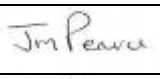
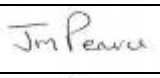
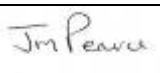
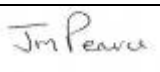
Strategy Approval Report

Promoting Authority	Environment Agency
Strategy Name	Pagham to East Head Coastal Defence Strategy

Photograph courtesy of the Maritime and Coastguard Agency

Date	June 2009
Version	5

StAR for Pagham to East Head Coastal Defence Strategy

Version	Status	Signed off by	Date signed	Date issued
1	Submission to NRG		24 October 2008	May 2009
2	NRG Resubmission 1 following review		18 March 2009	March 2009
3	NRG Resubmission 2		27 April 2009	April 2009
4	Return to NRG for signatures		3 June 2009	3 June 2009

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Environment Agency approval history sheet			
Strategy title: Pagham to East Head Coastal Defence Strategy		**Environment Agency project code:**IMSO000772	
Environment Agency project manager: Joe Pearce		**Date of StAR: November 2008**	
Consultant project manager: Ray Traynor		**Consultant:** Jacobs	
Environment Agency staff involvement			
Position	**Name**	**Signature**	**Date**
'I have reviewed this document and confirm the project meets Environment Agency and Defra/WAG criteria and recommend approval'			
Originator (PM)	Joe Pearce	Joe Pearce	28/10/08
Reviewer (project executive)	Samina Khan	S Khan	28/10/08
'I confirm I am content for the strategy as described in this document to proceed for approval and that strategic level risks have been identified.'			
Client representative	Gordon Wilson p.p. Andrew Gilham		17 October 2008
NEAS Operational Unit Manager	Phil Griffiths	Phil Griffiths	28 Oct 2008
'I have reviewed this document and confirm that it complies with the current StAR guidelines.'			
StAR Reviewer	Alastair Pitcher		29 Oct 2008
'I confirm I am content that the strategy as described in this document contributes to the delivery of our FRM Policy objectives as defined in the relevant CFMPs/SMPs, and that the strategy can proceed for approval.'			
Regional FRM Strategic and Development Planning Team Leader	Gary Lane		
'I confirm the project is ready for submission to NRG.'			
Operations Manager	Paul Sedgwick		29-10-08
NRG – National Review Group			
Date of meeting: 3 Dec 08	**Chairman:** (Acting) Richard Williams	**StAR amendment no:**	
Presenter(s): Joe Pearce (PM) Samina Khan (PE) Andy Gilham Hannah Pritchard Ray Traynor (Jacobs) David Lowsley			
Detailed record of any comments/actions required/additional information provided, to be appended to the StAR for onward transmission.			
Recommended for approval: In the sum of £	Date: 2 June 09 K J Allison		
Strategy approval			
Environment Agency	Head of ncpms and officers in accordance with the Environment Agency's SoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Environment Agency Board		
StAR Submitted	Date:		
Strategy Approval	**By:** In the sum of: £	**Date:**	
Defra Approval			
Submitted to Defra	**Date:**		
StAR amendment no. (if different):			
Defra Approval:	**Date:**		

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FINANCIAL SCHEME OF DELEGATION (FSoD) COVERSHEET

1.

Project name	Pagham to East Head Coastal Defence Strategy			Start date	July 2006
				End date	Nov. 2009
Business unit	Southern Region FCERM		Programme	FDGiA	
Project ref.	IMSO000772	Regional FSoD ref.		Head Office FSoD ref.	F/0910/0061 22/6/09

2.

Role	Name	Post Title
Project Sponsor	Andrew Gilham	Area Flood and Coastal Erosion Risk Manager
Project Executive	Samira Khan	ncpms Project Manager
Project Manager	Joe Pearce	ncpms Project Manager

3.

Outline Risk Assessment (ORA) Category	Low	☐	Medium	☐	High	☐

4.

FSoD schedule		Description	Delegation	
			Regional – up to	Environment Agency – up to
A1	☐	Non FRM project	£5m	£5m
A2	☐	FRM project within approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
A3	☐	FRM project outside of approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
A5	☐	Consultancy project	£300k	£500k
A9	X	FRM Strategy	£500k	£250m WLC Defra/£5m capital NAW
O1	☐	IS/IT project	--	£5m
T2	☐	Purchase or lease of land and buildings	£40k purchase/£10k pa lease	£5m

5.

FSoD value	£
Preparation costs for Form A/Business Case/PAR/FRM Strategy	N/A
Project costs	N/A
Whole Life Costs (WLC) of FRM Project or Strategy	£ 279 million

6.

Required level of Environmental Impact Assessment	N/A -	LOW	Medium ☐	High ☐

7.

FSoD approver name	Post title				Signature	Date
Paul Leinster	Chief Executive				[signature]	10.7.09
Chris Smith	Environment Agency Board				[signature]	16.7.09
FSoD consultee name	**Post title**				**Signature**	**Date**
Ken Allison	NRG Chair	RED ☐	AMBER ☐	GREEN ☐		
Miles Jordan RICHARD DUNN	Head of ncpms (Acting)				[signature]	24/10/08
Harvey Bradshaw	Regional Director					
Nigel Reader	Director of Finance				[signature]	22.6.09
David Jordan	Director of Operations				[signature]	22/6/09

8.

Form G	Form G value (£k)	Regional FSoD ref.	Head Office FSoD ref.	Latest FSoD authorised cost (£k)
1				
2				

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1. EXECUTIVE SUMMARY

Submission to obtain strategy approval

Southern Region: Pagham to East Head Coastal Defence Strategy *£ 279,000k*

Sponsoring Director: David Jordan - Director of Operations

Approval Route
Section A9 of the Financial Scheme of Delegation states that, for whole life costs in a Flood Risk Management Strategy Agency Board approval is required in excess of £50,000,000

Route:	National Capital Programme Manager	Miles Jordan
	National Review Group	Ken Allison
	Regional Director	Harvey Bradshaw
	Director of Operations	David Jordan
	Director of Finance	Nigel Reader
	Chief Executive	Paul Leinster
	Board	
	Defra /WAG	*(*required due to value)
	Treasury	*(*as advised by Defra)

1.1 Introduction and Background

1.1.1 The Pagham to East Head Coastal Defence Strategy has been produced by the Environment Agency in partnership with Chichester and Arun District Councils. This submission seeks approval for a 100 year strategy to manage coastal flooding and erosion risks in this area.

1.1.2 The Strategy area is the coastline of the peninsula south of Chichester, between Pagham and West Wittering in West Sussex (see key plan 1). The area is split into six management frontages. Land is generally low but many of the area's properties are on higher ground, resulting in the need to manage the risks from both flooding and erosion. Chichester District Council (CDC) manages four frontages. The Environment Agency manages the Medmerry frontage, with joint responsibility for the Pagham frontage shared with Arun District Council (ADC) and CDC.

1.1.3 The Strategy builds on an earlier draft strategy completed in 2001 and two Shoreline Management Plans (SMPs). The Selsey Bill to Beachy Head SMP 2 is currently awaiting approval and completion of the North Solent SMP 2 expected in spring 2010. The Strategy is consistent with the recommendations of the Catchment Flood Management Plan that covers the area and draws on Defra's Making Space for Water Strategy.

1.1.4 The principal objective of this Strategy is to *"identify sustainable coastal flood and erosion risk management in line with Defra Policy"* and the aims of the Strategy are in accordance with 'Creating a better place' aims.

1.1.5 The 2001 draft Strategy was not approved partly due to Natural England's concern over the long term viability of the option recommended for the Medmerry frontage.

1.1.6 This Strategy has reviewed and updated the 2001 draft and recommends a sustainable long term option for Medmerry.

1.1.7 The Environment Agency has powers to implement the Strategy under Section 165 of the Water Resources Act 1991. CDC and ADC both have similar powers as the Coastal Protection Authorities under the Coast Protection Act 1949. Planning Permission will be required for any new works recommended by the Strategy.

1.2 Problem

1.2.1 There are now 1,200 properties in the Strategy area at flood risk below the 0.5% annual event probability (AEP) flood level. With predicted sea level rise, by 2108 this will increase to an estimated 4,800 properties. Standard of Protection (SoP) against flooding offered by current defences varies between 0.5% AEP and 100% AEP.

1.2.2 Erosion is the key risk to urban frontages. Sections of defences on frontages at Selsey and East Wittering and Bracklesham require replacement to prevent failure in the next five to 10 years. Erosion damage to seafront properties could lead to the loss of 50 properties immediately after defences fail.

1.2.3 The total number of properties at flood or erosion risk over the next 100 years is 5,300.

1.2.4 The raised shingle bank defence at Medmerry breaches almost annually with the potential to put lives at risk and to affect critical infrastructure, small communities and 3,000 holiday caravans. Three properties on the Medmerry frontage are particularly vulnerable and could be lost within the next five years.

1.2.5 The low lying inland area at Medmerry has the potential to provide a major opportunity for creating 300-400 hectares of new inter-tidal habitat. This area could offset losses through coastal squeeze, outside this Strategy area, of internationally designated habitat. This could provide compensation habitat enabling other coastal flood and erosion risk management schemes to go ahead across the Solent. The new habitat could also contribute to the Defra Public Service Agreement (PSA) target requiring 95% of Sites of Special Scientific Interest (SSSI) to be in favourable or recovering condition by April 2011. The Medmerry Managed Realignment Project in conjunction with the Medmerry Land Acquisition Project (both are FSoD category A3) have been initiated to deliver these outcomes.

1.3 Options

1.3.1 No Active Intervention (NAI) was considered for all frontages as an economic base case. Do minimum was also considered for each frontage. From a longer list of options, the following were taken forward for further consideration: Hold the Line (Maintain and Sustain) and; Managed Realignment. Additionally Adaptive Management was considered at Pagham and East Head frontages (where uncertain natural development means flexibility is needed to make decisions and take actions based upon knowledge built up over time to achieve defined objectives as part of a Management Plan).

1.4 Recommended strategy

1.4.1 The Strategy recommends Hold the Line (Sustain) for frontages facing erosion risk at Selsey, East Wittering and Bracklesham and Cakeham. There is little scope for realignment as urban areas extend to the coast. Sustain options are the most economically effective as defences take account of sea level rise and minimise the damage from overtopping. Defences will be refurbished or replaced as they wear out (30-50 years). These will be designed to accommodate predicted sea level rise giving a precautionary approach with SoP improving as defences are renewed, falling back to the current standard over the design life.

1.4.2 Managed Realignment is recommended for the Medmerry frontage as the optimum way of managing flood risk over 100 years. New realigned defences are required to provide a 1% AEP SoP to Selsey's only road access and wastewater treatment works. Indicative defence alignments have been defined, however there is scope for adjustment to maximise habitat creation. There may be a possibility for a scheme to be developed in combination with proposals for private defences which could cover 1.1km at the eastern end of this frontage. The outcome of private frontage proposals will not affect the strategic recommendation for managed realignment of Medmerry Frontage.

1.4.3 Adaptive Management is recommended for Pagham and East Head. The natural geomorphological developments cannot be accurately predicted. A flexible approach, that

builds knowledge over time, is essential in order to manage flood and erosion risk with the requirements of the internationally designated nature conservation sites. Natural England fully supports this approach and is a member of the established advisory groups.

1.4.4 New inland defences will be provided to manage flood risk at West Wittering village. These will avoid any coastal squeeze effect on the internationally designated Chichester Harbour and provide defences within the indicative standard (1% AEP) at the end of the appraisal period.

1.4.5 Using a Building Trust with Communities approach to engagement during strategy development has raised community awareness of flood and erosion risks faced. Widespread opposition to initial proposals other than hold the line has altered to general acceptance of reasons for the need to change management practices.

1.4.6 Health and safety has been considered in option selection. Recommended options are likely to have a positive impact on the Water Framework Directive objectives. Detailed assessments will be undertaken during appraisal of schemes.

1.5 Economic case and outcome measures

1.5.1 The economic appraisal period is 100 years and Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) has been followed.

Table 1 – Economic Summary

Location	Pagham *	Selsey	Medmerry	E Wittering and Bracklesham	Cakeham	West Wittering**
Proposed SoP	tbc	1:100	1:100	1:100	1:100	1:100
Present value costs (£k)	12,700	33,600	11,100	25,400	3,350	913
Present value benefits (£k)	87,100	121,000	91,700	46,300	7,790	20,000
Net present value (£k)	74,400	87,400	80,600	20,900	4,430	19,100
Benefit cost ratio	6.8	3.6	8.2	1.8	2.3	21.9
Cost per residential property (£k)	10.4	16.8	15.3	29.1	67.1	7.7

***** Pagham – only indicative costs and benefits ****** Excludes Private works at East Head

Table 2 – Outcome Measures Summary

Frontage	Preferred Option	When outcomes will be realised	Outcome Measures (OM)					OM Score
			OM1 BCR	OM2 No. Props	OM2b No. Props	OM3 No. Props	OM5 ha	
Pagham	Adaptive Management	To be confirmed subject to need	6.8*	385	320	0	0	**2.5**
Selsey	Sustain	2013/2014**	3.6	560	587	0	0	**2.3**
Medmerry	Managed Realignment	2013/2014	8.2	348	6	0	0	**3.0**
E Wittering and Bracklesham	Sustain	2013/2014**	1.8	0	432	0	0	**1.2**
Cakeham	Sustain	After 2027	2.3	0	50	0	0	**1.7**
West Wittering	Local flood protection	2013/2014	21.9	55	0	0	0	**6.7**

* Pagham – only indicative costs and benefits ****** Subject to available funding

1.6 Environmental and Social Considerations

1.6.1 A non-statutory Strategic Environmental Assessment (SEA) was undertaken and presented in Appendix C. The SEA process has played a significant role in the development

of the Strategy, because the preferred environmental options are also the final preferred Strategy options for each of the frontages. The Strategy recommendations will not lead to the damage of internationally designated habitat within the Strategy area. Natural England has confirmed that an Appropriate Assessment for Natura 2000 sites is not required for the Strategy. Natural England has provided a letter in support of the Strategy (Appendix G).

1.6.2 The Strategy will maintain or improve the protection offered to the vast majority of properties. It can provide opportunities for habitat creation to help meet needs across the wider Solent.

1.6.3 Properties will be at risk of loss through erosion if funding cannot be achieved to improve the defences in Selsey, East Wittering and Bracklesham.

1.7 Risks

Table 3 – Key Risks

Risk	Key Mitigation
Renewed opposition to managed realignment at Medmerry, resulting in inability to gain planning permission.	Strategy consultation has already improved public understanding of this option and gained Local Authority support. Pro-active community and landowner engagement to continue in advance of scheme implementation.
Funding not available to progress schemes where priority is low.	Local Authorities to investigate alternative funding opportunities. If unsuccessful, exit strategies are to be produced before major failure of defences is anticipated.

1.8 Implementation

1.8.1 Following approval of this Strategy, Project Appraisal Reports (PARs) for schemes within the Strategy will be submitted for Environment Agency approval. Approval will be sought to begin PAR preparation for Managed Realignment at Medmerry before this Strategy is signed off due to the vulnerability of this defence that offers just a 1 in 1 SoP.

Table 4 - Strategy Costs

Item	Pagham (£K)	Selsey (£K)	Medmerry (£K)	East Wittering (£K)	Cakeham (£K)	West Wittering (£K)	Total (£K)
Costs Pre StAR							*751*
Environment Agency (including surveys)	*52*		*861*		*0*	*49*	*962*
Local Authorities (including surveys)	*33*	*123*		*114*	*0*		*270*
Consultants fees	*170*	*232*	*781*	*375*	*0*	*62*	*1,620*
Construction costs	*464*	*2,840*	*2,980*	*4,240*	*0*	*224*	*10,700*
Environmental enhancement	*20*	*116*	*116*	*157*		*10*	*419*
Supervision/ cost consultant fees	*80*	*549*	*386*	*427*	*0*	*32*	*1,470*
Compensation			*80*		*0*		*80*
Sub-total	*819*	*3,860*	*5,200*	*5,320*	*0*	*377*	*15,600*
Contingency (60%)	*491*	*2,310*	*3,120*	*3,190*	*0*	*226*	*9,340*
Total of above including contingency but excluding Inflation	**1,310**	**6,170**	**8,320**	**8,510**	**0**	**603**	**24,900**
Inflation @ 5% per annum	*13*	*921*	*1,250*	*1,800*	*0*	*81*	
Total capital cost	*1,320*	*7,090*	*9,490*	*10,300*	*0*	*684*	
Future construction costs (beyond Year 5)							**227,000**
Maintenance costs over period of strategy							**27,500**
Whole life cash cost (including maintenance without inflation)							**279,000**

Note: Strategy costs detailed above are for the first five years of expenditure. The costs within the table are presented to three significant figures.

1.8.2 Development of Medmerry realignment scheme should integrate appraisal of habitat creation opportunities. This is subject to approval of a separate habitat creation business case, driven by the need for compensatory habitat from schemes outside this Strategy area. PARs for the other schemes will commence in 2009 after approval of the Strategy.

1.9 Contributions and Funding

1.9.1The approval sum sought for the Strategy encompasses costs for implementing the recommended options.

1.9.2 At Medmerry, costs are included for realignment within this Strategy but not habitat creation which is the subject of a separate business case. Flood Defence Grant in Aid (FDGiA) will be sought for the costs (as presented in Table 3). Contributions will be sought from Southern Water and West Sussex County Council, the relevant highways authority.

1.9.3 Schemes to implement preferred options for Selsey, East Wittering and Bracklesham are unlikely to attract FDGiA. Chichester District Council will maintain these frontages in accordance with SMP policy and seek external funding to implement schemes.

1.9.4 The East Head management group established during the development of this Strategy will fund and implement the work defined at East Head. New defences to manage flood risk at West Wittering will be funded using FDGiA but possibilities for partnership working will be explored with local landowners.

1.10 Status

1.10.1 ADC and CDC have approved the Strategy (Appendix G).

1.10.2 The Strategy appraisal has confirmed the SMP policy recommendations for all but two frontages. These two are at East Head and Pagham where recommendations for hold the line and managed realignment have been replaced by adaptive management due to the uncertain future development of the associated coastal processes.

1.10.3 If the recommended options within the Strategy are implemented, they will provide continued or improved protection for 5,300 properties against flood and erosion risks over the next 100 years.

1.10.4 The Strategy will need approval from Defra who may refer it to the Treasury.

1.11 Recommendations

1.11.1 It is recommended that the Pagham to East Head Coastal Defence Strategy is approved for managing the risks of coastal flooding and erosion to the 5,300 properties.

1.11.2 The Whole Life Cost (excluding inflation) is £279,000k shared among the Environment Agency, Chichester and Arun District Councils. This includes a contingency of £105,000k. Presenting the approval costs to three significant figures results in a (negative) difference of £383k.

The Executive Summary ends here

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Directors Briefing Paper

Region:	Southern		**Project Executive:**	Samina Khan	
Function:	Flood Risk Management		**Project Manager:**	Joe Pearce	
Strategy Title:	Pagham to East Head Coastal Defence Strategy		**Code:**	IMSO000772	
NEECA Consultant:	Jacobs	**NCF Contractor:**	n/a	**Cost Consultant:**	n/a

The Problem:	The strategy area includes approximately 21km of coast and Pagham Harbour at risk of flooding and erosion. Current standard of protection varies widely from 100% to 0.5% annual event probability (AEP).
People at risk: **Probability of exposure:** **Consequence of exposure:**	Currently 1,200 properties are at risk from a 1:200 year flooding event or by breach of the existing defences. By the end of the 100 year strategy appraisal period 5,300 properties would be at risk of flooding or erosion.
Environmental resources at risk: **Probability of exposure:** **Consequence of exposure:**	Pagham Harbour SPA /RAMSAR and Chichester Harbour SPA/SAC, Bracklesham Bay SSSI and Selsey East Beach SSSI. Three Scheduled Ancient Monuments. Numerous footpaths and beaches.
Assets at risk from flooding: **Probability of exposure:** **Consequence of exposure:**	Communities at Selsey, Pagham, East and West Wittering. Pagham and Sidlesham wastewater treatment works. B2145 sole access road to Selsey. 3,000 caravans and chalets.
Description of proposed strategy:	The strategy recommends sustain for urban frontages, managed realignment at Medmerry and adaptive management at Pagham and at East Head within Chichester Harbour.
Outcome for people at risk:	5,300 properties protected from flooding and erosion during the strategy period.
Outcome for environmental resources at risk:	No adverse impact on SPA/RAMSAR/SAC sites. Major opportunity for compensatory habitat creation to offset losses across the Solent.
Outcome for assets at risk:	Indicative standard of protection sustained for all frontages

Costs (PVc): (100 year life inc. maintenance)	£87.2m	**Benefits: (PVb)**	£ 374m	**Ave. B: C ratio: (PVb/PVc)**	4.3
NPV:	£ 287m	**Incremental B: C ratio:**	N/a	**Whole life cost (cash value):**	£279m
Choice of Preferred Option:	The implementation of sustain options for urban frontages, managed realignment at Medmerry and adaptive management at Pagham and at East Head				
Total cost for which approval is sought:	**£ 279m (incl. £105m contingency)**				
Delivery programme. Completion dates:	Adaptive management commenced at Pagham and East Head by 2009 Medmerry managed realignment by 2014 Selsey West Beach improvements by 2013 East Wittering and Bracklesham improvements by 2014 West Wittering flood banks by 2013				
Are funds available for the delivery of this programme?	Yes subject to outcome measure scores				

External approvals:	Arun District Council, Chichester District Councils and Natural England have approved the strategy.
Defra approval:	Pagham outcome measure total (OM) 2.5, Selsey OM 2.3, Medmerry OM 3.0, East Wittering & Bracklesham OM 1.2, Cakeham OM 1.7, West Wittering OM 6.7.

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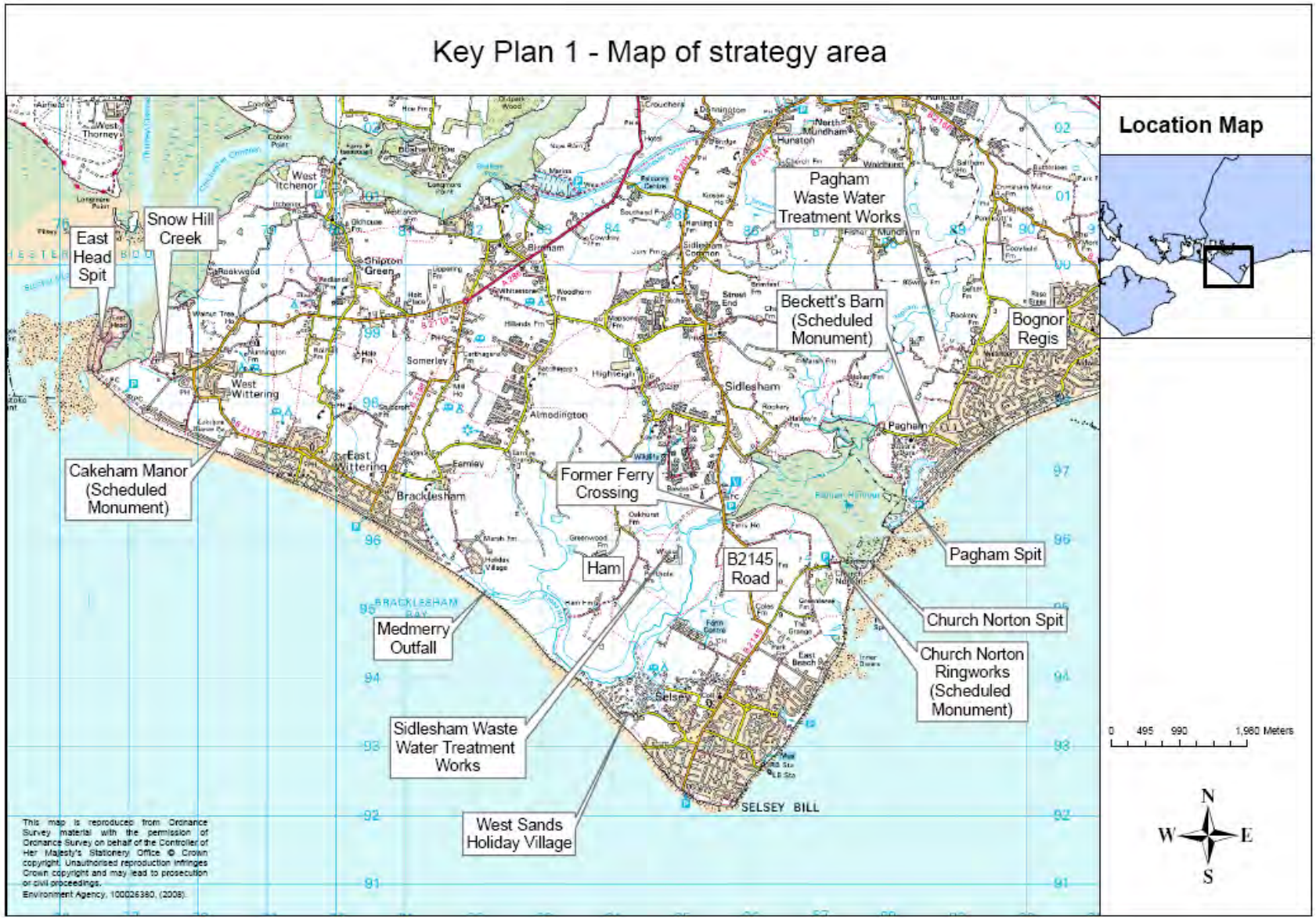
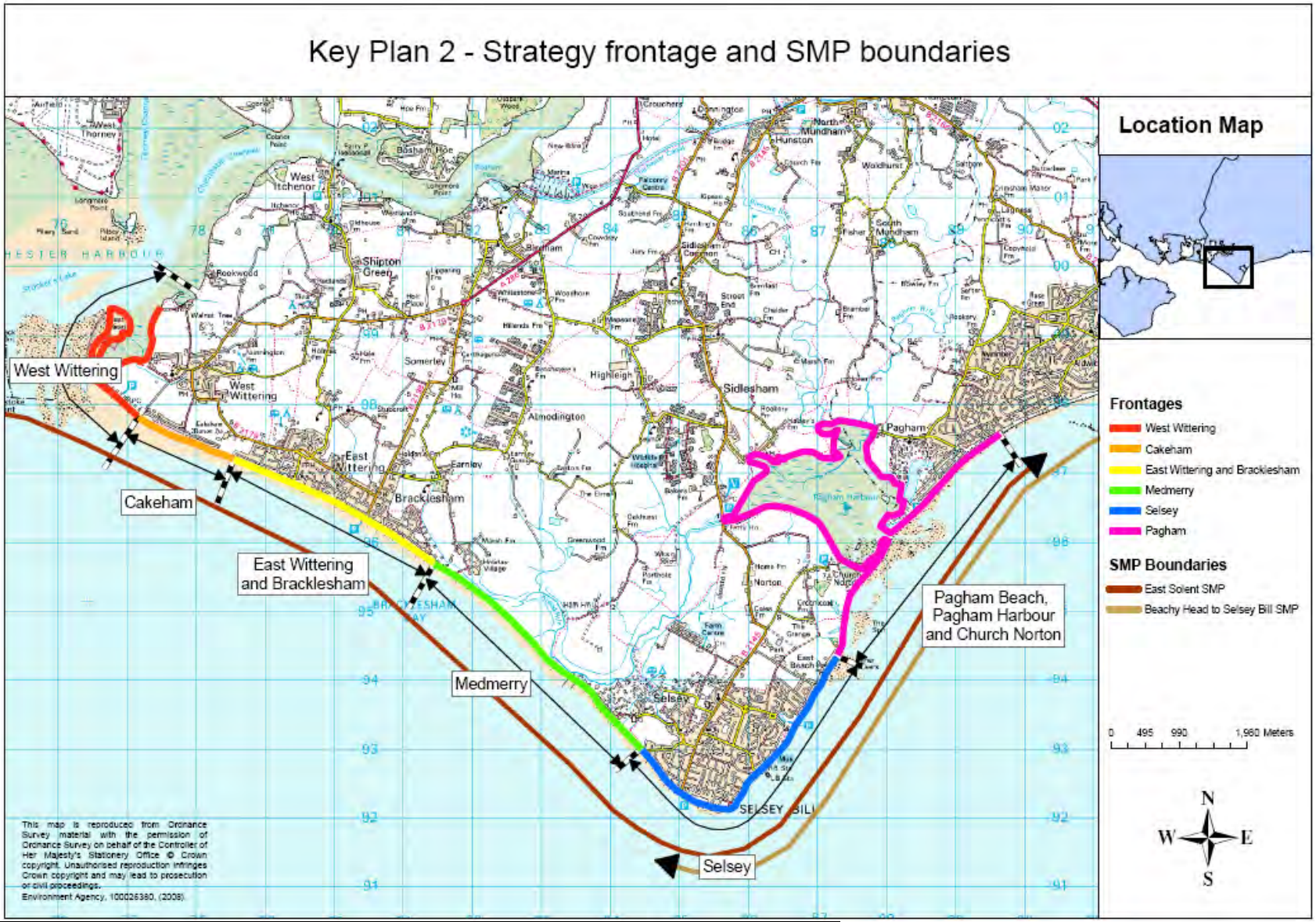
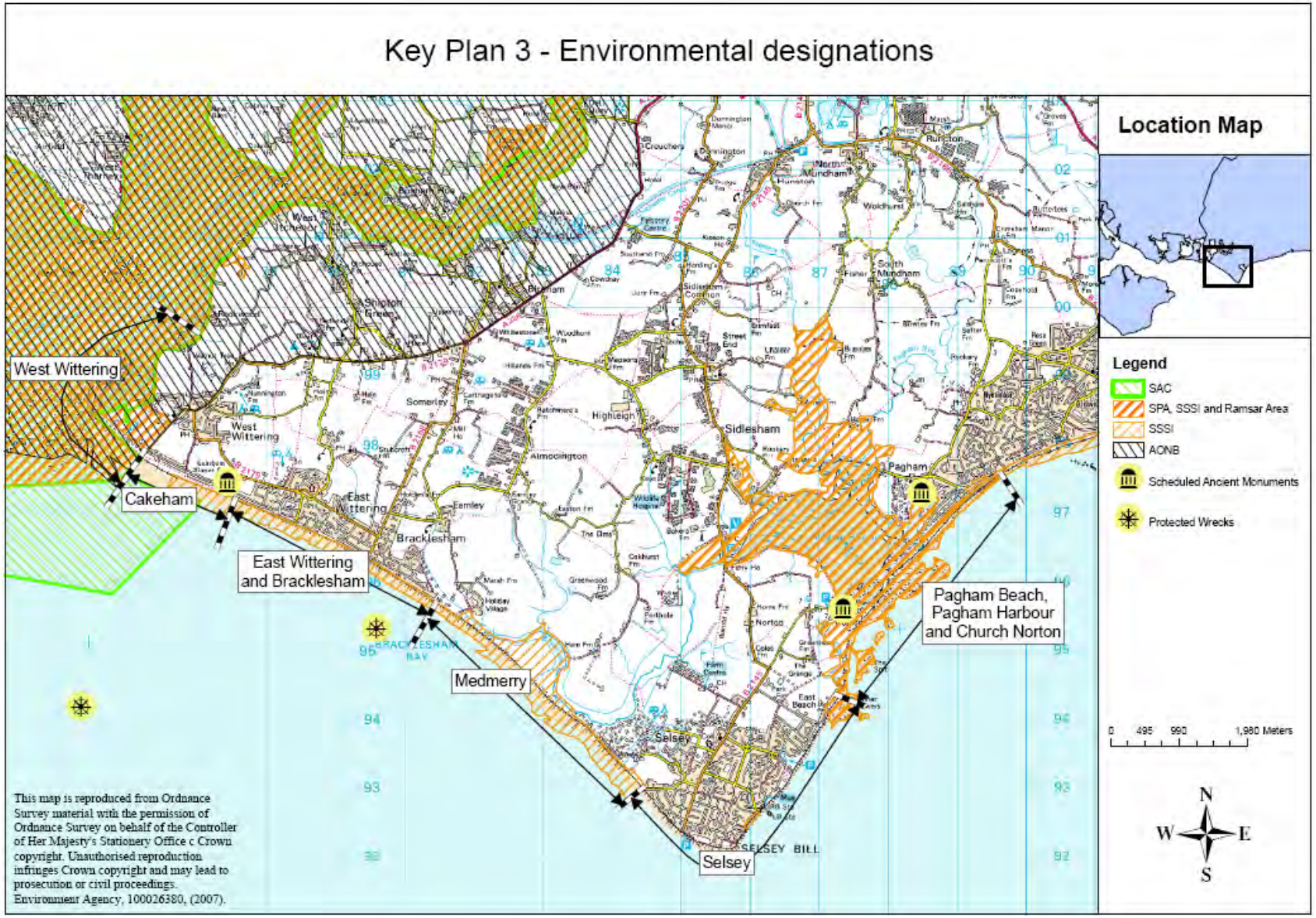
Key Plan 1 Map of the Strategy Area



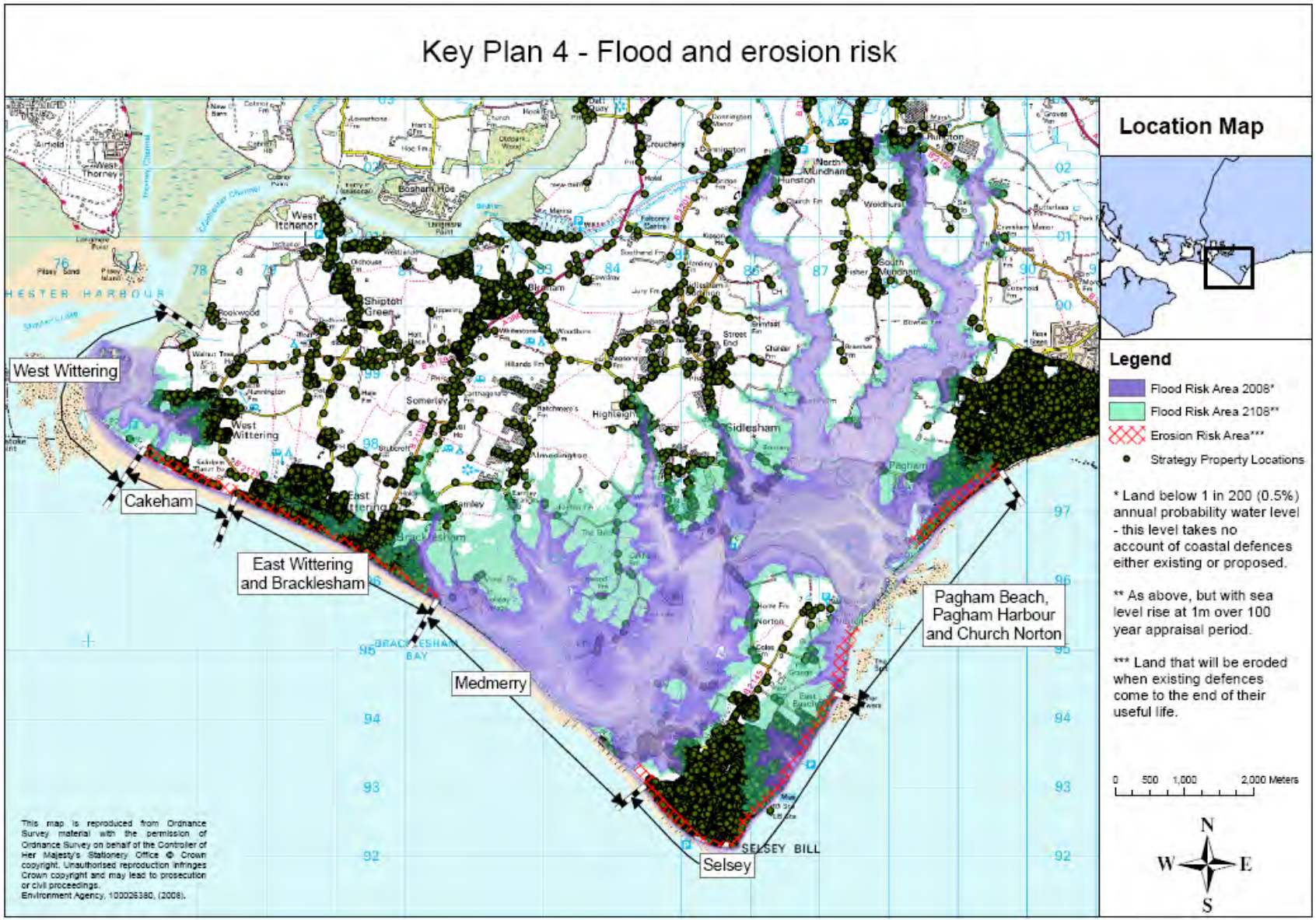
Key Plan 2 - Strategy Frontages and SMP Boundaries



Key Plan 3 - Environmental Designations



Key Plan 4 – Flood and Erosion Risk



Key Plan 5 – Operating Authority responsibility

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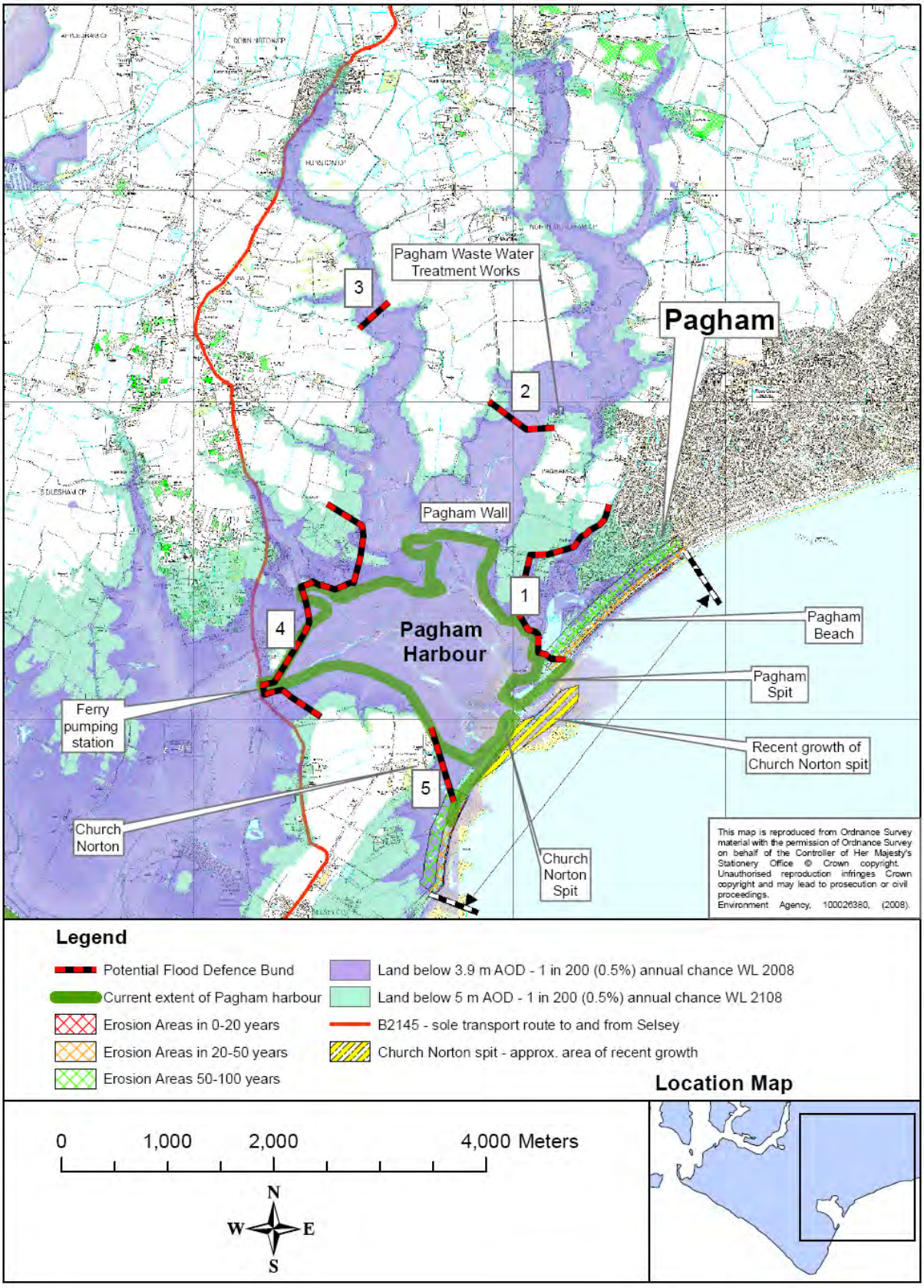
Key Plan 6 – Pagham Indicative plan

Key Plan 6 - Pagham Harbour plan of indicative scheme including potential defence bunds



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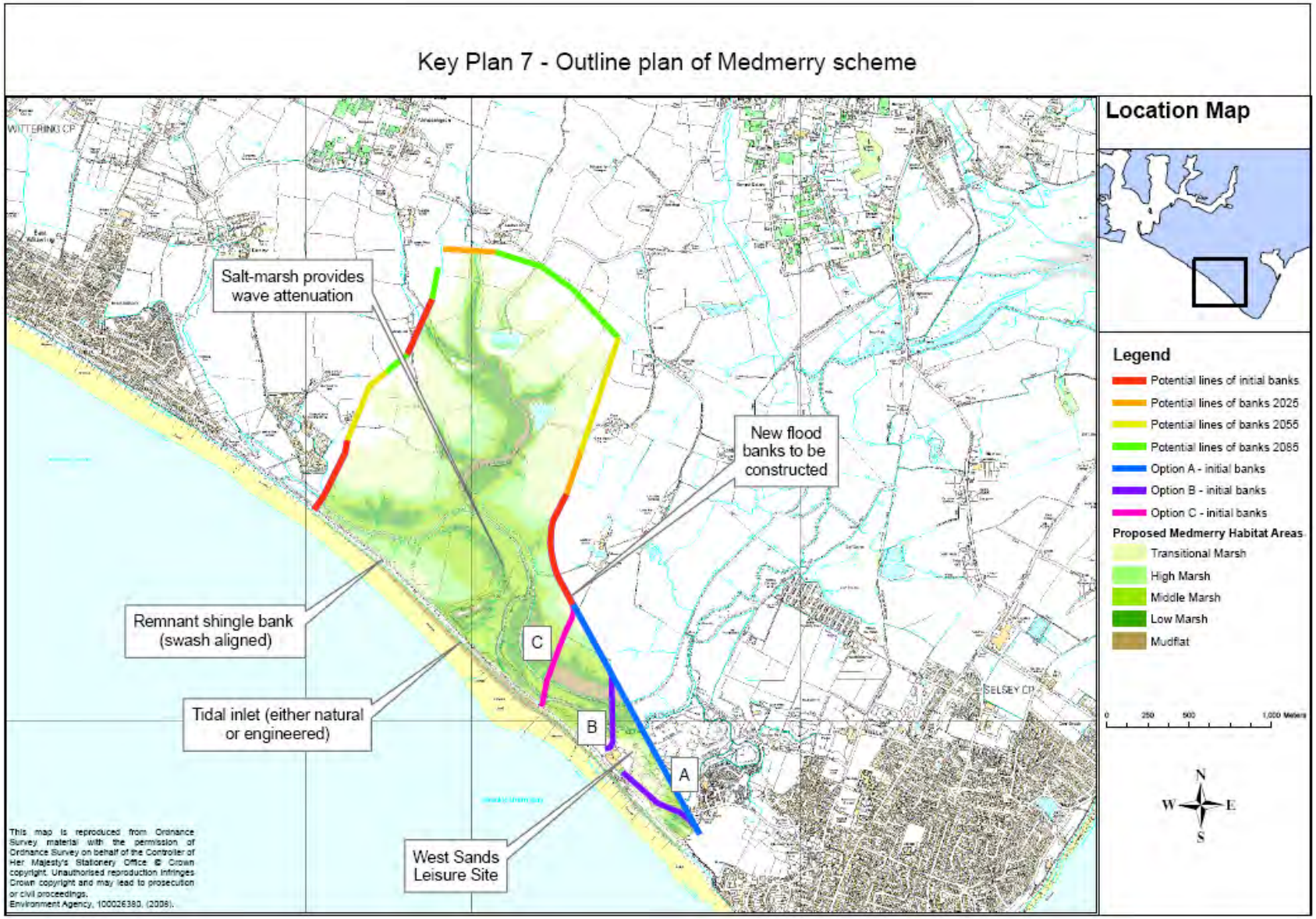
Key Plan 7 – Medmerry indicative scheme plan showing breach realignment options considered



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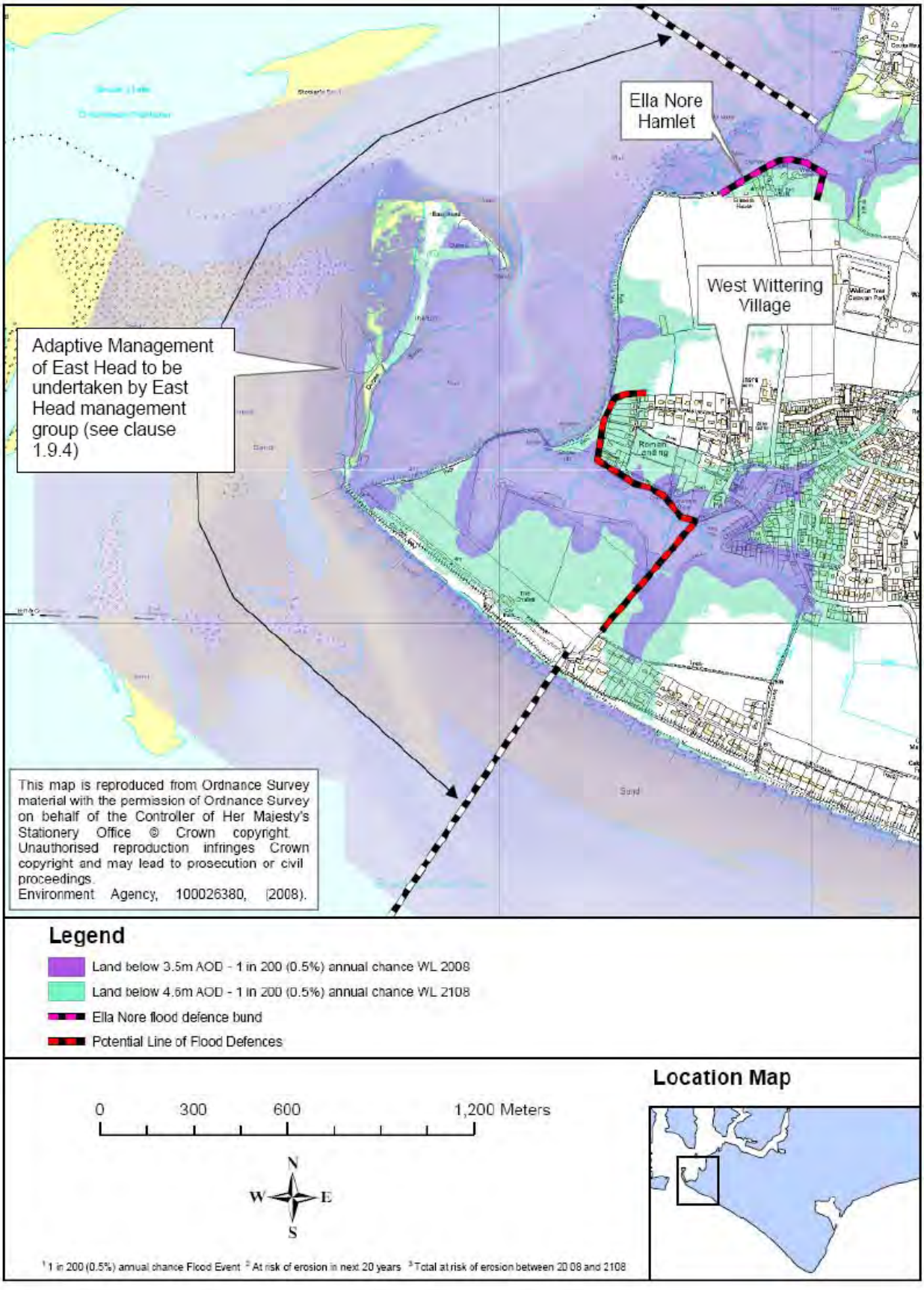
Key Plan 8 – West Wittering village scheme Plan

Key Plan 8 - West Wittering plan of indicative scheme including potential defence bunds



Key Plan 9 – Coastal Process summary plan

Key Plan 9 - Coastal Processes Map

Source: SCOPAC Sediment Transport Study

2. BUSINESS CASE

2.1 Introduction and Background

Purpose of Report and Background

2.1.1 The Pagham to East Head Coastal Defence Strategy (the Strategy) identifies the strategic flood and erosion risk management approach for the Strategy area over the next 100 years. The appraisal has been undertaken in accordance with the Defra Flood and Coastal Defence Project Appraisal Guidance (PAG) series of documents and the 'Supplementary Notes to Operating Authorities'. The Strategy builds on an earlier draft strategy and the two relevant Shoreline Management Plans (SMPs). It also draws on Defra's Making Space for Water Strategy.

2.1.2 The Strategy area is the coastline of the peninsula south of Chichester, between Pagham and West Wittering in West Sussex (see Figure 1). It has been developed by the Environment Agency in partnership with Chichester District Council (CDC) and Arun District Council (ADC). A strategy approach is clearly warranted for the area in accordance with Defra's PAG guidance as a long term and sustainable approach is needed to address complex flood and erosion risk management issues affecting the whole peninsula.

Strategic Objectives

2.1.3 The principal objective of this Strategy is to:
"identify sustainable coastal flood and erosion risk management in line with Defra policy".

2.1.4 The aims of the Strategy are to:

a) Provide a better quality of life for those who live in, work in or visit the area by managing flood and erosion risk.
b) Identify a range of sustainable options for managing flood and erosion risk, making wise use of natural resources.
c) Enhance the environment for wildlife.
d) Limit and adapt to the impacts of climate change.
e) Raise awareness of flood and erosion management issues and ensure the opinions of all stakeholders are taken into account.

History of and Legal Background to the Strategy

2.1.5 A Strategy for Pagham to East Head failed to gain acceptance from Defra in 2001 following changes in appraisal guidance. At the time, Natural England was unable to fully support the Strategy as they questioned the long term viability of the preferred option for the Medmerry frontage.

2.1.6 In 2004 a technical review was initiated to address Natural England's and Defra's concerns, building on the previous work to identify indicative preferred options for flood and erosion risk management. Between November 2006 and March 2007 an initial public consultation took place to discuss indicative preferred options. The feedback received was used in the completion of the draft strategy which underwent further public consultation between May and August 2008. This latest consultation resolved many key public concerns and received very positive feedback.

2.1.7 This Strategy reviews and updates the 2001 draft Strategy and develops the policies included in the Shoreline Management Plans (SMPs). The Strategy area is located at the intersection of two SMP areas. The Selsey Bill to Beachy Head SMP is currently awaiting approval. The findings of this Strategy will inform the North Solent SMP, currently under review with completion expected in spring 2010. The management recommendations for the

frontages are consistent with the recommendations detailed in the SMPs. The SMP recommendations for the Strategy area are summarised in the Shortlist of Options Table 6.

2.1.8 The Strategy is consistent with the recommendations of the River Arun and Western Streams Catchment Flood Management Plan (CFMP) 2008. The Strategy is also in accordance with the West Sussex Structure Plan, Chichester District Local Plan (adopted 1999), Arun Local Plan (adopted 2003) and related draft Local Development Frameworks.

2.1.9 The Environment Agency has permissive powers for managing the flood risk from designated main rivers and the sea under Section 165 of the Water Resources Act 1991. CDC and ADC have similar powers under the Coast Protection Act 1949 to address coastal flood risk and erosion as the local Coastal Protection Authorities.

Strategy Area

2.1.10 The Strategy covers the area south of Chichester in West Sussex known as the Manhood Peninsula and the adjacent Pagham Harbour. It covers approximately 21km of coastline from Pagham to West Wittering. A map of the Strategy area and key locations is provided in Figure 1.

2.1.11 The area has 14,000 properties in the main town of Selsey and villages including East Wittering, Bracklesham, West Wittering and Pagham. Today, around 1,200 properties are at risk of flooding and erosion; this could increase to over 5,300 properties over the next 100 years without further intervention.

2.1.12 The eastern boundary of the Strategy is at Pagham village where the primary coastal process changes from erosion (considered in this Strategy) to accretion (considered in the neighbouring Pagham to Arun Strategy, currently being appraised). Project partners continue to be involved in the development of both strategies.

2.1.13 The western Strategy boundary has been located to ensure the effects of flooding from Chichester Harbour on the village of West Wittering are considered in this Strategy. West Wittering may be subject to flood risk from both the open coast and from inside the harbour.

2.1.14 The Strategy area is divided into six frontages; Pagham, Selsey, Medmerry, East Wittering and Bracklesham, Cakeham and West Wittering. These were developed from the East Solent SMP management units (precursor to the North Solent SMP), which were based principally on the existing location of defences and natural coastal processes. The Strategy has grouped some units together to provide a more integrated approach. Responsibility for the frontages varies between Environment Agency, CDC and ADC, as detailed in Table 5 - Existing Defences and Assets at Risk. The frontage boundaries are shown on Figure 2.

2.1.15 Tourism is very important to the area with facilities for both day visitors and holiday-makers. The local population more than doubles during the summer holiday season with many visitors staying in static caravans or chalets. More than 3,000 holiday chalets and static caravan plots are currently in areas with a significant likelihood of flooding. As a consequence, there is substantial risk of loss of life or injury to holiday-makers.

2.1.16 Agriculture is the other main industry on the peninsula with the majority of the land rated from ‘good’ to ‘excellent’ under Defra’s Agricultural Land Classification. There is also an extensive greenhouse crop industry.

2.1.17 The main town of Selsey relies on a single road link, the B2145, originally constructed as a causeway in 1809. Historically Selsey has at times been an island accessed by a ferry. The B2145 causeway is vulnerable to flooding and the future viability of the community depends on maintaining this link. For the rest of the study area, the communities of West

Wittering, East Wittering, Bracklesham and Pagham are accessed by a network of minor roads.

2.1.18 Two major sewage treatment works are at risk from flooding. These serve the study area and the western side of Bognor Regis.

2.1.19 Several factors have contributed to the development of this Strategy. These include the poor standard of protection offered by some defences, risk to life and recent flood and erosion events, potential for realignment possibilities, environmental designations and the presence of active pressure groups. Support for the Strategy recommendations has now been gained through working to engage stakeholder groups and local communities.

Environmental Designations

2.1.20 The Strategy area is of particular environmental importance with international, national and locally designated sites which are detailed below and shown on Figure 3. Each of these sites have the potential to be affected by coastal flood and erosion risk management actions.

a) Internationally designated sites under Habitats and Birds Directives;
   - Pagham Harbour Ramsar and Special Protection Area (SPA);
   - Chichester Harbour Ramsar and Special Protection Area (SPA); and
   - Solent Maritime Special Area of Conservation (SAC).

b) Nationally designated SSSIs;
   - Pagham Harbour SSSI;
   - Selsey East Beach SSSI;
   - Bracklesham Bay SSSI; and
   - Chichester Harbour SSSI.

c) Local Designations including Pagham Harbour Local Nature Reserve (LNR) and two Sites of Nature Conservation Importance (SNCIs): Crablands Farm Meadow and West Wittering Beach.

d) Chichester Harbour to the western end of the study area is an Area of Outstanding Natural Beauty (AONB).

e) There are three Scheduled Monuments within The Strategy area; Cakeham Manor, the ring works south of St. Wilfred's Chapel at Church Norton and Becketts Barn in Pagham. There is also a protected wreck site off the coast at Bracklesham Bay and a Mulberry Harbour unit offshore from Pagham.

2.2 Problem

2.2.1 The Strategy area covers a coastline with a complex interrelationship between low-lying areas at risk from flooding and higher areas subject to erosion risk.

2.2.2 The area's three main urban centres at Pagham, Selsey and the Witterings are largely built on higher ground close to the coast. Parts of each urban centre and large areas of the peninsula in between are low-lying and currently at risk from coastal flooding. Before defences were built in the 1950s the coast here was eroding at an average rate of between one and two metres per year.

2.2.3 Climate change leading to rising sea levels will affect flood and erosion risk increasingly over time. Figure 4 shows areas at risk in the 1 in 200 year (0.5% AEP) flood envelope if no defences were in place in 2008 and in 2108. Climate change would also potentially lead to increased wave heights and more frequent storms, which would also reduce the effectiveness of defences.

2.2.4 There are 1,196 properties in the Strategy area currently at flood risk below the 1 in 200 year (0.5%) flood level. With predicted sea level rise this will increase by 2108 to an estimated 4,571 properties.

2.2.5 The following sections summarise the history of flooding and management for each of the six frontages. The current problems are identified and the need for strategic solutions to these problems is then justified. Table 5 in Section 2.2.10 summarises the properties and other assets for each frontage in the Strategy area.

Coastal Processes

2.2.6 The coastal area around the Selsey Peninsula is complex with a series of offshore and near shore banks, bars, shoals and reefs. These have significant impacts/interactions upon the local wave processes reaching Selsey Bill. Storm events can lead to episodic pulses of sediment being supplied to the shore from the offshore banks. This is the main source of sediment supply to the Strategy frontages.

2.2.7 The current net littoral drift rates along the Strategy frontages are relatively low as a result of the limited supply of new sediment and the interactions with the existing defences. The well-defined headland of Selsey Bill separates shorelines with different orientations and marks a change in the directions of net drift. On the western side, the limited availability of sediment has led to the shingle bank being aligned perpendicular to the dominant wave direction (swash aligned). Weak to moderate rates of drift operate along this frontage which is characterised by a shingle upper beach and sandy lower foreshore.

2.2.8 On the eastern side of Selsey Bill the presence of the headland which shelters the frontage from the large south westerly waves has allowed the shingle beaches to become more aligned with the sediment drift.

2.2.9 The interaction of the coastal processes around the two harbours at Pagham and Chichester are complex, and there uncertainties over their future development, which will be based upon the interaction between a range of processes. Detailed information about the coastal processes associated with each frontage is provided in Appendix A.

Assets at Risk

2.2.10 Table 5 summarises the current defences of each of the six frontages. The table also indicates the standard of current protection (flood risk), residual life of defences (erosion risk) and the properties and critical assets at risk from both flooding and erosion. Estimates of properties (both residential and commercial) at flood risk have been made for the base year (2008) and end of the Strategy period (2108). Approximately 5,033 residential properties and 285 commercial properties in total are estimated to be at risk of flooding or erosion by 2108 for all frontages. An estimate of the number of properties that can be expected to be written off (through either flooding or erosion) by 2108 under a No Active Intervention approach is also provided.

Table 5 - Existing Defences and Assets at Risk

Frontage (Length) Operating Authorities	Existing Defences		Properties at flood risk 2008	Properties at flood risk 2108	Property written off (flood and erosion) by 2108	SoP (%AEP) 2008	Residual Life (years)
Pagham 15km (4km open coast) Environment Agency ADC CDC	Extensive shingle beaches, banks and shingle spits with groynes. Pagham Harbour includes flood banks with harder protection in exposed areas.		303	1,303	333	2	1-20
			Other assets at risk: • B2145 Road (sole access to Selsey Town) • Pagham Waste Water Treatment Works • Pagham Harbour SPA/Ramsar/SSSI • Scheduled Monument				
Selsey 4.4km CDC	Sea walls, rock revetments and shingle beaches with timber groynes.		564	1,757	1,388	West Beach – 5 Selsey Bill – 1 East Beach - 2	West Beach – 5 Selsey Bill – 20 East Beach – 20 (groynes – 10)
			Other assets at risk: • SSSI – Selsey East Beach				
Medmerry 4.1km Environment Agency	Shingle beaches and banks with timber groynes.		213	800	369	100	1
			Other assets at risk: • B2145 Road (sole access to Selsey Town) • Sidlesham Waste Water Treatment Works • 2,875 Caravans and holiday chalets • 1,136ha Agricultural Land • Bracklesham Bay SSSI				
East Wittering 3.1km CDC	Sea walls, shingle beaches and timber groynes.		59	529	499	2	5-10
			Other assets at risk: • Bracklesham Bay SSSI				
Cakeham 1.5km CDC	Sea walls, shingle beaches and timber groynes.		0	10	51	0.5	20
			Other assets at risk: • 3.6ha of greensward • Bracklesham Bay SSSI • Solent Maritime SAC • West Wittering Beach SNCI • Scheduled Monument				
West Wittering 2.3km CDC	Groynes, breastworks, gabions, Natural dunes and various sea walls and earth banks.		58	172	96	2	<5
			Other assets at risk: • Chichester and Langstone Harbours SPA/Ramsar • Solent maritime SAC • Chichester Harbour SSSI/AONB				

Pagham - Operating Authority - Environment Agency, Arun and Chichester District Councils

2.2.11 The operational responsibility for Pagham Harbour is shared between all three operating authorities (Key plan 6). Arun District Council is responsible for the Pagham Beach frontage, the coastal frontage on the eastern side of the unit. Environment Agency is responsible for the inner harbour and the shingle spits in front of the harbour. Chichester District Council is responsible for the coastal frontage at Church Norton on the western side of the harbour joining on to the adjacent Selsey frontage.

History of Flooding and Erosion

2.2.12 Properties on the open coast are built above levels currently at risk of flooding at 1 in 200 (0.5%) levels. Pagham Harbour is separated from the open sea by mobile shingle spits. The harbour entrance was fixed with a sheet piled wall in the 1960s and since then the shingle banks have been managed by recycling and timber groynes (some with rock extensions). Since 2004 no recycling work has been needed due to a large natural build-up of shingle on the harbour-mouth spits. This increase in extent is believed to be due to the natural introduction of a large pulse of shingle material derived from the periodic (but erratic) onshore migration of the submerged Kirk Arrow Spit and nearshore shingle banks. The effects of this have been seen as a major growth in the Church Norton spit on the western side of the harbour. Early in 2007 this started to impact upon the Pagham Beach frontage leading to localised erosion. During the 20th Century, approximately 200 houses were built on the stable spit adjacent to the harbour mouth at Pagham Beach and on the low lying land behind. Approximately 300 houses (including those on and behind the spit) are now at risk of flooding or erosion. With no active intervention the number of residential properties at risk rises to 1,229 by 2108.

Current Problems

2.2.13 There is a complex relationship between managing the risks of flooding and erosion together with Pagham Harbour SPA:

a. Immediate erosion problems at Pagham Beach caused by morphological effect from growth of adjacent shingle spit affecting tidal flows and wave action around the harbour entrance.
b. The inner harbour is accumulating silt at 8mm per year which has decreased flood risk and could change the character of harbour vegetation and affect the tidal prism.
c. Uncertainty in movement of harbour mouth shingle spits which may either close the harbour causing drainage problems or open more fully exposing the inner harbour to increased wave action.
d. Potential for connectivity between the Pagham and Medmerry frontages under a 'Do Nothing' policy which would isolate Selsey from the 'mainland'.

Selsey – Operating Authority - Chichester District Council

History of Flooding and Erosion

2.2.14 The main risk to the Selsey frontages is through erosion, although the eastern part of Selsey is the lowest part of the town and here 564 properties are at risk of flooding if the existing defences were to breach. Prior to the construction of the sea walls around Selsey in the 1950s, regular coastal flooding events had been a serious problem for properties on the eastern side of Selsey. Since the construction of these defences, only minor over-topping has occurred on a very infrequent basis. The remainder of Selsey's defences protect 606 properties against loss from erosion over 100 years.

Current Problems

2.2.15 At West Beach, defences originally constructed in the 1950s are at the end of their lives, failure is expected within five years. On the rest of the Selsey frontage the residual life varies between 10 and 20 years. These defences comprise large concrete walls and groyne fields and these will become more expensive to replace as they deteriorate. CDC has had a scheme developed for the West Beach frontage since 2003 which has not been progressed due to a low priority score.

2.2.16 A short section of sea wall on West Beach failed in 2007 leading to 15 metres of erosion in one week. Emergency measures were completed in 2007 and permanent repair was completed by April 2009 including 50 linear metres of defences, providing erosion protection to 13 properties for the short term. Despite these emergency works the wider defence along the frontage is still at risk of failure within the next 10 years.

Medmerry - Operating Authority - Environment Agency

History of Flooding and Erosion

2.2.17 Medmerry has an extensive history of flooding, erosion and breach. In 1910 a breach linked through to Pagham Harbour and the open coast temporarily isolating Selsey from the 'mainland'. Historical maps show a tidal inlet and creek system with a connection to Pagham Harbour. The land has since been reclaimed as farmland.

2.2.18 Between 1976 and 1980 a recharge scheme was implemented, placing 230,000 cubic metres of shingle on the Medmerry frontage. In December 1989 the shingle bank breached and approximately 70% of the beach material was lost. Subsequently, regular and extensive beach management has been required. This has included both the import of beach material and the reprofiling of the existing beach each year. The annual maintenance expenditure has been £200k-£300k over recent years. Even with such maintenance the bank has breached 11 times since 1994. In March 2008, a breach caused flood damage to around 500 caravans. This was estimated to be a 1 in 20 year event.

Current Problems

a. The shingle bank fails on an almost annual basis leading to breaching and extensive flooding. The adjacent holiday park is vulnerable to flood damage and presents a risk to life and of injury. 58 residential and 10 commercial properties along with almost 3,000 caravans lie below the annual flood risk level behind the bank. The loss of the holiday park through flooding would also have a major impact on the local tourist economy.

b. The shingle bank defence is not a viable long term option for managing flood risk in its current location as the foreshore becomes steeper and sea levels rise.

c. Drainage from the west of the peninsula discharges to the sea at Medmerry outfall. This structure is in need of immediate replacement. Its failure would lead to flooding of areas inland including 146 houses at Earnley, Bracklesham, Sidlesham and Ham.

d. A breach of this frontage could also result in flooding of 213 properties, the waste water treatment works and the only access road to Selsey which if lost would threaten the viability of the community at Selsey.

East Wittering and Bracklesham - Operating Authority - Chichester District Council

History of Flooding and Erosion

2.2.19 Before construction of the defences in the 1950s this section of the coast was subject to high rates of erosion of between one and two metres annually. The defences have prevented flooding and erosion since their construction.

Current Problems

2.2.20 The residual life of both the groynes and timber breastwork has been estimated at less than 5 years. Properties have been built on higher ground adjacent to the defences. Failure would lead to 499 properties being lost through erosion over the next 100 years. If erosion is unchecked, flooding would eventually result to lower lying properties inland.

Cakeham - Operating Authority - Chichester District Council

History of Flooding and Erosion

2.2.21 Before construction of the defences in the 1950s this section of the coast was subject to high rates of erosion. The defences have prevented flooding and erosion since their construction.

Current Problems

2.2.22 The remaining life of defences is more than 20 years protecting 51 properties from flooding and erosion. There are no current flood and erosion problems.

West Wittering - Operating Authority - Chichester District Council

History of Flooding and Erosion

2.2.23 East Head near West Wittering, is a small but significant sand and shingle spit at the entrance to Chichester Harbour. The spit originally faced the south-west and has rotated through 90 degrees (clockwise) into the harbour over the past 200 years.

2.2.24 This area is very sensitive to changes in coastal processes which include both natural sediment supply and management practices. In 1963 a major breach occurred possibly as a result of sea defence works to the east interrupting sediment supply reaching the spit. Since 1963 with no changes to the updrift defences, the accretion of sand has doubled the size of the spit. This process was assisted by the use low cost techniques such as permeable windbreaks which enable natural processes to rebuild and extend the dune system.

2.2.25 The management of this area is extremely contentious among local people and harbour users, with many differing views on how it should be managed. The spit has little or no effect on flood and erosion risk to property.

2.2.26 In 2008 flood defences within Chichester Harbour were overtopped by the sea close to West Wittering village, but caused no property flooding due to low lying land that provides a storage area between the village and the coast.

Current Problems

2.2.27 East Head is a designated SPA, SAC and SSSI, managed by the National Trust. There is no current flood risk associated with East Head itself however it is of local environmental importance and a recreational resource. Chichester Harbour is the largest leisure harbour in the south east of England. Changes in East Head spit affect tidal flows into the harbour and have the potential to significantly impact on the viability of the harbour and

impact the internationally designated sites. As a consequence, the spit is highly valued by the local community and harbour users and there is a strong desire that it should be managed and protected.

2.2.28 During initial consultation on the options for this Strategy in 2007, 1,200 responses were received (out of 1,800) concerning the management of East Head. In response to this a working group (informally termed the East Head Working Group, EHWG) was formed to consider the issues and determine an agreed approach to managing the spit and the adjacent coastline.

2.2.29 East Head evolved naturally and will continue to do so. However, the future evolution of the spit is uncertain and is dependent on a range of unpredictable physical processes. The Strategy is needed to provide a framework to manage the impacts of these complex processes and to address a variety of management priorities. Efforts in the past which attempted to hold the spit in its position are not sustainable. It is likely that this would lead to increased overwashing with the possibility of a breach which would adversely affect the area's internationally designated salt marsh. Allowing the spit to move into a position more in balance with the coastal processes would help the site progress towards favourable condition for its geomorphology and avoid damage to the designated habitat.

2.2.30 Irrespective of the future development of East Head even taking into account the storage area provided between West Wittering and the coast, there are currently 58 properties at risk of flooding in a 1 in 200 year event. With rising sea levels, this number rises to 172 properties over the 100 year appraisal period.

2.3 Options Considered

Drivers and Constraints

2.3.1 Community pressure concerning the majority of frontages has significantly informed the development of this Strategy. Chichester District Council has recommended urgent schemes (where the residual life of defences is less than 10 years) with no success due to low priority scores. Subsequently in March 2007, a section of erosion defences at Selsey failed prompting emergency works to protect 15 properties.

2.3.2 International designations at Pagham and East Head constrain option selection, as they require the protection of the natural coastal processes. No compensatory habitat is required for delivery of this Strategy.

2.3.3 Across the Solent 600ha of replacement coastal habitat is likely to be needed to allow the implementation of coastal flood and erosion risk management schemes, over the next 100 years. To ensure this potential can be realised, a business case to purchase land and justify creating habitat in the Medmerry area is currently being prepared by the Southern Region Habitat Creation Programme. Approval will also be sought for a business case to appraise the requirements of a flood risk management scheme at Medmerry (culminating in a PAR) taking into account these habitat creation needs.

Strategic Option Consideration

2.3.4 A full range of strategic options has been considered in the development of the Strategy for each of the frontages. Historic evidence clearly shows a tendency for this coast to erode between Pagham and East Head. An 'advance the line' policy was therefore rejected as inappropriate for all frontages as this approach would be environmentally, economically and technically unsustainable. This is supported by policies in the SMPs which also reject an 'advance the line' approach.

2.3.5 The range of strategic options which were explored are summarised in Table 6.

Table 6 - Strategic Options

Strategic Option	Description
No Active Intervention	No maintenance or improvements undertaken allowing the existing defences to deteriorate under the impact of natural coastal processes.
Do Minimum	This option will provide a patch and repair approach on existing assets. This approach will revert to No Active Intervention once the residual life of existing defences is reached and cannot be extended any further.
Hold the Existing Defence line	Maintaining or changing the standard of protection on the existing Defence line. The implementation of this policy can be undertaken using the following approaches: • Maintain - Defences are maintained at their current level to minimise the damage from failure. Because of the effects of climate change there will be a reduction in the standard of protection over time. • Sustain – the defence levels are improved over time to preserve the standard of protection taking into account climate change. • Improve – Raise the standard of protection above that already existing.
Managed Realignment	Policies aimed at allowing a landward movement of the shoreline position with some form of management intervention, on both flood and erosion prone frontages.
Adaptive Management	Adaptive Management is an approach which promotes flexible decision making with an emphasis on sequential decisions and actions in the face of uncertainty. It provides the opportunity for improved management as more understanding of the system is gained over time. A Management Plan is established which sets out its objectives, possible measures to achieve these objectives and a series of trigger points for where intervention may be required. Monitoring forms a key element of the process.

2.3.6 There are a number of ways of implementing these strategic options and various options were explored in the earlier strategy.

a) The 2001 strategy considered 84 viable ‘do something’ options across the strategy area. These were appraised within the 2001 strategy and preferred options recommended for all frontages.

b) The 2004 technical review built upon previous work, refined the options further and included the consideration of additional realignment options at Medmerry.

c) The option appraisal from the 2004 review was presented in the initial Strategy consultation in November 2006. Feedback from this consultation led to the reconsideration of options including the use of offshore breakwaters and the development of a new strategic option of adaptive management. A new scheme option based upon land raising was also included within the development of the draft Strategy.

2.3.7 Details of the long list of options can be found within the SEA Environmental Report (Section 7 and Appendix C), and comments upon the options raised during the Strategy consultation (May 2008) are addressed through the Consultation Report (StAR Appendix D). The shortlist of options was developed to be consistent with the SMP/CFMP policy statements, SEA and Water Framework Directive (WFD) objectives.

Shortlist of Options

2.3.8 Table 7 shows the shortlist of options which were taken forward for further consideration. This table also states the management policy for each frontage stated in the SMPs. Full details of the options considered are provided in Appendix A - Technical Report.

Table 7 - Shortlist of Options

OPTION	FRONTAGE					
	Pagham	Selsey	Medmerry	East Wittering and Bracklesham	Cakeham	West Wittering
SMP Policy	Aldwick to Pagham – **Hold the Line** Pagham to East Beach – **Managed Realignment**	Hold the Line	Hold the Line (interim period subject to review & further study)	Hold The Line	Hold The Line	Hold The Line
No Active Intervention	✓	✓	✓	✓	✓	✓
Do Minimum (Reactive Repairs)		✓	✓	✓	✓	
Hold the Line - Maintain		✓		✓	✓	✓
Hold the Line - Sustain		✓		✓	✓	
Hold the Line - Improve			✓			
Hold the Line – Hard Defences			✓			
Hold the Line – Offshore Breakwaters			✓			
Hold the Line – Land Raising			✓			
Local flood banks	✓					✓
Managed Realignment			✓*		✓	
Adaptive Management	✓					✓

* Two 'managed realignment' options
1) 'Bank realignment' - move position of shingle bank inland (by either 50 or 250 metres) or
2) 'Breach realignment' - construct inland defences in the form of engineered banks and breach the existing shingle bank or allow it to breach.

2.3.9 In 2003 CDC undertook option appraisal for the West Beach part of Selsey frontage, East Witterring and Bracklesham frontages seeking to improve worn out defences. This work has been incorporated into the Strategy. Details are provided in Appendix A. Defences at both Selsey and East Wittering and Bracklesham manage erosion risk and damages caused by overtopping are small until the medium term in the appraisal period.

Climate Change

2.3.10 Defra Flood and Coastal Defence Appraisal Guidance Supplementary Note on Climate Change Impacts (October 2006) has been used to determine appropriate sea level rise allowances. Predictions of sea level rise for the South East region, taking into account isostatic rebound, over the Strategy period 2008-2108 are for a rise of 1.03 metres.

2.3.11 The majority of the frontages on the open coast are subject to coastal erosion. On these frontages, the preferred policy option is hold the line (sustain) over the Strategy's 100 years. The defences will be designed to withstand the impacts of overtopping as sea levels rise over their design-lifetime. The economics include an adaptive approach to climate

change with allowance for refurbishment and replacement of existing and new structures on each frontage during the 100 year period.

2.3.12 The Adaptive Management approach preferred for East Head and Pagham by its nature incorporates adaptation to sea level rise over time.

2.3.13 At Medmerry a precautionary approach to climate change is the most appropriate solution. The main driver will be to ensure that new inland defences will require the minimum intervention following their construction. The land seaward of the new defences could be used as compensatory habitat to offset losses caused by other flood and erosion risk management schemes elsewhere across the Solent.

Overdesign Events

2.3.14 An overdesign event has the potential to lead to overtopping of structures and rapid loss of beach material. Erosion is the primary risk at Selsey, East Wittering and Bracklesham and Cakeham limiting the impact of overdesign events unless defences fail. A breach is more likely through chronic failure over time rather than being driven by a single extreme storm event.

2.3.15 Around 600 properties at Selsey East Beach are at flood risk from overdesign events although more than 500 of these would only be affected if the sea wall is breached as overtopping is not a major issue.

2.3.16 At Pagham and Medmerry, an overdesign event could cause flooding to extend between the two frontages. Natural storage landward of existing and proposed defences ensures that major flooding will only be an issue if defences are breached. If a breach is caused, in an overdesign event around 700 properties, over 3,000 caravans, both the area's wastewater treatment works and the B2145 sole road link into Selsey are vulnerable.

2.3.17 At Pagham, there is also a risk of an event causing the harbour entrance spits to close the harbour entrance, leading to the creation of a lagoon. This would significantly impact on flood risk, the drainage function of the Harbour and also on the internationally designated habitats. There is also the possibility that a major storm could lead to significant changes to coastal processes at both the Pagham and Church Norton spits. Within the preferred adaptive management option Arun District Council is currently developing a protocol with Natural England to undertake emergency works within the Natura 2000 site. Overdesign flood events could affect over 70 properties at West Wittering.

2.4 Cost of Options

Cost Estimates

2.4.1 Whole life costing based over a 100 year appraisal period, including maintenance have been developed using discount rates in accordance with Treasury guidelines. These are expressed as Present Values at August 2008 base date and include for design, construction and supervision. The rates have been developed based upon recent similar schemes and industry construction indices. Cross reference has been made to the Unit Cost database. No allowance for contingency has been included within these rates; this is addressed through an optimism bias approach. Optimism bias (OB) has been added at 60% for the Strategy options, in line with Defra guidance.

2.4.2 Maintenance costs have been developed for all of the frontages, however where an Adaptive Management option is proposed, these must be treated with caution, as the actual extent of intervention required is uncertain.

2.4.3 Under a Hold the Existing Defence Line - Maintain option as sea levels rise the structures will be subject to increased overtopping and storm damage . To account for this an allowance has been made for maintenance cost rates to increase over time in line with sea level rise. This has been applied on the basis set out in Table 8. Larger sustain structures would not be subject to the same overtopping and consequent damage.

Table 8 Allowances for increased maintenance costs under a Hold the Existing Defence Line - Maintain option due to sea level rise'

Year	Maintenance Rate	Rate of Sea level Rise (mm/year)
Up to 2025	Current Rate	4
2026 to 2055	Current Rate + 30%	8
2056 to 2085	Current Rate + 60%	12
2085 onwards	Current Rate + 100%	15

2.4.4 Table 9 below summarises the Scheme Capital Cost, Whole Life Cost, Present Value Cost and Present Value Cost including Optimum Bias for all short listed options. Medmerry, banks 'A' to 'C' refer to indicative alignments for new inland defences shown on Key Plan 7.

Table 9 - Option Costs Summary

Frontage	Option	Total Scheme Whole Life Cost (£K)	Whole Life Cost without OB (£K)	PV Cost without OB (£K)	PV Cost with OB (£K)	Carbon Cost (Tonnes k)
Pagham	Adaptive Management (indicative costs only)	38,810	24,256	7,970	12,752	0.8
Selsey	Do Minimum	1,423	889	697	1,115	0.9
	Hold the Line – Maintain	146,976	91,860	24,711	39,537	193
	Hold the Line Sustain	118,121	73,826	20,973	33,557	118
Med-merry	Do Minimum (30 years only)	10,780	6,738	4,138	6,620	0.2
	Hold the Line – Hard Defences	60,247	37,654	32,267	51,627	5
	Hold the Line – Offshore Breakwaters	97,705	61,066	47,946	76714	14
	Managed Realignment – Bank Realignment set back 250m	63,753	39,846	23,913	38,261	8.6
	Managed Realignment – Breach Realignment Scenario A	21,813	13,767	7,326	11,721	1.6
	Managed Realignment – Breach Realignment Scenario B	20,361	12,860	6,959	11,134	5.2
	Managed Realignment – Breach Realignment Scenario C	19,731	12,466	6,809	10,894	1.4
East Wittering	Do Minimum (10 years only)	423	264	224	359	0.04
	Hold the Line – Maintain	86,118	53,824	15,911	25,547	41
	Hold the Line – Sustain	84,579	52,862	15,881	25,409	36
Cakeham	Do Minimum	387	242	152	243	0.04
	Hold the Line – Maintain	19,035	11,897	3,084	4,935	1.9
	Hold the Line – Sustain	15,436	9,648	2,096	3,354	1.5
	Managed Realignment	18,462	11,539	3,047	4,875	1.8

Frontage	Option	Total Scheme Whole Life Cost (£K)	Whole Life Cost without OB (£K)	PV Cost without OB (£K)	PV Cost with OB (£K)	Carbon Cost (Tonnes k)
West Wittering	Hold the Line – Sustain East Head and West Wittering	45,959	28,724	12,687	20,299	10
	Adaptive Management	8,861	5,538	1,863	2,981	0.9
	Flood Banks for West Wittering	2,076	1,298	571	913	0.8
	Adaptive Management + Flood Banks	10,937	6,835	2,434	3,894	1.7

Preferred Option

2.4.5 The combined preferred option total for all frontages is illustrated in Table 10.

Table 10 - Combined Preferred Option Costs (for initial 5 years)

Item	Pagham (£K)	Selsey (£K)	Medmerry (£K)	East Wittering (£K)	Cakeham (£K)	West Wittering (£K)	Total (£K)
Costs Pre StAR							*751*
Environment Agency (including surveys)	*52*	*0*	*861*	*0*	*0*	*49*	*962*
Local Authorities (including surveys)	*33*	*123*	*0*	*114*	*0*	*0*	*270*
Consultants fees	*170*	*232*	*781*	*375*	*0*	*62*	*1,620*
Construction costs	*464*	*2,840*	*2,980*	*4,240*	*0*	*224*	*10,700*
Environmental enhancement	*20*	*116*	*116*	*157*	*0*	*10*	*4,19*
Supervision/ cost consultant fees	*80*	*549*	*386*	*427*	*0*	*32*	*1,470*
Compensation	*0*	*0*	*80*	*0*	*0*	*0*	*85*
Sub-total	*819*	*3,860*	*5,204*	*5,313*	*0*	*377*	*15,107*
Contingency (60%)	*491*	*2,310*	*3,120*	*3,190*	*0*	*226*	*9,340*
Total of above including contingency, excl inflation	**1,310**	**6,170**	**8,324**	**8,503**	**0**	**603**	**24,447**
Inflation @ 5% per annum	*13*	*921*	*1,250*	*1,800*	*0*	*81*	
Total capital cost	*1,323*	*7,091*	*9,574*	*10,303*	*0*	*684*	
Future construction costs (beyond Year 5)							**227,000**
Maintenance costs over period of Strategy							**27,500**
Whole life cash cost (including maintenance without inflation)							**279,000**

2.5 Benefits of Options

Introduction

2.5.1 Present Value damages and benefits for each option are summarised in the following sections. Detailed information is included in the Technical Appendix B - Economic Appraisal.

Methodology

2.5.2 The latest national guidance (PAG 3) and supplementary guidance notes were used in this study. This includes Defra Climate Change Guidance (2006), the risk to life guidance issued by Defra in May 2008 and the use of the Economic Valuation of Environmental Effects (EVEE) (August 2007) to provide an ecosystem services approach for environmental benefits. The main assets include residential property, non residential property, agricultural land and caravans.

2.5.3 The values for the residential property within the study area (used for capping damage) are based on average transaction values obtained from the Land Registry, through the House Prices website, for the year between November 2006 and October 2007 inclusive (Price base November 2007). Recent reductions in property values do not affect the option appraisal decisions. The damages at Cakeham have been adjusted by a factor of 0.74 in line with Defra's guidance on reflecting socio-economic equity 2004. Non-residential properties were identified using the Environment Agency's National Property Dataset (NPD) which holds details of non-residential properties. Where it holds specific market values for a property, these have been used. The capital value was otherwise estimated from the rateable value provided. Caravans were valued using the Environment Agency's Guidance 'Damages and Benefits Associated with Caravans, Prefabricated Buildings, Mobile Homes and Caravan Parks. August 2007'. A value of £8,000 per caravan pitch has been used in this assessment. Agricultural land has been valued using the Defra Guidance May 2008. The value used was the average land value provided by the most recent Rural Land Market Survey (RICS Rural Market Survey H1 July 2008) date): £12,965/ha.

2.5.4 The B2145 forms the only access to Selsey. Loss of this road link through a breach between the Medmerry and Pagham frontages would isolate the community of 10,000 people, effectively turning Selsey into an island. West Sussex County Council, the authority responsible for maintaining the B2145, has confirmed that from an emergency planning perspective access must be retained to Selsey. The benefits realised by protecting this infrastructure are in the order of £1 billion. Protecting the B2145 and Sidlesham Waste Water Treatment Works is considered the 'base minimum' investment that must be made to maintain the viability of the community at Selsey, East Wittering and Bracklesham. The project appraisal for here has been considered on a least costs basis to protect the key infrastructure. Consideration has been given to the construction of individual defences to protect the infrastructure, however longer defence lines would be needed in this case (8.2km compared with preferred option 5.6km) making it a more costly option. This option was not pursued further.

Damages due to Flooding, Erosion and Managed Realignment

2.5.5 Flood damages were estimated using the data sets contained within the Multicoloured Manual. These were capped at the property value in line with guidance. Following the Multi-Coloured Manual, a figure of 10.7% of any recurrent damages was used, as an estimate of costs to the emergency services. Properties were considered lost through erosion when the coast was 5m from the property. Where properties sustained flood damage before erosion, the combined cost was not allowed to exceed their current market value. Under managed realignment scenarios the existing line of sea defence is relinquished. The economic assessment considers the cost of flood and erosion damage to all properties and land between the realigned defences and the sea.

2.5.6 £372m (PV) of damage would be caused by flood and erosion within the Strategy area over the appraisal period. A detailed breakdown by frontage is provided in Section 2.7.

Potential for interconnectivity between frontages

2.5.7 As stated in Section 2.5.4, The B2145 is potentially at risk of flooding from either Medmerry or Pagham frontages. There is historical evidence that Selsey has been separated from the mainland by a tidal channel running between Pagham and Medmerry which has opened and closed intermittently over the past 2,000 years. A major breach at Medmerry, connecting through to Pagham Harbour occurred as recently as 1910.Therefore one of the main considerations in strategic options appraisal is the prevention of a channel connecting between Medmerry and Pagham. If such a channel is allowed to form, this would then have significant impacts upon the wider coastal processes. Continued separation of the two frontages will need to continue over the appraisal period to meet the 'base minimum'

condition defined in section 2.5.4. Options selected for both Pagham and Medmerry will achieve the least cost solution to protecting Selsey's £1 billion assets.

2.5.8 In the long term, rising sea levels will allow for some flood connectivity between other frontages during extreme events. In all cases, potential connectivity has been considered in economic analysis and benefits are correctly apportioned to one frontage only, avoiding double counting.

a) There is potential for some interconnectivity between Pagham and Selsey frontages, from Church Norton towards properties in eastern Selsey. This can be addressed by the inclusion of Bund 5 if needed in the long term (see Key Plan 6).
b) There is some connectivity between Bracklesham and Medmerry units in the No Active Intervention scenario. Higher land on the coast at Bracklesham currently prevents a route for flooding to lower lying land at the western end of Medmerry frontage. This route for flooding could only materialise if severe erosion occurs at Bracklesham.
c) At Cakeham, there is a potential flood path through to properties on the neighbouring West Wittering frontage. This would only happen with significant erosion of the existing coastline.

Economic Gain due to Wetland Creation

2.5.9 Under the No Active Intervention and Managed Realignment options, extensive areas of inter-tidal and coastal habitat would be created. These habitats create value in their own right. These so-called provisioning, regulating and supporting values have been included in this assessment. This was valued in the assessment in accordance with the EVEE approach.

Wider Benefits of Wetland Creation – Making Space for Water

2.5.10 The preferred Managed Realignment option at Medmerry generates a more naturally functioning coastline and is a sustainable way of managing flood risk over 100 years. This option makes use of the higher ground inland to attenuate any wave action and will be aided by the growth of salt marsh vegetation. This provides a rare opportunity for creating a large area of salt marsh habitat on the largely urbanised coastline of southern England. This option embodies the principles of the Government's Making Space for Water policy.

Local economic issues not included within appraisal

2.5.11 The peninsula has a narrow industrial base, heavily reliant, in employment terms, on the service sector and a number of sectors whose business is highly seasonal. Seasonal employment in the area mainly consists of opportunities in tourism and horticulture or agriculture. Their continuation is important for long-term viability of the local community. The consideration of local economic impacts as transfer payments, under current appraisal guidance, raised significant concerns with the local community and was felt not to fully address the local economic issues.

2.5.12 Local concern over the application of Defra guidance and the methodologies used for the benefit cost analysis led to a review by the National Audit Office (NAO) in April 2008. The NAO confirmed that the extant cost-benefit guidance was followed correctly.

2.6 Environmental and Social Issues

Strategic Environmental Framework

2.6.1 A Strategic Environmental Assessment (SEA) was undertaken to assess the strategic options for each of the frontages in accordance with the EC Directive on SEA. The SEA assessed the impacts on all receptors and was undertaken in the context of the objectives of the Water Framework Directive.

2.6.2 Two of the Strategy frontages, Pagham Harbour and West Wittering, lie within the Natura 2000 network of protected sites. An assessment of 'likely significant effect' (Appendix 11) under the Habitats Regulations, was therefore required. Both assessments concluded no likely significant effect on the integrity of the Natura 2000 sites for the preferred option of Adaptive Management. Natural England has agreed that the known elements of the adaptive management options are not likely to effect the European sites.

a) At Pagham Harbour, Natural England have agreed that Adaptive Management will not impact on the internationally designated site. Additional works to manage flood risk may be needed in the medium to long term. If the need arises Natural England have agreed that such work is best assessed during appraisal.
b) At East Head spit, the works associated with Adaptive Management will be privately promoted. Actions will be implemented through the established advisory group that includes Natural England's participation. This work does not impact on the Operating Authorities' implementation of the Strategy.

2.6.3 The Statutory Environmental Bodies were consulted on the draft Strategy. Natural England has provided a letter of support, confirming that in their view the 100-year Strategy and the proposed options are likely to lead to environmentally acceptable solutions. Natural England were also involved in developing Adaptive Management options and currently support the local management groups at East Head and Pagham. English Heritage confirmed that they had no comments or objections in principle to the Strategy proposals.

Environmental Constraints and Risks

2.6.4 The preferred option selection process included consideration of the social and environmental constraints, risks and opportunities. The environmental implications, both positive and negative, are detailed in Section 2.7 (Choice of Preferred Option). Mitigation actions are detailed in Section 3.

2.6.5 The environmental constraints were identified in the SEA report and the main sites are illustrated on Figure 3. The following sections provide a summary of the constraints, risks and opportunities in the Strategy area.

2.6.6 The population of Selsey is approximately 10,000. East and West Wittering each have an approximate population of 4,500. Pagham extends from the eastern edge of the Strategy area towards Aldwick and Bognor Regis with a population of approximately 7,000. The risk of flooding and erosion affects a substantial proportion of the local population.

2.6.7 As well as the residential population there is a high influx of tourists during the summer months, effectively doubling the population of Selsey. The West Sands Holiday Village at Medmerry is one of the largest caravan parks in Europe. Loss of the caravan park would lead to significant adverse socioeconomic effects. Tourism is seen as vital for the economy of Selsey and it will be important to maintain the attractiveness of the coast for tourists.

2.6.8 Agriculture is the other main industry on the peninsula, with both a dependence on farmed land and extensive greenhouse cultivation. The majority of the land is rated from 'good' to 'excellent' under Defra's Agricultural Land Classification. There are several surface and groundwater abstractions for agricultural use and the overtopping of defences and saline intrusion is therefore an important issue for the viability of agriculture in the Strategy area. The peninsula is generally flat and low-lying and drainage is therefore a key issue. Although agriculture is important to the local economy, the better quality land and glass houses are found on higher ground, unlikely to be affected by coastal flooding and erosion. Areas at risk are relatively small and are therefore not considered to be of national importance.

2.6.9 The Strategy area has a rich diversity of ecological habitats and species and incorporates three internationally designated sites and four Sites of Special Scientific Interest (SSSIs). The shingle spits at Pagham provide an internationally important area for breeding populations of little tern and ringed plover with extensive area of saltmarsh and mudflat behind the shingle spits of Pagham Harbour. Chichester Harbour is internationally significant for wintering wildfowl and waders, and also for breeding birds. Both sites are also designated for their geomorphological importance. There are also areas of wetland habitat in the form of coastal grazing marsh behind the shingle ridge at Bracklesham Bay.

2.6.10 At Chichester and Pagham Harbours, hold the line options could have an adverse impact on the internationally designated sites, affecting geomorphology and habitats. Options to hold the line could only be promoted with a case of 'overriding public interest'. This has restricted the options available.

2.6.11 Additionally, large parts of the Strategy's foreshore and low cliffs are designated as Geological Conservation Review sites (GCRs) and SSSIs. All options can be considered but this does restrict how they can be implemented, affecting cost and standard of protection. The SSSI/GCR designation at Medmerry Cliffs prevents building of defences that completely halt any erosion of the foreshore.

2.6.12 There are three Scheduled Monuments that lie within the study area: Cakeham Manor, Ring works at Church Norton and Becketts Barn. Church Norton Ring works and Becketts Barn would both be at risk of flooding should defences fail within Pagham Harbour. English Heritage would oppose options that would result in the inundation of these sites. There is a protected wreck site off the coast at Bracklesham Bay and a Mulberry Harbour off Pagham, these will not be affected by the proposed options, but may be a minor constraint when considering marine deliveries. On land there have been a large number of finds which provide evidence of early human activity along the coastline.

Environmental Opportunities

2.6.13 A managed realignment option at Medmerry has the potential to provide new coastal habitat on land which is currently not designated. This will provide a secure basis for schemes to be promoted to manage flood and coastal erosion risk across the Solent. Further information is detailed in Section 2.3.3.

2.6.14 Scheme level promotion will allow partnership working and draw on a variety of funding sources to enhance the local environment. Community involvement will be an essential part of any scheme. Enhancements could be wide ranging including recreation and landscape improvements.

Consultation and Political and Social Issues

2.6.15 The draft Strategy consultation has confirmed that local residents have developed an improved understanding of coastal management issues. The Strategy team has gained the benefits of ongoing engagement using the 'Building Trust with Communities' approach. There is now general support for the Strategy's preferred options. It is now recognised that the Strategy proposals, if implemented, will provide a better standard of protection to the vast majority of people and properties in the area.

2.6.16 Community groups, such as Save our Selsey (SoS), who were strong objectors in the past, are now generally supportive of the recommended management options. Chichester District Council members have changed the position held initially and now support managed realignment at Medmerry. Approximately 1,200 objections were received from Chichester Harbour users during the initial consultation due to a perceived impact of the Strategy on the navigability of Chichester Harbour. However, during the most recent consultation, the local

Harbour Conservancy now support the Adaptive Management approach at East Head and encouraged others to do the same.

2.6.17 Though it has required a lot of effort, the opinions, ideas and concerns of the public and key stakeholders raised during ongoing engagement and formal consultation have been of value in selecting preferred options. Local community groups and key stakeholders have communicated their appreciation for the Strategy team's engagement efforts. For example, one organisation criticised the 'shortcomings and failures' of the initial consultation, only to state during the draft Strategy consultation their praise for the team's time, expertise and hard work'.

2.6.18 Details of the Strategy consultation are included in Appendix D Consultation Report and summarised below.

2.6.19 Between November 2006 and March 2007 an initial consultation was held with the local community and key stakeholders to raise awareness of the local flood and erosion risks and to get feedback on the indicative preferred options, identified in the Technical Review. During the consultation members of the Strategy team met over 1,200 people at exhibitions and workshops and received almost 2,000 responses, which were used in developing the draft Strategy. Many of these initial responses expressed opposition to the indicative preferred options presented.

2.6.20 During the initial consultation the East Head Working Group (now called East Head Coastal Issues Advisory Group) was formed to develop a management plan to address flood and erosion risks and the wider environment, including amenity, recreation and navigation. SoS was formed to lobby for Hold the Line options on all frontages. Two SoS members were elected to Chichester District Council on a platform of flood and coastal erosion issues.

2.6.21 After March 2007 the Strategy team maintained positive working relationships with key community groups in the area by holding regular meetings, updating partner websites and distributing newsletters.

2.6.22 Consultation on the draft Strategy preferred options occurred from May to August 2008. This included media work, the issue of over 4,000 consultation documents and the publication of all documents (consultation document, full Strategy document with appendices and frequently asked questions) on the Environment Agency website. Four public exhibitions were held across the Strategy area, which were attended by over 1,000 members of the public.

2.6.23 Meetings were arranged with local Parish, Town, District and County Councils, and numerous community groups, including SoS. A Stakeholder Engagement Plan was used to ensure the team met its objectives in dealing with the wide variety of stakeholders affected by the Strategy.
2.6.24 In implementing the Strategy options maintaining engagement with stakeholders will be essential.

2.7 Choice of Preferred Option

Introduction

2.7.1 This section assesses the short listed options for each frontage in the context of whether each option will meet the objectives of the Strategy.

2.7.2 For each frontage three tables are provided to explain the choice of the preferred option. The first table provides an economic summary of each option including the damages, benefits and benefit to cost ratio for each option. The preferred option is highlighted in blue.

2.7.3 A second table for each frontage summarises the technical and environmental implications of each option. Reasons for the rejection of the option on technical, economic or environmental grounds are also provided. The assessment matrices from the SEA were used to identify environmentally preferable options.

2.7.4 The third table for each frontage sets out the preferred option over the short, medium and long term. Further detailed assessment is provided in the Technical Assessment Report, SEA and Economic Report for technical, environmental and economic issues respectively.

2.7.5 Sensitivity tests were undertaken to consider the robustness of the decision making process. For the majority of frontages the works required for viable 'do something' options are similar so that fluctuations in price of any of the key elements (concrete, timber, shingle, labour, fuel and others) will affect available options in the same way. Analysis was also undertaken as to whether changes in the benefits and costs by+/-20% would alter the option selection. This process confirmed the robustness of the preferred options. Details of the analysis are included in Appendix B. Further sensitivity analysis was carried out for the Medmerry frontage and these are included in Sections 2.7.41 and 2.7.46.

2.7.6 One of the major uncertainties on the frontage is the future supply of littoral feed into the system. Option appraisal included consideration of the effect of importing additional beach material in future. It should be noted that the main feed to Strategy frontages is from offshore shingle banks around Selsey Bill with net littoral drift away from Selsey Bill in either direction.

2.7.7 A reasoned justification for the preferred option on technical, environmental and economic grounds is then provided. This includes details of the optimisation of the standard of protection.

Pagham frontage

Benefit Cost Summary

2.7.8 A benefit assessment for the Pagham frontage has been calculated despite the uncertainty in short term natural changes to the harbour. An indicative assessment has been made, based upon maintaining the harbour system in its current form over the appraisal period. This would involve Pagham Harbour being maintained as an open coastal inlet and assumes sediment supply is sufficient to maintain the spits either side of the harbour entrance. Costs have been calculated based on an assumed need for future works. Assumed works included work to harbour entrance, harbour mouth clearance, shingle recycling, construction of flood bunds realigned inland, construction of four groynes to the west of the harbour and maintenance work to all assets. Full details of the works are provided in Section 2.3.1 of Appendix A.

2.7.9 Given the uncertainty over the future development of Pagham Harbour, a patch and repair approach cannot be defined for this frontage. As coastal processes and interactions here are better understood it may be possible to define a do minimum scenario. It should be noted that the adaptive management approach may provide the least cost means of managing the risks at this location.

Table 11 – Pagham Economic Summary

Option	Potential PV Benefit (£K)	Potential PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
No Active Intervention	-	-	Potential 87,303	-
Adaptive Management	87,141	12,752	162	6.8

NB. Economic analysis is indicative only

Table 12 – Pagham Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Main Reasons for Rejection
No Active Intervention	• Uncertain outcome • Increased flood risk to properties and key assets including the B2145 road, Pagham Waste Water Treatment Works and 1,229 properties. Loss of these assets would lead to large adverse social and economic impacts. • Risk of adverse impact on SPA site • Loss of existing designated intertidal habitats and sea fish (sea bass) nursery. • Adverse impacts to agriculture in terms of saline intrusion and drainage • Potential loss of public access and coastal footpaths • Potential flooding of two Scheduled Monuments	Unacceptable impact on populations at Pagham and Selsey and key infrastructure including the only road access to Selsey.
Adaptive Management	• Management group established to develop Management Plan with objectives and schemes to be developed based on response to changing coastal processes over time. • Measures are likely to be required in the immediate future to address the issues with the shingle build up on the southern spit, unless storm activity resolves this situation. • Flexibility to manage uncertain coastal processes and geomorphological development	N/A – Preferred Option

Table 13 – Pagham Preferred Option

The **preferred option** for the Pagham frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
Short Term 0 - 20 Years	***Adaptive Management***
Medium to Long Term 20 – 100 Years	***Adaptive Management** unless understanding is sufficient that a more definitive option can be endorsed.*

Justification for Preferred Option

2.7.10 Given the level of uncertainty in this rapidly changing system, a flexible response is needed that can manage flood and erosion risk, as well as meeting legal obligations for protecting the internationally designated nature conservation site.

2.7.11 This approach is consistent with the SMP policy. Adaptive management is the best solution and will work with the natural sediment movement processes. It will allow for realignment of the western harbour mouth spit if this is needed. Adaptive management is the preferred environmental option in the SEA as it minimises environmental impacts during the short-term. The policy also allows for future consideration of habitat creation. This option would also promote community involvement with key stakeholders increasing the awareness of issues, constraints and opportunities and may assist in identifying locally funded solutions.

2.7.12 A coastal issues advisory group has been established to help develop and implement an Adaptive Management Plan. This includes the Environment Agency, local councils,

Natural England and local landowners. Specific actions in the short term would be to maintain Pagham Harbour as an intertidal system, develop a solution to the erosion of Pagham Beach, investigate opportunities for recycling material from the adjacent Aldwick Bay and to consider the need for new inner harbour flood defences to protect against rising sea levels. The approach of Adaptive Management will optimise the solutions here, improving understanding of the system and its responses over time.

2.7.13 The only viable option is Adaptive Management with a BCR of 6.8.

2.7.14 A range of outcomes has been considered based on the harbour remaining as a tidal system. If the harbour does remain open flood risk will increase and become significant as sea levels rise. This risk will be managed through the provision if needed, of five separate inland flood banks as shown on key plan 6. The main risk to the assets protected by the banks would be through breaching. The banks would initially be constructed with SoP of 1 in 1,000 and reducing to 1 in 100 over the appraisal period.

2.7.15 Bank 1 (see key plan 6) provides protection to the western side of Pagham village, and the Church Farm Holiday Park. This bank follows the line of the existing defences around the holiday park site.

2.7.16 Bank 2 provides protection to the Pagham WWTW and the areas towards North Mundham village. Pagham Rife is a key drainage channel that forms part of the existing Chichester Flood Alleviation Scheme.

2.7.17 Bank 3 provides protection to Hunston village. The alignment of this bank could be adjusted to address (potential) coastal squeeze issues in Pagham Harbour, if this becomes an issue.

2.7.18 Given the topography behind the banks 1, 2 and 3 there is no economic benefit in providing higher standards of protection than 1 in 100 against flooding (at the end of the appraisal period – Section 2.7.14), as overtopping can be managed within natural storage areas landward of the bunds.

2.7.19 Bank 4 provides protection to the B2145 and prevents a link to the low lying land at the rear of the Medmerry frontage. There is uncertainty over the amount of siltation the harbour will experience. Greater siltation is likely to decrease the flood risk to the B2145. The height of the bund will need to reflect this requirement.

2.7.20 In the long term Bank 5 may be required to prevent flooding of eastern parts of Selsey in extreme events.

2.7.21 Due to the rapid natural changes outlined in section 2.2.12, Arun District Council are currently undertaking a study that will increase understanding of the potential stability of the harbour inlet. This study is the first step in the implementation of the adaptive management approach. The initial outputs from the study have defined triggers for intervention at Pagham Beach to manage the erosion risk.

2.7.22 One further study is proposed for 2010/2011, as part of the adaptive management approach building upon the current work, considering the longer term development of the inner harbour and the consequences of this for the management of flood risk. This will provide refinement of triggers for intervention within the harbour system and define effects and impacts on Pagham Harbour's habitats and ecology. It will need to take account of any effect on the area's archaeology, and associated constraints and monitoring requirements.

2.7.23 Depending on the recommended actions from the studies, private funding may need to be sought by the management group.

2.7.24 Monitoring of the harbour and coastline is coordinated by the Regional Coastal Monitoring programme which is reviewed annually by the Environment Agency. Data will be used by the advisory group to determine and refine necessary management actions. The group will commission and oversee additional data collection and reporting as required.

2.7.25 Natural England have agreed that Adaptive Management will not impact on the internationally designated site. If banks 1 to 5 (described above) are required, further environmental assessment will be needed at scheme assessment stage. Natural England are committed to this approach. Details are given in Appendix 11 documents contained in the SEA Environmental Report, Appendix D.

2.7.26 A strategic review of the preferred option is likely to be required to commence by 2019. The timing of the review will be influenced by further studies and monitoring undertaken over the next five years. If capital works are required, project appraisal will need to confirm that recommended options comply with this Strategy. Non-compliance will require an appropriate strategic level review. A review should consider technical, environmental and economic developments and will need to address any coastal squeeze issues.

Selsey frontage

Table 14– Selsey Economic Summary

Option (with SoP at Year 99)	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
No Active Intervention	-	-	121,398	-
Hold the Line – Maintain (< 1in 1)	98,287	39,537	23,111	2.5
Hold the Line Sustain (1 in 100)	121,393	33,557	5	3.6

Table 15 – Selsey Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Main Reasons for Rejection
No Active Intervention	• Failure of defences between 10 - 20 years • Increased flood risk to approximately 1,700 properties. Loss of these properties would lead to large adverse social and economic impacts.	Serious detrimental effects on the community at Selsey, including loss of assets and local tourism economy. There would be safety issues related to the failing sea wall.
Do Minimum	• Selsey Bill/East Beach – maintenance of defences for over 20 years East Beach groynes maintained for 10 years • Maintenance of West Beach defences for next 10 years • Progressive loss of properties and key assets	Would only delay failure of defences for a short period of time. Serious detrimental effects on the community at Selsey, including loss of assets and local tourist economy.
Hold the Line - Maintain	• Defences maintained on current alignment • Effectiveness of groynes reduced over time • Frequent overtopping of sea walls with sea level rise in long term • Long term disturbance to two geological SSSIs • Minor adverse impacts on biodiversity and landscape associated with constructing and maintaining defences	Increased maintenance costs would be greater than the additional cost of raising defences for Sustain option.

Option	Technical and Environmental Key Issues	Main Reasons for Rejection
Hold the Line - Sustain	• Current standard of protection sustained to cope with sea level rise, avoid damage from frequent overtopping • Amenity value of existing beaches retained • Larger defences required may adversely impact landscape • Reduced risk from erosion and flooding to community at Selsey enables town to remain operational as a tourist resort • Uncertainty over long term beach supply (therefore an allowance for recharge is included as sensitivity).	N/A - Preferred Option

Table 16 – Selsey Preferred Option

The **preferred option** for the Selsey frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
0 – 100 Years	***Hold the Existing Defence Line - Sustain***

Justification for Preferred Option

2.7.27 A No Active Intervention or Do Minimum approach at this frontage would have significant detrimental impacts on the large community at Selsey both in terms of loss of assets and viability of the local tourist economy by the end of the short term. The realities of this flood and erosion risk were seen in March 2007 with the failure of the sea wall at West Beach. However there would be significant environmental benefits over the appraisal period of adopting these approaches.

2.7.28 Without defences in place, this frontage would be subject to both flooding and erosion as detailed in Section 2.2.14. Consideration has been given to subdividing the frontage but was rejected as viable management options could not sensibly separate areas of flood and erosion risk. During consultation, the local community voiced a strong preference for Selsey's coastline to be managed as a single unit.

2.7.29 Hold the Line options would result in minor impacts on conservation designations and geology, which are considered to be acceptable by Natural England.

2.7.30 A Hold the Line (Maintain) approach would result in increased exposure as sea level rise and the additional maintenance required would be greater than the additional cost of raising defences. Erosion is the key risk on this frontage with flood risk, only becoming significant if the defences breach at East Beach.

Option selection - Application of the Decision Rule

2.7.31 The viable option with the highest BCR (3.6) is Hold The Line sustain. This option has the highest benefits and is the lowest cost viable option. At the time of construction this would provide a SoP of 1 in 1,000 falling to 1 in 100 at the end of its design life. This provides for protection above or within the indicative range throughout the Strategy appraisal period. On this erosion risk frontage, residual damages are small with effective defences in place. The larger (sustain) defences are proposed on the basis of lower maintenance cost compared with the maintain option in the face of predicted sea level rise. A rise in level of one metre is currently predicted for this area over the 100 year appraisal period. The difference between a 1 in 50 and a 1 in 1,000 return period sea level is calculated at 0.3m (the same as sea level rise over the next 50 years). The high SoP at installation is justified on grounds of lower cost over the appraisal period rather than increasing the protection to assets.

2.7.32 There is no justification for further optimisation of the SoP because erosion and breach present the major risk to this frontage. There is no economic benefit in raising the SoP against flooding through overtopping above that currently proposed.

2.7.33 The design has taken a precautionary approach to consideration of climate change with the sea wall being raised in two phases. Given that the increase in wall height over the appraisal period will be of the order of 1m, it would not be economically efficient to undertake this in smaller steps (adaptive approach).

2.7.34 Although a Hold the Line Sustain option is economically justified it attracts a low priority for scheme implementation (Table 33). This makes a scheme unlikely to attract national funding. External funding is likely to be required to implement the scheme. The standard of protection provided by any new defences will not affect coastal processes for this or neighbouring frontages. It should be noted that works are required here in the immediate short term and as such funding opportunities need exploration immediately by project partners.

2.7.35 The likelihood that funding will be unavailable in the near future to implement the preferred option has been considered in developing the Strategy. In addition to the options presented in Table 15, a do minimum option for continuing maintenance while funding is sought has been considered. This option is only likely to be viable for 10 to 20 years.

Table 17 – Selsey Do Minimum Option

Option	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
Do Minimum (10 years only for West Beach, 20 years for East Beach and Selsey Bill)	31,762	1,423	89,726	28.5

2.7.36 There is a clear economic justification for continuing maintenance to prolong the life of existing defences while funding is sought to complete a scheme. If funding cannot be found, despite the continued maintenance, defence conditions will deteriorate. A point will be reached when defences can no longer be maintained and the only option available may be to withdraw maintenance and implement an exit strategy. Potentially affected communities have been made aware that this outcome, although unpalatable, may be inevitable. If this does occur the effect will be the same as NAI, delayed by the period of viable maintenance. Condition of defences will continue to be monitored to ensure that communities' health and safety and expectations are managed.

Medmerry frontage

Table 18 – Medmerry Economic Summary

Option (with SoP at year 99)	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio	iBCR
No Active Intervention	17,588 (EVEE)	-	88,760 (excludes EVEE benefits)	-	-
Do Minimum (30 years only before defences fail)	38,375 (includes 13,028 EVEE)	6,620	63,412	5.8	-
Hold the Line – Hard Defences (1 in 100)	88,615	51,627	145	1.7	-
Hold the Line – Offshore Breakwaters (1 in 100)	88,615	76,714	145	1.2	-
Managed Realignment – Bank Realignment set back 250m (1 in 100)	83,352	38,261	5,408	2.2	-
Managed Realignment – Breach Scenario A (1 in 100)	80,635 (includes 16,554 EVEE)	11,721	24,679	6.9	-
Managed Realignment – Breach Scenario B (1 in 100)	91.666 (includes 13,460 EVEE)	11,134	10,554	8.2	-
Managed Realignment – Breach Scenario B (1 in 200)	91.786 (includes 13,460 EVEE)	11,342	10,434	8.1	0.6
Managed Realignment – Breach Scenario C (1 in 100) (includes private scheme works)	97,662 (includes 12,123 EVEE)	10,894*	3,222	9.0	N/A

* Excludes costs for private frontage works proposed by landowner

Table 19 – Medmerry Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Main Reasons for Rejection
No Active Intervention	• Breach of shingle bank – potential for isolating Selsey through loss of access road. • Increased flood risk to approximately 800 properties, including properties at Ham village. Loss of these properties would lead to large adverse social and economic impacts. • Increased overtopping • Loss of sheet piled wall, residential properties and West Sands Caravan Park within 10 years • Sidlesham Waste Water Treatment Works subject to intermittent flooding and resulting in loss of sewage treatment to large parts of the peninsula and a serious contamination risk. • Erosion of cliffs leading to loss of SSSI and archaeological interest. • Loss of shingle and grazing marsh habitats and impacts on protected species • Possible biodiversity gain through creation of new inter-tidal areas • Impacts on the drainage system for the southern half of the peninsula • Direct loss of agricultural land subject to saline intrusion. • Using the EVEE approach gives a PV benefit of £17.6m for the implementation of a No Active Intervention.	Unacceptable impacts on the local community, economy and health and safety due to loss of access to Selsey, impacts to key infrastructure, loss of West Sands Holiday Village and the long term viability of agriculture. Significant risk of loss to life or injury, in particular in caravan parks behind defences.
Do Minimum	• Approach not sustainable longer than 30 years due to	Major risk of breach

Option	Technical and Environmental Key Issues	Main Reasons for Rejection
	increasing risk of breach • Major breach risk remains, resulting in same risks as No Active Intervention approach	remains, risk to health and safety and property considered unacceptable. High cost of maintenance.
Hold the Line – Hard Defence	• Provides good standard of protection over the appraisal period • Allows sediment transport to pass through the system • Likely to lead to steepening of the foreshore leading to increased severity of wave attack • Foundations of defences would impact on biodiversity and designated geological deposits • Disruption to recreational activities, beach amenity and public rights of way • Potential adverse impacts on landscape	Expensive option, potential to negatively affect geological SSSI. Major alteration to landscape character
Hold the Line – Offshore Breakwaters	• Provides good standard of protection over the appraisal period • Impacts on sediment. Health and safety issues for water based recreation activities, rip currents • Potential adverse impacts on marine environment including fisheries during construction • Potential adverse landscape impacts • Possible impact on designated offshore wreck	Expensive option, potential of transition effects to impact upon adjacent frontages
Hold the Line – Land Raising	• Could provide a good standard of protection over the appraisal period • Large impacts upon existing drainage infrastructure • Potential adverse landscape impacts • Major material import impacting on local communities	Not technically viable due to large quantity of material required and adaptation of existing infrastructure including roads and services
Managed Realignment – Bank Realignment	• Bank could 'roll back' allowing it to evolve naturally as sea levels rise • Increased risk of breach if bank not sited correctly • Possible temporary reduction in longshore drift due to creation of 'sediment sink' • Initial habitat loss but longer term net habitat creation • Loss of grazing marsh habitat • Potential local surface water drainage issues	Significantly higher costs than breach alignment with similar benefits. Beyond 100 years, flood risk would increase
Managed Realignment – Breach Realignment (Scenario B)	• Creation of a new tidal inlet • Interruption to littoral drift whilst system develops which could last decades • Major opportunities for (salt marsh) habitat creation/biodiversity • Loss of grazing marsh • Potential local surface water drainage issues • Requirement to permanently divert public rights of way • Loss of 9 houses, 200 caravan plots and caravan park facilities if private defences are not built.	N/A – Preferred Option

Table 20 – Medmerry Preferred Option

The **preferred option** for the Medmerry frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
Short Term 0-20 Years	*Managed Realignment - Breach Realignment*
Medium to Long Term 20 – 100 Years	*Hold the New Defence Line*

Justification for Preferred Option

2.7.37 Managing flood risk at Medmerry is crucial to the future of Selsey town and the peninsula's low-lying villages and holiday parks. Without defences, large areas of land would flood on each tide, Selsey's only road link would be severed and the wastewater treatment works flooded. Selsey could be isolated from the 'mainland', with associated high risk to life and property.

2.7.38 The current shingle bank defence is vulnerable and provides a low standard of protection. As sea levels rise, holding the line with the shingle bank will cost more and the risk of breach and flooding will increase. The shingle bank will not provide an effective defence over the next 100 years.

2.7.39 Separate bank and breach realignment scenarios were defined for the appraisal. Bank realignment involves moving the existing coastal embankment inland and maintaining it in the revised position for the remainder of the appraisal period. Breach realignment involves forming new flood bank defences inland from the coast. The existing coastal shingle embankment could then be allowed to breach naturally or, alternatively, a section of bank could be deliberately removed to enact the realignment.

2.7.40 Managed Realignment will improve the current standard of protection and reduce flood risk, providing improved protection over the next 100 years. New defences would be built inland to provide improved protection for properties at Ham and Earnley, road link and sewage treatment works for Selsey. A deliberate engineered breach is preferred to a more unpredictable natural breach, as this approach would be more acceptable to the local community. It could provide the opportunity to create new inter-tidal habitat to offset losses elsewhere within the Solent.

2.7.41 Managed Realignment at Medmerry would also provide protection for the B2145 access road to Selsey. The economic effect of maintaining the access to Selsey has been considered. 2,657 additional residential properties and 217 commercial properties (not at flood or erosion risk) would benefit from the protection of the access. Using average property values for the area this would equate to an additional £670m of benefits provided by the scheme. This would increase OM score by 18.7 to 21.7. Maintaining the B2145 access to Selsey will potentially require measures to manage flood risk from both the Medmerry and Pagham frontages. Given the uncertainty over the future natural development of the Pagham unit, this has only been included to illustrate sensitivity as the extent of works required at Pagham is as yet unknown. This will form part of future assessments.

Option selection - Application of the Decision Rule

2.7.42 The viable option with the highest BCR (8.2) is Managed Realignment – breach realignment. This option has the highest benefits and is the lowest cost viable option. At the time of construction this will provide a SoP of 1 in 1,000 falling to 1 in 100 at the end of the appraisal period. This provides for protection above or within the indicative range throughout the Strategy appraisal period.

2.7.43 A precautionary approach to climate change has been adopted for bank construction and the initial SoP at construction will be in excess of 1 in 1,000 reducing to 1 in 100 over the 100 year appraisal period. An adaptive approach was considered with the SoP falling to 1 in 100 after 60 years, with works at this point to raise defences a further 0.5m. This would give an overall PV cost saving of 1.6%. Given the small difference in costs, a precautionary approach was selected to decrease the risk of breach during the appraisal period, minimise construction risks and avoid possible environmental disadvantages. New intertidal habitat formed through managed realignment is likely to attract environmental designation restricting ability to implement future schemes to raise defences.

2.7.44. The critical infrastructure, Sidlesham WWTW and the B2145 road will be afforded a SoP against overtopping greater than 1 in 1,000 throughout the whole appraisal period. This is due to the natural topography between the proposed defence and the road which provides additional flood storage. Overtopping of the banks would not reach the critical infrastructure. Breach of the defences is the critical determinant.

2.7.45 As the height of defences is driven by the need to prevent breaches and the vast majority of assets would not be affected by overtopping by over-design events, further optimisation to increase SoP is not economically justifiable. Additional benefits of raising defences are outweighed by costs as shown in Table 18.

2.7.46 Environmental benefits calculated using EVEE guidance are included for all the options where they apply. These environmental benefits, Strategy costs and Outcome Measures are calculated assuming that this Strategy does not secure any land for new habitat creation. Compensatory habitat is not required in order to implement the Strategy's preferred options. Therefore an economic case to secure land would be needed beyond the scope of this Strategy (and deliver new habitat to compensate for coastal squeeze losses elsewhere). Environmental benefits are explicitly stated in Table 18. Managed realignment would remain the preferred option even with the exclusion of these benefits. This approach ensures there is no double counting of environmental benefits.

2.7.47 This provides an option sustainable over 100 years. Managed Realignment options have the best benefit cost ratio and habitat creation is consistent with the optimum economic option for managing flood risk.

2.7.48 The owners of the West Sands Holiday park are currently investigating potential ways to improve coastal defences for their site at Medmerry. The landowner has been a key stakeholder for this Strategy and the relationship has been developed. As private defence proposals are currently not finalised (or in receipt of necessary approvals), realignment options were appraised without their consideration. Realigned defences A and B (indicative alignment shown on Key Plan 7) assume there are no private defences in place and illustrate the most cost effective route. However alignment C as shown, identifies that there are opportunities to work with new private defences if they are constructed. The construction of the private defences here, subject to them being of suitable design, would not compromise the integrity of the preferred managed realignment option and their effect could be incorporated within the wider scheme.

East Wittering and Bracklesham frontage

Table 21 – East Wittering and Bracklesham Economic Summary

Option (with SoP at Year 99)	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
No Active Intervention	-	-	46,277	-
Hold the Line – Maintain (< 1 in 1)	46,255	25,547	22	1.8
Hold the Line – Sustain (1 in 100)	46,255	25,409	22	1.8

Table 22 – East Wittering and Bracklesham Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Reasons for Rejection
No Active Intervention	• Uncontrolled realignment of coastline • Failure of groynes and concrete walls within 5 years • Once defences have failed, erosion at approximately 1m per year exposing inland areas to flood risk, properties lost through erosion • Increased flood and erosion risk to approximately 500 properties. Loss of these properties would lead to large adverse social and economic impacts. • Impact on tourist economy	Significant detrimental impacts on community of East Wittering, including loss of property and function as a coastal tourist resort
Do Minimum	• Maintenance of erosion defences for up to 10 years • Following this period, similar impacts to No Active Intervention	Would only delay failure of defences for a short period of time. Eventual significant detrimental impacts on community of East Wittering, including loss of assets and function as a coastal tourist resort
Hold the Line – Maintain	• Erosion defences maintained on current alignment at current height.	Increasing overtopping risk across the appraisal period
Hold the Line – Sustain,	• Erosion defences maintained on current alignment, assets and properties protected • Additional recharge may be required to maintain beach levels reducing wave impacts and adding to amenity value • Disturbance to geological interest of SSSI	N/A – Preferred Option

Table 23 – East Wittering and Bracklesham Preferred Option

The **preferred option** for the East Wittering and Bracklesham frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
0 – 100 Years	***Hold the Existing Defence Line - Sustain***

Justification for Preferred Option

2.7.49 This frontage has been the subject of a feasibility study by CDC, leading to the development of a scheme to PAR stage in 2003. This scheme has not been progressed due to its low priority score. The Strategy work has built upon this appraisal. A Hold the Line Sustain - reconstruct approach is preferred to account for risks of rising sea levels over the next 100 years. This option is also the most cost-effective option and is consistent with the SMP policy. This option has been selected taking into account the effect of our recommended management change at the neighbouring Medmerry frontage (managed realignment) which could reduce the amount of shingle available at East Wittering.

2.7.50 A Hold the Line Sustain option is likely to result in a long term minor negative impact on conservation designations and geology but a positive impact on landscape.

2.7.51 Although a Hold the Line Sustain option is economically justified, it attracts a low priority for scheme implementation (Table 21). This makes a scheme unlikely to attract national funding and external funding will need to be explored. It should be noted that works are required here in the immediate short term and as such funding opportunities need exploration immediately by project partners.

Option Selection - Application of the Decision Rule

2.7.52 The viable option with the highest BCR (1.8) is Hold The Line sustain (Option A from CDC PAR). This option has the highest benefits and is the lowest cost viable option. The defences here prevent erosion and no intermediate (Hold the Line – maintain) options exist.

2.7.53 The option maintains the defences at the current level up to year 40. Beyond year 40 rising sea levels are likely to result in increased exposure of the defences to wave activity and overtopping. The defences will need to be raised to control the exposure and resultant increased maintenance costs. Raising the SoP for overtopping above that already existing will have negligible economic benefits. The Hold the Line option will provide a SoP in excess of 1 in 100 in relation to the erosion risk with proper maintenance.

2.7.54 The design will take a precautionary approach for the remainder of the appraisal period (after year 40).

Table 24 – East Wittering Do Minimum Option

Option	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
Do Minimum (first 10 years only)	10,262	359	30,568	28.6

2.7.55 The likelihood that funding will be unavailable in the near future to implement the preferred option has been considered in developing the Strategy. In addition to the options presented in Table 21, a do minimum option for continuing maintenance while funding is sought has been considered. This option is only likely to be viable for 10 years.

*2.7.*56 There is a clear economic justification for continuing maintenance to prolong the life of existing defences while funding is sought to complete a scheme. If funding cannot be found, despite the continued maintenance, defence conditions will deteriorate. A point will be reached when defences can no longer be maintained and the only option available may be to withdraw maintenance and implement an exit strategy. Potentially affected communities have been made aware that this outcome, although unpalatable, may be inevitable. If this does occur the effect will be the same as NAI, delayed by the period of viable maintenance. Condition of defences will continue to be monitored to ensure that communities' health and safety and expectations are managed.

Cakeham frontage

Table 25 – Cakeham Economic Summary

Option (with SoP at year 99)	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
No Active Intervention	-	-	7,786*	-
Hold the Line – Maintain (< 1 in 1)	7,359*	4,935	427	1.5
Hold the Line – Sustain (1 in 100)	7,785*	3,354	12	2.3
Managed Realignment (1 in 100)	7,785*	4,875	12	1.6

* Property values adjusted by 0.74 to account for socio-economic equity in line with Defra guidance 2004.

Table 26 – Cakeham Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Reasons for Rejection
No Active Intervention	• No impacts for 20 years • Coastline would then realign inland, leading to the eventual loss of around 50 properties	Unacceptable long-term risk to property. Loss of greensward amenity value
Do Minimum	• Maintenance of erosion defences for next 30 years then reversion to No Active Intervention	Unacceptable long-term risk to property. Loss of greensward amenity value
Hold the Line – Maintain	• Maintain erosion defences as current • Effectiveness of groynes reduced over time • Frequent overtopping of sea walls with sea level rise in long term	Preferred option over short term (0-20 years). Beyond 20 years increased maintenance costs would make less cost effective than the sustain option.
Hold the Line – Sustain	• Maintain erosion defences as current for next 20 years • Maintains the current situation in relation to coastal processes • More extensive work required over time dependent on sea level rise and sediment supply • New defences could result in adverse impacts to SSSI and geological interest	N/A –Preferred option over medium to long term
Managed Realignment (minor)	• Maintain erosion defences as current for next 20 years • Provides more sustainable system into the future • Improvement of sediment transport continuity • Impacts on recreational and amenity areas of greensward but compensated by increased area of beach	Cost (unless sediment supply reduces)

Table 27 – Cakeham Preferred Option

The **preferred option** for the Cakeham frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
Short Term 0 - 20 Years	***Hold the Existing Defence Line - Maintain***
Medium - Long Term 20 – 100 Years	***Hold the Existing Defence Line - Sustain***

Justification for Preferred Option

2.7.57 The Cakeham frontage is in fair condition. Only ongoing maintenance of the existing defences is needed in the short term. In the medium to long term existing defences would be raised, depending on sediment supply and sea level rise. This option can be adjusted slightly to incorporate a minor realignment (maximum of 30m from the current coastline) to give a more natural coastal profile. This would smooth out a current discontinuity perpetuated by existing coastal defences. This would not affect any existing properties or alter SoP on this erosion risk frontage.

Option Selection - Application of the Decision Rule

2.7.58 The viable option with the highest BCR (2.3) is Hold The Line sustain. This option has the highest benefits and is the lowest cost viable option. At the time of construction, in year 20, the SoP will be 1 in 1,000 falling to 1 in 100 at the end of its design life. This provides for protection above or within the indicative range throughout the Strategy appraisal period.

2.7.59 There is no justification for further optimisation of the SoP because erosion is the major risk to this frontage. There is no economic benefit in raising the SoP against flooding through overtopping above that currently proposed.

2.7.60 The design has taken a precautionary approach to consideration of climate change beyond year 20, when the existing defences reach the end of their design life.

2.7.61 Major works are not needed at Cakeham for the next 20 years and the Strategy plans for no schemes in its immediate implementation. The relatively low BCR for the preferred option means that funding priority will remain low and funding may be an issue when defence works are needed. In addition to the options presented in Table 25, a do minimum option for continuing maintenance has been considered. This option is not likely to be viable beyond 30 years.

Table 28 – Cakeham Do Minimum Option

Option	PV Benefit (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio
Do Minimum (first 30 years only)**	4,739*	243	3,051	19.5

* Property values adjusted by 0.74 to account for socio-economic equity in line with Defra guidance 2004

2.7.62 There is a clear economic justification for continuing maintenance to prolong the life of existing defences. If after this time, funding cannot be found, despite the continued maintenance, defence conditions will deteriorate. A point will be reached when defences can no longer be maintained and the only option available may be to withdraw maintenance and implement an exit strategy. Potentially affected communities have been made aware that this outcome, although unpalatable, may be inevitable. If this does occur the effect will be the same as NAI, delayed by the period of viable maintenance. Condition of defences will continue to be monitored to ensure that communities' health and safety and expectations are managed.

West Wittering frontage

Table 29 – West Wittering Economic Summary

Option (with SoP in Year 99)	PV Benefit* (£K)	PV Cost (£K)	PV Residual Damage (£K)	BC Ratio	iBCR
No Active Intervention	-	-	20,045	-	-
Do Minimum	Not practical at this location				
Hold the Line – Sustain East Head and West Wittering (1 in 200)	20,041	20,299	4	1.0	-
Adaptive Management and Flood Banks for West Wittering (1 in 100)	20,041	3,894	4	5.1	-
Stand-alone Flood Banks for West Wittering (1 in 50)	19,753	863	211	22.9	-
Stand-alone Flood Banks for West Wittering (1 in 100)	19,960	913	85	21.9	4.1
Stand-alone Flood Banks for West Wittering (1 in 200)	20,041	961	4	20.9	1.7

*Benefits shown are FRM benefits from protecting West Wittering Village and do not include the wider harbour amenity values.

Table 30 – West Wittering Technical and Environmental Issues

Option	Technical and Environmental Key Issues	Reasons for Rejection
No Active Intervention	• East Head likely to move landwards leading to greater risk of breach, pedestrian access would be restricted • Increased risk of overtopping and breach, has the potential to form second channel to Chichester Harbour with significant impacts on navigability • Erosion of saltmarsh and overtopping of banks inside Harbour increases flood risk to West Wittering and loss of farmland • Popular recreational site and assets including car park, beach huts and picnic site at increasing risk • Possible loss of dune habitat but compensated by reversion to more natural processes along the coastline	Potential for significant impacts on local flood risk and Chichester Harbour. Option does not address potential for dramatic changes. Over time flood risk to West Wittering village would increase leading to the loss of around 170 properties and the viability of the community.
Do Minimum	• Maintenance of defences then reversion to No Active Intervention	Same as No Active Intervention
Hold the Line	• Maintain coastline on current alignment • Increasing quantities of material required over time • Works against natural coastal processes • Construction of new defences would lead to adverse impacts on environmentally designated sites • Impacts on the geomorphological requirements of the SSSI interests • This could provide protection to West Wittering village without the construction of local flood protection measures.	Option would significantly alter the character of the area and hinder the ability for the East Head spit to adjust in line with coastal processes. Benefit cost ratio is less than unity. Not supported by landowner (National Trust) or Natural England.
Adaptive Management	• Advisory group established to develop Management Plan • Objectives and schemes to be developed based on response to changing coastal processes over time	N/A – Preferred Option
Flood banks to protect West Wittering	• Road level raised to provide embankments to reduce flood risk to West Wittering • Access implications for residents and local sailing club	N/A – Preferred Option

Table 31 – West Wittering Preferred Option

The **preferred option** for the West Wittering frontage, based upon the overall appraisal of technical, environmental and economic criteria is:	
Short Term 0 – 20 Years	***Adaptive Management*** *for East Head and the construction of* ***new local flood defences*** *to protect West Wittering Village and consideration of the need for local flood defences to four properties at the northern end of Ella Nore Lane*
Medium Term 20 – 50 Years	***Adaptive Management unless understanding is sufficient that a more definitive option can be endorsed.*** ***Hold the New Defence Line on the flood banks at West Wittering village*** ***Local flood Defences to four properties at the northern end of Ella Nore Lane.***
Long Term 50 – 100 Years	***Adaptive Management unless understanding is sufficient that a more definitive option can be endorsed.*** ***Hold the New Defence Line on the flood banks at West Wittering village.*** ***Hold the New Defence Line on local defences at the northern end of Ella Nore Lane.***

Justification for Preferred Option

2.7.63 The evolution of East Head has only limited effect on the flood and erosion risk management for properties and land in West Wittering. In national economic terms there is no justification for undertaking works at East Head from FCERM budgets. However, management of East Head is important due to its environmental and amenity value and the potential for impact on navigation within Chichester Harbour. Solutions to manage East Head will be undertaken using local funding mechanisms. EVEE benefits do not apply for works at East Head as they are unlikely to promote the formation of new habitat. Works to hold the line could result in damage to existing habitats. The extent of this loss is uncertain and this option is not economically viable without including these extra economic costs. EVEE is therefore not included in economic considerations at East Head.

2.7.64 The processes operating around East Head are complex. To get a better understanding of these issues and the approaches needed to manage them, the East Head Working Group (EHWG) was formed. Group members included Cakeham Manor Estate Ltd, CDC, Chichester Harbour Conservancy, Environment Agency, National Trust, Natural England, West Wittering Estate plc and West Wittering Parish Council. The group has been developing a management plan to address flood and erosion risk and wider environmental issues including amenity, recreation and navigation. The Adaptive Management approach has been agreed by the group to optimise solutions here, improving understanding of the system and its responses over time. In moving from discussion of issues to producing and implementing plans, the group has recently changed to become the East Head Coastal Issues Advisory Group (EHCIAG) which will also seek to secure private funding for the works (Appendix E).

2.7.65 Hold the Line options at East Head spit were rejected as they have a BCR of less than one. These options are also likely to create significant environmental impacts on the internationally designated habitats and would raise objections on conservation grounds. Adaptive Management was the preferred option on environmental grounds assessed in the SEA.

2.7.66 EHWG commissioned a panel of expert geomorphologists (from HR Walllingford and Portsmouth University) to examine the likely effect of proposed Strategy recommendations. The Panel concluded that the evolution of East Head spit is unlikely to increase flood risk to West Wittering village.

2.7.67 The existing defences to West Wittering village comprise of low bunds adjacent to the harbour (1 in 1 SoP) and the natural storage capacity provided by the low lying Snow Hill Creek valley. The inner harbour defences are overtopped by an annual occurrence event, but no property damage occurs. The storms of March 2008 (1 in 20 return period event) did not lead to any flooding problems within the village. The proposed location for the flood banks follows the boundary of the creek system and as such it will act as a secondary line of defence. The alignment proposed provides the cheapest viable option for managing flood risk. The SoP is not dependent on the existing coastal defences that are privately owned (see Key Plan 8). This option will not impact upon the international designations.

2.7.68 In the medium term privately funded local defences may be required to provide flood protection to four isolated properties (to the north of West Wittering village at the end of Ella Nore lane). There is no flood connection to West Wittering village (Key plan 8). There are no opportunities here for a managed realignment approach to the north of West Wittering.

Option Selection - Application of the Decision Rule

2.7.69 The viable option with the highest BCR (22) is provision of new local flood banks. At the time of construction this will provide a SoP of 1 in 180 falling to 1 in 100 at the end of its design life. This provides for protection within the indicative range (land use band B) throughout the Strategy appraisal period. This is the optimum SoP and higher standards have been discounted because of the low iBCR (1.7).

2.7.70 An adaptive approach to climate change has been taken with successive raising of bank levels to counter the effects of sea level rise. This approach reduces the risk of excessive overtopping that could result in a breach and avoids future construction impacts.

Residual Risks

Table 32 - Risks and Mitigation

Risk	Key Mitigation
Risk of not securing funding to progress schemes. This is a major issue for the Selsey East Beach and East Wittering & Bracklesham frontages, where works are required urgently	This is the main risk to the implementation of the Strategy; many of the existing frontages where immediate work is required are currently not a priority for national funding. Local Authorities are looking at alternative funding opportunities. If unsuccessful exit strategy to be followed. Failure to achieve funding would then require the development of an Exit Strategy.
Major storm impact at Pagham either leading to blockage of the Harbour entrance or major erosion issues on Pagham Beach	Arun District Council developing protocol to undertake emergency works in Natura 2000 site.
Further collapses on Selsey West Beach sea wall prior to scheme implementation	Chichester District Council to monitor existing defences and make necessary repairs
Major storm impacts at Medmerry leading to extensive breach in shingle bank	Environment Agency team to continue to maintain existing shingle berm and keep adjacent residents informed of all works
Public opposition to introduction of a managed realignment option at Medmerry	Strategy consultation has already improved public understanding of this option and gained Local Authority support. Ongoing community engagement, building upon Strategy consultation will be necessary to deliver this. Environment Agency team looking to progress pro-active engagement as part of scheme development and implementation
Failure of sections of the East Wittering and Bracklesham defences	Chichester District Council to monitor existing defences and make necessary repairs within the existing budgets. Chichester District Council to look at local beach recycling to maximise standard of protection provided
Breach of Neck or Hinge at East Head	Monitoring to identify risks, East Head Working Group looking to implement recharge spring 2009
Advisory Group or working group unable to raise local funding to implement adaptive management at East Head	Group is working closely with local community and partners to achieve funding. Anticipated that funding will be achievable. Failure to achieve funding would then require the development of an Exit Strategy.

Recommendations/Approval Sign Off

2.7.71 It is recommended that the Pagham to East Head Coastal Defence Strategy is approved for managing the risks of coastal flooding and erosion to the 5,304 properties.

2.7.72 A9 approval is recommended for the Pagham to East Head Coastal Defence Strategy for the whole life cost (excluding inflation) of £279,383k shared among the Environment Agency, Chichester and Arun District Councils. This includes a contingency of £104,635k.

Recommended Overall Preferred Option

2.7.73 The overall preferred option is included in Table 33 below.

Table 33 – Preferred Option

Frontage	Preferred Option	BC Ratio	PV Benefit (£K)	PV Cost (£K)	Whole Life Cost (£K)	No. of properties protected Residential
Pagham	Adaptive Management	6.8	87,141*	12,752*	38,810	1,229
Selsey	Hold the Line – Sustain	3.6	121,393	33,557	118,121	1,998
Medmerry	Managed Realignment	8.2	91,666	11,134**	20,361	727
East Wittering & Bracklesham	Hold the Line – Sustain	1.8	46,255	25,409	84,579	874
Cakeham	Hold the Line – Sustain	2.3	7,785	3,354***	15,436	50
West Wittering	Adaptive Management and local flood protection for West Wittering Village	5.1	20,041	3,894*	10,937	149
West Wittering	Local flood protection to West Wittering village	22.0	20,041	913	2,076	149

* Costs and benefits for Adaptive Management are indicative only.
** The selection of the final bank alignment for Medmerry will be dependent upon a number of factors including private defence proposals.
*** The medium- to long-term policy options for Cakeham will be considered in detail during future strategy reviews and through the scheme feasibility study.

2.7.74 The delivery of this Strategy will provide protection for 5,027 residential properties and 285 commercial properties as well as other assets including the B2145 road and two wastewater treatment works. The Strategy if implemented will avoid damages of £347m.

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Outcome Measures

Table 34 - Outcome Measures

Outcome measure 1 - Benefits and Costs	PV Cost of Project (against Do Nothing) £000s	Total PV Benefit (against Do Nothing) £000s	PV Cost of Project (against Do Minimum) £000s	Total Flood PV Benefit (against Do Minimum) £000s
Pagham	£12,752*	£87,141*	n/a	n/a
Selsey	£33,557	£121,393	£32,442	£89,631
Medmerry	£11,134	£91,666	£4,514	£53,291
East Wittering & Bracklesham	£25,409	£46,255	£36,441	£35,993
Cakeham	£3,354	£7,785	£1,491	£3,046
West Wittering	£913	£19,960	n/a	n/a

Outcome measure 2 a - Risk to Households Reduced - Flooding	Standard of Service Before (%)	Standard of Service After (%)	Total No. of Households with Reduced Probability of Flooding	Very Significant >5% Households	Significant ≤5% and >1.3% Households	Moderate ≤1.3% and >0.5% Households	Low ≤0.5% Households
Pagham	2%	0.5%	385	213	84	88	0
Selsey	2%	2%	560	330	117	113	0
Medmerry	100%	0.5%	348	289	14	45	0
East Wittering & Bracklesham	2%	2%	0	0	0	0	0
Cakeham	1%	1%	0	0	0		0
West Wittering	2%	1%	55	36	10	9	0

Outcome measure 2 b - Risk to Households Reduced - Erosion	Total No. of Households with Reduced Probability of Erosion	Very Significant - >10yr Households	Significant - >10yr and ≤20 yr Households	Moderate - >20yr and ≤50yr Households	Low - >50yr and ≤100yr Households
Pagham	320	0	0	107	213
Selsey	587	0	5	121	461
Medmerry	6	0	0	0	6
East Wittering & Bracklesham	432	0	23	183	226
Cakeham	50	0	0	12	38
West Wittering	0	0	0	0	0

Outcome measure 3 - Households in Deprived Communities	**Number of Super Output Areas ranked in bottom 1500**	**Ranking of IMD for Lowest Ranked Super Output Area Impacted by Project**
Pagham	0	18,908
Selsey	0	20,800
Medmerry	0	17,216
East Wittering & Bracklesham	0	17,741
Cakeham	0	23,782
West Wittering	0	23,782
Outcome measure 4 - Contribution to improving SSSIs	**SSSI Flood Management Remedies (ha)**	
All frontages	0	
Outcome measure 5 - Net BAP gain	**Net gain in BAP (ha)**	
All frontages	0	
OM Scores	Outcome Measure score	
Pagham	2.5	
Selsey	2.3	
Medmerry	3.0 (Increases to 21.7 if benefits of maintaining access to Selsey included)	
East Wittering & Bracklesham	1.2	
Cakeham	1.7	
West Wittering	6.7	

2.8 Other Considerations

Flood Warning and Development Control

2.8.1 The Environment Agency's Flood Warning system covers the Strategy area. Currently 26% of the population at risk subscribes to this service. The adoption of this service was promoted through the exhibitions during the public consultation along with information on flood resilience.

2.8.2 Development control is an important tool in the management of future flood risk. It will be necessary to continue to regulate development in the floodplain to avoid putting new assets at risk in accordance with PPS25. It will also be necessary to maintain access to flood risk management assets and to coordinate the actions of all Operating Authorities within the Strategy area.

Flood Resilience

2.8.3 The Environment Agency will continue to promote measures to increase the flood resilience of properties. These can range from preparing a plan in case of flooding emergencies, through to practical information on how to reduce levels of flood damage. There may be opportunities for the Operating Authorities to consider and extend these approaches. The community has identified its wish to assist in this during the Strategy consultation.

Emergency Planning

2.8.4 Emergency planning is a vital part of managing the risks to coastal communities and the authorities constantly update their procedures to account for changing circumstances. It will be necessary to ensure that the Strategy's outcomes and identified risks are fed into the local emergency planning system. Recent changes in the coastal processes around Pagham Harbour have led Arun District Council to revise the Emergency Plan for the Pagham frontage to address the changed flood and erosion risk. Arun District Council is also developing a protocol with Natural England in case emergency works are required at short notice within the internationally designated site.

Public Safety

2.8.5 Operating Authorities should keep under review the issue of loss of life due to wave impact or drowning and update their risk assessments in line with any change to the defence structures or climatic variability. It may be necessary to improve signage, raise awareness or develop bylaws to address these issues. The design of the managed realignment scenario will need to address the Public Safety Risk assessments during its design stage. Engagement with the community will assist in raising public understanding of the changes in risk.

Sustainable Construction

2.8.6 Options have been carefully assessed with regard to delivery of sustainable construction objectives. A fundamental criterion of option development has been to identify and achieve integrated engineering, environmental and sustainable solutions. This approach will be further developed within future scheme appraisal and subsequent detail design stages. A carbon calculator has been used to develop carbon costs for all options considered.

Construction and Safety

2.8.7 Health and safety elements form a key consideration in the design at a strategic level. At this stage the options are not sufficiently developed to allow a comprehensive assessment of all the health and safety issues. However, the following generic risks have been considered as part of the option appraisal process:

a) Flood Risk – the areas at risk need to be identified and also the speed at which inundation can occur. The majority of the peninsula is low lying with a flat topography and the high tidal range will allow rapid progression of the tide across the area. The provision of an appropriate warning system, appropriate life-saving equipment and emergency plans will be crucial to areas where flood risk remains high.
b) Tidal inundation – under certain managed realignment scenarios, local access ways may be at risk of being inundated during extreme tides. This could require appropriate warning systems and signage. Consideration of these changes will need to be included within emergency arrangements and the emergency plans modified.
c) Earth embankment structures – these can become overgrown and attract the attentions of burrowing animals, which can undermine the integrity of the structure. The burrows can also form a potential trip hazard. These structures must be recognised as assets that require an appropriate inspection and maintenance regime.
d) Access over defences – steep embankments and rock structures can create difficulties with access and egress from the coast. Consideration should be given during the design of the structures for appropriate access and any signage arrangements required.
e) Given that there is only a single road into Selsey, consideration should be given to the incorporation of an 'emergency services' access along the flood banks at Medmerry.

Maintenance

2.8.8 Maintenance requirements and costs for the preferred strategic options have been assessed and allowances for these costs have been included in the benefit cost assessment.

3. STRATEGY PLAN

Scheme Elements and Construction Approach

3.1 The Strategy proposes a programme of capital works to reduce the risk of coastal erosion and flooding from the sea. Implementation of the Strategy will depend upon the Environment Agency (EA), Chichester District Council (CDC) and Arun District Council (ADC) working together and with other partners. A summary of the programme is provided in the Implementation Plans below. Table 40 includes actions for the East Head Coastal Issues Advisory Group (EHCIAG) that will seek private funding to complete works.

Table 35 - Pagham Implementation Plan

Timeframe	Actions	Timescale	Responsibility
Short Term Adaptive Management	Develop protocols with Natural England for undertaking emergency works as a priority.	By Dec 2008	ADC
	Completion of ADC Study on the current issues on Pagham Beach. These will inform the development of an Adaptive Management Plan.	By Dec 2008	ADC
	Initiate an advisory group to develop and help implement an Adaptive Management Plan. We would expect this group to include the Environment Agency, Arun and Chichester District Councils, West Sussex County Council, Natural England and key stakeholders such as local landowners and parish councils.	By Dec 2008 Ongoing	ADC, CDC, EA ADC, CDC, EA
	Undertake studies on inner harbour to understand future flood risk, building upon the coastal and Inlet studies undertaken by ADC This plan would provide a framework for flexible decision-making over the next 100 years, seek to address funding issues and communicate with local residents. Specific actions for the Pagham Adaptive Management Plan could include: a) maintaining Pagham Harbour as an inter-tidal system at least for the next 20 years, by keeping the harbour entrance open; b) Agree monitoring needs to meet technical and environmental requirements. Commission data collection through existing or additional monitoring programmes. Review data annually to ensure the group's defined objectives can be met. c) defining the management needs for the area's internationally important habitats; d) developing a short term solution to the erosion of Pagham Beach caused by the thinning of the Pagham spit, believed to be caused by accumulation at Church Norton spit; e) investigating opportunities for recycling material from the adjacent Aldwick Bay frontage; and f) consider the need for new inner harbour flood defences to protect against rising sea levels.	2012/13 Up to 20 years Annually	EA Advisory group members Advisory group members. (EA responsible)
	Undertake review of Adaptive Management as preferred option (unless review of whole Strategy already planned).	2019	EA
Medium Term	Continuation of Adaptive Management unless understanding is sufficient that a more definitive option can be endorsed.	Ongoing	ADC, CDC, EA
Long Term	Continuation of Adaptive Management unless understanding is sufficient that a more definitive option can be endorsed.	Ongoing	ADC, CDC, EA

Table 36 - Selsey Implementation Plan

Timeframe	Actions	Timescale	Responsibility	SoP at construction
Short Term Hold the Existing Defence Line - Sustain	Investigate alternative funding opportunities	By Dec 2009	CDC	-
	Progress developed scheme for West Beach	By Dec 2009	CDC	-
	Replace groynes on West Beach and recharge if required	By Dec 2013		-
	Initiate scheme for replacement of groynes on East Beach Involvement of Natural England in process to address issues with geological SSSI	By Dec 2014	CDC	-
	Raise sea wall at West Beach	By 2018	CDC	> 1in 1,000
	Initiate raising and refurbishment of sea wall at East Beach and Selsey Bill, and replacement of groynes on Selsey Bill. Consider need for beach recharge	By 2028	CDC	> 1in 1,000
Medium Term Hold the Existing Defence Line - Sustain	Refurbish sea wall at West Beach	By 2038	CDC	-
	Replace groynes at West Beach	By 2043	CDC	-
	Refurbish existing sea wall at East Beach and Selsey Bill, replace groynes at East Beach, consider need for beach recharge	By 2048	CDC	-
	Refurbish Sea wall at West Beach	By 2057		-
	Replace groynes at Selsey Bill, consider need for beach recharge	By 2058	CDC	-
				-
Long Term Hold the Existing Defence Line - Sustain	Refurbish sea wall at East Beach and Selsey Bill, consider need for beach recharge	By 2068	CDC	-
	Replace groynes at West Beach consider need for beach recharge	By 2072	CDC	-
	Raise sea wall at West Beach	By 2077	CDC	> 1in 1,000
	Replace groynes at raise sea wall at East Beach and Selsey Bill, consider need for beach recharge	By 2088	CDC	> 1in 1,000
	Replace groynes at West Beach consider need for beach recharge	By 2097	CDC	-
	Refurbish sea wall at East Beach and Selsey Bill, consider need for beach recharge	By 2108	CDC	-

Table 37 - Medmerry Implementation Plan

Timeframe	Actions	Timescale	Responsibility	SoP at construction
Short Term Managed Realignment Breach Realignment	Maintenance of existing shingle bank	Up to 2013	EA	-
	Ongoing engagement with stakeholders and community	2009 ongoing	EA	-
	Confirm availability of funds to implement habitat creation	By 2011	EA	-
	Negotiations with landowners and stakeholders and Agreements in place to secure land	By 2011	EA	-
	Seek partnership opportunities to maximise habitat gain and add environmental enhancements. Including consideration of the potential for High Level Stewardship	Up to 2013	EA	-
	Develop outline design of scheme and complete other studies as required	By 2011	EA	-
	Commence monitoring of habitats and other key parameters	By 2011	EA	-
	Detailed design of scheme including drainage works	By 2012	EA	-
	Apply for Planning Consent accompany with Environmental Statement. Footpath Diversion Orders if required , Land Drainage Consent and FEPA Licence	By 2012	EA	-
	Engineering works and construction including breaching shingle bank	2011 to 2014	EA	> 1in 1,000
	Second phase flood bank construction and associated works	2025	EA	> 1in 1,000
Medium Term - Hold the New Defence Line	Third phase flood bank construction and associated works	2055	EA	> 1in 1,000
Long Term Hold the New Defence Line	Fourth phase flood bank construction and associated works	2085	EA	> 1in 1,000

Table 38 - East Wittering and Bracklesham Implementation plan

Timeframe	Actions	Timescale	Responsibility	SoP at construction
Short Term Hold the Existing Defence Line - Sustain	Consider local beach recycling	2009	CDC	-
	Replace 2/3 of existing groynes	2013	CDC	-
	Replace 50% of breastworks	2018	CDC	-
	Replace remaining 1/3 of existing groynes and breastworks	2023	CDC	-
Medium Term Hold the Existing Defence Line - Sustain	Replace 2/3 of existing groynes	2043	CDC	-
	Replace 50% of breastworks	2048	CDC	1 in 100
	Replace remaining 1/3 of existing groynes and breastworks	2053	CDC	1in 80
Long Term Hold the Existing Defence Line - Sustain	New sea wall	2058	CDC	> 1in 1,000
	Replace 2/3 of existing groynes and remaining breastworks	2073	CDC	-
	Replace remaining 1/3 of existing groynes	2083	CDC	-
	Replace 2/3 of existing groynes and remaining breastworks	2103	CDC	-

Table 39 - Cakeham Implementation Plan

Timeframe	Actions	Timescale	Responsibility	SoP at construction
Short Term - Hold the Existing Defence Line - Maintain	Maintain existing groynes and breastworks	Up to 2027	CDC	-
	Consider whether to replace groynes/breastworks on existing alignment or realign slightly and whether beach recharge is required	2028	CDC	> 1in 1,000
Medium Term - Hold the Existing Defence Line – Sustain or minor realignment	Consider whether to replace groynes/breastworks on existing alignment or realign slightly and whether beach recharge is required	2057	CDC	> 1in 1,000
Long Term - Hold the Existing Defence Line – Sustain or minor realignment	Consider whether to replace groynes/breastworks on existing alignment or realign slightly and whether beach recharge is required	2087	CDC	> 1in 1,000

Table 40 - West Wittering Implementation Plan

Timeframe	Actions	Timescale	Responsibility	SoP at construction
Short Term Adaptive Management for East Head and the construction of local flood protection for West Wittering Village and the properties to the north of the village (as required).	Monitoring	Ongoing	EHCIAG	-
	*Adaptive management - Recycle shingle to behind the Hinge	By end 2009	EHCIAG	-
	Develop Scheme for local flood banks to West Wittering village	By end 2011	EA	-
	*Adaptive management - install geotextile sill	By 2012	EHCIAG	-
	*Adaptive management – modify existing defences recycle as required	2013 onwards	EHCIAG	-
	Construct flood bunds or raise road, includes new sluice gate	2013	EA/CDC	1 in 180
Medium Term Adaptive Management for East Head and Hold the existing defence line at West Wittering and the properties to the north of the village (as required).	*Adaptive management – modify existing defences recycle as required	2029	EHCIAG	-
	Raise new defences if required	2029	EA	> 1in 1,000
	Private construction of local flood bunds to properties to the north of West Witting Village (as required protecting four properties)	2057	Private	-
Long term Adaptive Management for East Head and Hold the existing defence line at West Wittering and properties to the north of the village (as required).	*Adaptive management – modify existing defences recycle as required	2059	EHCIAG	-
	Raise road if required	2059	EA	> 1in 1,000
	Raise road if required	2089	EA	> 1in 1,000

* Actions to be taken using private funding

Defence Standard

3.1.1 Implementation of the Strategy recommendations will provide protection from flooding and erosion above or within the indicative range throughout the Strategy appraisal period.

Management of Environmental Impacts

3.1.2 The environmental impacts and sustainability considerations of the proposed scheme have been identified in the Strategic Environmental Assessment and the Habitats Regulations screening assessments.

Consents and Permissions

3.1.3 Requirements for consents including planning permission, Land Drainage Consent and Food and Environment Protection Act (FEPA) licenses will be considered during the detailed appraisal phase. The need for further assessment will be considered at detailed appraisal stage through Environmental Impact Assessment reporting for the local level. Further consideration of the options against the Habitats Regulations and Countryside and Rights of Way Act will be necessary at the appraisal stage. There may also a need for protected species licences.

Funding

3.1.4 Funding and its limited availability has been recognised as one of the key issues in the Pagham to East Head Coastal Defence Strategy. It was highlighted in the initial consultation for the Strategy between November 2006 and March 2007, and people's concerns were raised and noted. This still remains a pressing issue.

3.1.5 Given the likelihood of national funding the owners of the West Sands Holiday Park are looking to implement their own (private) defences. The East Head Coastal Issues Advisory Group is also looking to raise funding locally to implement the adaptive management plan at East Head.

National Flood and Coastal Defence Funding

3.1.6 In terms of priority for national funding, only limited elements of the Strategy currently have the potential to achieve national funding in the short term. These include the construction of flood bunds at West Wittering and for the implementation of the preferred option at Medmerry. However, for all other frontages, national funding is unlikely in the immediate future. For certain frontages, notably West Beach Selsey and East Wittering & Bracklesham, the condition of the existing defences is such that intervention is required immediately to maintain the effectiveness of these defences. If national funding cannot be secured, these would need to be financed from alternative sources. Consequently the Operating Authorities will need to develop a mechanism to explore alternative funding sources. The Strategy itself will provide the framework for further discussions in respect of funding and allow the Operating Authorities to focus on realistic management options. If funding cannot be achieved then the Operating Authorities may have to consider the development of Exit Strategies.

Alternative Funding

3.1.7 There are several potential sources of funding including those identified below:

a) Central Government funds (Lobby Government for additional Flood and Coastal erosion Risk Management funding)
b) Government agencies (e.g., Defra, Environment Agency, Natural England)
c) Increased contributions by Local Authorities
d) Local taxation (Community well being, tourism, development)
e) Flood defences levies (Regional Flood Defence Committee)
f) Development charges
g) EU initiatives (e.g. Objective 2, Life+)
h) Regeneration funding
i) Private funding partnerships, commercial enterprises
j) The general public (e.g. individuals and households affected/benefitting)
k) Businesses and utilities affected
l) Wildlife or other charities (e.g. WWF, RSPB)

3.1.8 It is unlikely that any individual source of funding will be able to provide the necessary funding for local defences. It is more likely that all of these have the potential to make a contribution towards their delivery. In order to identify funding sources the Operating Authorities should consider the formation of a dedicated group. This may need to include interested stakeholders, local and regional bodies and community groups.

3.1.9 East Head Coastal Issues Advisory Group is investigating the funding available to implement adaptive management at East Head. Initial indications are that local funding will be available to implement the initial recharge. Identifying funding for future works, including the geotextile sill, will be a key objective for the group.

3.1.10 Pagham Parish Council has recently raised its precept to create a fund to assist with future coastal defence works.

3.1.11 Contributions will be sought from Southern Water and West Sussex County Council, the relevant highways authority.

Exit Strategy

3.1.12 Defra's 'Maintenance of Uneconomical Sea Defences - A Way Forward' provides guidance for Operating Authorities on how to implement the 'No Active Intervention' policy where there is insufficient economic justification for continuing to maintain the defences. It recommends the development of an Exit Strategy in order to address the legal obligations and to control flood risk.

Short Term Spend Profile

3.1.13 The spend profile in Tables 41 and 42 shows the cash costs for the recommended short term actions, by location and by organisation respectively. These include the privately funded works for Adaptive Management at East Head.

Table 41 – Capital Spend Profile Summary

Frontage	Total Cost (£K)	Years 1	2	3	4	5
Pagham	1,310*	1,060*	250*	0	0	0
Selsey	6,169	0	0	926	5,243	0
Medmerry	8,320	652	217	1,269	5,147	1,035
East Wittering	8,505	154	0	0	0	8,351
Cakeham	0	0	0	0	0	0
West Wittering Adaptive management (privately funded)	463*	185*	0	0	278*	0
West Wittering Local flood banks	602	91	0	0	511	0
Inflation @ 5% pa	4,033	0	23	225	1,762	2,023
Total (excl. inflation)	25,369	2,142	467	2,195	11,179	9,386
Total (incl. inflation)	29,402	2,142	490	2,420	12,941	11,409

*Indicative costs for adaptive management works

Table 42 – Capital Spend Profile by Organisation

Element	Total Cost (£K)	Years 1	2	3	4	5
Environment Agency	9,172	7435	467	1,269	5,658	1,035
Chichester District Council	14,674	154		926	5,243	8,351
Arun District Council	1,060*	1,060*	0	0	0	0
East Head Coastal Issues Advisory Group (private)	463*	185*	0	0	278*	0
Total (incl. risk & inflation)	29,402	2,142	490	2,420	12,941	11409
Total (incl. risk & inflation, excl. private funding)	28,895	1,957	490	2,420	12,619	11,409

*Indicative costs based for adaptive management works

Key Staff

3.1.14 Table 43 summarises the key staff involved in the preparation of the Pagham to East Head Coastal Defence Strategy.

Table 43 – Key Staff

Organisation	Name	Job Title
Arun District Council	Colin Rogers	Director of Services
Arun District Council	David Green	Head of Infrastructure, Works and Engineering
Chichester District Council	Keith Morgan	Assistant Director, Building and Environmental Management
Chichester District Council	Paul Over	Assistant Director, Employment and Prosperity
Chichester District Council	David Lowsley	Senior Engineer, Building and Environmental Management
Environment Agency	James Humphrys	Solent and South Downs Area Manager
Environment Agency	Andrew Gilham	Solent & South Downs Area Flood & Coastal Erosion Risk Manager
Environment Agency	Samina Khan	ncpms Project Executive
Environment Agency	Joe Pearce	ncpms Project Manager
Environment Agency	Hannah Pitchford / Anthony Bishop	NEAS Senior Environmental Assessment Officer
Environment Agency	Gordon Wilson	Asset Systems Management (South Downs) Team Leader
Environment Agency	Robert Carr	Asset Systems Management Officer, Flood Risk Management
Environment Agency	Stacia Staunton	Principal External Relations Officer
Jacobs consultants	Ray Traynor	Consultant project manger

Future Reviews of Strategy

3.1.15 The Strategy is based upon current understanding and information. It will need to adapt to future changes and it will be important to reflect changes in the area, improvements in understanding of coastal process and climate change, the results of monitoring, any lessons learnt, outcomes of future strategic planning (e.g. SMPs and CFMPs), and new directions or changes in Government policy. Defra currently recommend that strategies are reviewed at five year intervals (Ref. FCDPAG2 1999), however this should be considered guidance and if issues arise that warrant modification of the Strategy an earlier review can be implemented.

Procurement

3.1.16 The Strategy has been produced using the NEECA2 framework supplier Jacobs, directly appointed by the Environment Agency.

3.1.17 Following approval of this StAR, separate approvals will be sought for the proposed schemes. Procurement details will vary according to which Operating Authority promotes the works.

3.1.18 Environment Agency will take forward works to manage flood risk for Medmerry and West Wittering frontages. Environment Agency framework suppliers will undertake the implementation, managed by ncpms. The procurement process has already started for the vulnerable Medmerry frontage to enable works to begin on site as soon as possible. Regional Procurement and Commercial Services Manager have guided the project team through this process.

3.1.19 Contributions will be sought together with any opportunity for external funding to implement the managed realignment scheme at Medmerry. If possible, needs for habitat creation will be incorporated into scheme development, ensuring that schemes outside the immediate Strategy area that require compensatory habitat can progress. Opportunities for partnership working will be sought and taken up where appropriate.

3.1.20 Chichester District Council will promote schemes for Selsey and Bracklesham & East Wittering. The ability to take schemes to implementation is uncertain due to low funding priority. Environment Agency, in line with its coastal overview role, will ensure that any opportunity for packaging is fully explored if works are progressed.

3.1.21 Natural processes on the Pagham frontage may mean that capital works are not required during the appraisal period. Following ADC's current study, the Environment Agency will undertake further investigation. Consultancy services will be procured through an existing framework contract (either NEECA2 or SFRM). Where works to manage flood risk are recommended by studies, these will be promoted by the Environment Agency using framework contracts managed by ncpms. Erosion risk management works for Pagham Beach will, if needed, be promoted by ADC. Such works are likely to be relatively small but Environment Agency will ensure opportunities for packaging together with other similar schemes are fully explored.

3.1.22 East Head Coastal Issues Advisory Group are promoting relatively small-scale privately funded works as part of the Adaptive Management Plan. Chichester District Council as chair of the group and Environment Agency as group members will ensure that current and future works take advantage of any opportunities for cost savings through combining works.