothing approach

Aspect	Potential Impact
NATURAL ENVIRONMENT	
Geology and geomorphology	Minor impact from increased erosion and scour leading to earlier failure of the defences.
Topography	No significant impact
Hydrology	Failure of the control structures will result in worse erosion and scour and lead to an earlier failure of the defences.
Conservation designations	Potentially positive impact on estuarine habitats in compartments A & G (Stour and Orwell SPA/Ramsar site/SSSI) with an opportunity to accommodate coastal squeeze; Potentially minor negative impact on freshwater habitats (Alderman Canal LNR) due to increased saltwater incursion.
Ecology	Potentially negative impact due to direct loss of habitats/species due to flooding and indirectly through changes in water quality; Potentially positive impact through ability of habitats to accommodate coastal squeeze.
Water resources	Temporary negative impact on surface water abstraction in Compartment B and potentially negative impact on consents to discharge in the floodplain.
Water quality	Potentially negative impact, possibly temporary, due to floodwater transporting pollutants/ contaminated materials into local watercourses.
Climate and air quality	No significant impact.
HUMAN AND BUILT ENVIRONMENT	
Local community	Significant negative impact on local community due to increased risk of damage to / loss of property and lives in compartments A-D, H, J & K and psychological distress of increased flooding; Negative impact on the opportunity for future housing developments in compartments C and H.
Land use and land ownership	Significant negative impact on current and future land uses due to increased risk of flooding.
Landscape	Temporary negative impact on landscape during flooding and as the flood defences fall into disrepair; No opportunities for visual enhancements.
Navigation and Port Activities	Significant negative impact due to increased risk of flooding disrupting commercial port activities and damaging port infrastructure; Negative impact during flooding events due to disruption/cessation of navigation.
Infrastructure and Traffic	Negative impact due to increased risk of flooding of strategic and local transport links.
Noise	No significant impacts.
Tourism and Recreation	Significant negative impact on existing tourist and recreational sites in compartments H & J, and on cycle and pedestrian ways; Potentially negative impact on new facilities due to an increased risk of flooding.
Fisheries	Potentially negative impact due to stranding of fish from increased flood risk; Potentially positive impact due to the increased opportunities for the natural development of new habitat and refuges.
Archaeology and Cultural Heritage	Significant negative impact in compartments C, H and J due to an increased risk of flooding of and damage to archaeological/ heritage interest.
Contaminated Land and Waste Management	Increased risk of flooding and erosion of contaminated land sites which may have a negative impact on surface water quality and potentially groundwater resources; Potentially negative impact on the operation of existing waste management sites at times of flood.

Aspect	Potential Impact
Flood defences	Significant negative impact due to the deterioration of existing flood defences.
PLANNING	
Plans and policies	Conflict with a number of national, regional and local legislative designations and policies due to a risk of damage to sites and individual features, and a compromise for future regeneration plans for Ipswich; Potentially positive in creating an opportunity for estuarine habitats to adapt to coastal squeeze in line with the SPA site management conditions.

Any do something options to manage flood risk in Ipswich must be justified in comparison to the baseline Do Nothing scenario. These are discussed below.

2.3.3 Do Something options

Under Do Something, an appropriate **line** of defence needs to be established. The following generic options were considered for a range of water levels (Option 1 being Do Nothing):

- **Option 2 - Hold the line**: hold the existing defence line.
- **Option 3 - Retreat the line**: managed realignment by identifying a new line of defence and, where appropriate, constructing new defences landward of the existing defences.
- **Option 4 - Advance the line**: advance the existing defence line by constructing new defences seaward or riverward of the existing defences.

The town of Ipswich already has a Flood Warning scheme in place. The aim of this scheme is to save lives by warning people prior to a flood event. As any scheme could be affected by a higher-than-standard storm, it is considered that flood warning will remain necessary for any option. Therefore it has not been considered as a separate option, but incorporated within every option.

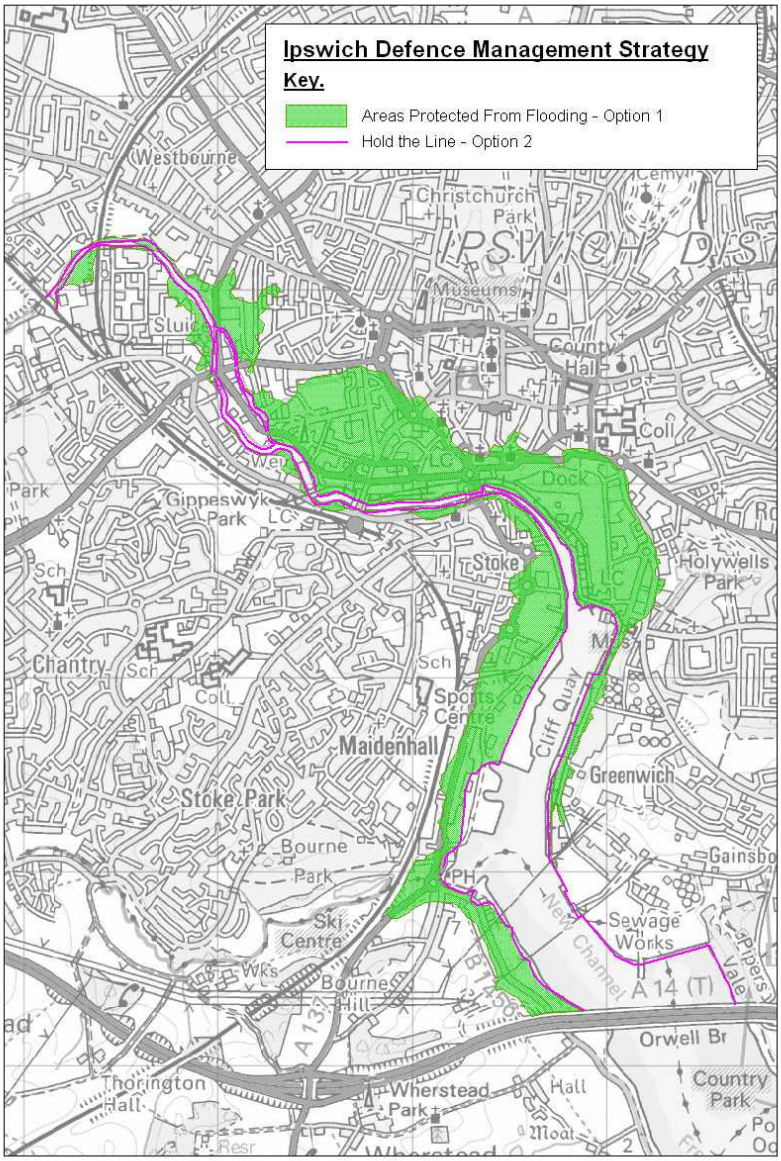
The three alignment options are detailed below. The study then screened these generic options, and developed localised options as a result of the screening process.

2.3.4 Hold the Line (Option 2)

Within this option the existing defences and control structures would be maintained in their present positions. However, the standard of protection against flooding offered by the existing defences would need to be increased in some areas to provide a specific standard of defence. This requires the raising of existing defences or the construction of new defences if the existing ones cannot be modified. As a consequence of the manner in which flood defence schemes are funded, the standard of defence provided would vary for different areas of Ipswich depending on the relative costs and benefits i.e. consideration of the land use behind the flood walls and the cost of the works. Existing defences would be replaced before they reach the end of their assessed residual life (as anticipated by the Condition Survey Appendix C) and any subsequent replacements would take place at the end of their design life. Replacements would be to the estimated crest level to provide the required SoP at the end of the expected life or the strategy life if earlier. The operation of the control structures could also be modified with the intention of reducing the risk of flooding downstream; the effects of such modifications would require investigation. The 'Hold the Line' option is shown on Figure 8.

The effect of assumptions made in Hold the Line is tested through sensitivity analysis as part of the economic assessment. However, the Hold the Line option does not assume a consistent flood protection standard throughout Ipswich, even though it is a single urban area. There may be socio-economic impacts associated with this approach which cannot be quantified by this study.

Figure 8 Do Nothing and Hold the Line flood defence options



2.3.5 Managed Realignment (Option 3)

Within the option, the defences would be realigned landward, to an appropriate inland line. The principle of managed realignment is to reduce risk and cost, by removing the flood defences from the waterside environment. This would require construction of new defences, and possibly some maintenance of existing riverwalls and control structures, depending on the local morphology. Again, the standard of defence provided will depend on the assets protected by the defences. This option, and its implications in Ipswich is discussed further in Section 2.3.7 – High Level Option Screening.

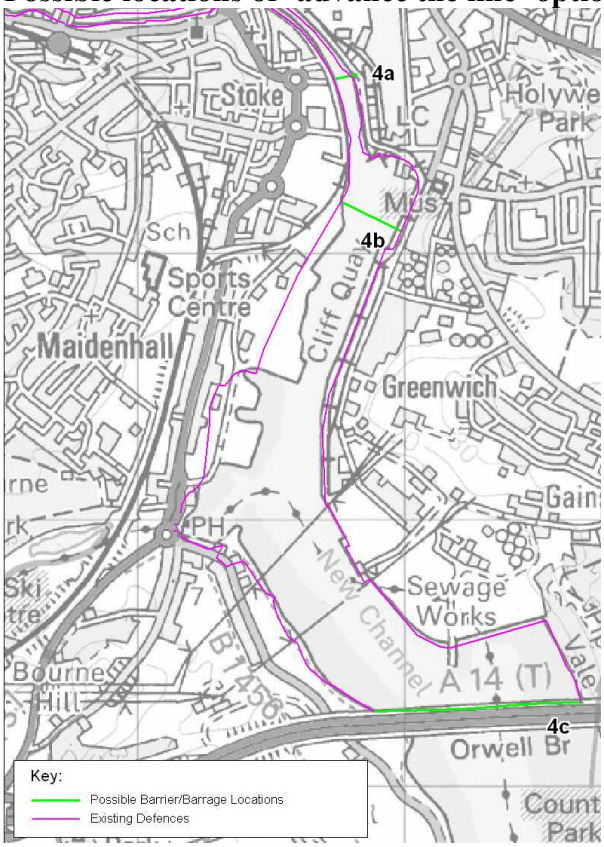
2.3.6 Advance the Line (Option 4)

Generally, building new defences in front of existing defences is not considered an appropriate solution, since it narrows the width of the river, which can have implications for flooding. However, another way of advancing the line would be a tidal structure or barrier. A 'tidal structure' or barrier, located within Ipswich would reduce the risk of flooding to areas upstream of the structure from the tidal flows, although it would not address and could potentially increase flooding from the upstream river system.

There are two main types of tidal structure: a barrage or a barrier. A barrage forms a permanent tidal limit and retains water upstream of the structure creating a freshwater river upstream. A barrier is a surge control structure which is deployed during extreme tidal conditions to reduce the risk of flooding upstream. Due to the impact from a barrage on aspects such as navigation, water quality and land use, it was decided that a barrage was not an appropriate solution for Ipswich; but a barrier concept was retained for further consideration. Three locations have been identified as being potentially suitable for a barrier structure, as shown in Figure 9:

- Option 4a - Upstream of the Velocity Control Structure through the New Cut
- Option 4b - Upstream of the Port
- Option 4c - Upstream of the Orwell Bridge

Figure 9 Possible locations of 'advance the line' options



The barrier would prevent tidal flooding upstream, but works would also be required to prevent tidal flooding downstream, and fluvial flooding upstream.

The barrier would be the limit of navigation during operation, its impact on navigation upstream when in stand-by mode would be dependent on the nature of the structure involved. The barrier structure itself would have a visual impact within the existing historical context of Ipswich.

2.3.7 High Level Option Screening

A high level appraisal of the environmental, technical and economic issues associated with the generic options, including the Do Nothing option (Option 1) was undertaken for each flood compartment. Any options which were identified as being completely unacceptable in specific compartments were subsequently removed from the study, resulting in a 'short list' of options

Options considered unacceptable were:

- River-wide managed realignment (Option 3) – due to the urban nature of the area, and the relatively narrow flood plain in some areas, the scope for economically justified managed realignment was limited. Any large-scale realignment would have removed value from too many assets in Ipswich, and possibly affected the commercial centre of the town.

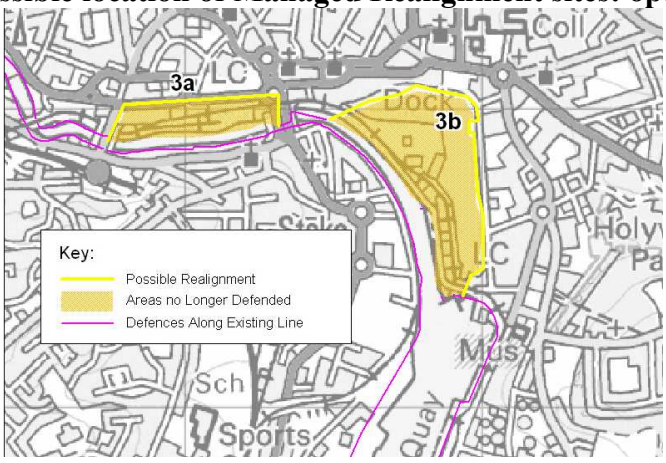
Local Realignment

Three sites were identified at which local or compartment-wide realignment could be considered:

Option 3a Commercial Road and Grafton Way area (Compartment H) - the River Action Group report[2] had already identified this disused railway yard (see Figure 10) as potential parkland. This could be managed to become part of the flood plain, with earth embankment providing defence slightly inland within the park.

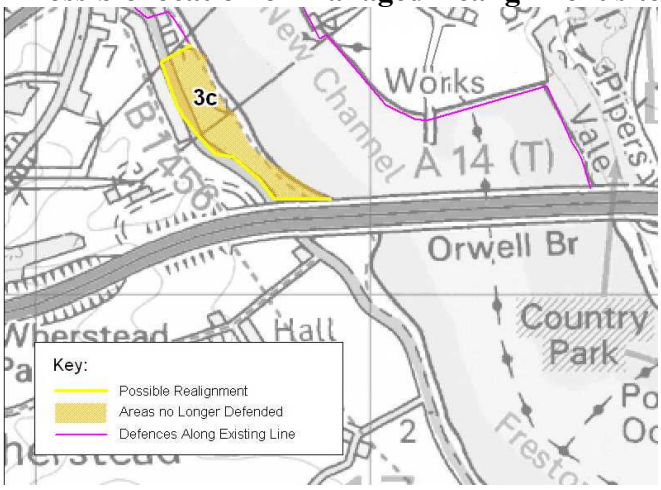
Option 3b Wet Dock area (Compartment H) – There are flood defences positioned along the New Cut that currently protect the island and the land northward from the areas of flooding. The position of the defences could be moved to the northern and eastern quays of the Wet Dock as shown in Figure 10. This would involve raising the quay walls at Wherry, Neptune and Orwell Quays and Neptune Wharf. The existing walls on the island would be allowed to fail over time causing the island area to become undefended and more vulnerable to flooding, whilst still providing flood defence to the majority of the assets in Ipswich

Figure 10 Possible location of Managed Realignment sites: options 3a and 3b



Option 3c – There is a potential to set back the flood defences could be set back at the downstream end of the study area, upstream of Orwell Bridge as shown in Figure 11 (Compartment A). There are currently two sets of defences along this section, both of which are earth embankments. One is approximately 60m riverward of the other. The position of the defences could be set back to the inland embankment. The area between these defences may convert to intertidal habitat. A proposal by ABP in Ipswich had identified the area in front of Wherstead Road at the Orwell Bridge as a potential saltmarsh or mudflat creation site to be used as possible compensation for the Port expansion. However, during consultation local residents expressed concerns, which would need to be addressed if this sub-option is progressed.

Figure 11 Possible location of Managed Realignment sites: option 3c



Step 1 Environmental Screening

A high-level assessment of the environmental issues associated with each of the generic options (do nothing, hold the line, retreat the line, advance the line) was undertaken as part of the SEA process. Each generic option was scored in terms of environmental acceptability, and the key environmental constraints and opportunities were noted.

The Step 1 option assessment resulted in a number of options being identified as feasible for further investigation on environmental grounds. Any options which were identified as completely unacceptable in specific compartments were removed from the Study.

Therefore, the potential options taken forward were as follows:

- Option 1 – Do Nothing
- Option 2 – Hold the Line.
- Option 3 – Retreat the line at three locations, known as 3a, 3b and 3c (see Figures 10 and 11) in combination with hold the line at all other locations.
- Option 4 – Advance the line at three specific locations known as 4a, 4b and 4c (see Figure 9) by constructing a tidal barrier in combination with hold the line.

2.3.8 Further Option Screening

Consultation as part of the SEA process indicated that managed realignment in the Wet Dock area (Option 3b) would be unacceptable to most consultees, as well as being difficult to construct due to existing buildings and use of the wet dock by the Port. The location of any defences would be likely to be at the water's edge due to existing buildings. The cost would be unlikely to be of much difference to holding the line along the Island site, although to retain a working port there may need to be expensive land raising.

The likely cost of managed realignment at the proposed park area (Option 3a), and the hydraulic impact, were considered to be so similar to Hold the Line that for the purposes of analysis the option could be considered as hold the line, with potential to explore the realignment more at the next stage, if Hold the Line was the preferred option.

Examination of potential barrier locations indicated that the cost of a barrier relates mainly to its span and the hydraulic head difference it operates under. For cost effectiveness, the only acceptable location would be along the New Cut (Option 4a), which limits the span to between 20 and 40m. In addition, a barrier further downstream would have much more impact on Port business, and on amenity use of the river, which would negatively impact on the strategy objectives, and the multi-criteria analysis of options undertaken in the SEA.

The following generic options for flood defence management for the town of Ipswich were taken forward for detailed environmental, hydraulic and economic analysis:

- Hold the Line with retreated defence at Wherstead (Option 3c) as a sub-option, hereafter just referred to as the 'Hold the Line' (HTL) scenario; and
- Hold the Line with a tidal barrier in the new cut (Option 4a), hereafter just referred to as the 'Barrier' scenario.

2.3.9 Standard of protection of options

Once the line of defence has been determined, the standard of protection provided by the defences can be examined. Standards of protection (SoP) ranging from a 1 in 2 to 1 in 300 years return flood event were considered for the Hold the Line (with or without localised retreat) scenario for each compartment. A Maintain option whereby the defences are kept at their existing crest levels (and therefore the SoP decreases over time) was also considered.

For the Barrier scenario, 1 in 100, 1 in 200 and 1 in 300 SoP barriers were considered for the compartments that would be protected by the barrier (C, D, E, H, I, J and K). Compartments A, B and G are downstream of the proposed barrier location and compartments F and L are upstream of the tidal limit. Flood defences for these compartments (A, B, F, G and L) will therefore be unaffected by the presence of the barrier – modelling having demonstrated their independence - hence their SoP will be the same as that determined under the Hold the Line scenario. Therefore, the barrier option has been taken to relate to a combined compartment, for the purposes of comparison with Hold the Line.

2.3.10 Hold the line vs Do Minimum Option

The Strategy reviewed the potential of a minimum investment option (Do Minimum).The defences at Ipswich have already failed in 2 major compartments. Others are nearing the end of their useful life. Maintenance at Ipswich generally comprises servicing of mechanical and electrical components, grass cutting, and inspection and repair of defences as necessary.

Due to the types of defences in Ipswich and the fact that many are reaching the end of their useful life, a Do Minimum option, where maintenance is undertaken until the asset reaches the end of its useful life at which time the asset is allowed to fail, would be similar to Do Nothing, with some additional low level maintenance expenditure. In particular, the fact that significant refurbishment is required for the water control structures within the first 5 years, and that some defences have already failed precludes the maintenance approach to Do Minimum.

A Maintain option, whereby the existing defences and any new defences are constructed to the existing crest levels (i.e. maintaining the current defence height) has been considered as the minimum investment option. However, under such an approach, the standard of protection would decline over time due to the impacts of climate change resulting in sea level rise and increased fluvial flows.

2.3.11 Over-design events and catastrophic failure of barrier

Any options considered must incorporate approaches for managing over-design events. At strategy stage, the design of options is not detailed enough to undertake a detailed analysis of over-design events and their impacts. However, decisions will have to be made about whether wall design must be robust enough to withstand loading from the landward side, or whether walls would be designed to fail to release retained water; and the implications for flood risk. For the purposes of this Strategy, it has been assumed that over-design events will overtop defences and fill compartments without walls failing.

It has been assumed that both Barrier and Hold the Line options will react similarly to over-design events. However, the installation of the barrier gate at an initially higher standard, and the construction of compartment boundaries in C and H to the equivalent level, means that in early years of implementation Ipswich would be less vulnerable to over-design events with a barrier option in place.

Design issues, including the type of barrier, will be addressed in the proposed barrier study. The strategy proposal for the barrier is for the highest “indicative SoP” stipulated by Defra, however the barrier will be designed to incorporate flexibility in the light of future uncertainties.

2.3.12 Climate change

The effects of climate change have been taken fully into consideration within the strategy study, as detailed in Section 2.2.4. These have been incorporated into the modelling outcomes for each option, and hence taken into account within the technical, environmental and economic appraisals.

2.3.13 Environmental implications

The environmental implications of the Hold the Line and Barrier scenarios are detailed in the following section, which details the Strategic Environmental Assessment undertaken as part of this study. A summary table is included as Table 8.

2.4 Strategic Environmental Assessment (SEA)

The Strategic Environmental Assessment (SEA) does not fall within the remit of the recently issued Environmental Assessment of Plans and Programmes Regulations (2004) due to the timescale of the study. However, the context of the SEA Directive and forthcoming UK Regulations was taken into account during the SEA process

2.4.1 Overview of the SEA process

A Strategic Environmental Assessment (SEA) for Ipswich Flood Defence Management Strategy was undertaken alongside the technical and economic assessment. This SEA was undertaken in stages as shown in Table 5. The outcome of the SEA is reported within the document: 'Ipswich Flood Defence Management Strategy, Strategic Environmental Assessment, 2004' (The SEA document, Appendix B to this PAR).

Table 5 Work undertaken within each stage of the SEA process

Stage	Environmental assessment	Consultation	Outcome of the stage
1	- Data gathering	- Introduction to the Study - Seeking Strategic Objective information	- Identify baseline environment and planning context - Establish Strategic Objectives
2	- Further data gathering - Assessment of the Do Nothing option - Step 1 assessment of the generic options to produce a short list of proposed options	- Consultation on the proposed options	- Identification of the short list of proposed options and associated impacts
3	- Step 2 assessment of the proposed options to identify the environmentally preferred option	- Consultation on the overall preferred option	- Identification of the overall preferred option

2.4.2 Environmental assessment of options

In undertaking a flood defence management study it is necessary to consider a range of generic flood defence options including Do Nothing and Do Something options.

Prior to investigating strategic options it is important to understand the implications of not maintaining or improving the flood defences in Ipswich – the Do Nothing approach. An environmental assessment was therefore undertaken, alongside a technical and economic assessment, of the Do Nothing scenario. A summary of the outcome of this assessment is provided as Table 4 in this PAR.

Following the assessment of the Do Nothing approach, an assessment of the generic flood defence strategy options was undertaken as a two-step process. Any options within specific compartments which were identified as completely unacceptable in environmental terms with

no opportunity for mitigation were subsequently removed from the study. A similar process was undertaken relating to the technical and economic issues. This process resulted in a 'short list' of proposed options which were assessed in more detail during Step 2.

During the next stage consultation was undertaken on this 'short list' of proposed options. Information from the consultation and a review of the environmental baseline and planning context enabled the proposed options to be assessed against the Strategic Objectives during the Step 2 environmental assessment. The application of a scoring system allowed the identification of whether or not the specific option was in compliance with each Objective, and to reflect any statutory obligations. This enabled an overall environmental score to be applied to each option and hence the options ranked in order of preference from an environmental perspective. The outcome of this assessment process was the identification of an environmentally-preferred option. This process is reported within the SEA appended to the PAR. This information was fed into the selection of a Strategy option, alongside the assessment of economic and technical issues to enable an overall preferred option to be identified. Consultation was undertaken on the overall preferred option before concluding the outcome of the Strategy Study. It should be noted that the preferred strategy option, once approved, would be subject to project-level environmental impact assessment (EIA). It is at this stage where the specific environmental impacts (for example location, size and nature) would be examined in greater detail.

2.4.3 Strategic objectives

Government guidance (as set out in FCDPAG2 (Defra 2001)) states that the aims and objectives for a Strategy Study "should be established jointly with stakeholders and consultees and be expressed in suitable terms, which address the identified problems without presupposing any specific solution". Strategic Objectives for this study were based on the high level objectives for flood defence management from Defra and reflect the duties and powers of the Agency in the context of flood defence and its other roles. These Objectives are supplemented with Objectives which reflect the local context; these additional Objectives have been established through a:

- consultation process with stakeholders and consultees, in particular the Steering Group; and
- review of contemporary and relevant environmental information made readily available to the study team and associated constraints and opportunities.

The 27 Strategic Objectives were divided into seven groups of impact -human impacts, flora and fauna impacts, amenity impacts, archaeology and heritage impacts, landscape and visual impacts, water impacts and socio-economic impacts. A list of Objectives is provided in Appendix 5 in Section 5.5 of this PAR.

2.4.4 Overview of the objectives-led environmental assessment of the proposed short-list options ("Step 2")

To facilitate an environmental assessment of the proposed options, each option was assessed against the Strategic Objectives. A scoring system was applied to reflect the degree to which each specific option either met or did not meet each Objective. A compliance percentage score was then calculated for each option which enabled the options to be ranked in order of compliance with the Strategic Objectives.

The environmental assessment of the proposed options was undertaken by a multi-disciplinary project team. The outcome was presented to the Steering Group and the assessment revised in response to feedback from the Steering Group on local issues and environmental conditions. This process sought to ensure that all relevant factors were considered in the evaluation of an environmentally preferred strategic flood defence option.

Outcome of the objectives-led environmental assessment of the proposed options

The percentage scores for compliance with the Strategic Objectives and the ranking of the proposed options are provided in Table 6. The assessment tables showing the analysis of each option against the 27 objectives are provided in Appendix 5 (Section 5.5). The assessment process, in parallel with the consultation activities in particular with the Steering Group, identified a number of key issues which appeared to be relevant to the assessment of each of the seven proposed options. These key issues were the:

- Presence of a range of sites designated for their nature conservation value, including European and national status sites;
- Impact of coastal squeeze on European designated sites arising from a Hold the Line approach;
- Historical context of Ipswich and the associated designated archaeological features and heritage areas;
- Existing landscape context of Ipswich;
- Existing and future residential and leisure uses along the Rivers Orwell and Gipping; and the
- Planning context and Area Action Plan for Ipswich.

The outcome of the assessment indicates that a barrier located in the New Cut area in combination with improvements to existing defences where appropriate is the environmentally preferred strategic option. This is discussed in Section 2.7.

Table 6 Percentage compliance and ranking of the strategic options

Ranking	Option	% score
1	**Barrier (option 4a)**	**87**
2	Barrier (option 4b and 4c)	76
3	Hold the Line with retreat option 3c	74
4	Hold the Line with Retreat option 3a	70
5	Hold the Line	68
5	Hold the Line with retreat option 3b	57

Further details of the Strategic Environmental Assessment are provided within the SEA document (Appendix B). A summary of the key impacts of the barrier and hold the line options is tabled in Section 2.7 as part of the preferred option identification.

2.5 Costs of Options

2.5.1 Option Costings Basis

The option construction costs were estimated from Contractor information, previous schemes of similar works and from estimation handbooks[3]. The cost of a barrier was cross-checked through an independent calculation by a Cost Consultant. The prices were brought to a common base date using appropriate price indices. A contingency cost of 25% to cover the residual risks described in Section 3.9 was initially added to the material costs only (i.e., not to the other costs such as general and preliminaries or access etc). Therefore the optimism bias factor applied to the total present value cost has been reduced from 60% to 35% (resulting in net 60% allowance). This is a conservative approach, as the contingency will have been factored up into compensation, engineering fees and Agency costs to effectively be 31%. The cost build-up sequence is shown in Table 7.

Table 7 Cost build up sequence

Cost of Materials, Plant and Labour
(1) MATERIAL COST (MC)
General and Preliminary Items (25-30% of MC) Contingencies (25% of MC) Access (5-10% of MC)
(2) CONSTRUCTION COST (CC)
Land Purchase (£6.530/ha) Compensation (5% of CC) Site Investigation (£20/linear m)
(3) SUB TOTAL (ST)
Engineering Cost (15% of ST) Agency Cost (5% of ST)
(4) TOTAL COST (TC)
Optimism bias (35% of TC)
(5) TOTAL COST (inc. optimism bias)

The works are split into two categories – asset replacement and raising/improvement works. For the purposes of this cost calculation, the total cost of providing flood defences to the required standard of protection is the sum of the cost of raising the defences to that standard plus the cost of replacing the defences to that higher standard when they reach the end of their residual life. In addition to this, annual maintenance over the whole Strategy period and the cost of refurbishment works to the existing control structures has been included. For the barrier option, the cost of construction of the barrier has been considered as well as the additional maintenance costs over the Strategy period for the new structure.

The barrier itself as a single cost entity has a slightly different distribution of add-on percentages. General and preliminary works are higher at 35%. Land purchase and compensation costs are single costs of £0.9M and £1M respectively. Engineering cost is £1.5M, and Agency costs are £0.2M, distributed over the first 5 years.

2.5.2 Replacement Works

Black & Veatch undertook a detailed Condition Survey (Appendix C) of all of the defences in Ipswich as part of the Study. The construction type, crest level, length, condition and residual life were recorded for each flood defence in the study area. Defences which were classified 'undefended' during the Condition Survey have not been assigned a raising or replacement cost in this calculation. It is assumed that the first replacement works to each defence will take place during its residual life bracket.

The existing defences have been assumed to be replaced on a like for like basis, apart from masonry walls, which are assumed to be replaced by concrete for the purposes of this costing. The types of defence considered are concrete walls, steel sheet pile walls and earth embankments. The design life of new structures has been assumed as follows:

- Concrete walls – 100 years after replacement
- Steel sheet pile walls – 50 years after replacement
- Earth embankments – 30 years after replacement (to major refurbishment)

For the Hold the Line scenario it has been assumed that all replacement works are to the required crest level to protect to the specified standard in the next replacement year. For the Barrier scenario, in order for the barrier to provide a uniform standard of protection to the entire barrier compartment, it has been assumed that all replacement works (within the barrier compartment) will be to the required crest level at end of the strategy period (i.e. 2102).

Under the Barrier scenario, if no river wall defence is required in the barrier compartment costs have been allowed for to maintain the riverbank where the Agency may be obliged to undertake such works.

2.5.3 Wall Raising

It has been assumed that all raising works will be undertaken in the first 5 years of the Strategy, so that the Strategy standard of defence is implemented within this timescale. Necessary replacement works/construction of new defences will also be undertaken during this time.

As with replacement works, it has been assumed that raising works under Hold the Line are to the required crest level in the next replacement year and those required under the Barrier scenario are to the crest level required for 2102.

It was assumed for the purposes of this cost calculation that all defences in Ipswich have the capacity to be physically raised by up to 600mm, subject to a site investigation of some kind. Where defences would require raising in excess of 600mm it has been assumed that the defences would need to be replaced. However, recent information from the Port Authority, and the recent failure of a wall on the Island Site, indicated that none of the walls in C or H were robust enough to withstand additional raising works. Therefore, any need for increased defence height in these compartments would necessitate replacement of the existing walls. This is reflected in the costings. All consequent replacement works will be carried out to the same timetable as the raising works.

2.5.4 Visual mitigation for high walls

Compartments C (right bank) and H (left bank) in Ipswich have been identified as having great potential for development, with the River Orwell at the focal point becoming an important recreational feature.

In order to protect against tidal flooding under the Hold the Line options, large flood defences are required along these compartments, which will impede the view of the river from the riverside developments. It has been suggested through discussion with Ipswich Borough Council that this is unacceptable and unless mitigation is sought, planning consent for the flood defence works in these areas could be rejected.

An allowance has been made for sympathetic facing of the walls in the urban area, on the landward and riverward faces. In addition, given the significant height of walls, viewing panels have been allowed for in all walls in compartments C and H will be more than 1.5 metres above the landward ground level. It has been assumed that the viewing panels have a design life of 50 years, after which wall replacement (including the viewing panels) is required.

2.5.5 Barrier Option

The most viable 'advance' option considered as part of this study concerned the construction of a tidal barrier in the River Orwell at a site within the New Cut, upstream of the Velocity Control Structure. This location was chosen to allow the option to be costed. The actual location will need further study in order to determine the optimum barrier position with minimum risk.

Cost consultant Arup provided an approximate construction cost for a tidal barrier of £18 - £24 million. £18 million has been used in the base case costings as the higher figure did not reflect the likely barrier types considered within the BV cost estimate; however £24 million was used as a sensitivity test (see below). An earlier report (1997) by Montgomery Watson[11] assessed the cost of a barrier/barrage with road bridge at approximately £11.35M, which was considered too low to use as a reference point

2.5.6 Maintenance Costs

Maintenance costs have been allowed for new and existing defences (including the barrier) and control structures.

2.5.7 Control Structures

There are several control structures on the Gipping and Orwell rivers which regulate river level, flow and velocity. These structures are:

- Norwich Railway Line Sluice
- Horseshoe Sluice
- Handford Sluice
- Velocity Control Structure
- Bourne Sluices

Kenneth Grubb Associates (KGA) produced a report (Appendix D) on behalf of BVCs as part of Stage 1 of the study. The report found that the control structures were coming to the end of

their useful life and all would require major refurbishment in as little as 5 years time. The report also provided costs for the refurbishment of these structures to increase their useful life to 25 years. These costs have been used in this cost calculation.

2.5.8 Summary of Costs and Timings

The total gross (non-discounted) and present value (PV) costs for each option considered are set out in Table 8. For the Barrier scenario, costs are presented for the barrier compartment only. These costs include works to the control structures and installation of the barrier, as well as raising and replacement works to defences.

Table 8 Gross and PV costs for all options considered

Strategic Option	Option	Gross costs, £	PV costs, £
Maintain	Maintain	87,622,165	24,808,787
Hold the Line	1 in 2	77,922,251	22,460,443
	1 in 5	84,418,928	25,145,124
	1 in 10	87,459,444	26,665,184
	1 in 20	90,631,415	27,542,282
	1 in 50	94,465,444	30,043,380
	1 in 100	103,673,774	38,020,266
	1 in 200	107,980,917	41,089,312
	1 in 300	108,821,012	42,361,868
Barrier	1 in 100 barrier	38,338,566	28,157,287
	1 in 200 barrier	38,936,991	28,627,733
	1 in 300 barrier	38,936,991	28,983,567

All costs have been updated to Q2 2004 using a construction price index[4], and discounted over the 100-year appraisal period.

2.5.9 Sensitivities

To ensure a robust decision is made in terms of options selection, numerous sensitivity tests have been carried out on the costs to test the effect of changing the assumptions made in deriving the costs. These are summarised below, their impact on the decision (in terms of economic preference) are summarised in Section 2.7.

- Increased rate of replacement (i.e. reduced assumed design life as follows: 75 yrs for concrete walls, 35 years for steel sheet pile walls, 25 years for earth embankments and 35 years for viewing panels).

- Implement 2102 Strategy defence levels by Year 5 (i.e. defence level required for specified SoP in 100 years time).

- Operate Norwich Railway Line Sluice to hold back fluvial water (assumed not to operate under base case assessment, and therefore replacement costs of structure not included).

- Increase 1 in 300 SoP barrier cost to £24 million.

- Increase barrier maintenance cost to £1.5 million every ten years, as initially suggested by the Agency's cost consultant, Arup. (Through discussions with BVCs experts, it was decided that this allowance for maintenance was generous and was consequently reduced under the base case assessment).

- Through the consultation process, the barrier option was identified by the majority of consultees as the preferred option for Ipswich. It was generally felt that the implementation of a Hold the Line option would lead to the construction of high flood defences along the river bank, which could reduce the potential for riverside development in Ipswich. A sensitivity test was undertaken to assess the impact that a public enquiry process might have on the total project cost.

- A sensitivity test of the cost of a public enquiry was also undertaken for the barrier option, using the 0.5M cost, for comparison.

- Debbages Boatyard is a commercial property located in compartment C, upstream of the barrier location used for the purposes of this cost calculation. The construction of a tidal barrier in the River Orwell will impact on the navigability of the river, which may have an adverse impact on the business activities of Debbages Boatyard. Therefore, a sensitivity test was carried out where the cost of relocating Debbages Boatyard was included in the total option costs. It was assumed that the cost of relocating the business is in the order of £500k, which is very conservative.

- The initial timing of wall replacements is determined by the assessed residual life of the defences. A sensitivity test was undertaken where the residual life bands were reduced with the intent that the defences would be initially replaced earlier in the Strategy period

- Arcelor have recently bought Corus and closed the Corus sheet piling mill. As a result the Agency will no longer have access to sheet piling from Corus and will have to import sheet piling from the continent for future projects. In addition to this, demand for steel worldwide has grown substantially due to the major development taking place in China and other developing economies, pushing up the price of scrap steel and raw materials. The Agency has received advice that these two recent events may increase the cost of steel from current prices by 30% over the next twelve months. A sensitivity test was undertaken where the cost of steel (for both sheet piling and the barrier) has been increased by 30%. On a more positive note, Arcelor uses only recycled metal, improving the sustainability of any sheet piling works.

The findings of the sensitivity analyses are discussed in Section 2.7.

2.5.10 Optimism Bias Cost

Recent changes to Defra Guidance require Strategy costs to be increased by up to 60% to account for appraisers' initial optimism in the production of cost estimates. A table of risk factors and average percentages of optimism bias is presented by Defra, to be modified as necessary in relation to project specifics.

Analysis of the risk components relating to optimism bias for Hold the Line and Barrier was undertaken. Whilst the two options have different risks, the overall risks to each in terms of optimism bias proved very similar – the Barrier option has higher risk in terms of engineering difficulty, whereas the Hold the Line option has higher risks in terms of planning constraints, need for public enquiries and public opposition.

Given that the benefit cost ratios for the two options proved to be relatively similar, it was decided to use the same optimism bias percentage for both, at the full 60%, and to test the

impacts of risk realisation on the preferred option through sensitivity analyses. This will enable clarity and visibility of decision-making.

Optimism bias has been applied after the total present value costs for each option have been determined. A risk register is included in Appendix 3 (Section 5.3) to this document for the preferred option. Monte Carlo analysis has not been applied, given that the costings are high level due to the high level of uncertainty.

2.5.11 Preferred Option Costs

A breakdown of the preferred option costs in terms of present value, gross cost and Agency SOD approval cash cost (including 60% optimism bias) is shown in Table 9. An annualised spend profile is included in detail in Section 3.4

Table 9 Cost breakdown for preferred option

	Cost for economic appraisal (with Optimism Bias)	Gross cost (with Optimism Bias)	Agency SoD approval cost Cash (without Optimism Bias)
Costs to PAR:			
Agency Staff	Sunk Costs	101,000	101,000
SI Costs	Sunk Costs	5,500	5,500
Consultant	Sunk Costs	309,100	309,100
Contractor	Sunk Costs	58,000	58,000
Cost Consultant	Sunk Costs	1,500	1,500
PAR to Construction:			
Agency Staff	239,746	457,209	292,025
SI Costs (+ public enquiry)	758,202	823,052	1,139,403
Consultant	826,055	1,420,854	1,100,901
Contractor			
Cost Consultant	145,774	250,744	194,277
Other Costs	4,930,529	8,288,551	1,788,268
Construction:			
Construction costs	22,085,370	36,511,520	31,350,350
Inflation Allowance for * months			
Agency staff	479,492	914,419	584,049
Site Supervision	1,652,111	2,841,768	2,201,803
Cost Consultant	291,549	501,489	388,553
Compensation	1,360,726	2,109,977	2,226,739
Other Costs	9,861,057	16,577,102	3,576,535
Future Costs:			
Maintenance	1,025,078	3,348,756	
Future construction	Included over 100 years	Included over 100 years	
TOTAL	**43,655,690**	**74,521,472**	**45,318,902**

2.5.12 Contributions

Much of the river frontage, and some sections of river, is owned by either the Port or Ipswich Borough Council, some frontages also being owned by individuals or small businesses. If the Strategy proposes renewing frontages owned by others, in circumstances where the flood wall is founded on those frontages, a contribution will be sought from the owners who benefit from having their frontage replaced. This is not a flood risk benefit, simply the benefit of having an asset renewed. Considerable dialogue has been maintained with consultees who may be

deemed "beneficiaries" if the strategy is adopted and the early works are implemented. These include the local authorities and developers.

To date there has been no firm offer of commitment to contributions. However, EEDA have indicated that they may contribute to a further barrier study if a case is made for the regeneration effect on Ipswich. In addition, recent correspondence from Ipswich Borough Council has identified that the Haven Gateway Partnership has applied for £16M of regeneration funding for the Haven Gateway area (Harwich, Tendring, Ipswich, Felixstowe), some of which may be secured as contribution funding for the barrier.

2.6 Benefits of Options

2.6.1 Methodology

Detail of the methodology used to calculate the damages can be found in the Economic Appraisal Report (Appendix H) and in the Strategy Report itself. Economic appraisal has been carried out in accordance with FCDPAG3[5] and the Supplementary Note of March 2003[6] to FCDPAG3, using flood damage data from the Multi-coloured Manual (MCM)[7].

The benefits are defined as the loss averted by implementing the strategy. The economic benefits are therefore the difference between the Do Something and Do Nothing damages. The assessment of the value of the damage caused by flooding has been estimated using established techniques. The present value (PV) of the Do Nothing and Do Something damages over the 100 year appraisal period has been obtained using a discount rate of 3.5% Years 0 to 30, 3.0% Years 31 to 75, reducing to 2.5% thereafter, as stipulated in the Supplementary Note to FCDPAG3[6].

Compartment boundaries were identified from the LiDAR data and confirmed with site visits, which spot levelled at the boundaries. The extent of transference across boundaries was tested. Allowance for raising or strengthening compartment boundaries to reflect the standard of protection has been made allowance for within the option costing.

For the purposes of the strategy, given the urban area, all benefits are assumed to be avoidance of flood losses.

Some properties are flooded with such frequency that it is more economic in the long term to abandon them rather than to repair each time flooding occurs. In such cases properties are "written off" whereby the value of the asset (the write off cost) is incurred only once instead of an AAD each year. This approach was used for the Do Nothing and Do Something scenarios.

Damages within the port have been based on a maximum total cost of cargo on the port land of £25 million, using data from ABP. The total area of the port has been measured as 0.916km^2, resulting in an average damage value per square metre of £27.3. The port land is split between compartments B, G and H. In theory, the majority of the value of the port is mobile and therefore able to relocate. This approach has been adopted for Do Nothing (i.e. no port damages included in the Do Nothing damages calculation); however, under a Do Something scenario it has been assumed that the port will not relocate as it is protected up to a given standard of protection. In addition, discussions with ABP have led to the port areas in compartments B and G being undefended due to the location of the line of defence behind the port land. Consequently, damages associated with the port have only been included for compartment H under the Do Something scenario.

All damages have been updated to August 2004 using the Retail Price Index[8].

2.6.2 Do Nothing

Under the Do Nothing scenario it has been assumed that damages will arise from overtopping of the existing defences until the first wall failure in each compartment. The point of failure is determined by the assessed lowest residual life of the existing defences within the compartment. A probabilistic assessment has been made to determine the probability of a defence failing in a particular year before the end of its residual life, this being unity once the residual life of the asset has been reached.

A summary of the PV damages for the Do Nothing scenario is provided in Table 10.

Table 10 Summary table of Do Nothing present value damages

Compartment	Do Nothing
A	4,743,784
B	18,371,555
C	32,953,536
D	2,231,552
E	12,565,332
F	no assets at risk
G	no assets at risk
H	79,275,892
I	2,436,402
J	209,658,873
K	7,182,182
L	1,252,122
Total	**370,671,231**

2.6.3 Do Something Options

Do Something options examined include:

- Maintain existing defences along the existing line
- Hold the Line to a range of standards
- Barrier to a range of standards

The town of Ipswich already has a Flood Warning scheme in place. The aim of this scheme is to save lives by warning people prior to a flood event. As any scheme could be affected by a higher-than-standard storm, it is considered that flood warning will remain necessary for any option. Therefore it has not been considered as a separate option, but incorporated within every option.

2.6.4 Maintain

Under the Maintain option, damages are accrued from overtopping of defences set to the existing crest levels. The amount of damage accrued each year will increase due to the decrease in the standard of protection as sea levels rise. The existing standard of protection for each compartment was discussed previously in Section 2.2.3.

Under the Maintain option, it has been assumed that defences are maintained and therefore not subject to failure.

A summary of the PV damages for the Maintain scenario is provided in Table 11.

Table 11 Summary table of Maintain present value damages

Compartment	Maintain
A	4,751,032
B	17,616,160
C	25,794,429
D	968,685
E	9,253,432
F	no assets at risk
G	no assets at risk
H	65,865,606
I	1,710,421
J	94,776,604
K	4,996,327
L	513,016
Total	**226,245,713**

2.6.5 Hold the Line

For the purposes of the damages calculation, under the Hold the Line scenario it has been assumed that the required standard of protection is implemented in Year 5. Thereafter, the required standard of protection is maintained, resulting in the same damage being accrued each year to the end of the appraisal period. Prior to Year 5, damages are only accrued due to overtopping of the existing defences. Damages are only caused by overtopping of the defences as it has been assumed that defences will be maintained and therefore not subject to failure. The total present value damages for each of the Hold the Line options is summarised in Table 12.

Table 12 Summary of Hold the Line PV damages

Compartment	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200	1 in 300
A	5,328,998	5,001,480	4,059,814	3,260,853	2,318,649	1,915,628	1,704,122	1,543,779
B	11,927,288	10,927,959	7,490,772	4,911,084	3,073,753	2,184,164	1,781,645	1,659,722
C	37,715,678	32,907,919	28,815,173	19,875,160	10,704,702	4,536,687	1,787,581	1,254,761
D	2,934,610	2,592,486	2,286,864	1,460,092	718,989	404,673	252,785	208,530
E	18,414,936	14,977,332	12,538,467	9,351,078	6,091,460	4,078,730	2,393,989	659,830
F	no properties at risk							
G	no defences required							
H	82,061,147	80,461,600	70,673,138	45,675,481	26,017,440	14,033,174	8,878,128	4,359,999
I	3,777,645	3,014,109	2,586,634	1,617,372	893,803	539,229	376,014	155,535
J	219,424,139	209,421,673	185,481,272	101,619,672	55,304,807	25,224,569	7,961,545	3,928,336
K	12,018,943	9,832,008	7,355,478	5,271,599	3,656,437	1,789,631	443,593	227,077
L	1,646,249	1,575,751	1,486,010	1,044,101	760,122	492,588	298,515	265,848
Total	**395,249,633**	**370,712,316**	**322,773,621**	**194,086,492**	**109,540,162**	**55,199,073**	**25,877,918**	**14,263,417**

2.6.6 Barrier

As discussed previously, consideration has been given to a tidal barrier located in the New Cut. Such a barrier would protect compartments C, D, E, H, I, J and K from tidal flooding. Compartments A, B, F, G and L would be unaffected by the barrier as they are either downstream of its proposed location (compartments A, B and G) or upstream of the tidal limit (compartments F and L).

Compartments C, D, E, H, I, J and K can be treated as one compartment (called the 'barrier compartment) as they will be protected to a uniform standard of protection. In addition to the barrier, existing defences within the barrier compartment will still be required and may require some raising/replacing to protect against fluvial flooding. Protection against fluvial flooding is to be to the same standard of protection as that against tidal flooding, thereby providing a uniform standard of protection throughout the barrier compartment against all extreme events.

For the purposes of the damages calculation, under the Barrier scenario it has been assumed that in Year 5 the barrier will be operational and flood defences will be in place within the barrier compartment to protect against the specified standard of protection in 100-years time. Prior to Year 5, damages are only accrued due to overtopping of the existing defences. As, with the Maintain option, damages are only caused by overtopping of the defences as it has been assumed that defences will be maintained and therefore not subject to failure.

Barriers offering standards of protection lower than 1 in 100 have not been considered as these would be below the range of the indicative standard. In addition, the majority of the cost of the barrier is in the super structure and it was considered that spending such a large amount of money was not justifiable for standards below 1 in 100 years.

The total present value damages for the barrier options are summarised in Table 13.

Table 13 Summary of Barrier PV damages (barrier compartment only)

Compartment	1 in 100 barrier	1 in 200 barrier	1 in 300 barrier
A	N/A	N/A	N/A
B	N/A	N/A	N/A
Barrier	50,606,693	22,093,636	9,942,193
L	N/A	N/A	N/A
Total	**50,606,693**	**22,093,636**	**9,942,193**

2.6.7 Summary of Benefits

The benefits, being the reduction in damages from the Do Nothing to the Do Something damages, have therefore been calculated as in Table 14. For the Hold the Line options, compartments have been grouped into those included in the barrier compartment and those not affected by the barrier ('other' compartments).

Table 14 Summary of PV benefits for all Do Something options (Maintain, Hold the Line and Barrier options)

Compartment	Maintain	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200	1 in 300	1 in 300 barrier
A	-7,248	-585,214	-257,696	683,970	1,482,931	2,425,135	2,828,156	3,039,662	3,200,005	N/A
B	755,395	6,444,267	7,443,597	10,880,784	13,460,472	15,297,803	16,187,392	16,589,910	16,711,833	N/A
C	7,159,108	-4,762,141	45,617	4,138,364	13,078,376	22,248,835	28,416,849	31,165,956	31,698,776	
D	1,262,867	-703,057	-360,934	-55,312	771,461	1,512,563	1,826,879	1,978,767	2,023,023	
E	3,311,901	-5,849,604	-2,411,999	26,866	3,214,254	6,473,872	8,486,602	10,171,343	11,905,503	
H	13,410,286	-2,785,256	-1,185,708	8,602,754	33,600,410	53,258,451	65,242,718	70,397,763	74,915,893	336,361,576
I	725,981	-1,341,243	-577,707	-150,232	819,030	1,542,599	1,897,173	2,060,388	2,280,868	
J	114,882,268	-9,765,266	237,200	24,177,601	108,039,201	154,354,066	184,434,304	201,697,327	205,730,536	
K	2,185,854	-4,836,761	-2,649,826	-173,296	1,910,583	3,525,744	5,392,550	6,738,589	6,955,104	
L	739,106	-394,127	-323,629	-233,888	208,021	492,000	759,534	953,607	986,274	N/A
Total	**144,425,518**	**-24,578,402**	**-41,085**	**47,897,611**	**176,584,739**	**261,131,069**	**315,472,158**	**344,793,313**	**356,407,814**	**336,361,576**

It should be noted that for many of the lower standard of protection options, the benefits are negative. This is due to the timing of the write off (spread due to probability and discounted under Do Nothing and in Year 0 for Do Something options). No benefits are given for the barrier option for compartments A, B and L as these are not within the barrier compartment and are therefore not affected.

2.6.8 Socio-economic effects

In July 2004 Defra issued revised guidance to Economic Appraisal procedures[5] on reflecting socio-economic equity in economic appraisals and the appraisal of human related intangible impacts of flooding[12]. At this time the economic appraisal for this study was in its final stages.

Deprivation has been considered in the Priority Score assessment with one point added to the People component of the final score, see section 2.7, indicating that the study area is more economically deprived than the UK on average. Therefore, the justification for the pursuit of the strategy would only be enhanced further by including the latest guidance from Defra on reflecting socio-economics equity. The effect on humans (i.e. stress) due to flooding has not been considered as it would again only improve the case for a strategy that was already justified. The additional work to implement this latest guidance was therefore considered not necessary at this stage as the additional benefit in terms of increased BCR was outweighed by the cost of carrying out the work.

2.7 Choice of Preferred Option

As stated above, river-wide managed realignment was discounted at an early stage due to the urban nature of the area and the limited flood plain in most areas. Consideration of managed realignment options identified that any proposed set back at the wet dock area would still need to be at the waters edge given the extensive development of the area.

Cost and technical implications excluded the two most downstream barrier sites. Section 2.3 discusses this in more detail, along with the fact that setback sites at Wherstead and at the proposed parkland site upstream of the wet dock were unlikely to be of an order of difference to hold the line in terms of hydrodynamic impact and cost.

FCDPAG4[9] approaches have been used to determine risk of defence failure as well as risks of options. A Risk 2.2 risk register has been compiled for each option. Optimism Bias of 60% has been used for both options, based on the fact that whilst a barrier has more technical risk, Hold the Line has more risks in terms of acceptability. This also allows a greater clarity in decision making, as risk issues can be clearly addressed in the sensitivity analysis.

2.7.1 Economic Appraisal of options

Hold the Line preferred option

For the Hold the Line scenario a FCDPAG3 table summarises the PV costs and PV benefits, along with the resulting benefit cost ratio (BCR) and net present value (NPV) for each compartment. More detail can be found in the Economics Appendix (H). The economically preferred Hold the Line option for each compartment has been identified by following the FCDPAG3 decision rule and these are summarised in Table 15. It can be seen that the overall benefit cost ratio is 7.46 and the NPV is £302 million.

Table 15 Summary of preferred Hold the Line option for each compartment

Compartment	SoP	Cost (including optimism bias), £	Benefit, £	BCR	NPV, £
A	no scheme				
B	1 in 100	3,912,271	16,187,392	4.14	12,275,121
C	1 in 300	12,603,002	31,698,776	2.52	19,095,773
D	1 in 100	1,707,714	1,826,879	1.07	119,165
E	1 in 300	5,665,357	11,905,503	2.10	6,240,145
F	no properties at risk				
G	no defences required				
H	1 in 300	14,946,474	74,915,893	5.01	59,969,418
I	no scheme				
J	1 in 300	6,829,042	205,730,536	30.13	198,901,494
K	1 in 200	1,127,777	6,738,589	5.98	5,610,812
L	no scheme				
Overall HTL		**46,791,639**	**349,003,567**	**7.46**	**302,211,928**

Table 15 shows that under the Hold the Line scenario, there is no viable scheme for compartments A, I and L as no option had a BCR greater than unity. No intervention options have been considered for compartment F as there are no properties at risk from flooding. Compartment G consists of port owned land only and ABP has indicated that no defences are required. For the remaining compartments, a variable standard of protection is provided, ranging from 1 in 100 to 1 in 300. The preferred Hold the Line option is shown in Figure 8. It must be noted that of these compartments, only J is robust enough to secure funding.

Of the above, compartments C, D, E, H, I, J and K can be compared directly with the barrier option. Outside these compartments, there is only the Hold the Line option to compare against Do Nothing.

All PAG tables are detailed in the Economics Appendix, which includes details of the incremental benefit-cost ratios etc.

Barrier preferred option

For the Barrier scenario, all compartments to be protected by the barrier have a uniform standard of protection and therefore are considered as one compartment. The economic analysis for the Barrier scenario showed that the 1 in 300 SoP barrier was the preferred option, having the highest BCR. The benefits and costs for the barrier compartment for the 1 in 300 SoP option are shown in Table 16 along with the resulting BCR and NPV. Table 16 also shows the equivalent option for the Hold the Line scenario. The preferred Barrier option is shown in Figure 9.

Table 16 FCDPAG3 summary table of preferred Barrier and Hold the Line option for barrier compartment only (compartments C, D, E, H, I, J and K)

Compartment	SoP	Cost (including optimism bias), £	Benefit, £	BCR	NPV, £
C	1 in 300	12,603,002	31,698,776	2.52	19,095,773
D	1 in 100	1,707,714	1,826,879	1.07	119,165
E	1 in 300	5,665,357	11,905,503	2.10	6,240,145
H	1 in 300	14,946,474	74,915,893	5.01	59,969,418
I	no scheme				
J	1 in 300	6,829,042	205,730,536	30.13	198,901,494
K	1 in 200	1,127,777	6,738,589	5.98	5,610,812
Overall HTL		**42,879,368**	**332,816,176**	**7.76**	**289,936,808**
Overall Barrier	**1 in 300**	**39,127,816**	**336,361,576**	**8.60**	**297,233,761**

Table 16 shows that for the barrier compartment, the BCR is 8.60 for a 1 in 300 SoP barrier and the NPV is £297 million.

Hold the Line v Barrier Option

Comparing the two options for the barrier compartment, and referring to Table 17 it can be seen that the Barrier option provides an overall higher SoP to the barrier compartment and at lower cost, resulting in a higher BCR and NPV. The 1 in 300 SoP Barrier option is therefore the economically preferred option for Compartments C,D,E,H,I,J,K.

Overall preferred option

The preferred option overall is shown in Table 17.

Table 17 Summary of preferred option for each compartment

Comp.	SoP	Cost (including optimism bias) £	Benefit £	BCR	NPV £	No. of residential properties protected
A	No Scheme					0
B	1 in 100 HTL	3,912,271	16,187,392	4.14	12,275,121	211
C,D,E,H,I,J,K	1:300 barrier	39,127,816	336,361,576	8.60	297,233,761	629
F	No properties at risk					0
G	No defences required					0
L	No Scheme					0
Preferred Strategy		**43,040,087**	**352,548,968**	**8.19**	**309,508,881**	**840**

Under the economically preferred option, compartments C, D, E, H, I, J and K (known collectively as the barrier compartment) will be protected to a 1 in 300 SoP (tidal and fluvial) via a tidal barrier constructed in the New Cut and some wall improvement works along the

river frontage. Compartment B will be protected to a 1 in 100 SoP (tidal and fluvial) by wall improvement works. No active intervention is proposed for the remaining compartments.

Discussions with Defra have indicated that decision making should ultimately focus on the robust economic appraisal and return on public investment. A number of assumptions have been made in order to develop the costings and the benefit assessment – these assumptions have been tested through sensitivity analysis to inform the decision making process.

2.7.2 Sensitivity Testing

A key issue in sensitivity testing for HTL is that for some cases tested, the application of the decision rule changed the preferred standards of defence for the flood compartments, making protection no longer viable in some compartments. Therefore, a comparison of changes in BCR is not sufficient to reflect the impact on the local population of these changes.

The benefit cost ratios resulting from the various sensitivity tests undertaken are summarised in Table 18, which shows that the BCR for the Hold the Line scenario (overall) ranges from 7.15 to 8.05, and that for the Barrier from 7.08 to 10.38.

Table 18 Summary benefit cost ratios resulting from sensitivity tests

	Preferred option	**HTL BCR**	**Barrier BCR**	**HTL NPV**	**Barrier NPV**
Base Case	Hold the Line: A: No scheme B: 1 in 100 C: 1 in 300 D: 1 in 100 E: 1 in 300 H: 1 in 300 I: No scheme J: 1 in 300 K: 1 in 200 L: No scheme Barrier: 1 in 300 Barrier Overall: Barrier	Barrier comp: 7.76 Overall: 7.46	Barrier comp **8.60** Barrier + B: **8.19**	Barrier comp: £290m Overall: £302m	Barrier comp: **£297m** Barrier + B : **£310m**
Norwich railway line sluice in operation	Overall: Barrier	Base Case Barrier comp: 7.76 Overall: 7.46-	Barrier comp: **11.20** Barrier + B: **10.38**	Base Case Barrier comp: £290m Overall: £302m-	Barrier comp: **£306m** Barrier + B: **£319m**
Implement 2102 SoP by year 5	Hold the Line: B: 1 in 20 C: 1 in 50 D: No scheme E: 1 in 100 J: 1 in 200 K: 1 in 50 Overall: Barrier	Barrier comp: 6.75 Overall: 7.75	Base Case Barrier comp **8.60** Barrier + B: **8.19**	Barrier comp: £284m Overall: £297m	Base Case Barrier comp: **£297m** Barrier + B : **£310m**

Table 18 Summary benefit cost ratios resulting from sensitivity tests cont.

Sensitivity test	Differences to base case	HTL BCR	Barrier BCR	HTL NPV	Barrier NPV
Increased wall replacement rate	Hold the Line: C: 1 in 50 D: No Scheme Barrier: No change Overall: Barrier	Barrier comp: 7.93 Overall: 7. 53	Barrier comp **8.22** Barrier + B: **7.80**	Barrier comp: £281m Overall: £293m	Barrier comp: **£295m** Barrier + B: **£307m**
Reduced Residual Lives	Hold the Line: D: No scheme Barrier: No change Overall: Barrier	Barrier comp: 7.84 Overall: 7.50	Barrier comp **8.48** Barrier + B: **8.07**	Barrier comp: £289m Overall: £301m	Barrier comp: **£297m** Barrier + B: **£309m**
Increased barrier structure cost	Barrier: No change Overall: HTL	Base Case Barrier comp: **7.76** Overall: **7.46**	Barrier comp: 7.33 Barrier + B: 7.08	Base Case Barrier comp: £290m Overall: £302m	Barrier comp: **£290m** Barrier + B: **£303m**
Increased barrier maintenance costs	Barrier: No change Overall: HTL	Base Case Barrier comp: **7.76** Overall: **7.46**	Barrier comp: 7.50 Barrier + B: 7.23	Base Case Barrier comp: £290m Overall: £302m	Barrier comp: **£292m** Barrier + B: **£304m**
30% increase in steel cost	Hold the Line: C: 1 in 50 D: No scheme Barrier: No change Overall: HTL	Barrier comp: **8.42** Overall: **8.00**	Barrier comp 8.32 Barrier + B: 7.93	Barrier comp: £283m Overall: £296m	Barrier comp: **£296m** Barrier + B: **£308m**
Public enquiry 0.5M	Overall: Barrier	Overall: 7.38	Barrier comp: **8.46** Barrier + B: **8.05**	Overall: £302m	Barrier comp: **£297m** Barrier + B: **£309m**

Table 18 Summary benefit cost ratios resulting from sensitivity tests cont.

Sensitivity test	Differences to base case	HTL BCR	Barrier BCR	HTL NPV	Barrier NPV
Hold the Line further public enquiries: **enquiry 2** **enquiry 3** **enquiry 4**	Overall: Barrier	Overall: 7.30 7.23 7.15	Base Case Barrier comp **8.60** Barrier + B: **8.19**	Overall: £301m £301m £300m	Base Case Barrier comp **£297m** Barrier + B: **£310m**
Barrier and buy out Debbages Boatyard	Overall: Barrier	Base Case Barrier comp: 7.76 Overall: 7.46-	Barrier comp: **8.49** Barrier + B: **8.10**	Base Case Barrier comp: £290m Overall: £302m	Barrier comp: **£297m** Barrier + B: **£310m**
Increased land value	Hold the Line: No change Barrier: No change Overall: Barrier	Barrier comp: 8.41 Overall: 8.05	Barrier comp **9.89** Barrier + B: **9.37**	Barrier comp: £318m Overall: £330m	Barrier comp: **£348m** Barrier + B: **£360m**

Sensitivity analysis

The history of the Ipswich strategy has indicated that the choice of economically preferred option is sensitive to changes in costings. A number of analyses have therefore been carried out, to review impacts on barrier justification, impacts on Hold the line justification, and impacts on choice of preferred option of changes in the base case assumptions. These sensitivity analyses are documented in the cost and benefit appendices.

The first important finding is that if the barrier can be operated in conjunction with the Norwich Railway Line Sluice, far fewer fluvial defences will be required upstream, and therefore there is a large cost saving, increasing the barrier benefit cost ratio to 11.20, and the NPV to £306M. The uncertainties relating to upstream impacts if the sluice is closed during a fluvial event have been flagged in the modelling appendix (E). For this reason, this cannot be taken as the base case for the barrier option until resolved. A study is presently being undertaken for the fluvial river Gipping. It is recommended that the findings are used to inform the next stage of study; however the outcome of that study can only make the preferred option more favourable, therefore the Strategy is not dependent on the fluvial strategy for implementation.

The barrier proposal includes implementing the 2102 standard in the barrier compartment by year 5. The equivalent approach for Hold the Line reduced the BCR to 6.75 from 7.76, demonstrating that the barrier remains better value. The implementation of the 2102 standard in year 5 for the barrier has been proposed due to the majority of the barrier cost being infrastructure which will remain in place for the 100 years – it was therefore considered

sensible to maximise the benefit of this early investment by undertaking other works to give full closure to the barrier compartment.

Various tests have been undertaken to assess the impacts of cost increases. Increasing the rate of wall replacement, or reducing the initial residual life of the walls, both **increase** the BCR for hold the line, by changing the standards and compartments protected on application of the Decision Rule. The tests reduced the BCR and NPV for the barrier, although this remained the preferred option. The impacts of solely increasing barrier costs were to reduce the BCR to below that of Hold the line base case, although the NPV for the barrier remained higher. This demonstrates the sensitivity of the preferred option, although this was tested against a significant cost increase on top of the optimism bias. A sensitivity test for the new supplier of steelwork and piling in the UK found that increasing the cost of steel by 30% also made the barrier slightly less cost-beneficial than Hold the Line – again the NPV for the barrier remained significantly higher; the standard in C reduced to 1:50 (below the indicative standard) and the protection to D was no longer justified. In reality, it is likely that this scale of cost will not be standard across the range of steel products (sheet pile costs will increase more).

The implications of objections to the options were considered. Consultees have indicated that they would require a public enquiry if the Hold the Line option was implemented – this has the effect of reducing the BCR to between 7.38 to 7.15. If this was taken as the HTL base case, none of the sensitivity scenarios would affect the barrier being the preferred option. The likelihood of the barrier requiring a Public Enquiry was also tested. The need for the barrier to buy out an upstream business was also included, although this has a relatively minor effect on the BCR.

A final sensitivity was undertaken to reflect the importance of the current regeneration of Ipswich. Defra guidance states that future values (of land, property etc) cannot be considered in the economic appraisal. However, the Project Team and Steering Group felt that the issue of regeneration was sufficiently important to warrant an assessment of the effects of different options on the regeneration. The findings are that the barrier BCR increases more than the Hold the Line, implying that the barrier is less likely to have a detrimental effect on the regeneration of Ipswich.

In summary, choice of the barrier option is sensitive to cost, although the return in terms of net present value of the barrier indicates that the value of the barrier option is always higher than that of Hold the Line. The cost effects in terms of capital and maintenance costs will only be determined through more detailed study of the barrier option. This may also indicate whether operation of the Norwich Railway Line Sluice is a viable option, in which case the barrier BCR will be significantly higher than that of Hold the Line.

Each barrier is unique thus early estimates cannot be precise. The approach adopted has been cautious in order to develop costs that are considered to be robust. The report specifically recommends that a further in-depth study of the barrier option is undertaken to ensure robustness, if that option is to be pursued. The study could lead to an increase in estimated costs but with a corresponding reduction in risks, and related contingencies, giving a total cost that will not exceed the figures provided within the PAR document.

Analysis was undertaken of the point of change of preferred option between Barrier and Hold the Line. If the barrier cost £21.75M, the barrier and HTL option would have equal bcrs. This would also be the case if the capital cost of the barrier remained £18M, but the maintenance

costs of the barrier increased to £1.15M every 10 years. Finally, if the cost of HTL and the Barrier option were both increased to reflect increased steel costs, an increase of 30% is the point at which HTL would be preferred above the Barrier. This is because at this point, Compartment D is no longer viable, hence the costs reduce for the HTL option.

The barrier option is likely to require some sort of public enquiry, due to the need for a Harbour Revision Order if navigation changes, or for other reasons. It was therefore considered prudent to treat the Public Enquiry sensitivity analysis as the base case, i.e. include an allowance in the base case for a Public Enquiry from this point onwards. **Therefore, the PV cost is £43,665,690 for Barrier + Compartment B, the gross cost is £74,045,472 (excluding sunk costs), the NPV is £308,730 for both (Barrier + Compartment B), and the bcrs are 8.46 and 4.14 for the barrier and Compartment B respectively.**

2.7.3 Multi-Criteria Analysis

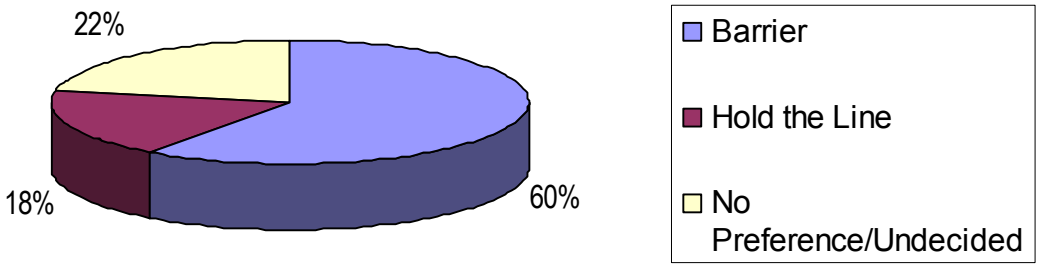
The objectives-led appraisal of the options discussed in Section 2.4 found the following:

The outcome of the assessment indicates that a barrier located in the New Cut area, in combination with improvements to existing defences where appropriate, is the environmentally preferred strategic option, scoring 87% - some 10% higher than any other option (See Table 6 in Section 2.4).

2.7.4 Consultation on the preferred option

Following the consultation exercise undertaken during August / September 2004 forty-four responses were received. Twenty-seven (61%) of the respondents expressed a preference for the Barrier (Advance the Line) option, largely due to the lesser environmental impact in terms of visual amenity. Eight respondents (18%) stated a preference for the Hold the Line option, with ten respondents (21%) expressing no preference / undecided. This information is summarised in Figure 12 Respondent status was not considered – all were given equal weight. A summary of the responses from key consultees and internal Environment Agency functions is provided in Appendix 4 (Section 5.4 to this PAR).

Figure 12 Consultation responses



2.7.5 Environmental implications of the Barrier and Hold the Line options

The objectives-led assessment process identified the preferred option on an environmental basis to be a barrier located in the New Cut area in combination with improvements to

existing defences (refer to section 2.7.3). This assessment process reflected the relative merits or adverse impacts associated with the key issues identified above. For example, the landscape and historical context of Ipswich was found to be a critical factor in relation to wall raising works. The barrier structure has the potential for an adverse impact on the existing historical setting of the Waterfront and New Cut (depending on the nature of the structure and mode of operation). When implementing the barrier, upstream wall raising works would only be undertaken in compartments B, I and K, and when replacement is required this is likely to be to a lower height than the current walls. However, wall raising in H downstream of the barrier would be required to the same height as the Hold the Line scenario. In contrast, a Hold the Line option would result in a significant increase in the flood defence wall heights (0.5 to 1m) in compartments B-E, H and J-K. In many places this is likely to obstruct views of the river from the adjacent river access and walks, would adversely impact on the historical context of Ipswich and may compromise the regional plans to regenerate the town centre, in particular the Waterfront, and to enhance the tourism potential of the town. In addition, the standard of protection from flooding would be higher with the barrier option, being to a standard of 1 in 300 years upstream of the structure, compared to a varying standard of protection with the Hold the Line approach.

The assessment raised a concern regarding the impacts of a Hold the Line approach within the downstream sites designated for nature conservation value (SPA/Ramsar/SSSI). The only Ramsar site is downstream of the study area. The preferred option will not increase impacts on the site because of the types of defences. However, a Hold the Line (or HTL and barrier) approach may result in coastal squeeze and hence loss of a declining BAP habitat. Through discussions with the Port it was agreed that no works would be undertaken within their land to prevent disruption to their commercial activities, including land to the northeast of the Orwell Bridge within the designated areas (compartment G).

The specific adverse environmental impacts arising from the preferred option will depend not only on its design, but to a large extent on the mode, duration and frequency of operation of the barrier. For example, whether the barrier has an impact on upstream navigation will depend partly on the type of gates selected. However, based on information obtained within the Strategy Study, it is not anticipated that there would be any significant impacts on the SPA/Ramsar/SSSI site from either changes in water level, estuarine sediment processes, water quality or other environmental aspects. Further studies would be undertaken during detailed design stage to inform the development of the scheme design.

English Nature consultation responses

Throughout the study the project team has consulted with English Nature (EN), both within the Steering Group context and in a separate meeting concerning the possible impacts arising from a barrier structure on the downstream features of nature conservation. In addition, EN has provided responses to the formal consultation exercises. An EN letter is appended to this document as the response to the preferred option consultation.

The Wherstead mudflat area, within both the proposed extension to the SPA and the newly extended SSSI boundary, has been highlighted as a site of particular importance for high tide feeding for over-wintering birds, being one of the last areas on the estuary to be inundated. As such, EN has raised concerns about the loss, either temporary or permanent, of such mudflat habitat if there were any changes in water level or tidal propagation, resulting from the operation of the barrier, or changes in water quality and sediment processes within the designated sites.

These issues relate directly to operation of the barrier. Information obtained through the Strategy study suggests that there will not be a significant impact on the nature conservation value of the SPA, Ramsar site and the SSSI, or on the management objectives for the sites. However, further analysis will be undertaken during the design stages to both support this and to inform the design process. A summary of the issues is presented below; full details of the specific concerns raised by EN and the responses are provided in the SEA document.

Changes in water levels: during operation of the barrier, significant downstream water level changes are not anticipated. However, water level impacts are likely to occur upstream of the barrier. The lack of drainage of the fluvial flows will result in a higher water level upstream which will not reduce with the tide.

Changes in water quality: a significant impact on water quality, in particular within the boundary of the European designated sites, is not considered likely. This will be studied in more detail during the next stage.

Alterations in the sedimentation process: whilst modelling to determine any changes to sediment movement has not been undertaken during the current Strategy study, it is considered that any impacts would not be significant in comparison to the normal processes.

English Heritage consultation response

English Heritage (EH) has raised concerns about the adverse impact of intrusive works for the barrier, and the possible impact of scour on the marine interests. The issues concerning sediment processes are discussed in section 9.3.5 of the SEA document. EH has identified a requirement to develop a detailed mitigation plan alongside EH and other relevant bodies (e.g. County Archaeologist, Ipswich Borough Council; Archaeologist, Environment Agency), during the detailed design stages. This would ensure that the archaeological risks and opportunities were identified, and appropriate measures implemented. More detailed discussion would be undertaken with EH during project implementation.

Environmental opportunities

The nature conservation benefits associated with managed realignment, in particular in the Wherstead mudflats area, have been identified by English Nature during consultation. Whilst the options relating to retreating the line in specific locations did not rank as highly as the barrier option, the outcome of the Strategy study does not necessarily preclude the investigation of a localised managed realignment scheme(s) during the subsequent design phases of implementation of the Strategy. For example, within Compartment A, immediately northwest of the Orwell Bridge, the current line of defence is along the river; there is the potential for a managed realignment of the line of defence to an existing wall to the rear, with the potential for facilitating creation of intertidal habitat.

Since this study is at strategy level the development of a monitoring plan is not possible. During implementation of the Strategy, individual elements of the Strategy will be subject to environmental impact assessment, and appropriate monitoring plans will be developed at this stage, in liaison with relevant consultees.

A summary of the key implications of both options is provided in Table 19.

Table 19 Summary of the key implications of the Hold the Line and Barrier options

	Hold the Line option	Barrier option
Standard of defence (flood event in 100 years time)	On a compartment basis, ranging from Do Nothing to 1 in 300 year.	Barrier compartment: 1 in 300; Upstream of the barrier compartment: Do Nothing. Downstream of the barrier: ranging from Do Nothing to 1 in 100 year.
Extent of works	Improvements to the majority of existing defence walls.	Construction of the barrier, limited wall raising upstream and improvements to the majority of defences downstream.
Height of wall raising works	Walls will be raised to a higher level than for a barrier: between approximately 0.5m & 1.1m (depending on compartment).	Lower wall heights than Hold the Line, or no requirement at all: Barrier compartment: <0.5m, if required; Upstream of the barrier compartment: none required. Downstream of barrier: between approximately 0.75m & 1.0m.
Key adverse environmental aspects	Potential impact on historical setting, visual amenity and recreational use from increase in wall heights. Possible compromise to the future development of the Wet Dock area.	The Barrier may be the limit of navigation in the River Orwell. Potential impact on historical setting at barrier site. Other impacts dependant on design, mode & frequency of operation.
Key beneficial environmental aspects	Navigation unaffected. Minimal long term change in water levels, siltation and water quality.	Higher standard of defence and lower walls upstream of the barrier.
Key economic aspects	Bcr = 7.46 NPV = £302m	Barrier Bcr = 8.46 Comp B bcr = 4.14 NPV = £310m
Socio-economic aspects	Compartments A , F, G I and L undefended. B and D 1:100, K 1:200, C, E, H and J 1:300	Compartments A, F, G and L undefended, B 1:100, C, D, E, H, I, J, K 1:300
Key technical aspects	Standard design, continuous raising and replacing cycle.	Unique design for barrier. Fewer raising and replacement works needed

2.7.6 Residual flood risk

The principal residual flood risk once the Strategy is implemented will mainly be due to failure of the barrier to operate other than in undefended areas. This risk can be avoided at design stage by building in a secondary failsafe, such as upstream stoplogs.

There will always be a risk of overtopping of defences (walls and barrier) through an over design event. Flood warning must be maintained for Ipswich in the event of such an occurrence. Design considerations for the walls will include water levels on the landward side as well as the riverward side – in some cases wall are designed to collapse when the landward water level is higher than riverward, allowing water within the flood compartments to drain into the river. However, as Ipswich is subject to tidal surges, flooding may take place over 2 or 3 tides, so breaching the walls would not be appropriate.

For undefended areas, flood protection measures may be recommended to the local community. This is particularly an issue in Compartment A, where the existing defences are low, and 35 residential properties and a local road are at risk of intermittent flooding.

2.7.7 Priority Score

All flood defence funding is allocated according to priority, determined in terms of economic benefit, risk to people and impact on the environment. Each criterion is evaluated and scored according to government guidance. The priority score threshold needed to attract funding for works in 2004/5 is currently 20, reducing to 19 in 2005/6/7 and 15 in 2007/8[13]. The calculated priority score for the preferred option is shown in Table 20.

Table 20 – Priority Scores for the Barrier and Compartment Options

	Barrier Compartments	**Compartment B**
Economics	15.9	7.3
People	3.2	5.0
Environmental	2.0	2.0
Total	**21.0**	**14.3**

The barrier compartment economics score includes the amended bcr to allow for a Public Enquiry

Compartment B's priority score of 14.3 will be influenced by factors such as the percentage Optimism Bias adopted, plus the possibility of the benefits increasing slightly if the economic analysis included indirect or intangible damages not assessed at Strategy stage, including road damages. Therefore, as it is likely to achieve 15, Compartment B has been included in the SoD Approval sum for year 4.

Whilst the table above shows the priority score for the preferred option, the priority score for the HTL option was also reviewed (Table 21), to ensure that the barrier investment made good business sense.

Table 21 – Priority Scores for the Hold the Line Option for barrier compartments

Compartment	SoP	Economic score	People score	Environment score	Total score
C	**1:300**	**4.03**	**1.33**	2.00	**7.36**
D	**1:100**	**1.14**	**1.75**	2.00	**4.89**
E	**1:300**	**3.20**	**2.15**	2.00	**7.35**
H	**1:300**	**9.02**	**1.21**	2.00	**12.23**
I		No viable scheme			
J	**1:300**	**20.00**	**4.23**	2.00	**26.23**
K	**1:200**	**10.95**	**10.00**	2.00	**22.95**

The barrier compartment offers a good return on investment. Whilst under HTL, the priority scores in Compartments J and K are high, it is clear that under HTL Compartments J and K would be the only Compartments in Ipswich that received Priority Score funding. This would jeopardise the regeneration of central Ipswich, particularly Compartment H, which has already benefited from millions of pounds of investment from Government for projects including the new University. It would leave over 500 properties in central Ipswich

undefended – putting at least 1200 people at risk when defences fail, who are not currently under threat. Whilst the economic analysis does not include the value of human life, one human life is likely to be worth over £1M, based on COBA values. If these were included in the analyses, every compartment with residential property in would be cost-effective to defend, and the barrier can do this more effectively, and to a higher standard of defence than Hold the Line.

2.7.8 Conclusion

Flood defences within Ipswich are reaching the end of their useful life, and do not fully protect the town against tidal flooding. A range of options to provide flood defences to Ipswich have been examined within this study, along with the justification for any improvements.

In conclusion, it may be seen that defending Compartments C, D, E, H, I, J and K with a barrier to a 1:300 year standard is the preferred option. This entails providing a higher standard in the interim, such that the 300 year standard is provided in 100 years time, assuming 6mm/year sea level rise. Given the broad nature of the option assessment, the requirement to include for an additional 500mm sea level rise should be incorporated at the next stage of design.

The implementation of the 2102 standard in year 5 for the barrier has been proposed due to the majority of the barrier cost being infrastructure which will remain in place for the 100 years – it was therefore considered sensible to maximise the benefit of this early investment by undertaking other works to give full closure to the barrier compartment.

The barrier option has a bcr of 8.60, and a priority score of 20.85. The priority score breaks into 21.4 for the barrier compartment works, and 14.3 for Compartment B. As the priority score required to progress works is likely to be 15 in 2007/8 Compartment B works will also be progressed.

Compartment A does not form part of this application for funding. However, it has been identified as a potential habitat creation site, as an opportunity for environmental enhancement. This could be considered in a subsequent study, at which time the opportunity for strengthening the rear bank in the compartment, or localised defence to the properties therein could be examined.

Compartments F and L have a preferred option of no active intervention. Compartment F does not have any assets in the floodplain; any further development in this Compartment should have its own defences built in. Compartment L has 10 commercial properties at risk within the floodplain, although the ground level is relatively high, so that the standard of defence within the compartment is actually between 1:10 and 1:20.

The Barrier and Hold the Line options have a relatively similar benefit cost ratio, such that the choice of preferred option can be sensitive to small changes, unless Norwich Railway Line Sluice operates to defend upstream of the barrier from fluvial flooding, in which case there is a much stronger preference for the Barrier. However, the impacts of closure upstream of NRLS have to be determined.

Implementing the barrier will improve the standard of protection to 629 houses over the next 6 years. The barrier option also includes wall works. These are necessary immediately in

order to provide an adequate standard of protection in Compartment H, improving the standard of protection to 41 houses immediately (year 1).

The study has provided detail of the condition of defences, which could be used to plan future replacement works. The Strategy has proved that even if the timing of future replacements changes, the barrier will be the preferred option. The Strategy has also assumed that there can be no raising works in Compartments C and H without replacing the deteriorating existing walls.

The study has also undertaken assessment of the water control structures. All structures were found to be necessary to the management of flood risk, although Norwich Railway Line Sluice was not included in the baseline assessment due to uncertainty over the upstream impacts if it was closed. Horseshoe Sluice in particular was found to require replacement of some M + E elements in the near future.

Although it would be difficult to fully assess the impact of one option over the other in terms of the ongoing regeneration of Ipswich, the Steering Group have made it clear that wall raising sufficient to counter the impacts of sea level rise will impact on the regeneration of much of the waterfront area, such that a barrier would be preferable. This has been tested through an alternative economic analysis, which has shown that reducing the development potential along the Island site has a significant impact on the overall regeneration. The regeneration is likely to improve the bcr of the barrier, once development has occurred, to 9.37. Whilst the Environment Agency must not encourage development within the flood plain, it must be borne in mind that other government bodies have invested significantly in the redevelopment of Ipswich.

However, the barrier is unlikely to be constructed before year 5, simply because of the further studies and design needed. As the standard throughout Ipswich will be improving from 1:100 or less (i.e. below the standard at which PPG25 allows new development without its own defence measures to be constructed) to 1:300, the additional benefits of the improved standard may not be realised by developers unless there are interim planning agreements which take into account the future development. These planning agreements could be developed with the local authorities in exchange for developer contributions to the overall scheme.

This study has developed a range of water levels throughout Ipswich for different event floods, which may be used for planning purposes. These water levels should be updated when the barrier is in place. In addition, the findings of the fluvial study of the Gipping, and the tidal study of the estuary should be incorporated. The impact of downstream realignment on the Orwell was tested using the ISIS model, and shown to have very little impact on the water levels at Ipswich.

There are two other studies being undertaken on the river, which cover the fluvial and tidal respectively. It is timely that the findings of the studies will feed into the further development necessary to implement the Strategy in Ipswich. However, it is crucial that works in Ipswich are progressed quickly, partly due to the failed defences in Compartment H which need replacement immediately, and partly due to the time it will take to develop the barrier option to construction. The works in Compartment C and H will also need to have riparian owner contributions negotiated, which will be time consuming.

A 5 year plan for structural works and raising works should be developed in detail, to prioritise works in Compartment H. This must incorporate the findings of the fluvial study to

assess whether Norwich Railway Line Sluice can be incorporated into the Strategy, and therefore establish the extent of wall raising necessary.

A further stage of study for the barrier should be commissioned immediately, to ensure that the programme to implement the Strategy can be met within the next 6 years. The study will need to establish the best location for the new barrier, which will utilise the newly developed Orwell Estuary 2D model. Early liaison with the consultant for this study has ensured that the model will be capable of being developed in detail in the appropriate area, ensuring a best value approach.

Summary

The barrier is the preferred option in terms of economic value and return on investment. The benefit cost ratio is robust through a range of sensitivity tests, and could increase significantly if Norwich Railway Line Sluice has no major upstream impacts when operated. The choice of preferred option could revert to Hold the Line if there are significant cost increases, although this option would be subject to significant planning constraints which may return the barrier to the preferred option. It is recommended that further investigation of the location and design of the barrier is undertaken to enable additional cost certainty.

The barrier is the preferred option from consultation responses, and in terms of the multi-criteria analysis. At this stage, it is not anticipated that there would be any significant adverse environmental impacts, other than localised construction impacts, however the impacts on navigation, for example, will depend on the location and design of the barrier, and must be consulted on.

The barrier is seen by the Steering Group as less detrimental to the regeneration of Ipswich than any Hold the Line option. It is recommended that further study stages investigate the potential opportunities involved with the regeneration of Ipswich.

2.7.9 Recommendations

1. It is recommended that approves a strategy based on Option 4a – tidal barrier in the New Cut with raised defences downstream and fluvial defences upstream.

2. It is recommended that the Agency approves the 6-year capital expenditure programme in the sum of £44.84M (£45.319 M including sunk costs)

3. It is recommended that the barrier option is taken on to a further detailed study, to determine location, type etc. This study should take into account the potential need to raise to a higher standard in the future. The study will include development of a Procurement Strategy, Legal and Estates planning and a Communication Plan.

4. It is recommended that the data in this document is used to develop a 5-year programme for wall improvement works, in conjunction with a Framework Contractor, so that the remedial works and raising works necessary to implement the Strategy are undertaken.

5. It is recommended that negotiations continue with Ipswich Borough Council, EEDA, Suffolk County Council and others about the potential for multi-functional benefits

and contributions, through facilitating development of the Island site, in discussion with IBC and EA planners over short term implications for planning approvals within the flood plain.

6. It is recommended that the Environment Agency examines the opportunity for environmental enhancement in Compartment A.

2.8 Other Considerations

2.8.1 Flood Warning

Ipswich has a flood warning scheme in place, and will continue to be warned for tidal and fluvial flood risk. The ISIS model and related report has been supplied to Eastern Area for use in flood warning.

2.8.2 Technical Aspects

The flood assessment of Ipswich has been undertaken using an ISIS 1D model to reflect the flows in the river, and modelled spillways to simulate breach or overtopping flooding. This was undertaken in 2002-2003. Whilst this allows representation of flood scenarios and river behaviour, results are averaged along the cross section, which does not provide sufficient detail to determine localised hydrodynamic impacts of a barrier. However, Black and Veatch have formed, at the behest of the Environment Agency, an Estuaries Management Group to share expertise and create value. Although BV has undertaken this Strategy, Halcrow is undertaking the Stour and Orwell Strategy. As part of this study, a 2D/3D model of the estuary is being constructed. It is proposed that this is used, possibly with more cross section data, to model the best physical location. This offers the Agency a best value approach. The EMG has ensured that the modellers and project managers are aware of potential future use of the model. The timing is appropriate, as the Do Nothing model was recently calibrated. The 2D/3D model will also allow predictions of direct or indirect downstream impacts which will facilitate investigation of environmental impacts.

2.8.3 Effect of Option on river regime

The existing river regime is based on centuries of human intervention. From the New Cut upstream, the river comprises hard defences as far upstream as Constantine Weir, above which are a mixture of hard, soft and combined defences. The river channel has been reshaped and the banks regarded, and the flow is controlled by a series of control structures. Implementation of a barrier option, with fluvial defences upstream, will not change the existing requirement for control structures, other than possibly Norwich Railway Line Sluice – the effects of operating this sluice at time of fluvial flood need to be investigated in the Agency's recently procured study.

Operation of the barrier is likely to be for surge events only – the frequency of the closures will depend on the determined lower limit of protection, and ongoing sea level rise. Most of the time, the barrier will not impact on river behaviour upstream. A concern relating to storage of fluvial water when the barrier is closed led to the barrier option being modelled for combined tidal and fluvial events. However, the Joint Probability Best Practice Guide[10] identifies that the probability of fluvial flooding at the same time as tidal flooding in East Anglia is very low. Discussions with IBC's drainage engineer have identified that although there are land drainage problems associated with tide locking of the existing drains into the

river at the new cut, these problems have been partly resolved through Anglian Water's Project Orwell. Removing the surge element will not make these problems worse.

More detailed modelling is required to determine the best location and localised impacts of the barrier. It is recommended that this is undertaken as the next stage of study.

The requirement for solely fluvial defence raises the possibility of returning some upstream areas, which no longer require defence, to an unmodified state. However, there may be legal issues relating to the Agency's history of providing channel delineating structures. For the purposes of the strategy, replacement costs of channel structures have been included.

The effects of the barrier downstream will again be limited to times of closure, other than possible navigation impacts. The closure during a surge tide was modelled to see if the water level downstream changes. The ISIS model showed a water level change of less than 6mm for a 300 year surge event, which is well within the model accuracy ranges. It is recommended that this is investigated further with the 2D estuary model currently being constructed.

Consultation has been undertaken with English Nature (EN) to identify any concerns relating to the sites of nature conservation importance at the downstream end of the study area (Stour and Orwell Ramsar and Special Protection Area (SPA) / Orwell Estuary Site of Special Scientific Interest (SSSI). EN highlighted the importance of the area of high tide feeding on the Wherstead mudflat. An assessment of the likely impacts from the barrier on the water quality, sedimentation processes and water levels indicates that there is unlikely to be a significant impact on these sites. More detailed environmental assessment will be undertaken alongside the proposed modelling during the detailed design stage.

English Heritage (EH) has highlighted the potential presence of buried archaeological remains and wrecks in the general area of intrusive works for the barrier. A mitigation plan will be developed alongside EH and Suffolk County Council during the detailed design stage to ensure that appropriate action is taken to minimise any impact both during and after the works.

2.8.4 Sustainability considerations

Environmental issues and Sustainable Construction

A detailed environmental impact assessment (EIA) will be undertaken during the detailed design stage. This will include consultation with relevant authorities regarding specific environmental aspects of the scheme, and build on consultation undertaken during the development of this Strategy. Information on environmental constraints and opportunities obtained from this process will be integrated within the detailed design. This will ensure that opportunities to enhance the environment are optimised, and, where possible, adverse impacts are avoided, and mitigation measures incorporated to reduce the overall impact.

Where possible, sustainable materials will be used. Presently, the facing of sheet pile walls has been assumed to be masonry or recycled stone. It would be possible to use timber if this proves to be more sustainable – this should be investigated further within the PAR. In addition, the takeover of Corus by Arcelor means that sheet piling will now be made from recycled steel rather than new materials. The EAP will address issues such as the procurement of materials and measures to minimise local disturbance.

2.8.5 Economic and social issues

For economic sustainability, the commercial and residential use of Ipswich must be maintained, along with the arterial infrastructure necessary to support the town. A barrier option will protect the town centre and upstream residential and commercial areas. However, Wherstead Road and the associated housing in Compartment B will not be defended to as high a standard, although the standard is within the indicative range for a town, suggested in FCDPAG3[5], and Compartment A will be undefended. This may have issues for the community in terms of inclusivity.

The implementation of a barrier requires a significant early investment. However, once in place, much of the infrastructure will not need to be replaced over the 100 year scheme life, although it will need to be refurbished.

The barrier is believed by the Steering Group to be far more in keeping with the regeneration of Ipswich that continued Hold the Line along the waterfront. Significant government investment, through funding bodies such as EEDA has led to an urban renaissance in Ipswich, much of which is focussed on the waterfront area. Visual amenity is therefore very important.

2.8.6 Future Management Requirements

The walls within Ipswich that provide flood defence, and the walls which the Agency has a commitment to maintain, will need to be maintained throughout their life, and renewed at intervals depending on the materials used. The grassed banks will need mowing, and maintenance of crest width and level.

The control structures will need regular maintenance, along with refurbishment and renewal as necessary. The barrier will need maintenance and some refurbishment over its life. Maintenance will depend on the type of structure, and also on decisions made during the design of the barrier. In addition, the barrier and control structures will have associated operating costs.

These maintenance, refurbishment and replacement timings have been assessed in outline, and costs included within the 100 year costing for the Strategic analysis. It is recommended that a monitoring and maintenance plan is drawn up once the Strategy is implemented, to detail future requirements and expenditure.

All structures will have demolition costs. These are included where relevant within the 100 year costing.

2.8.7 Health and Safety Issues

Health and Safety issues have been considered within the Strategy, mainly through interviews with Contractors familiar with wall works and barriers, regarding safety and buildability. In addition, discussions have been held with BV safety professionals. The lessons learned will be carried on to the next stage, at which time it may be appropriate to have Contractor involvement and the appointment of a Planning Supervisor.

Health and Safety Plans will be initiated during the design and tender production stages of the various elements of works and included within the tender documents. There may be merit in producing a co-ordinated compilation of plans for the whole of Ipswich.

2.8.8 Links to Planning Policy

During the SEA process a review of the existing legislative and planning framework was undertaken. This included international and central government policy, national and regional planning policy, local planning policy, and other local management plans. The review informed the assessment of the 'do nothing' approach and the establishment of the objectives which formed the basis for the objectives-led environmental assessment of the proposed options. Further details are provided within the SEA document.

Ipswich is currently undergoing 'urban renaissance' – the regeneration of the town centre which has been driven by the Borough Council and EEDA through planning strategy and investment. The next 5 years, i.e. the time in which the Strategy will be partially implemented, will be a crucial time of redevelopment of brownfield sites in the waterfront area, to meet ODPM targets and to meet the demand for new housing in Ipswich. However, much of the waterfront area does not currently enjoy the standard of defence necessary in order to secure unrestricted planning consent, or the insurance of new homes through the Association of British Insurers (ABI).

It may be appropriate for the Agency and IBC planners to take into account the future defence plans when considering planning applications over the 5 years until the Strategy is fully implemented.

An allowance has been included in the preferred option costs for a Public Enquiry. A transport and works order for the whole scheme may be determined to be the most appropriate way forward for the project to be implemented. It may be possible to develop the barrier in conjunction with plans to develop the Haven Gateway, as developed by the Haven Gateway Partnership, in which case contribution funding may be secured.

3 PROJECT PLAN

3.1 Proposed Strategy

The preferred option for Ipswich is to defend the area for the next 100 years to the following standards, by means of a barrier in the New Cut to defend the majority of the urban area from tidal flooding, with wall replacement or raising as required upstream to defend from fluvial flooding, and downstream to defend from tidal flooding where appropriate. The proposed defence standards under the preferred option are shown Table 22.

Table 22 Defence standards for preferred option

Compartment	Standard of Protection
A	No active intervention
B	1 in 100
C	1 in 300
D	1 in 300
E	1 in 300
F	No properties at risk
G	No defences required
H	1 in 300
I	1 in 300
J	1 in 300
K	1 in 300
L	No active intervention

The strategy to defend to a particular standard within the compartments takes account of 6mm/year sea level rise, and 20% increased fluvial flow over the 100 year life of the Strategy, in accordance with Defra guidance.

3.2 Objectives

The objectives of the next stage of study are similar to those in Section 2.2.5. However, specific objectives relating to the next stage of work are as follows:

- To determine in more detail the most suitable location for the barrier, based on hydrodynamic loading and impacts.
- To determine type of barrier, and cost
- To assess environmental impacts of the barrier
- To assess detailed risks pertaining to the barrier option
- To review economic benefit, and weigh against the Hold the Line option.
- To develop a plan for wall raising and replacement, and compartment closures to implement standards defined in the Strategy.
- To develop a plan for refurbishment of control structures.

The defences within the Strategy which are to be raised or replaced extend from Wherstead Road in the south to Yarmouth Railway Line Bridge. Whilst the next stage of works will necessitate a more detailed study of the barrier, this should be within the context of developing a detailed plan for raising and renewal works to implement the remainder of the Strategy.

3.3 Defence Condition

Whilst the majority of defences in Ipswich are in relatively good condition, some defences, particularly around the Island site, are in poor condition. Localised failures have occurred. Urgent works are required to either replace the failed defences or install a secure secondary defence until the Strategy is implemented.

In addition, most of the water control structures through Ipswich will need some refurbishment within the next 5 years. A programme of refurbishment works is planned.

There is a programme of raising works involved in implementing the Strategy. ABP as the Port Authority in Ipswich has confirmed that walls on the New Cut, initially built in the 1920's, are unlikely to withstand any additional loading in the form of wall raising. Therefore the Strategy has allowed for replacing rather than raising of any walls on the Island and Compartment C.

3.4 Timing of works

The Strategy will be implemented i.e. the appropriate standard of defence provided in each compartment by Year 5. This will involve construction works comprising wall raising, wall replacement, closure works and commissioning and construction of a tidal surge barrier. Table 23 shows the initial breakdown of the 6 year plan of works including contingencies to represent the strategic equivalent of 'most likely' risk.

The annualised spend profile, with interest of 5% and full Optimism Bias of 60%, is shown in Table 24, and this sum is used to develop the SoD approval sum.

Table 23 6 year plan of works for the preferred option (with out optimism bias)

Defence ID	Comp.	strategy	year	cost	rasie/replace?
sunk costs			0	476,000	
			Sub-total	**476,000**	
410511L06A	H	300	0	789,707	Replace
			Sub-total	**789,707**	
410511L04A	H	300	1	273,647	Replace
410511L04Z	H	300	1	298,524	Replace
410511L04B	H	300	1	254,044	Replace
410511L04C	H	300	1	35,325	Replace
410511L04D	H	300	1	84,701	Replace
410511L04E	H	300	1	305,903	Replace
Barrier design			1	375,000	
			Sub-total	**1,627,145**	
410511L04F	H	300	2	36,977	Replace
410511L04H	H	300	2	19,384	Replace
410511L04J	H	300	2	16,916	Replace
410511L04K	H	300	2	75,268	Replace
410511L04L	H	300	2	110,465	Replace
410511L04M	H	300	2	143,829	Replace
410511L05	H	300	2	814,425	Replace
Horseshoe Sluice			2	133,250	Replace
Barrier design			2	375,000	
Public enquiry			2	500,000	
			Sub-total	**2,225,515**	
410511R10Z	C	300	3	736,359	Replace
410511R10	C	300	3	360,758	Replace
410511R11	C	300	3	138,577	Replace
410511R12	C	300	3	205,930	Replace
410511R13	C	300	3	1,356,446	Replace
410521L03A	J	300	3	37,020	Replace
Handford Sluice			3	88,500	Replace
Barrier design			3	375,000	
			Sub-total	**3,298,590**	
410511R04	B	100	4	575,411	Replace
410511R04Z	B	100	4	337,082	Replace
410511R05	B	100	4	263,521	Raise
410511R0609N	B	100	4	700,543	Replace
410521R01F	E	300	4	11,746	Replace
408711L06	K	300	4	22,991	Raise
408711L07	K	300	4	34,845	Raise
408711L09A	K	300	4	155,132	Raise
408711R02	I	300	4	105,909	Raise
408711R06	I	300	4	30,593	Raise
Bourne Sluices			4	22,000	Replace
Velocity Control Structure			4	152,500	Replace
Barrier design			4	375,000	
			Sub-total	**2,787,274**	
Barrier		300	5	16,500,000	
			Sub-total	**16,500,000**	
			TOTAL	**27,704,231**	

The actual likely cost to the Agency on an annual basis has been calculated (Table 24). The costs are discounted capital costs above, and undiscounted with interest below. The profiles contain contingency of 25%, but not the additional 35% for Optimism bias.

Table 24 Annualised Spend Profile

Year	Preferred option (without optimism bias)		Preferred option (with optimism bias)	
	Capital cost	Capital cost inc. 5% annual interest	Capital cost	Capital cost inc. 5% annual interest
sunk costs	476,000	476,000	476,000	476,000
0	789,707	789,707	1,066,105	1,066,105
1	1,627,145	1,708,502	2,196,645	2,306,477
2	2,225,515	2,453,631	3,004,446	3,312,401
3	3,298,590	3,818,530	4,453,097	5,155,016
4	2,787,274	3,387,948	3,762,819	4,573,730
5	16,500,000	21,058,646	22,275,000	28,429,172
Total	**27,704,231**	**33,692,964**	**37,234,112**	**45,318,902**

3.5 Environmental Impacts

On implementation of the Strategy, project-specific environmental impact assessment will be undertaken, in accordance with Environment Agency procedures and relevant legislation. This process shall inform the development of the detailed design, and identify specific consents and permits that are required. In particular there will be close liaison with English Heritage and English Nature throughout the process of detailed design, to discuss the outcome of technical studies and therefore develop a design which addresses any specific concerns and integrates appropriate mitigation measures. In addition, advice will be sought regarding post-construction monitoring requirements. An Environmental Action Plan (EAP) will be developed, as part of this process. It will be an evolving document with the facility for it to be updated throughout the scheme. This will ensure that the contractor is aware of environmental constraints and that appropriate mitigation and monitoring measures are implemented during the construction phase. Relevant sections of the EAP should be incorporated into the contract documents so that the contractor will be contractually bound to them.

3.6 Procurement/Project Management

3.6.1 Project Team

Black & Veatch Consulting provided the consultancy services for the Strategy Study and this PAR under the National Framework Agreement.

The Agency Management team was:

- Chris Allwork — Project Team Leader
- Rod Hicks — Project Manager
- Peter Marjoram/Ivan Nicholls — Representative, Flood Defence Operations
- Peter Doktor — NEAS representative
- Andrew Brasnett — Finance representative

3.6.2 Timescale

The Strategy Study commenced in March 2001, in a commission to Black and Veatch under the NEECA framework. This was based on the NEC PSC Contract, Option E. Work was carried out in three stages, with the Final Strategy Report being issued in February 2005.

It is proposed that the strategy is implemented over the next 6 years. The PAR identifies the preferred option and justification for the implementation of the strategy within this timescale.

A construction procurement (National Contractors Framework) Strategy is currently in place. This has a strong focus on partnering, and the Engineering and Construction Contract (ECC 2nd Edition) will be used for procuring consultancy and construction services. Under the NCF agreement, the Contractor will work with the framework consultant to deliver an integrated service. The consultant will remain employed directly by the Agency. The Framework seeks national co-ordination of regional medium and long term plans, leading to identification of project packaging opportunities and longer term working arrangements. A Programme Management initiative in Anglian has included Ipswich works. The primary procurement objective for construction works is to continue using the framework contractor engaged in the pre-construction processes. Where specialist works are required (e.g. major M&E works) other contractors will be appointed via the Environment Agency's Procurement department.

The next stage of works will be separated into 3 elements pertaining to the barrier, existing control structures and wall works. PARs are likely to be required for the wall works and control structures. A further stage of study will be needed for the barrier to determine hydrodynamic impacts. Contractors will be appointed at PAR stage, in line with the Environment Agency's incentivisation arrangements.

3.7 Risk and Safety

The risks associated with this project are identified in Appendix 3 to this report where an assessment has been made culminating in the level of Contingencies being set at 25%. This has been used throughout the build up of Scheme Costs derived for the strategy review stage of the scheme.

At this strategy review stage, it is possible only to calculate the cost implications of the various hazards and risks that are likely to occur to all of the works, and not on a scheme by scheme basis. A consequence of this is that a monetary value for the risk is not calculated for the whole of the works, but as a percentage of the construction cost. Each element is assigned a risk factor, in terms of a percentage and these summed to determine the probable total risk. A more detailed risk assessment will be undertaken during the project appraisal stage. This may result in different levels of contingencies for each compartment.

As well as a contingency allowance, the costing has allowed separately for:

- Site investigation costs
- Land purchase (at 6.5k/Ha)
- Compensation (at 5% of construction cost)
- Access

The barrier itself had specific sums allocated for access (£0.5M), land purchase (£0.9M), Compensation (£1M), and Site Investigation (£0.2M), as well as a 25% contingency. All sums have had 35% added to them for Optimism Bias above the contingency.

The key areas of risk associated with each option are listed below.

3.7.1 Unforeseen Ground Conditions

Much work has been carried out along the river walls in Ipswich, and across the river channel for structures such as the Velocity Control Structure and the variable nature of the soils is well known. In addition, springs are known to exist in Ipswich, which occur unpredictably. Consequently provision is already made for dealing with many of the problems associated with poor ground and the cost estimates made within the Strategy address the poor ground conditions. An allowance of 8% of the construction cost has been set for dealing with variable ground not identified in the ground investigations. The residual risk of poorer ground is reduced to an acceptable level as contingencies cover extra works.

3.7.2 Cost Variation

Costs that vary in the estimates cause problems in that insufficient funds are set aside to procure the works. Further, higher costs may compromise either scheme viability and or selection. Further studies or design development may raise new issues which have not been allowed for. A 6% contingency has been allowed for cost over-runs that may exceed allocated funds. A further 1% contingency has been allowed for to cover the impact of increased costs on scheme validity or selection. These relatively low allowances can be applied because a robust contingency was used when developing the cost estimates for the economic analysis. Furthermore, scheme viability and selection was tested by varying the costs in the sensitivity element of the economic analysis.

3.7.3 Inappropriate Design/Change in Scope

Wall replacement and raising works have been widely used throughout Ipswich, and there is therefore plenty of experience associated with this type of work. However, the preferred barrier option is different to the existing scheme, and every barrier is different in relation to solving site-specific problems. The total contingency therefore includes 5% of construction costs to accommodate the likelihood of inappropriate design.

3.7.4 Defences Fail Earlier than Anticipated

Wall conditions used for this strategy review are based on the 2002 Condition Survey Report. The residual life of structures is grouped into 5 year periods. The priority of works is affected by these grouped periods. The works programme has been developed to ensure that the worst condition walls are replaced first and before their estimated residual life. The consequence of incorrect condition assessment only becomes significant if there is a sudden unforeseen collapse putting assets at risk. This is unlikely, thus a sum of 1% of construction costs has been included to cover this hazard. The size of the contingency reflects the magnitude of damage that would be caused by an unexpected collapse.

The 2002 condition survey shall be augmented as part of the PAR stage of the project. This will allow a more appropriate works programme to be developed.

3.7.5 Strategy Not Accepted/Failure to Meet the Programme

This Strategy Review demonstrates that there is a clear need for the flood defence works at Ipswich. The Strategy should therefore be accepted by Defra and the risk is believed to be low. In addition, public consultation has indicated a public preference for the barrier option. However, there is a risk that its approval is delayed, or requires additional enquiries or information and Agency Costs will be incurred seeking approval and managing delays to

future works. A figure of 5% of construction costs has been included, to cover any additional works needed during a delayed start.

The risk of a public enquiry, for either Hold the Line or the Barrier, is a real risk, which may delay proceedings and add cost. As it would have the same effect on both, it will not change the choice of option, however it may make the overall option less viable in terms of benefit cost ratio and priority score. In analysis of the preferred option, it was decided to include a sum for Public Enquiry in the preferred option cost for approval.

The risks identified were along with percentage impact:

Unforeseen Ground	8%
Inaccurate Cost Estimates & discount	5% + 1%
Inappropriate Design	5%
Wall Condition	1%
Strategy not accepted/failure to meet programme	5%
	25%

An allowance of 25% of construction costs was initially included in the estimate of Scheme Costs. It was not possible to determine a cost value of the risks on a scheme-by-scheme basis. However, the above figure of 25% appears consistent with other similar assessments. Management of these risks has also been discussed in Appendix F. Risks that cannot be controlled by the appliance of contingency sums will be addressed in the PAR stage.

Recent guidance from Defra regarding the probability of an optimism bias in cost estimates required that a higher contingency be applied to best estimates of project costs. Defra guidance[6] suggests that the Optimism Bias starts at 60% of total Present value costs at Strategy Stage. This figure has been applied to all project costs in place of the contingency sum discussed earlier, and is included in the economic base case.

3.8 Gateway Process Outline Risk Assessment

3.8.1 Benefit cost ratio

The benefit cost ratio is robust, and has been sensitivity tested. Whilst the sensitivity testing results put the bcr of the barrier compartment within the range of 7.08 to 10.38 (including 60% optimism bias), the next stage of analysis of the barrier will increase the design certainty and reduce the cost risks.

3.8.2 Clarity of benefits

The benefits assessed are existing, tangible, mainly direct damages. There is no reliance on one or more specific industries, or on the regeneration of Ipswich. Therefore, the benefits are clearly identified.

3.8.3 Impact on business

The impact on the Agency's business will be to reduce the flood risk to 840 houses, 246 businesses and part of the port (in compartment B). The MTP contains sufficient funds to commence works to the failed walls in Compartment H in year 05-06, along with funds to develop the barrier outline design. The works proposed in year 2 are to Compartment B,

which currently does not have sufficient priority score to progress. However, funds are not currently fully in place to continue upstream works and construct the barrier over the next 5 years after approval.

3.8.4 Internal interface

The Strategy project team includes a client representative from Operations, and a NEAS representative. The Steering Group includes a representative from Development Control, and a representative from Corporate Services. The Project Board comprise representatives from the client and financial groups. Each interface body has met regularly throughout the development of the strategy. It will be important to continue to involve these representatives, especially NEAS, Operations and planners, through the next stages of development of the barrier option**.**

3.8.5 External impact

Consultation has identified that the barrier option is the preferred option in Ipswich. The design of the gate and structures may impact on upstream navigation, which will mainly affect a local boatyard owner, although a Harbour Revision Order may be required, which may be time consuming. Budgets have been identified to allow for associated costs, as well as a public enquiry.

The proposed withdrawal of defence provision in Compartment A, and possibly in Compartment L although only a few commercial properties are affected in L, will have impacts on the local community, who are already concerned about flood risk and the potential difficulties in obtaining insurance for their properties. A large proportion of the village at Wherstead may find their properties unsaleable, and at increasing flood risk (currently 1in 2 years or 0.5 probability), which may well disintegrate this community. It is recommended that the study for environmental enhancement opportunities here goes ahead, which may also consider localised defence to the properties.

3.8.6 External involvement

Discussions have been held with the Steering Group regarding development of a combined barrier and access road to the Island, which would require external contribution. At this stage, there is no intention to progress this, as no agreement has been forthcoming from local beneficiaries, however it remains an opportunity. There is also scope to integrate barrier development with waterfront projects developed as part of the regeneration of Ipswich. The Partnerships Officer has been involved in discussions with EEDA to explore this – this should be considered in more detail at the next stage. However, the barrier option is sufficiently robust to progress without external involvement.

3.8.7 Degree of innovation

Each barrier is different, as each is developed specifically for conditions in a particular river or estuary, at a precise location. There is, therefore, always a higher element of innovation relating to barriers, than, say, continuing to raise and replace flood walls along an existing line. However, the design of barriers is not inherently highly innovative, and the lessons learned from previous design, construction and operation, are widely known.

The proposed software to model the local impacts is new, although the model being developed for the Stour and Orwell Strategy will ensure familiarity before the software and

model are used on this project. The model will already be calibrated and validated by the time it is required for this study.

3.8.8 Resource availability

The existing key members of the project team – PE Chris Allwork, PM Rod Hicks and NEAS Peter Doktor – will continue to be available for further development of the project. Resources from Black and Veatch, with specialist experience of barriers, will also be available to develop this project**.**

3.8.9 Contract management

The next stage of study will be through the NEECA Framework, presumably Option C. If Black and Veatch are appointed to undertake this work, they will subcontract Halcrow to further develop the Stour and Orwell model, within the terms of the Estuary Management Group set up by both consultants and the Agency. Immediate wall replacement in Compartment H could be undertaken through design and build or through traditional procurement via NEECA and NCF. Later wall works could also follow either procurement route, although they will be less urgent, and a PAR may be required before design.

3.8.10 Urgency of delivery

The failed walls in Compartment H expose Ipswich to higher residual flood risk than would otherwise be the case, and should be replaced as a matter of urgency. Works on some of the sluices are also urgent.

Whilst the barrier is not as urgent, the time to develop an option through outline and detailed design, then to construct, is sufficient to require an early start if the Strategy is to be implemented within 5 years after approval. This is particularly urgent in Ipswich, given the regeneration of the waterfront area, and the local plans for development within the floodplain.

4 RECOMMENDATIONS SIGN OFF

Ipswich Flood Defence Strategy - The project referred to in this report relates to a strategy to provide flood defence to the town of Ipswich. The report supports the decision to install a 1 in 300 SoP barrier in the new cut and to improve existing flood defences in 1 downstream flood compartment.

4.1 Operating Authority Environment Agency

Approval is sought for the expenditure of £45.32 million over the next 6 years as follows:

	Preferred option (with optimism bias)	
Year	Capital cost	Capital cost inc. 5% annual interest
sunk costs	476,000	476,000
0	1,066,105	1,066,105
1	2,196,645	2,306,477
2	3,004,446	3,312,401
3	4,453,097	5,155,016
4	3,762,819	4,573,730
5	22,275,000	28,429,172
Total	**37,234,112**	**45,318,902**

The whole life cash cost (excluding maintenance) of the strategy is £70.70 million.

Strategy recommended for approval & Submission to DEFRA for approval at a cost of	£

Project Manager	Name	Rod Hicks	Signature	
			Date	

Scheme recommended for approval
& Submission to DEFRA for approval

Project Executive	Name	Chris Allwork	Signature	
			Date	

Scheme recommended for approval
& Submission to DEFRA for approval

Budget Manager	Name	Mark Johnson	Signature	
			Date	

* Select as appropriate but at least one option must be selected from the options in brackets.
# Select as appropriate or delete whole line as far as this point. Note: -
Fin.Mem. agreement applies to Environment Agency Financial Memorandum agreements only.

4.2 Department for Environment Food and Rural Affairs

Approval is sought for the expenditure of £44.84 million over the next 6 years as follows[2]:

Year	Preferred option (with optimism bias)	
	Capital cost	Capital cost inc. 5% annual interest
0	1,066,105	1,066,105
1	2,196,645	2,306,477
2	3,004,446	3,312,401
3	4,453,097	5,155,016
4	3,762,819	4,573,730
5	22,275,000	28,429,172
Total	**36,758,112**	**44,842,902**

*Study/Strategy/AIP to first 6 years work/Scheme recommended for:-
further study/rejection/approval for:-
Fin.Mem. agreement/agreement/approval at a cost of

Senior Engineer	Name		Signature	
			Date	

*Study/Strategy/AIP to first 6 years work/Scheme accepted/recommended for:-
further study/rejection/approval for:-
Fin.Mem.agreement/agreement/approval

Regional Engineer	Name		Signature	
			Date	

*Study/Strategy/AIP to first 6 years work/Scheme accepted/recommended for:-
further study/rejection/approval & submission to DEFRA for:-
Fin.Mem.agreement/agreement/approval

Chief Engineer	Name		Signature	
			Date	

* Select as appropriate.

[2] sunk costs not included. See Environment Agency breakdown for total with sunk costs.

5 APPENDICES

5.1 Appendix 1 –Appendices to the main document)

- Appendix A References and Bibliography
- Appendix B Strategic Environmental Assessment
- Appendix C Condition Survey Report
- Appendix D Structures Survey Report
- Appendix E Hydraulic Modelling Report
- Appendix F Costs Report
- Appendix G Economic Appraisal Report
- Appendix H Land Value Report

5.2 Appendix 2 - Economic Spreadsheets

PAG Tables (See separate CDs for economics spreadsheets)

5.3 Appendix 3 - Risk Register

Attached
(Ipswich_par_risk register.xls)

5.4 Appendix 4 – List of Consultees and Responses

5.5 Appendix 5 - Strategic Environmental Appraisal Summary

5.6 Appendix 6 - Defra Submission Checklist

5.7 Appendix 7 – PAR data sheets

5.8 Appendix 8 – Priority Score Sheets

5.9 Appendix 9 – EN letter

APPENDIX 1

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5 Defra, Flood Coastal Defence Project Appraisal Guidance Volume 3 Economic Appraisal FCDPAG3, December 1999

6 Defra, FCDPAG3 Supplementary Note To Operating Authorities, Revision To Economics Appraisal Procedures Arising From The New HM Treasury "Green Book", March 2003

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8 Uk Retail Price Index, **www.wolfbane.com/rpi.htm**

9 Defra, Flood Coastal Defence Project Appraisal Guidance Volume 4 Approaches to Risk (FCDPAG4), February 2000

10 Ian Meadowcroft (EA), Peter Hawkes (HR Wallingford) and Suresh Surendran (EA), Joint Probability Best Proactive Guide: Practical Approaches for Assessing Combined Sources of Risk for Flood and Coastal Risk Managers, 2004

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12 Supplementary Note To Operating Authorities, Revision To Economic Appraisal On Reflecting Socio-Economic Equity In Appraisal And Appraisal Of Human Related Intangible Impacts Of Flooding – July 2004 (Defra)

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APPENDIX 2

APPENDIX 3

APPENDIX 4

5.10 Appendix 4 - List Of Consultees And Responses /Strategy Report Consultation

A summary of consultation responses from key consultees and internal Environment Agency functions during consultation on the preferred option is provided as Table 25 and Table 26 respectively.

Table 25 Summary of consultation responses from key consultees (Stage 3)

Consultee	Response	Corresponding action
English Heritage	***Preferred option: hold the line*** Barrier construction would involve extensive groundworks with potentially destructive impacts on estuarine archaeology. This is considered to be more damaging than the potential impacts of raising walls, although the flood walls will have a visual impact on the setting of historic buildings on the waterfront.	Telephone discussion with EH (28/10/04): There would be a requirement to work with EH to develop a programme of mitigation. This may include a desk-based assessment, site evaluation and detailed recording. Comments from EH on draft SEA document (04/01/05): section 9.3.6 (of the SEA) covers concerns regarding inter- and sub-tidal archaeology. Also concerns about the impact of the barrier on the character of the Conservation Area and setting of any relevant listed buildings. EH will assist in developing a detailed mitigation plan.
English Nature	***Preferred option: hold the line*** Hold the line is likely to lead to an environmental acceptable solution. EN anticipates that the proposal is not likely to have a significant effect on a European or Ramsar site. EN does not consider that the barrier option is not likely to lead to an environmentally acceptable solution due to concern about the effects of the barrier on tidal propagation, water quality, and sediment movement within the designated sites, over the projected period of the flood defence strategy. The proposal is *likely* to require an Appropriate Assessment under the Habitats Regulations. Regarding the potential managed realignment site at Wherstead, EN identified this as a site which offers considerable potential in contributing towards the provision of a morphologically sustainable estuarine form that is capable of responding to the impacts of sea level rise.	Telephone discussion with EN and issue of draft SEA document for comment. Comments from EN on draft SEA document (12/01/05)*:* The proposal is likely to lead to an environmentally acceptable solution. However, based on information available to date, EN anticipates that the proposal is likely to have a significant effect on the Stour and Orwell Estuaries SPA and, therefore, is likely to require an appropriate assessment under the Conservation (Natural Habitats &c) Regulations 1994. This advice is provisional and will need to be reviewed under the Regulations when the design details are available.
Countryside Agency	Do not wish to provide any comments.	None required
Ipswich Borough Council (2 respondents)	***Preferred option: Barrier*** 1. Refer to comments submitted for the proposed options consultation. The potential for developing brownfield land in the central area will be enhanced. 2. Raised concerns about the need for raising walls downstream of the barrier in compartments C and H. Suggested locating the barrier further downstream to	None required

	avoid this problem. Recommended that the barrier gates should be side hung to allow navigation.	
DEFRA (Rural Development Service)	No response to consultation, but regularly kept informed of project progress and on Steering Group.	None required
Suffolk County Council	***Preferred option: Barrier*** Concern about the hold the line proposals, particularly in relation to visual impact and ongoing disturbance and disruption to the future community and preventing the successful development of the waterfront area. The construction of a barrier might be promoted as a joint structure associated with a new river crossing to carry road traffic. Other benefits that could be expected are better waterfront development, less disruption and delay in promoting and implementing waterfront development, less disturbance to the future waterfront community from ongoing maintenance and improvements, visual impact significantly improved and more areas protected and to a higher standard, at least initially.	None required
Associated British Ports - Ipswich	***Preferred option: Barrier*** Stated as a *strong preference*. Raising existing defences by up to 1m will have a significant adverse effect on the regeneration prospects of a large swathe of Ipswich. It is questionable as to whether the existing historic structures, particularly alongside the New Cut, have the structural capacity to support such further loads without significant expenditure. Much of the Ipswich waterfront area is within a Conservation Area, care and attention must be paid to the appropriate choice of materials for new construction.	Individual response provided to some specific questions.
Babergh District Council	***Preferred option: not specified*** The chosen option makes no difference to Babergh DC.	None required
Mid-Suffolk District Council	***Preferred option:*** No response.	
East of England Development Agency	***Preferred option: Barrier*** Limited visual and environmental intrusion and widespread opportunities for regeneration throughout central Ipswich. EEDA has been and continues to be active in the regeneration and redevelopment of Ipswich, particularly around the Wet Dock area, where increases in wall heights indicated in the Hold the Line option would be visually unacceptable and would have a negative impact on the area.	None required
Anglian Water	***Preferred option:*** No response.	

Table 26 Summary of consultation responses from internal Environment Agency consultees (Stage 3)

Consultee	Response	Corresponding action
Aaron Dixey, Planning Liaison	***Preferred option: barrier*** From a planning perspective the Planning Liaison team is interested in the barrier option as this would seem to give a better standard of protection to the area. The only questions that arise relate to what the consequences would be should the barrier fail. This would need to be explored by Ipswich BC when allocating land for development in the area benefiting from the barrier. The least consequential area should be developed first and with the most sensitive sorts of development. This message needs to be sold along with the barrier i.e. that having a defence does not take you out of the flood plain, it just lowers the likelihood of the flood effecting you.	Consider during detailed design stage.
Andrew Baker, Monitoring and Data (hydrometry)	***Preferred option: No comments***	None required
Andrew Brasnett, Procurement	***Preferred option: No comments***	None required
David Knagg, Environment Management	***Preferred option: No comments***	None required
Fiona Ireland, Regulatory (water resources)	***Preferred option: No comments***	None required
Ian Bliss, Partnerships	***Preferred option: barrier*** From the limited involvement in the study the Barrier looks like the preferred option certainly in terms o the potential for the opportunities it presents.	None required
Peter Marjoram	***Preferred option: hold the line*** The installation of a barrier will still require the refurbishment and part replacement of the existing defences within Ipswich, particularly the New Cut. It may well also require additional defences upstream with potential increased use of the floodplain in Sproughton area. The barrier will be an additional cost as well as the additional cost of manning and maintaining such a structure.	None required
Ivan Nicholls	***Preferred option: barrier*** A barrier would mean the tidal defence of Ipswich would be centred in one area (the docks) and would not then require the construction disruption through the town required to construct the hold the line option. On the technical side, I would like to see the barrier constructed as a mitre gate barrier with hydraulic rams and hydraulic power pack units all similar to the newly upgraded lock flood gates. This would then give similarities in design and construction and consequently operation and maintenance. This then has the potential to keep costs at a minimum. If the new barrier was sited immediately upstream or downstream of the VCS then the standby generator could	Consider during detailed design stage.

	be used. The existing VCS and Flood gates have an emergency mobile hydraulic power pack that could be used on the new barrier if similar designs were used. Mitre gates would give a very low aesthetics impact on the area requiring only a small building on either side of the new cut to house the hydraulic power packs and control and the hydraulic rams would be below ground level in pits.	
Jeremy Bloomfield, Strategic Planning, Flood Defence	Views were fully and freely expressed during the project and my thoughts and views are encapsulated in the final report.	None required
Kate Mayes, Development Control	***Preferred option: barrier*** The barrier will provide a standard of protection of between 1 in 200 and 1 in 300 years upstream of the barrier. This is the minimum standard of protection required for new development under Government guidance and therefore from a Development Control view point this is the best option.	None required
Merle Leeds, FRB Conservation	No response	
Ros Wright, Ecological Appraisal	No response	
Ruth Medler, Monitoring and Data (chemical)	***Preferred option: No comments*** No comment on the options, however if the barrier is constructed may want to comment on any methodology in relation to the Areas water quality sampling strategy and any impact it may have.	Consider during detailed design stage.
Simon Barlow, Development Control	Refer to response from Kate Mayes.	None required
Stan Jeavons, Flood Defence Operations	***Preferred option: No comments***	None required
Yvonne Daly, Regulatory (water quality)	***Preferred option: No comments***	None required

APPENDIX 5

Appendix 5 - Strategic Environmental Appraisal (Summary)

A strategic environmental assessment (SEA) was undertaken on the seven short list proposed options, as described within Section 2.4. This appendix provides a list of Strategic Objectives, an overview of the scoring system and the SEA tables.

Strategic Objectives

1 To improve flood protection

a) To reduce the risk to life from flooding.
b) To seek to avoid or minimise damage to the built environment in Ipswich from flooding.

2 To enhance the environment for wildlife

a) To protect and enhance, where possible, habitats and species designated as being of international or national importance (Stour and Orwell SPA/ Ramsar site/ European Marine Site; Orwell Estuary SSSI; Wherstead mudflats as a future SPA)
b) To protect and enhance, where possible the habitats and species designated as being of local importance (County Wildlife Sites, Ancient Woodlands)
c) To improve, where possible, the conservation value of the area, particularly with respect to protecting, enhancing, restoring or creating wetland and coastal habitats and associated flora and fauna.
d) To prevent encroachment into the river channel.
e) To accommodate and manage, where possible, the effects of 'coastal squeeze'.

To comply with DEFRA High Level Target 9

a) To avoid damage to environmental interest
b) To ensure no net loss to habitats covered by Biodiversity Action Plans
c) Seek opportunities for environmental enhancement

To maintain, develop and improve fisheries

a) To minimise obstructions and barriers to fish.
b) To manage river flows and levels and conserve habitats so as to safeguard, and where possible, improve the value of watercourses for fish and other wildlife.

3. To enhance opportunities for recreation

a) To protect existing uses and future needs and demands for informal water and land-based recreation including walking, canoeing, boating, fishing and cycling, such as: access at and to the waterfront particularly along the non-tidal stretch of the River Gipping, the number and quality of public rights of way and cycle routes, provision of a tidal weir near West End Road for canoeists.
b) To develop the Wet Dock for tourism and complementary purposes.
c) To preserve public access to places of natural beauty and to buildings, sites and objects of archaeological or historic interest.

4. To conserve features of archaeological and historical importance

a) To protect and conserve buildings, sites and objects of archaeological, architectural, historic or engineering interest

5. To conserve and enhance the landscape character along the river

a) To consider the landscape context of the whole river, further the conservation and enhancement of natural beauty and conserve features of special interest.

6. To maintain and improve water resources

a) To maintain and, where possible, improve surface and groundwater quality.
b) To minimise the release of contaminants from contaminated land or waste management sites.
c) To ensure land drainage is not impeded.
d) To prevent the pollution of watercourses within the Strategy area.
e) To provide effective flood defences, and, where necessary, raise standards of protection, to maintain the integrity of the catchment's freshwater rivers and the coastal fringe.

7. To have regard to the economic and social well being of local communities

a) To maintain and enhance opportunities to improve the local environment through brownfield development, including within the Wet Dock area.
b) To ensure that opportunities for economic redevelopment / regeneration of urban areas are not compromised.
c) To maintain and, where possible, enhance the infrastructure within Ipswich (eg roads, railways, public rights of way, cycle routes).
d) To maintain access to the dock and wharves under ABP ownership and, where possible, to accommodate further expansion of the port.
e) To maintain, and where possible, improve the navigational use of the River Orwell.

Strategic Environmental Assessment scoring system

A compliance score was applied for each Strategic Objective relating to each of the seven proposed options. The scoring system is provided in Table 27

Table 27 Scoring system for the assessment of the proposed options

1 ½	Objective fully met and improvements/enhancements provided	1	Objective met
½	Objective partially met	0	Objective not met

A compliance percentage score was then calculated for each option based on the methodology described below. This enabled the options to be ranked in order of compliance with the Strategic Objectives. The calculation applied equal weighting to the seven impact groups because it was recognised there were differing numbers of Objectives in each group which could potentially 'skew' the outcome. The chosen calculation methodology therefore lessens the influence of groups that contain more objectives, and increases the influence of categories that contain fewer objectives. Calculation of compliance percentage score for each proposed option:

1. The total score attained within each of the seven groups of objectives was calculated eg a score of 4 for the 'flora and fauna impact' group.
2. The score achieved was divided by the optimum total. This assumed that a score of 1 was the optimum compliance score. Where additional enhancements would be achieved and a score of 1 ½ is assigned, this would be reflected as exceeding 100% compliance. For example, for 'flora and fauna impacts' there are 10 Objectives so the optimum total is 10, and the achieved score of 4 is divided by 10.
3. The scores for each of the seven groups were totalled and divided by seven to obtain and average, and expressed as a percentage.

Strategic Environmental Assessment tables

Option 2: Hold the Line (all compartments except B and G)

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell including within the SPA boundary and proposed extension, and hence result in a net loss of intertidal habitat over time through coastal squeeze.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**b**	1	**c**	0	**d**	1	**e**	0	**Total**	**2**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	1	**b**	0	**c**	0					**Total**	**1**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	1	**b**	1							**Total**	**2**
AMENITY IMPACTS	The increase in wall heights throughout the study area may compromise access to the river for recreation purposes, although will ensure protection from flooding for riverside activities.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	0	**b**	1	**c**	1					**Total**	**2**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls rather than replacement will limit the significance.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1									**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	There will be an adverse impact on the visual setting of the river and adjacent areas from the increased height of walls. The significance of any impact will depend on the extent of wall raising and the material used. However, the study area is predominantly within an urban and industrial setting. Contrary to regional and local planning policy.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	0									**Total**	**0**
WATER IMPACTS	There is a slight potential for water pollution during the construction works but this should be controlled with adherence to good practice. There is not likely to be a change to the existing land drainage regime.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	1	**c**	1	**d**	1	**e**	1	**Total**	**5**
SOCIO-ECONOMIC IMPACTS	This option will maintain the 'status quo' with respect to the existing navigation and infrastructure and, depending on the standard of protection, will enhance the opportunities for brownfield development within the flood plain. However, the height of walls may compromise the development opportunities, in particular for residential properties.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	0	**b**	0	**c**	1	**d**	1	**e**	1	**Total**	**3**

Option 3a: Retreat the Line (Commercial Road and Grafton Way area) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding, with a small area of land adjacent to the river subject to periodic flooding. The realigned defence would contain the flood water within the managed realignment area.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell including within the SPA boundary and proposed extension, and hence result in a net loss of intertidal habitat over time through coastal squeeze. The area of managed realignment provides an opportunity for habitat creation; the extent and value of the intertidal habitat would need to be determined in a detailed study.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**b**	½	**c**	1	**d**	1	**e**	0	**Total**	**2 ½**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	1	**b**	0	**c**	1					**Total**	**2**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	1	**b**	1							**Total**	**2**
AMENITY IMPACTS	The increase in wall heights throughout the study area may compromise access to the river for recreation purposes, although will ensure protection from flooding for riverside activities. The area of managed realignment may provide the opportunity for urban open space, although the nature of the habitat is yet to be determined.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	½	**b**	1	**c**	1					**Total**	**2 ½**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls rather than rebuilding will limit the significance. The area of managed realignment is on the fringes of the AAI and appropriate measures will be required during construction of the realigned defences with respect to the potential for buried remains.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1									**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	There will be an adverse impact on the visual setting of the river and adjacent areas from the increased height of walls. The significance of any impact will depend on the extent of wall raising and the material used. This is contrary to regional and local planning policy. The small realignment area may add to the amenity of the area.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	0									**Total**	**0**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The realignment area is not within a known area of contaminated land; appropriate ground investigations would be required to define the risk of pollution from the site.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	½	**c**	1	**d**	½	**e**	1	**Total**	**4**
SOCIO-ECONOMIC IMPACTS	This option will maintain the 'status quo' with respect to the existing navigation and infrastructure and, depending on the standard of protection, will enhance the opportunities for brownfield development within the flood plain in all areas apart from the small realignment site. However, the height of walls may compromise the development opportunities, in particular for residential properties.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**A**	0	**B**	0	**c**	1	**d**	1	**e**	1	**Total**	**3**

Option 3b: Retreat the Line (Wet Dock) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding, but will permit flooding of the Island site and Wet Dock area. The realigned defence would contain the flood water within the managed realignment area.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**B**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell including within the SPA boundary and proposed extension, and hence result in a net loss of intertidal habitat over time through coastal squeeze. The area of managed realignment provides a limited opportunity for habitat creation adjacent to the existing CWS; however, the extent and value of the intertidal habitat would need to be determined in a detailed study.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**B**	1 ½	**c**	1	**d**	1	**e**	½	**Total**	**4**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	1	**B**	½	**c**	½					**Total**	**2**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	1	**B**	1							**Total**	**2**
AMENITY IMPACTS	The increase in wall heights throughout the study area may compromise access to the river for recreation purposes, although will ensure protection from flooding for riverside activities. The area of managed realignment is unlikely to provide a significant opportunity for recreation.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	½	**B**	0	**c**	1					**Total**	**1 ½**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features outside the managed realignment area. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls rather than rebuilding will limit the significance. However, the realignment area is within the AAI and Conservation Area, with a potential for damage to features from intermittent flooding of the area and an alteration in the setting of the Wet Dock historic area.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	½									**Total**	**½**
LANDSCAPE AND VISUAL IMPACTS	There will be an adverse impact on the visual setting of the river and adjacent areas from the increased height of walls. The significance of any impact will depend on the extent of wall raising and the material used. This is contrary to regional and local planning policy. Intermittent flooding of the managed realignment may either enhance or reduce the existing character of the river setting.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	0									**Total**	**0**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The realignment area is within a known area of contaminated land and hence there is a high risk of ongoing pollution from the site.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**B**	½	**c**	1	**d**	½	**e**	1	**Total**	**4**
SOCIO-ECONOMIC IMPACTS	This option will maintain the 'status quo' with respect to the existing infrastructure but may affect navigational uses in the Wet Dock area. Depending on the standard of protection the opportunities for brownfield development within the flood plain will be enhanced in all areas apart from the small realignment site. However, the height of walls may compromise the development opportunities, in particular for residential properties.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	0	**B**	0	**c**	1	**d**	1	**e**	0	**Total**	**2**

Option 3c: Retreat the Line (Wherstead area) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding, but will permit flooding of an area of Wherstead. Structures would be installed to contain the flood water within the managed realignment site.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell and hence result in a net loss of intertidal habitat over time through coastal squeeze. However, within proposed extension to the SPA, the area of managed realignment will provide an opportunity for habitat creation. The extent and value of the intertidal habitat would need to be determined in a detailed study.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	1 ½	**b**	1	**c**	1	**d**	1	**e**	1	**Total**	**5 ½**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	1	**b**	½	**c**	½					**Total**	**2**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	1	**b**	1						**Total**	**2**
AMENITY IMPACTS	The increase in wall heights throughout the study area may compromise access to the river for recreation purposes, although will ensure protection from flooding for riverside activities. The area of managed realignment will result in a minor diversion of the Suffolk Coast and Heaths path.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	½	**b**	1	**c**	1					**Total**	**2 ½**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls rather than rebuilding will limit the significance. The realignment area is outside any protected areas.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1								**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	There will be an adverse impact on the visual setting of the river and adjacent areas from the increased height of walls. The significance of any impact will depend on the extent of wall raising and the material used. This is contrary to regional and local planning policy Intermittent flooding of the managed realignment may enhance the character of the river setting at this location.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	0								**Total**	**0**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The realignment area is not within a known area of contaminated land; however, appropriate ground investigations would be required to define the risk of pollution from the site.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	1	**c**		**d**	1	**e**	1	**Total**	**4**
SOCIO-ECONOMIC IMPACTS	This option will maintain the 'status quo' with respect to the existing navigation and infrastructure and, depending on the standard of protection, will enhance the opportunities for brownfield development within the flood plain in all areas.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	0	**b**	0	**c**	1	**d**	1	**e**	1	**Total**	**3**

Option 4a: Advance the Line (Island site) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence downstream of the structure will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell including within the SPA boundary and proposed extension, and hence result in a net loss of intertidal habitat over time through coastal squeeze. The structure is located upstream of the SPA/SSSI and within a CWS. There is a potential for an impact on the integrity of the CWS from the siting of the structure and on all protected areas within the estuary from changes in the hydrodynamics and sediment transport. The impacts will depend on the nature of the structure and mode of operation and further study is required to define such impacts. However, initial consultation with EN suggests that the frequency of operation of the barrier will not result in any significant impacts on the integrity of the SPA. Fish passes will be provided in structure for use during periods of closure.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**b**	½	**c**	0	**d**	0	**e**	0	**Total**	**½**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	½	**b**	0	**c**	0					**Total**	**1**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	½	**b**	½							**Total**	**1**
AMENITY IMPACTS	Although the increase in wall heights throughout the study area may compromise access to the river for recreation purposes, the wall height will be significantly lower upstream of the structure than for the hold the line option (option 2) which may facilitate easier access to the river. The defences will ensure protection from flooding for riverside activities.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	1	**b**	1	**c**	1					**Total**	**3**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls will limit the significance. The structure is to be located within a historic setting, and as such may detract from the existing features; the significance will depend on the type of structure.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1									**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	The use of a barrier allows the wall heights to be limited compared to a hold the line option. The significance of any impact will depend on the extent of wall raising and the material used, and the nature of the design of the structure. However, the likely height of walls upstream of the structure is significantly lower than for the hold the line option.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	1									**Total**	**1**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The location of the structure is within a known area of contaminated land and therefore adequate studies and control measures will need to be implemented to reduce the risk of pollution. There may be a loss of navigation upstream of the structure depending on the nature and mode of operation. There is a slight increased risk of pollution where the unusual event of tide locking occurs.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	1	**c**	½	**d**	1	**e**	1	**Total**	**4 ½**
SOCIO-ECONOMIC IMPACTS	This option will enhance the opportunities for brownfield development within the flood plain in all areas depending on the standard of protection, and may provide an opportunity for additional infrastructure. However, during times of closure navigation will be limited to the location of the barrier.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	1 ½	**b**	1	**c**	1	**d**	1	**e**	½	**Total**	**5**

Option 4b: Advance the Line (Cliff Quay area) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	Maintaining the existing line of defence downstream of the structure will prevent natural migration of the intertidal habitat in response to rising sea levels in the tidal section of the River Orwell including within the SPA boundary and proposed extension, and hence result in a net loss of intertidal habitat over time through coastal squeeze. The structure is located upstream of the SPA/SSSI and within a CWS. There is a potential for an impact on the integrity of the CWS from the siting of the structure and on all protected areas within the estuary from changes in the hydrodynamics and sediment transport. The impacts will depend on the nature of the structure and mode of operation and further study is required to define such impacts. However, initial consultation with EN suggests that the frequency of operation of the barrier will not result in any significant impacts on the integrity of the SPA. Fish passes will be provided in structure for use during periods of closure.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**b**	½	**c**	0	**d**	0	**e**	0	**Total**	**½**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	1	**b**	0	**c**	½					**Total**	**1**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	½	**b**	½							**Total**	**½**
AMENITY IMPACTS	Although the increase in wall heights throughout the study area may compromise access to the river for recreation purposes, the wall height will be significantly lower upstream of the structure which may facilitate easier access to the river. The defences will ensure protection from flooding for riverside activities.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	1	**b**	1	**c**	1					**Total**	**3**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls will limit the significance. The structure is not located within the vicinity of known historic features.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1									**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	The use of a barrier allows the wall heights to be limited compared to a hold the line option. The significance of any impact will depend on the extent of wall raising and the material used, and the nature of the structure. However, the likely height of walls upstream of the structure is significantly lower than for the hold the line option.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	½									**Total**	**½**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The location of the structure is within a known area of contaminated land and therefore adequate studies and control measures will need to be implemented to reduce the risk of pollution.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	1	**c**	1	**d**	1	**e**	1	**Total**	**5**
SOCIO-ECONOMIC IMPACTS	This option will enhance the opportunities for brownfield development within the flood plain in all areas and may provide an opportunity for a road bridge combined with the flood defence structure. There may be a loss of navigation upstream of the structure depending on the nature of the structure and likely impacts on the Port activities, including the turning circle.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	1 ½	**b**	1	**c**	1	**d**	0	**e**	0	**Total**	**3 ½**

Option 4c: Advance the line (Orwell bridge) in combination with Hold the Line

HUMAN IMPACTS	This option will result in a specified standard of protection from flooding.										
Objective	**To improve flood protection**										
Scoring	**a**	1	**b**	1						**Total**	**2**
FLORA AND FAUNA IMPACTS	The structure is located within the SPA/SSSI and hence there will be a degree of impact on the integrity of the SPA and on all protected areas within the estuary from changes in the hydrodynamics and sediment transport. The impacts will depend on the nature of the structure and mode of operation and further study is required. Where the line of defence is maintained upstream this will prevent the natural migration of the intertidal habitat in response to rising sea levels, although this does not apply to compartments A and G.										
Objective	**To enhance the environment for wildlife**										
Scoring	**a**	0	**b**	0	**c**	0	**d**	0	**e**	0	**Total**	**0**
Objective	**To comply with DEFRA High Level Target 9**										
Scoring	**a**	0	**b**	0	**c**	0					**Total**	**½**
Objective	**To maintain, develop and improve fisheries**										
Scoring	**a**	½	**b**	½						**Total**	**1**
AMENITY IMPACTS	Although the increase in wall heights throughout the study area may compromise access to the river for recreation purposes, the wall height will be significantly lower upstream of the structure which may facilitate easier access to the river. The defences will ensure protection from flooding for riverside activities.										
Objective	**To enhance opportunities for recreation**										
Scoring	**a**	1	**b**	1	**c**	1				**Total**	**3**
ARCHAEOLOGY AND HERITAGE IMPACTS	This option will reduce the risk of flooding within the archaeologically protected areas in Ipswich and hence conserve existing features. Whilst there is a potential for a slight impact on the historic river walls, the process of increasing the height of existing walls will limit the significance. The structure is not located within the vicinity of known historic features.										
Objective	**To conserve features of archaeological and historical importance**										
Scoring	**a**	1								**Total**	**1**
LANDSCAPE AND VISUAL IMPACTS	The use of a barrier allows the wall heights to be limited compared to a hold the line option. The significance of any impact will depend on the extent of wall raising and the material used, and the nature of the structure. However, the likely height of walls upstream of the structure is significantly lower than for the hold the line option and the structure will be adjacent to the existing road bridge.										
Objective	**To conserve and enhance landscape character along the river**										
Scoring	**a**	½								**Total**	**½**
WATER IMPACTS	There is a slight potential for water pollution during construction works of the defences but this should be controlled with adherence to good practice. The location of the structure is not within a known area of contaminated land; however, appropriate ground investigations would be required to define the risk of pollution from the site. The structure may affect navigation upstream.										
Objective	**To maintain and improve water resources**										
Scoring	**a**	1	**b**	1	**c**	1	**d**	1	**e**	1	**Total**	**5**
SOCIO-ECONOMIC IMPACTS	This option may affect navigation upstream of the structure depending on its nature, with associated impacts on the Port activities. It will enhance the opportunities for brownfield development within the flood plain in all areas.										
Objective	**To have regard to the economic and social well being of local communities**										
Scoring	**a**	1 ½	**b**	1	**c**	1	**d**	0	**e**	0	**Total**	**3 ½**

APPENDIX 6

5.11 Appendix 6 – DEFRA Submission Check List

(See latest Grant Memorandum)

Project Appraisal Report (Engineer's Report)	
Hard copy of Approval History Sheet, with signatures	
Hard copy of SoD Coversheet, with signatures	
Letter from English Nature giving their support to the proposals	

APPENDIX 7

Appendix 7 – Defra PAR data sheet

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):	IMAN 000737	LDW/CPW	
Project Name (60 characters max.):	Ipswich Flood Defence Management Strategy		
Promoting Authority: Defra ref (if known)	LDW 40245		
Name	Environment Agency – Anglian Region		
RE Region:			
Emergency Works: *(Y/N)*	N		
Strategy Plan Reference:	40245	LDW/CPW	
Shoreline Management Plan:		LDW/CPW	
Project Type:	Strategy Plan		

Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project Coast Protection/Sea Defence/Tidal Flood Defence/Non-Tidal Flood Defence/Flood Warning - Tidal/Flood Warning - Fluvial/Special

CONTRACT DETAILS

Estimated start date of works/study:	March 2001	
Estimated duration in months:	51	
Contract type	Framework	

Direct labour, Framework, Non Framework, Design/Construct

COSTS

	APPLICATION (£)	Defra ADJUSTMENT (£)
Appraisal:	486k	
Costs for Agency approval:	44,843k	
Total Whole Life Costs:	43,656k	

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS:

Windfall Contributions:	0	
Deductible Contributions:	0	
ERDF Grant:	0	
Other Ineligible Items:	0	

Defra use only, below this line on this page

Application submission date:			
Date application received:		Last papers received:	
Recommendation:		Action Office:	

Formal Approval/Agreement/Agreement to Strategy/Without Prejudice/Refer Back (HQ/Region)

Special Conditions required? (Yes, only if conditions required on approval letter): *Y/N*

Special Conditions:

Progress:	Officer (Surname)	Start (date)	Complete (date)	Days
Senior Engineer:		/ /	/ /	
Regional Engineer:		/ /	/ /	

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	Anglian Region, Eastern Area	Ref.
Name of watercourse (fluvial projects only):	Gipping/ Orwell	
District Council Area of project (all projects):	Ipswich Borough Council	Ref.
Grid Reference (all projects):	TM 156441	
(OS Grid reference of typical mid point of project in form ST064055)		
Specific town/district to benefit:		

DESCRIPTION

Brief project description including essential elements of proposed project/study
(Maximum 3 lines each of 80 characters)

Develop a plan to manage flood risk in Ipswich from tidal and fluvial flooding over the next 100 years.
Proposed project – to undertake wall raising and replacement works where necessary, whilst developing adetails of a barrier to be constructed at the New Cut in Ipswich

Postcodes of protected property wholly or partially within proposed benefit area
IP1, IP2, IP3, IP4, IP9

DETAILS

Design standard (return period):	Compartment A: 0 Compartment B: 100 Compartment C: 300 Compartment D: 100 Compartment E: 300 Compartment F: 0 Compartment G: 0 Compartment H: 300 Compartment I: 0 Compartment J: 300 Compartment K: 200 Compartment L: 0	yrs
Existing standard of protection (return period)	Compartment A: 2	yrs

	Compartment B: 4 Compartment C: 74 Compartment D: 165 Compartment E: 46 Compartment F: 193 Compartment G: 98 Compartment H: 29 Compartment I: 77 Compartment J: 128 Compartment K: 14 Compartment L: 193		
Design life of project:	100 yrs		yrs
Fluvial design flow (fluvial projects only):	m^3/s		m^3/s
Tidal design level (coastal/tidal projects only):	5.19 m		m
Length of river bank or shoreline improved:	10.93 m		m
Number of groynes (coastal projects only):			
Total length of groynes* (coastal projects only):	m		m
Beach Management Project? *Y/N*			
Water Level Management (Env) Project? *Y/N*			
Defence type (embankment, walls, storage etc	Barrier, walls , control structures		

* i.e. total length of all groynes added together, ignore any river training groynes

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):		Not Applicable/Received/Awaited	
EA Region Consent (LA Projects only):		Not Applicable/Received/Awaited	
Non Statutory Objectors: Y/N			
Date Objections Cleared:			

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

ENVIRONMENTAL CONSIDERATIONS

English Nature (or equivalent) approval:	Received	Not Applicable/Received/Awaited	
Date received	12 Jan 2005		

Sites of International Importance (*Y/N* for each)
Answer Y if project is within, adjacent to or potentially affects the designated site

Special Protection Area (SPA):	Y	
Special Area of Conservation (SAC):	Y	
Ramsar Site	Y	
Biosphere Reserve	N	
World Heritage Site	N	

Sites of National Importance (*Y/N* for each)
Answer Y if project is within, adjacent to or potentially affects the designated site

Environmentally Sensitive Area (ESA):	N	
Site of Special Scientific Interest (SSSI):	Y	
Area of Outstanding Natural Beauty (AONB):	N	
National Park	N	
National Nature Reserve	N	

Other Environmental Considerations

Listed structure consent	N/A	Not Applicable/Received/Awaited	
Water Level Management Plan Prepared? *Y/N*	N/A		
FEPA licence required? *NA/R/A*	N/A		
Water Fringe Area affected? *Y/N*	Y		

Compatibility with other plans

Shoreline Management Plan	N/A	Yes/No/Not Applicable	
Water Level Management Plan	N/A	Yes/No/Not Applicable	
Local Environment Agency Plan	N/A	Yes/No/Not Applicable	

SEA/Environmental Impact Assessment

SEA/Environmental Impact Assessment	SEA	

Advertised/Planning Approval granted/SI 1217 not applicable/Statement prepared

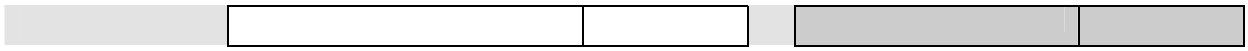
Environmental Statement prepared? *Y/N*	N/A		
Objections received	N		

(None/Overruled/ Sustained/ Outstanding)

Countryside Agency agreement?	N/A	CA had no comments	

Not Applicable/Received/Awaited (CA approval required if ES issued)

Other agreements	Detail	Result	(Not Applicable/Received/Awaited for each)	
	English Heritage	Received		



Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

COSTS, BENEFITS & SCORING DATA

(Apportion to this phase if part of a strategy)

Local authorities only: for projects done under Coast Protection Act 1949, please separately identify:
FD = Benefits from reduction of asset flooding risk; CE = Benefits from reduction of asset erosion risk

Benefit type (DEF: reduces risk (contributes to Defra SDA 27); CM: capital maintenance; FW: improves flood warning; ST: study; OTH: other projects)			

LAND AREA

Total area of land to benefit:	188.6 ha			ha	
of which present use is:	FD	CE		FD	CE
Agricultural:	0 ha	ha		ha	ha
Developed:	188.6 ha	ha		ha	ha
Environmental/Amenity	0 ha	ha		ha	ha
Sched. for development:	0 ha	ha		ha	ha

PROPERTY PROTECTED

	Number		Value (£'000s)			Number		Value (£'000s)	
	FD	CE	FD	CE		FD	CE	FD	CE
[1]Resid.	840		138,595						
Comm./ind.	246		523,779						
Other: (description below)	Port		3,646						
Description:						Description:			

COSTS AND BENEFITS

[1]Present value of total project whole life costs (£'000s):	43,656			
Project to meet statutory requirement? *Y/N*				
	£'000s		**£'000s**	
	FD	CE	FD	CE
Present value of urban benefits:	352,549			
Present value of agricultural benefits:	0			
Present value of environmental/amenity benefits:	0			
[1]Present value of total benefits (FD & CE)	352,549			
Net present value:	308,893			
Benefit/cost ratio:	8.08:1			:1
			Category U/UA/AU/EU etc:	
Base date for estimate:	Aug 04			
Project Appraisal Guidance used: *Y/N*	Y			
PAG Decision rule stages III and IV applied: *Y/N*	Y			

5.11.1 OTHER PRIORITY SCORING DETAILS[1]

Economics		People		Environmental	
Non-works study, eg coastal process (Y/N)?	N	Risk*:	H	BAP net gain (Ha):	0
		Vuln**:	1	SSSI protected (Ha):	0
				Other habitat (Ha):	0
				Heritage sites***:	I or II*

*(VH, H or N/A); **(from ODPM website) *** ("I or II*" , "II or other" or "N/A") See back page for score calculation details

Exemption Details (if exempt from priority scoring system)

Exempt from Scoring (Y/N):			
Reason (max 100 chars):			

[1]Highlighted fields all used to generate priority score - see Annex for calculation flowchart

APPENDIX 8

5.12 Appendix 8 - Priority Score Calculation Flowchart

ECONOMIC SCORE

BARRIER COMPARTMENT ONLY		Benefits (£'000s)		Costs (£'000s)		Economic Score
	Divide	336,362	by	39,743	multiply by 2 and subtract 1 =	15.93

Economic score = (benefits / costs * 2) –1 (Max is 20)

PEOPLE SCORE

No of residences		Cost (£'000s)		Base People Score		Risk factor very high = 2 high = 1	Affluence factor: 1 to 300 301 to 1500 1501 to 6664 6665 to 8114 8115 to 8414	Add: +2 +1 no adjustment -1 -2		People Score
629	multiplied by 75, divided by	39,743	=	1.19	plus	1	plus	1	=	3.19

(Max is 8) (Max. is 12)

People score = (number of residences protected * 75 / cost) + risk factor + vulnerability factor

ENVIRONMENTAL SCORE

BAP (Ha)		SSSI (Ha)			Other (Ha)		Cost (£'000s)		Heritage I or II* = 2 II or other = 1		Environmental Score
(0	multiplied by 2)	(0	multiplied by 1.5)	plus	0)	multiplied by 25 divided by	39,743	plus	2	=	2
(	(0)	plus	(0)								

Environmental score = (((BAP area created *2) + (SSSI area protected * 1.5) + other designated area protected) * 25 / cost) + heritage factor (Max is 12)

TOTAL SCORE

Economic + People + Environmental =	21.11

Studies should be scored as for the works to which they relate; studies not related to works (eg coastal process studies for SMPs) score 20. (Max is 44)

Please note there is an Internet Score Calculator at http://www.defra.gov.uk/environ/fcd/policy/grantaid.htm

ECONOMIC SCORE

COMPARTMENT B ONLY		Benefits (£'000s)		Costs (£'000s)		Economic Score
	Divide	16,187	by	3,912	multiply by 2 and subtract 1 =	7.28

Economic score = (benefits / costs * 2) –1 (Max is 20)

PEOPLE SCORE

No of residences		Cost (£'000s)		Base People Score		Risk factor very high = 2 high = 1	Affluence factor: 1 to 300 301 to 1500 1501 to 6664 6665 to 8114 8115 to 8414	Add: +2 +1 no adjustment -1 -2		People Score
211	multiplied by 75, divided by	3,912	=	4.04	plus	1	plus	0	=	5.04

(Max is 8) (Max. is 12)

People score = (number of residences protected * 75 / cost) + risk factor + vulnerability factor

ENVIRONMENTAL SCORE

BAP (Ha)		SSSI (Ha)			Other (Ha)		Cost (£'000s)		Heritage I or II* = 2 II or other = 1		Environmental Score
(0	multiplied by 2)	(0	multiplied by 1.5)	plus	0)	multiplied by 25 divided by	3,912	plus	2	=	2
(	(0)	plus	(0)	plus							

Environmental score = (((BAP area created *2) + (SSSI area protected * 1.5) + other designated area protected) * 25 / cost) + heritage factor (Max is 12)

TOTAL SCORE

Economic + People + Environmental =	14.32

Studies should be scored as for the works to which they relate; studies not related to works (eg coastal process studies for SMPs) score 20. (Max is 44)

Please note there is an Internet Score Calculator at http://www.defra.gov.uk/environ/fcd/policy/grantaid.htm

APPENDIX 9

LOWESTOFT RAILWAY LINE BRIDGE

NORWICH RAILWAY LINE BRIDGE
(UPPER LIMIT OF STUDY AREA)

HORSESHOE SLUICE

IPSWICH

STOKE BRIDGE

THE ISLAND SITE

NEW CUT

WET DOCK AND WATERFRONT

CLIFF QUAY

BOURNE BRIDGE

WHERSTEAD MUDFLAT

ORWELL BRIDGE
(LOWER LIMIT OF STUDY AREA)

Designed	PJN	Date	Mar 03
Checked	MCR	Date	Mar 03
Drawn	PJN	Date	Mar 03
Checked	MCR	Date	Mar 03
Released	MF	Date	Mar 03

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Additional Data	PJC	MF			09/04
2.	Minor changes	SPT				11/04

Key:

Ipswich Watercourses

Ipswich Flood Defence Management Strategy Study

Study Area

ENVIRONMENT AGENCY

Contract no.	Approved	Date
108553		Nov 04
		Scale: 1:15,000

BLACK & VEATCH
Black & Veatch Consulting

Drawing no. **Figure 1**

R:\Projects108553_IPS\Workspaces\Study_area.Wor SPT Nov 04

Designed:	SDK	Date:	Dec 03
Checked:		Date:	
Drawn:	PJC	Date:	Oct 04
Checked:	AA	Date:	Oct 04
Reviewed:		Date:	

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Minor Changes	SPT				11/04

Key:

- 1 in 300 Year Floodplain
- Compartment Boundaries
- **A** Compartments A - L

L
K
F
I
E
J
D
H
C
B
G
A

HORSESHOE SLUICES
HANDFORD SLUICES
CONSTANTINE WEIR
VELOCITY CONTROL STRUCTURE
WETDOCK FLOODGATES
BOURNE SLUICES

IPSWICH
Chantry
Maidenhall
Stoke
Stoke Park
Greenwich
Rose Hill
Gainsborough
River Orwell
Orwell Bridge

Ipswich Flood Defence Management Strategy Study

1 in 300 Return Period for 2002 and Control Structures

ENVIRONMENT AGENCY

Contract no.	Approved:	Date:
108553		Nov 04

BLACK & VEATCH
Black & Veatch Consulting

Scale: 1:17,500 (at A3)

Drawing no.: **Figure 2**

R:\projects\108553_IPS\Workspaces\1in300yrFloodfor2002_221104.WOR SPT Nov04 (c)BVCs

Designed:	SDK	Date:	Dec 03
Checked:		Date:	
Drawn:	PJC	Date:	Oct 04
Checked:	AA	Date:	Oct 04
Reviewed:		Date:	

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Minor Changes	SPT				11/04

L
K
F
E
I
J
D
H
C
B
G
A

HORSESHOE SLUICES
HANDFORD SLUICES
CONSTANTINE WEIR
VELOCITY CONTROL STRUCTURE
WETDOCK FLOODGATES
BOURNE SLUICES

IPSWICH
Chantry
Maidenhall
Stoke Park
Greenwich
Rose Hill
Gainsborough
Istead
River Orwell
Orwell Bridge

Key:

- 1 in 300 Year Floodplain
- Compartment Boundaries
- **A** Compartments A - L

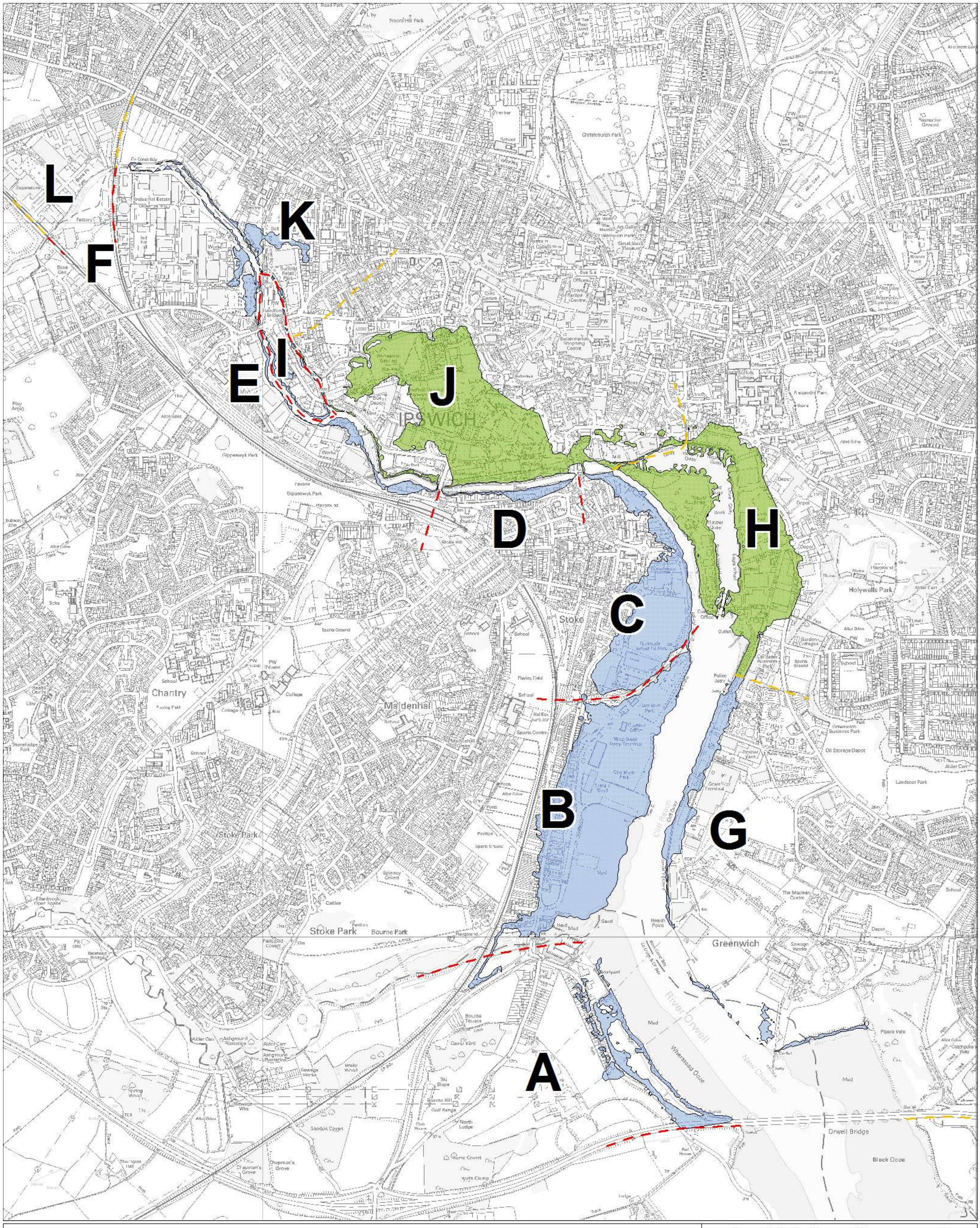
Ipswich Flood Defence Management Strategy Study

1 in 300 Return Period for 2102 and Control Structures

ENVIRONMENT AGENCY

Contract no. 108553	Approved:	Date: Nov 04
BLACK & VEATCH Black & Veatch Consulting		Scale: 1:17,500 (at A3)
		Drawing no. Figure 3

R:\projects\108553_IPS\Workspaces\1in300yrFloodfor2102_271004.wor SPT Nov04 (c)BVCs



Key.

- Left Bank Compartment Boundary
- Right Bank Compartment Boundary
- Flooding from Breaching and Overtopping
- Flooding from Overtopping

A Flood Compartments A - L

Ipswich Defence Management Strategy Study

Area at Immediate Risk of Flooding

ENVIRONMENT AGENCY

Scale 1:15,000	Contract No 108553	Designed PJC	Date Aug 02
Date Aug 02	Drawing No **Figure 4**	Checked RE	Date Aug 02
BLACK & VEATCH Black & Veatch Consulting		Drawn	Date
		Checked	Date

R:\Projects\108508\Combined\Contours_ldc\Contours_pjc_080802.WOR SPT Nov 04

Designed	SJH	Date:	Oct 02
Checked	MCR	Date:	Oct 02
Drawn	SJH	Date:	Oct 02
Checked	MCR	Date:	Oct 02
Reviewed	MF	Date:	Oct 02

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Additional Data	PJC	MF			09/04
2.	Minor changes	SPT				11/04

Christchurch Park
River Gipping CWS
Alderman Canal LNR and CWS
IPSWICH
Stoke Hill, Ancaster Road
Birkfield Drive
Holywell's Park & Canal
Stoke Tunnel Cutting
River Orwell CWS
Landseer Park Carr
Volvo/Raeburn Road Site
Stoke Park Wood
Bourne Bridge Grassland CWS
Belstead Brook
Belstead Brook Meadow
Braziers Wood
Bourne Park Reedbed
Braky Wood
Pipers Vale
Spring Wood
Bobbitshole, Belstead
Ashground Covert & Alder Carr
Orwell Estuary Ramsar / SPA

Key:

- Ramsar / Special Protection Area (SPA)
- Potential Expansion to SPA
- Site of Special Scientific Interest (SSSI)
- Local Nature Reserve (LNR)
- County Wildlife Sites (CWS)
- Local Wildlife Sites
- Ancient Woodland

This information was obtained from a map provided by Suffolk Biological Records Centre at a scale of 1:27,042.
Therefore this map is only indicative of the official designated boundaries.

Ipswich Flood Defence Management Strategy Study

Designated Nature Conservation Areas

ENVIRONMENT AGENCY

Contract no. 108533	Approved: MF	Date: Nov 04	
BLACK & VEATCH Black & Veatch Consulting		Scale: 1:20,000	
		Drawing no. Figure 5	

R:\Projects\108553_IPS\Data\Workspaces\Nature_Conservation_Areas.wor SPT Nov 04

Designed	PJN	Date:	NOV 02
Checked	MCR	Date:	NOV 02
Drawn	PJN	Date:	NOV 02
Checked	MCR	Date:	NOV 02
Reviewed	MF	Date:	NOV 02

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Additional Data	PJC	MF			09/04
2.	Minor changes	SPT				11/04

Key:

- Scheduled Monuments (SMs)
- Area of Archaeological Importance (AAI)
- Conservation Area
- Sites and Monuments Record (SMR)
- Listed Buildings

Ipswich Flood Defence Management Strategy Study

Features of Cultural Heritage

ENVIRONMENT AGENCY

Contract no. 108553	Approved:	Date:	Nov 04
BLACK & VEATCH Black & Veatch Consulting		Scale:	1:20,000
		Drawing no.	**Figure 6**

R:\Projects108553_IPS\Workspaces\Cultural_Heritage.Wor SPT Nov 04

Designed	PJN	Date:	NOV 02
Checked	MCR	Date:	NOV 02
Drawn	PJN	Date:	NOV 02
Checked	MCR	Date:	NOV 02
Reviewed	MF	Date:	NOV 02

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date
1.	Additional Data	PJC	MF			09/04
2.	Minor changes	SPT				11/04

Key:

- Protected Open Space with High Amenity
- Protected Open Space
- Protected Country Park
- Public Rights of Way (Footpaths)
- Proposed Cycle Routes

Ipswich Flood Defence Management Strategy Study

Recreation and Leisure Use

ENVIRONMENT AGENCY

Contract no. 108553	Approved:	Date:	Nov 04
BLACK & VEATCH Black & Veatch Consulting		Scale:	1:20,000
		Drawing no.	**Figure 7**

R:\Projects\108553_IPS\Workspaces\Natural_Environment.Wor SPT NOV 04

Designed:	SDK	Date:	DEC 03
Checked:		Date:	
Drawn:	AJS	Date:	DEC 03
Checked:		Date:	
Reviewed:		Date:	

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date

Key:

- Protected against 1 in 100yr Flooding
- Protected against 1 in 200yr Flooding
- Protected against at least 1 in 300yr Flooding
- No Active Intervention
- Line of Defence (1 in 100yr Standard of Protection)
- Line of Defence (1 in 200yr Standard of Protection)
- Line of Defence (1 in 300yr Standard of Protection)
- Compartment Boundaries
- A — Compartments A - L

Ipswich Flood Defence Management Strategy Study

Hold the Line Option

ENVIRONMENT AGENCY

Contract no.	108553	Approved:	
Date:	Nov 04		
Scale:	1:16,000		
Drawing no.	Figure 12		

BLACK & VEATCH
Black & Veatch Consulting

R:\projects\108553_IPS\Workspaces\standardofprotection.wor SPT Nov 04

Designed	SDK	Date	DEC 03
Checked		Date	
Drawn	AJS	Date	DEC 03
Checked	AJM	Date	JUN 04
Reviewed	HAED	Date	JUN 04

Rev.	Nature of Revision	Drawn	Chkd.	Rvwd.	Appd.	Date

Key:

- Protected against 1 in 100yr Flooding
- Protected against at least 1 in 300yr Flooding
- No Active Intervention
- Line of Defence (1 in 300yr Standard of Protection)
- Line of Defence (1 in 100yr Standard of Protection)
- Compartment Boundaries
- A — Compartments A - L

Ipswich Flood Defence Management Strategy Study

Advance the Line (Barrier Preferred) Option

ENVIRONMENT AGENCY

Contract no. 108553	Approved:	Date: Nov 04
BLACK & VEATCH Black & Veatch Consulting		Scale: 1:16,000
		Drawing no. Figure 13

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