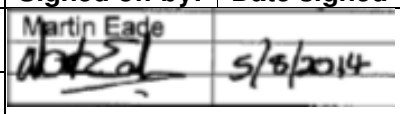
Strategy Appraisal Report

Authority scheme reference	B&H4
Defra/WAG LDW number	CPW/2042
Promoting authority	Brighton and Hove City Council
Strategy name	Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review

Brighton Seafront, February 2014

Date	November 2014
Version	3.0

StAR for Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review

Version	Status	Signed off by:	Date signed	Date issued
1.0	Final	Martin Eade 		August 2014
2.0	Final (following LPRG pre-brief comments)			October 2014
3.0	Final (following LPRG meeting)			November 2014

Template version – April 2011

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TABLES

APPENDICES

For technical approval of the business case

Brighton and Hove City Council

Project name: Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review

Approval Value: £159,000k

Sponsoring Director: Geoff Raw Strategic Director

Non-financial scheme of delegation

Part 11 of the Non-financial scheme of delegation states that approval of FCERM Strategies/Complex Change Projects, following recommendation for approval from the Large Projects Review Group, is required from the Regional Director or Director, Wales and Director of Operations.

Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review		**Project Code: CPW/2042**	
Project Manager: Martin Eade		**Date of Submission: Aug 2014**	
Lead Authority: Brighton and Hove City Council		**Version No: 1.0**	
Consultant Project Manager: Jon Denner		**Consultant: CH2MHILL (Halcrow)**	
The following confirm that the documentation is ready for submission to PAB or LPRG. The Project Executive has ensured that relevant parties have been consulted in the production of this submission.			
Position	**Name**	**Signature**	**Date**
Project Executive	Geoff Raw	Signature Executive Director Environment, Development and housing	Date 8.8.14
	Job Title:	Executive Director Environment, Development and housing	
2. Review by: Large Projects Review Group (LPRG)			
Date of Meeting(s):		**Chairman:**	
Recommended for approval: In the sum of £:		**Date:**	**Version No:**
3. Environment Agency NFSoD approval *Officers in accordance with the NFSoD.*			
Version No:		**Date:**	
Project Approval	**By:** In the sum of: £	**Date:**	
4. Defra or WAG approval *(Delete as appropriate)*			
Submitted to Defra / WAG or Not Applicable (as appropriate)		**Date:**	
Version No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		**Date:**	
Comments:			

NON FINANCIAL SCHEME OF DELEGATION (NFSoD) COVERSHEET FOR A FCRM COMPLEX CHANGE PROJECT / STRATEGIC PLAN

1.	**Project name**	Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review			**Start date**	February 2012
					End date	August 2014
	Business unit	FCERM		**Programme**	FDGiA	
	Project ref.		**Regional SoD ref.**		**Head Office SoD ref.**	-

2.	**Role**	**Name**	**Post Title**
	Project Sponsor	Geoff Raw	Executive Director E, D & S
	Project Executive	Geoff Raw	Executive Director E, D & S
	Project Manager	Martin Eade	Coast Protection Engineer

3.	**Risk Potential Assessment (RPA) Category**	**Low**	☐	**Medium**	☒	**High**	☐

4.	**NFSoD value**	**£k**
	Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	£158,675

5.	**Required level of Environmental Impact Assessment (EIA)**	**N/A** ☐	**Low** ☐	**Medium** ☐	**High** ☒

6.	**NFSoD approver name**	**Post title**	**Signature**	**Date**
		Regional Director/Director Wales		
		Director of Operations		
	NFSoD consultee name	**Post title**	**Signature**	**Date**
		LPRG Chair		

1 Executive summary

1.1 Introduction and Background

1.1.1. The Brighton Marina to River Adur Flood and Erosion Risk Management Strategy Review (henceforth referred to as the Strategy) presents the business case and implementation plan for the management of the Brighton Marina to River Adur coastal frontage and Shoreham Locked Section by Brighton and Hove City Council and Adur and Worthing councils. This report examines the problem, identifies strategic objectives and identifies and appraises options to manage the shoreline in line with the current Flood and Coastal Erosion Risk Management (FCERM) Appraisal Guidance.

1.1.2. A Brighton Marina to River Adur Strategy Plan was completed in 2003 (henceforth referred to as the 2003 Strategy) with the recommendation that this be reviewed on a five yearly basis. The 2003 Strategy was noted by Defra but not formally approved due to changes in the approval process around the time of submission. This current Strategy provides an update and review of the 2003 Strategy as agreed with the Environment Agency's National Review Group on 22nd October 2009.

1.1.3. The objectives established for the 2003 Strategy were reviewed and updated through consultation. The overall aim of the Strategy is to establish a plan that sets out sustainable, technically sound, environmentally acceptable and economically viable flood and erosion risk management for the study area between Brighton Marina and the River Adur for the next 100 years. The area covered by the Strategy, see Key Plan 1, is defined in the west by the lock gates of Shoreham Harbour, and includes the locked basin of the harbour, port, the eastern part of Southwick, Portslade by Sea and the open coast from the mouth of the River Adur (also referred to as Shoreham Harbour Entrance) to Brighton Marina, and Brighton Marina itself in the east. The study area aligns with the boundaries of the neighbouring approved Arun to Adur Flood and Coastal Erosion Strategy Review and the proposed study of the coast between Brighton Marina and Newhaven.

1.1.4. The Strategy area has been divided into three Units consisting of 1 - Shoreham Locked Section, 2 - Open Coast and 3 - Brighton Marina. The boundaries were established from an assessment of the Shoreline Management Plan (SMP2) and the 2003 Strategy boundaries and factors including long term erosion, coastal processes, beach management and flood extents. Units 1 and 2 have a shared flood and erosion risk area so a combined benefit area has been used for the economic damages assessment to avoid any double-counting.

1.2 Problem

1.2.1. The supply of natural beach material to the open coast frontage from the west is impeded by the mouth of the River Adur and the associated training walls. Limited sediment supply coupled with the natural attempt of the coast at Shoreham to orientate itself into a position normal to the prevalent south south-west wave direction, has resulted in significant erosive forces at the Shoreham end of the frontage. The residual life of the assets along the Shoreham frontage range from 15-30 years to <1 year. Shoreham Port Authority has a strategic programme of defence renewal, the speed of which is subject to the availability of funds, and manages immediate breach risk on an ad hoc basis by repairing seawalls, re-deploying rock armour from ineffective structures to form revetments on vulnerable sections and repairing existing timber and rock groynes. Under a No Active Intervention scenario, it is predicted that erosion will result in the failure of defences along Southwick Beach by Year 10 and breach through into the locked section by Year 20.

1.2.2. The open coast frontage is also at risk of flooding from wave overtopping. Significant variations in defence heights and beach widths along the frontage have resulted in a number of weak points susceptible to flooding. Poorly maintained and deteriorated assets along the Southwick to Hove frontage have resulted in a poorly controlled beach susceptible to significant storm draw down and breach risk. A low crest level at the Hove Deep Sea Anglers' building which is exposed to wave overtopping can result in flooding of Western Esplanade and Basin Road. The poor beach alignment at Kings Esplanade has resulted in a promontory at this section of the frontage with a narrow steep beach susceptible to wave overtopping.

1.2.3. The lack of a consistent and sustained beach management programme has exacerbated the imbalance of beach material along the open coast affecting both erosion and flood management. Mechanical shingle bypassing at Shoreham by Shoreham Port Authority supplies approximately 11,000 m^3 a year but is insufficient to replace the lost material, as the net drift along the frontage averages about 16,000 m^3. Continuing accretion of material at the eastern end has caused operational issues for the Southern Water outfall but the lack of an agreed beach management framework has resulted in infrequent shingle recycling.

1.2.4. The lock gates at Shoreham Port are not flood defence structures, as they act only to retain water levels within the basin. The current standard of protection, taking into account the lock gates, is <100 % Annual Exceedance Probability (hereafter AEP) which equates to a 1 in 1 year event. Future sea level rise will reduce the ability of the Port to manage land use and will increasingly impact the viability of the businesses that use the port. Over time, this will lead to reduced use of the Port and the associated reduction in income would result in a reduced ability to spend money on maintaining the coast protection. The Port is a Trust Port; this means it relies on the income from those businesses using its land and must re-invest all profits back into the Port. With a large amount of operational infrastructure to maintain, the Port's potential to improve flood defence within this area is therefore limited. However, without the coast protection activities carried out by the Port Authority, neighbouring properties and infrastructure would become vulnerable to erosion and flooding as the Port's defences fail.

1.2.5. The breakwaters and flood defences at Brighton Marina are currently well maintained by the Brighton Marina Company. The current standard of protection is 0.5 % (1 in 200).

1.2.6. The storm events during Winter 2013/14 caused significant damage and disruption, including flooding to 30 commercial premises on Brighton seafront and factories and warehouses within Shoreham Port. Brighton and Hove City Council received financial contributions as part of the storm recovery fund and is currently restoring Open Coast (Unit 2) defences. Emergency repair works included the repair of breaches in seawalls and rebuilding some of the more critical groynes and revetments. Adur and Worthing councils are in the process of submitting a PAR for emergency works at Southwick Beach.

1.3 Options considered

1.3.1. A long list of options considered technically suitable for providing continued and improved flood and erosion risk management for the study area was drawn up by the Project Team. This built on the work undertaken in the SMP2 and the 2003 Strategy. The long list options were appraised in respect of high level economic, technical, social and environmental factors to select a shortlist of options for each Unit. Whether an option was considered further or not was related to the relative performance against these factors and whether there were any 'showstoppers' which precluded the option further. The generic options considered in the long list and taken forward to the short list for appraisal included No Active Intervention, Do Minimum, Maintain, Sustain and Improve.

1.3.2. The assessment of the shortlisted options considered detailed economic, technical and environmental issues and led to the development of the preferred options for each Unit. The assessment considered whether the options would be technically achievable and address the coastal erosion and flood risk to people, properties and infrastructure. The outcomes of this assessment resulted in the selection of a recommended strategy for management of coastal erosion and flood risk, taking into account climate change impacts over the duration of the Strategy.

1.4 Recommended Strategy

1.4.1. The preferred strategic approach for the Strategy is for Improve (0.5 % AEP) for Units 1 and 2, with Sustain in Unit 3. These recommendations are in agreement with the preferred Hold the Line policy outlined in SMP2. In the short term, capital schemes are required along the coast at Southwick Beach to Portslade, Western Esplanade, Hove Deep Sea Anglers' Buildings, Kings Esplanade and Lower Promenade to reduce the risk of erosion and flooding due to wave overtopping. Improvement works to the lock gates at Shoreham Locked Section are recommended to address flood risk.

1.5 Economic Summary

1.5.1. Table 1.1 summarises the 100 year economic appraisal for the preferred Strategy.

Table 1.1 Summary of Preferred Options and Economic Appraisal

Unit	Details	Present Value Cost* (£k)	Present Value Benefits (£k)	Benefit-Cost Ratio*
1 and 2 – Shoreham Locked Section and Open Coast	Option 6A - Improve 0.5 % (1 in 200)	52,253	190,376	3.6
3 – Brighton Marina	Option 4 - Sustain	6,336	121,929	19.2
Totals		**58,590**	**312,305**	

*Costs include 60 % optimism bias (reduced to 20 % for maintenance costs)

1.6 Environmental and Social Considerations

1.6.1. There are a number of national and local designations within the Strategy area. A Strategic Environmental Assessment (SEA) has been prepared to support the Strategy.

1.6.2. A large proportion of the Strategy's coastal urban fringe falls within the 40 % most deprived Super Output Areas in the UK. Only Kings Esplanade and Brighton Marina are outside this threshold. Three areas, to the east and west of Brighton Pier and Fishersgate fall within the 20 % most deprived areas in the UK.

1.6.3. Consultation has been carried out throughout the Strategy development with key stakeholders and the public. The public were consulted on the short listed options in 2013. The public consultation for the proposed Strategy in 2014 included an exhibition of static displays at four locations (Hove Town Hall, Brighton Library, the King Alfred Leisure Centre and Adur Civic Centre) for a week each time. In 2014, 28 consultation responses were received from local residents and interested parties on the proposed Strategy. Natural England and English Heritage stated their support for the Strategy, whilst the Environment Agency and the Marine Management Organisation confirmed that they had no specific comments on the Strategy. Further support was provided by Brighton and Hove City Council Sustainability Officer, Brighton Marina and Shoreham Port. Shoreham Harbour Regeneration partnership also provided general support, but raised concerns about the effect on surfers and a local business along the open coastal frontage. Other consultees had no objections to the Strategy work but some concerns were raised regarding the effect on Basin Road South Site of Nature Conservation Interest, views from a local café and the potential for improving provisions for cyclists.

1.6.4. The proposed preferred Strategy options will not prevent the WFD environmental objectives being achieved.

1.7 Implementation and Outcome Measure score

1.7.1. The Strategy recommends capital works at six sites in the first five years of the Strategy to address key weaknesses in the current defences and flood risk – Shoreham Locked Section, Southwick Beach to Portslade, Western Esplanade, Hove Deep Sea Anglers' buildings, Kings Esplanade and Lower Promenade (east of the Pier).

1.7.2. Table 1.2 shows the annualised spend profile (cash cost) capital works and maintenance for Units 1, 2 & 3 over the next five years (excludes storm recovery expenditure in 2014).

Table 1.2 Annualised cash spend profile (Units 1, 2 & 3)

Costs (£k)	2014/15	2015/16	2016/17	2017/18	2018/19	Future Years	Total
Units 1 and 2 – Shoreham Locked Section and Open Coast Partnership Funding Score = 29 % (108 % with contributions)							
Capital	0	0	13,657	750	0	28,403	42,810
Non-capital	600	600	563	563	563	53,528	56,418
Optimism Bias*	120	120	8,307	563	113	27,747	36,970
Inflation**		14	910	115	56	11,415	12,510
Total	**720**	**734**	**23,437**	**1,990**	**731**	**121,094**	**148,708**
Total (excluding inflation)	*720*	*720*	*22,527*	*1,876*	*676*	*109,678*	*136,198*
Unit 3 – Brighton Marina Partnership Funding Score = Not Applicable (fully funded by contributions)							
Capital	0	0	0	0	0	1,277	1,277
Non-capital	171	170	170	170	170	16,177	17,028
Optimism Bias*	34	34	34	34	34	4,002	4,172
Inflation**		4	4	4	4	429	450
Total	**205**	**208**	**208**	**208**	**208**	**21,885**	**22,926**
Total (excluding inflation)	*205*	*204*	*204*	*204*	*204*	*21,456*	*22,477*
Total (Units 1,2&3 incl. inflation)	**925**	**942**	**23,645**	**2,199**	**939**	**142,978**	**171,634**
Total (Units 1,2&3 exc. inflation)	*925*	*924*	*22,731*	*2,080*	*880*	*131,134*	*158,674*

Note * 60 % for capital works and 20 % for maintenance costs ** Inflation applied at 2 %

1.8 Contributions and Funding

1.8.1. Funding for the capital and maintenance works for the Strategy will be met by Flood Defence Grant in Aid and significant partner contributions, as shown by Table 1.3.

Table 1.3 Breakdown of Contributions and Funding

Unit	Funding Source	Annual budget (£k)	Whole Life Cost (£k)	PV Cost (£)
1	Shoreham Port Authority Contributions	225	22,460	9,547
2	Shoreham Port Authority Contributions	400	40,000	11,925
2	Brighton and Hove CC Contributions	164	16,400	4,889
2	Western Esplanade Management Company Contributions	2	200	60
3	Brighton Marina Contributions	225	22,477	6,336

1+2+3	**Total Contributions**	**N/A**	**101,537**	**32,757**
1+2	FDGiA Funding	N/A	57,137	25,833
1+2+3		**N/A**	**158,675**	**58,590**

1.8.2. These contributions will provide £26,420k for the works in Units 1 and 2, and FDGiA funding will be required for the remaining £25,833k (PV costs).As the schemes progress, additional contributions for funding may be sought from these contributors and potentially Shoreham Power Station and Southern Water due to a small number of commercial properties receiving a large share of the benefits.

1.8.3. Capital works and maintenance at Brighton Marina, estimated as £6,336k (PV cost) over the strategy period, will be wholly funded by the Brighton Marina Company. No FDGiA funding is sought for Unit 3.

1.9 Key Project Risks

1.9.1. The key project risks are described in Table 1.4.

Table 1.4 Key Project Risks

Key project risk	Adopted mitigation measure
Delay or difficulty in obtaining funding.	Liaise with relevant organisations to secure external funds and developer contributions. Failure to secure funding will require plans to be prepared by the Environment Agency and Local Authorities for affected communities to adapt. Work with local communities to organise and maintain emergency plans, increase local preparedness and resilience. Continue annual maintenance.
Unforeseen ground conditions (e.g. contaminated material, voids, steel, etc.).	Site Investigation at PAR/detailed design stage.
Beach material no longer available from Shoreham bypassing. Alternative source required for recycling/beach widening.	Confirmation of source and grading at Project Appraisal Stage. Liaison with Shoreham Port Authority and Environment Agency.
Working limited by habitat designations, leading to delays and/or more expensive construction methods.	Liaison with Natural England and other key stakeholders early on and throughout PAR and construction process.
Variation in inflation.	Monitor inflation and allow risk budget.

1.10 Recommendations

1.10.1. It is recommended that the Brighton Marina to River Adur Flood and Coastal Erosion Risk Strategy Review is approved under the Non-Financial Scheme of Delegation to enable flood and erosion risk to approximately 500 properties over 100 years to be managed appropriately.

1.10.2. The Strategy (Units 1, 2 & 3) Whole Life cash cost (excluding inflation) is £158,674k including 60 % optimism bias (OB) for capital costs and 20 % OB for maintenance costs. This includes capital works at Unit 1 (Shoreham Locked Section), Unit 2 (the Open Coast), Unit 3 (Brighton Marina), and maintenance works for the whole of Units 1, 2 & 3. Maintenance contributions from Brighton and Hove City Council, Shoreham Port Authority and Western Esplanade Management Company (WemCo) will provide £79,060k whole life cash cost (excluding inflation), with an additional capital works and maintenance contribution of £22,477k from Brighton Marina.

1.10.3. Capital works and maintenance at Brighton Marina will be wholly funded by the Brighton Marina Company. No FDGiA funding is sought for Unit 3.

1.11 Directors' Briefing Paper

Region:	Southern	**Project Executive:**	
Function:	Flood Risk Management	**Project Manager:**	Martin Eade
Project Title:	Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review	**Code:**	CPW/2042

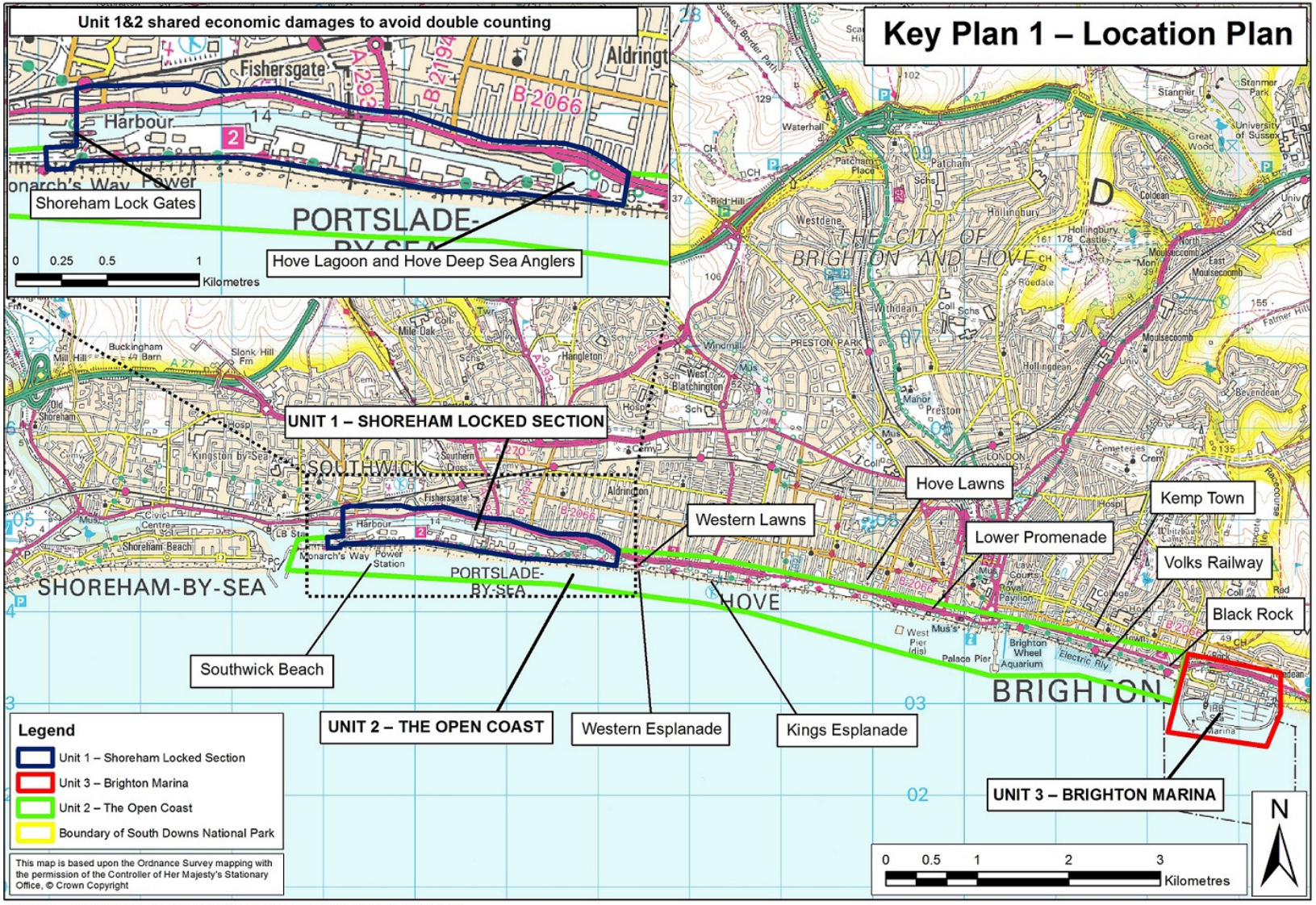
NEECA Consultant:	CH2M HILL (Halcrow)	**NCF Contractor:**	n/a	**Cost Consultant:**	n/a

The Problem:	The erosion and coastal flooding risks across the Strategy area are interlinked by coastal processes and risk management to the most vulnerable areas relies heavily on beach management. Current flood risk to Shoreham Locked Section is 100 % (1 in 1) and sections of the open coast frontage are at risk of wave overtopping on an annual basis. Many coastal defence assets are in a poor condition and under a No Active Intervention scenario it is predicted that 22 residential and 167 commercial properties would be lost to erosion within the first 20 years; increasing to 260 residential and 266 commercial properties by Year 100, including the loss of the majority of businesses and land forming Shoreham Port.
Assets at risk from flooding and erosion:	Residential and commercial businesses along Brighton seafront, Shoreham Port and the A259 to the north of the port including residential and commercial property are at risk of erosion and flooding.

Existing standard of flood protection:	Unit 1: Shoreham Locked Section 100 % (1 in 1) Unit 2: Open Coast between 100 % (1 in 1) to >0.2 % (1 in 500) Unit 3: Brighton Marina 0.5 % (1 in 200)	**Proposed standard of flood protection:**	0.5 % (1 in 200)
Description of proposed schemes:	Over the next five years the Strategy recommends: improvements to lock gate area at Shoreham; beach management including annual bypassing from Shoreham and recycling from Kemp Town; construction of new defences including groynes and revetments between Southwick Beach and Hove; and groyne upgrades in some sections of the open coast.		

Costs (PVc): (100 year life inc. maint)	58,590k	**Benefits: (PVb)**	312,305k	**Ave. B:C ratio: (PVb/PVc)**	5.33
NPV:	253,716k	**Incremental B: C ratio:**	3.0	**Whole life cost (cash value):**	158,675k

Choice of Preferred Option:	Improve 0.5 % (1 in 200) with wall raising and beach widening
Total cost for which approval is sought:	**£159 million (inc. OB)**
Delivery programme:	• Improvements to lock gate area at Shoreham Port (Year 2) • Construction of rock revetments, rock and timber groynes; wall repair, beach widening and groyne lengthening/raising from Southwick Beach to Western Esplanade (Year 2) • Replacement timber groyne field at Western Esplanade (Year 2) • Beach widening and groyne lengthening/raising at Lower Promenade west of pier, Kings Esplanade and Hove Deep Sea Hove Deep Sea Anglers' Buildings (Year 2) • Construction of access ramps at Southwick Beach and Kemp Town (Y2)
Are funds available for the delivery of this project?	Partnership funding contributions are currently available to meet £101,537k of the £158,674k.
External approvals:	Brighton and Hove City Council, Adur and Worthing councils
Defra approval:	N/A



Key Plan 1 - Strategy units for the Brighton Marina to River Adur Strategy Review

2 Introduction and background

2.1 Purpose of this report

2.1.1. This Strategy Appraisal Report (StAR) presents the business case and implementation plan for the Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review (henceforth referred to as the Strategy) and seeks approval of the Strategy. The total cash cost implementation value of the Strategy preferred options for Units 1 and 2 (Shoreham Locked Section and the Open Coast) and Unit 3 (Brighton Marina) is £158,674k (including £41,141k optimism bias) over 100 years.

2.1.2. The Strategy recommends the preferred options for flood and erosion risk management for Shoreham Locked Section, the coastline between the River Adur and the western breakwater at Brighton Marina and Brighton Marina itself (Refer to Key Plan 1).

2.1.3. The appraisal has been undertaken in accordance with the Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG).

2.1.4. A Strategic Environmental Assessment (SEA) has been undertaken in parallel with the options appraisal in order to find the preferred option and determine our Strategy. The SEA Environmental Report is provided in Appendix O.

2.2 Background

Strategic and legislative framework

2.2.1. The Beachy Head to Selsey Bill Shoreline Management Plan 2006 (SMP2) sets the high level policy for the management of the coastline. The Strategy frontage lies within Sub Cell 4d of the SMP2. The SMP2 subdivided Sub Cell 4d into 27 policy areas based on geology, coastal processes and features present. The Strategy area covers two policy areas. Brighton Marina to Portslade by Sea is covered by PU 4d12 and Shoreham Harbour (Southwick) is covered by PU 4d13.

2.2.2. The SMP2 promotes sustainable and deliverable policies for the coastline over the next 100 years The policies are set out over three timescales; the present day or short-term (0 to 20 years), the medium-term (20 to 50 years) and the long-term (50 to 100 years). The SMP2 policy for both Brighton Marina to Portslade by Sea (4d12) and Shoreham Harbour (Southwick) (4d13) policy areas is Hold the Line for the three epochs.

2.2.3. This is a Strategy Review of the 2003 Brighton Marina to River Adur Strategy Plan (see 2.2.9). This Strategy Review commenced in 2012 and has taken account of the SMP2 policies and includes up-to-date information and monitoring data collected since 2003. The update takes the same basic approach as the 2003 Strategy and has included several new supporting studies including a Condition Survey Report (Appendix H), Coastal Processes Report (Appendix I), No Active Intervention Report (Appendix J) and Options Report (Appendix K).

2.2.4. The Strategy Review considered the changing flood and erosion risks around the shoreline and the sub-division of the coast in the 2003 Strategy. For the updated Strategy the area has been divided into three Units (Key Plan 1) for the development and assessment of options. Two units (Units 1 and 2) have been combined into one Benefit Area to allow for the combined flood plain and avoid the double counting of economic benefits.

2.2.5. The Strategy is consistent with recommendations in the River Adur Catchment Flood Management Plan (CFMP), published September 2009.

2.2.6. Shoreham Locked Section and the beach fronting Shoreham Port from Southwick Beach to Portslade is owned by Shoreham Port Authority with the exception of approximately 650 m of coastal frontage, which is owned by Adur District Council. Shoreham Port Authority became responsible for coast protection along the Adur-owned frontage in 1987 and currently maintain the entire port frontage from the Harbour entrance in the west to the start of the Western Esplanade frontage using Port Authority income. The remainder of the frontage is owned and managed by Brighton and Hove City Council. The exceptions are the beach fronting Western Esplanade, which is privately owned and maintained by the Western Esplanade Management Company (WemCo) and Brighton Marina, which Brighton and Hove City Council leases to Brighton Marina Company. Under their lease the Brighton Marina Company have full management responsibility for the coastal defences at the marina.

2.2.7. The proposed works will be promoted by Brighton and Hove City Council and Adur and Worthing councils (a joint authority) using their permissive powers under the Coast Protection Act 1949. A delivery team comprising the Brighton and Hove City Council, Adur District Council, Shoreham Port and WemCo will be set up to deliver all works along this frontage (see 7.2), with the exception of Brighton Marina.

2.2.8. Under the Shoreham Harbour Acts, Shoreham Port Authority have powers to 'remove, use, sell or dispose of any shingle on West Beach' in Shoreham (on the west side of the River Adur), which is land owned by the Port. The Authority is not, however, permitted to deplete the reserve of shingle 'unreasonably' and uses these powers only to reduce excessive beach build up on the western frontage with its possible impacts on navigation, and to replenish beach levels to the east of the harbour entrance.

2.2.9. The lease agreement between Brighton and Hove City Council and Brighton Marina places legal restrictions on the Brighton Marina Company. Brighton Marina Company has covenanted with the Brighton & Hove City Council, in a lease dated 12th March 1980, to keep the Marina in good repair and condition. Brighton Marina Company is therefore legally obliged to keep the Marina (including the sea walls and breakwaters) in good repair.

Previous studies

2.2.10. A Brighton Marina to River Adur Strategy Plan was completed in 2003 (henceforth referred to as the 2003 Strategy) with the recommendation that this be reviewed on a five yearly basis. The 2003 Strategy recommended Improve (0.5 % AEP, 1 in 200-year standard) on the open coast, Maintain at Shoreham Locked Section (but with expectation of future quay wall raising) and Sustain (0.5 % AEP, 1 in 200-year standard) for Brighton Marina. The 2003 Strategy was noted by Defra but not formally approved due to changes in the approval and funding processes around the time of its submission. This current Strategy provides an update and review of the 2003 Strategy's recommendations as agreed with the Environment Agency's National Review Group on 22nd October 2009.

2.2.11. The study area aligns with the boundaries of the neighbouring approved Arun to Adur Flood and Coastal Erosion Strategy Review (2010) and the proposed study of the coast between Brighton Marina and Newhaven.

2.3 Environmental and Social Considerations

2.3.1. There are a number of national and local designations within the Brighton Marina to River Adur Strategy area. A Strategic Environmental Assessment (SEA) has been prepared.

2.3.2. Consultation has been carried out throughout the Strategy development with stakeholders and the public. The public were consulted on the short listed options in 2013. The public consultation for the proposed Strategy in 2014 included an exhibition of static displays at four locations (Hove Town Hall, Brighton Library, the King Alfred Leisure Centre and Adur Civic Centre) for a week each time. In 2014, 28 consultation responses were received from local residents and interested parties on the proposed Strategy. Natural England and English Heritage stated their support for the Strategy, whilst the Environment Agency and the Marine Management Organisation confirmed that they had no specific comments on the Strategy. Further support was provided by Brighton and Hove City Council Sustainability Officer, Brighton Marina and Shoreham Port. Shoreham Harbour Regeneration partnership also provided general support, but raised concerns about the effect on surfers and a local business along the open coastal frontage. Other consultees had no objections to the Strategy work but some concerns were raised regarding the effect on Basin Road South Site of Nature Conservation Interest, views from a local café and the potential for improving provisions for cyclists.

2.3.3. The proposed preferred Strategy options will not prevent the WFD environmental objectives being achieved.

Social and political background

2.3.4. A large proportion of the Strategy's coastal urban fringe falls within the 40 % most deprived Super Output Areas in the UK. Only Kings Esplanade and Brighton Marina are outside this threshold. Three areas, to the east and west of Palace Pier and Fishersgate fall within the 20 % most deprived areas in the UK.

2.3.5. The coastline between Brighton Marina and the River Adur features some of the country's most iconic tourist beaches. The Economic Impact of Tourism, Brighton & Hove 2012 report estimated that total expenditure by visitors to Brighton & Hove is estimated to have been in the region of £753,480,000 in 2012. This translated to £753,480,000 of direct income for local businesses. Although it cannot be determined how many visitors visit Brighton solely to visit the beach front, it must be agreed that the wide amenity beaches protecting a number of seafront businesses is a vital draw of this seaside town.

2.3.6. The StAR was approved by the Environment, Transport and Sustainability committee of Brighton and Hove City Council on 1st July 2014. This approval, combined with the letter of support from Adur and Worthing councils (Appendix P), confirms the councils' commitment to the development of the Strategy, through the promotion and implementation of the action plan and investing resources into the maintenance of the coastal defence assets.

Location and designations

2.3.7. The Strategy area is defined by a western boundary at the lock gates at Shoreham Harbour, including the east basin, the open coast from the mouth of the River Adur (also referred to as Shoreham Harbour entrance) to Brighton Marina and Brighton Marina itself.

2.3.8. There are approximately 5 km of quay wall within Shoreham Locked Section and the length of the coastal frontage is approximately 11km. This consists of:

- 3.2km of Shoreham Port coastal frontage;
- 6.8km open coastal frontage between Shoreham Port and Brighton Marina;
- Brighton Marina which occupies approximately 1km of coastal frontage.

2.3.9. The open coast is orientated southerly on the section east of the river mouth and south south-westerly at the Brighton Marina. See Key Plan 1.

2.3.10. The hinterland behind the shingle beach coastline between the River Adur and Brighton Marina is heavily developed, with Shoreham Port at the western end and the urban areas of Hove and Brighton to the east. Shoreham Port is a thriving and successful commercial port. Typical activities by the Port and its tenants include the bulk handling of timber and aggregates and the export of grain and recycled materials. The Port is also the fourth largest fishing port in England and Wales (www.marinemanagement.org.uk/fisheries/statistics/annual.htm).

2.3.11. At the eastern end of the Strategy frontage is Brighton Marina. This is the largest marina in the UK with 1,400 berths, 800 residential properties and planning permission for a further 850 and 600,000 sq.ft of commercial space.

2.3.12. There are a number of national and local designations within the Strategy area. These sites are illustrated in Figure 3 of the Strategic Environmental Assessment (SEA) Environmental Report (Appendix O). The designations include:

- Shoreham Beach, Basin Road South, Volk's Railway and Black Rock Beach Sites of Nature Conservation Interest (SNCIs);
- South West Rocks, Looe Gate and Brighton Marina marine SNCIs;
- Beachy Head West Marine Conservation Zone (MCZ);
- Black Rock GCR;
- A number of Scheduled Monuments, Conservation Areas, Historic Parks and Gardens and listed buildings including the Albion and Banjo Groynes and some wreck sites.

2.3.13. Outside the Strategy area there are two Sites of Special Scientific Interest (SSSIs); Brighton to Newhaven SSSI and River Adur SSSI, and the South Downs National Park lies to the immediate east of Brighton Marina.

History of Coastal Erosion and Flooding

2.3.14. The Coastal Processes Report (Appendix I) provides an overview of the coastal processes and sediment balance along the frontage. Sediment drift is from west to east and sediment feed from the west is blocked by the breakwaters at the River Adur mouth. As a consequence, the Shoreham to Hove frontage has suffered long term erosion. To compensate for this Shoreham Port Authority have undertaken a regular annual shingle bypassing operation since 1993 to replace some of the shingle that would have been transported from the west. However, the volume is insufficient and coupled with the poor condition of many of the control structures along the Southwick Beach frontage, this continues to result in a narrowing beach. Shoreham Port Authority has a strategic programme of groyne renewal, subject to and limited by the availability of funds, and undertakes ad hoc work to repair seawalls and revetments and move rock around on this frontage to address breaches and immediate breach risk.

2.3.15. Conversely, beach material has naturally been accreting on beaches towards the eastern end of the Strategy area. This has always occurred due to the changing bathymetry in this area limiting the easterly drift and has been exacerbated by the construction of Brighton Marina in the 1970s. The most easterly beaches in Kemp Town have in particular significantly grown since construction of the western breakwater in 1973/4. This has resulted in some operational issues for the Southern Water outfall located to the west of the western breakwater. In May 2010, and again in the autumn of 2013, Brighton and Hove City Council, in partnership with Shoreham Port Authority, moved beach material from Kemp Town (Black Rock) west to Southwick to assist in addressing this imbalance.

2.3.16. Following the storm events of Winter 2013/2014 localised flooding was recorded at several locations along the open coast frontage (wave height considered to be a 1 in 50 year event and five other storms over period greater than a 1 in 1 year event). A number of houses at Western Esplanade experienced loss of decking and other beach structures and a resident at the eastern end noted that flood water that had overtopped near the Hove Deep Sea Anglers' beach had run down Western Esplanade causing sewage to back up in the resident's ground floor garage. The Hove Deep Sea Anglers' buildings suffered undermining along the seaward side of their buildings. Along the lower promenade around Brighton Pier flood water entered 45 arches (including 30 commercial properties) causing extensive internal damage.

2.3.17. The storm events during Winter 2013/14 caused significant damage and disruption at Southwick Beach. Flooding occurred to factories and warehouses within Shoreham Port and property flooded at Basin Road South. Over 300 mm depth of shingle and debris from collapsed coast protection structures was deposited along Basin Road (and along large areas of the promenade through Portslade and Hove). The storms closed access to the sewage works, power station, café and other port tenants for a short period, port staff worked continuously for eighteen hours to re-open the road.

2.3.18. Post-storm repair works included the repair of breaches in seawalls and rebuilding some of the more critical groynes and revetments. Shingle and other debris was cleared over a period of approximately a fortnight initially and then repeatedly following subsequent events. Adur and Worthing councils are in the process of submitting a PAR for emergency works from the storm recovery fund. Brighton and Hove City Council has already received financial contributions as part of the storm recovery fund, which is currently being used to restore Unit 2 open coast defences following the 2013/14 winter storms.

2.3.19. At Shoreham Locked Section flooding can occur due to overtopping and/or opening of the lock gates. When the water level outside the gates is greater than that in the basin itself, the lock gates are forced open. To prevent this, the water level in the basin is usually kept at the level of the highest astronomical tide (HAT) by pumping. With the pumps operating, the gates typically opened on the two highest tides of the year.

2.3.20. The opening of the lock gates by high sea levels leads to localised property flooding on the northern edge of the basin. This occurred during the tidal surge on the 6th December 2013; where flood waters entered the basin, flooded property and caused considerable damage to the electrical and mechanical equipment at the locks. However, due to the storm's direction, the water levels within the harbour were not particularly extreme. A significant surge event within the harbour would threaten property (residential and commercial) as well as a 33kv electrical substation and an oil terminal.

2.4 Current approach to coastal erosion and flood risk management

Measures to manage the probability of flood and erosion risk

2.4.1. The lock gates at Shoreham are not flood defence structures, and cannot manage flood risk to the basin. The standard of protection within the locked section is 100 % AEP (1 in 1), as the lock gates will open in excess of this water level. Flooding does occur regularly and the port has undertaken, where possible, some local flood resilience measures to limit the impacts. The port also manages the land use of areas prone to flooding. However, further flood proofing of infrastructure and property along all 5km of quay walls within the lock basin would be impractical.

2.4.2. The open coast between the River Adur and Brighton Marina is heavily developed and constrained by a range of seawalls and revetments. The entire length of the beach frontage is also controlled by a series of timber, rock, masonry and concrete groynes.

2.4.3. Annual shingle bypassing across the mouth of the River Adur from Shoreham 'West Beach' to Southwick Beach has been undertaken by Shoreham Port Authority to feed beaches starved of sediment supply by the River Adur breakwaters. Since 1993 approximately 11,000 m^3 has been moved each year. Shoreham Port Authority has also occasionally coordinated the movement of shingle from Black Rock to Southwick on behalf of Brighton and Hove City Council. Approximately 7,500 m^3 was moved in 2010 and 9,000 m^3 was moved in 2013.

2.4.4. At Brighton Marina the outer breakwaters prevent open water waves propagating into the Marina. In addition, the inner harbour wall and lock gates currently prevent overflow to a standard of protection greater than 0.2 % AEP (1 in 500).

2.4.5. Shoreham Port Authority currently maintain their lock gates as they are integral structures to the port operations. Along the open coast between the River Adur and Western Esplanade, Shoreham Port Authority also currently spend approximately £380,000 per annum on coast protection, including the shingle bypass operation. In 2013, an additional £250,000 was spent on the replacement of two timber groynes. Following the 2014 storms, additional emergency works were undertaken (see 2.3.17 above).

2.4.6. The Western Esplanade Management Company (WemCo) allocate approximately £2,000 per year to the repair of the timber groynes fronting their residences.

2.4.7. In 2014, Brighton and Hove City Council received FDGiA funding for emergency repair works following storm damage to the coastal frontage (Unit 2). In addition, the port spent £700k on emergency repairs to timber groynes and revetments. WemCo also spent an additional £5k for repairs to timber groynes.

2.4.8. Brighton and Hove City Council has an annual budget of approximately £200,000 per year for their coastal frontage which extends from Western Esplanade to Brighton Marina and then Brighton Marina to Saltdean. It is estimated that approximately £164,000 is allocated to the Strategy frontage each year. This includes for the repair of concrete structures and for beach re-profiling.

2.4.9. The coastal frontage is monitored by the Adur and Worthing Coastal Survey Team as part of the Strategic Regional Coastal Monitoring Programme, coordinated by the Channel Coastal Observatory (CCO). The data produced by Adur and Worthing councils is held in a national database at the National Oceanographic Centre (NOC) in Southampton and is freely available via the www.channelcoast.org website. As part of this regional monitoring regime ATV-mounted laser scan surveys of the entire frontage are undertaken on a six monthly basis in the spring and autumn. Post storm surveys of their respective frontages are also undertaken by the Brighton and Hove City Council Engineer and Shoreham Port Authority. Post storm event inspections are undertaken by an in-house maintenance team, surveyors and engineering staff.

2.4.10. To date there has not been a co-ordinated Beach Management Plan for the Strategy frontage, but the Environment Agency are currently in the process of developing the South East Coast Beach Management Plan Programme (SECBMP). This plan will extend from Selsey Bill to Brighton and has been set-up to create a set of hierarchical Beach Management Plans (BMPs) that form the basis for a coordinated regional approach to beach management funding, and that can potentially lead to savings due to large scale coordinated approach, economies of scale and transparent assessment of risks (South East Coastal Group website, 2014).

2.4.11. The SECBMP will initially address four main work areas that seek to improve the evidence base and large scale management approach. They are;

- create a consistent dataset of Joint Return Probabilities around the Southeast, based on wave buoy data and water levels from the coastal boundary data set;
- improve the design approach for shingle beaches through development of a run-up formula for shingle beaches based on field data;
- carry out sediment budget analysis for linked frontages to feed into large scale beach movements and the scale of required management interventions;
- create a BMP document template that will be trialled (South East Coastal Group website, 2014).

2.4.12. To date a Regional Shingle Sediment Budget Report (June 2013) which proposes a sediment budget for the Selsey Bill to Brighton Marina frontage has been published as part of the SECBMP (http://www.se-coastalgroup.org.uk/sediment-budgets/). This has been reviewed during this Strategy. Future outputs from the SECBMP should be considered during future updates of the Strategy.

Measures to manage the consequences of coastal erosion and flood risk

2.4.13. The Environment Agency do not currently provide a flood warning service for the Brighton area. However, this is currently being reviewed by the Environment Agency following the localised flooding of the Lower Promenade during the 2013/2014 winter storms.

3 Problem definition and objectives

3.1 Outline of the problem

3.1.1. The supply of material to the western beaches of the open coast frontage is impeded by the mouth of the River Adur and the associated training walls. Limited sediment supply coupled with the natural attempt of the coast at Shoreham to orientate itself into a position normal to the prevalent south south-west wave direction (see Coastal Processes Report Appendix I), has resulted in significant erosive forces at the Shoreham end of the frontage. The residual life of the assets along the Shoreham frontage range from 15-30 years to <1 year. Shoreham Port Authority has a strategic programme of defence renewal, the speed of which is subject to the availability of funds, and manages immediate breach risk on an ad hoc basis by repairing seawalls, re-deploying rock armour from ineffective structures to form revetments on vulnerable sections and repairing existing timber and rock groynes.

3.1.2. The No Active Intervention (NAI) Report (Appendix J) provides predicted erosion rates based on a NAI scenario where no further bypassing from Shoreham or recycling from Kemp Town would take place and assuming all defence maintenance is ceased. This would rapidly result in the denuding of Southwick to Portslade beaches, resulting in the failure of defences along Southwick Beach by Year 10 and breach through into the locked section by Year 20.

3.1.3. The Strategy area is exposed to two forms of flooding. Along the open coast, flooding due to wave overtopping occurs. Within Shoreham Locked Section, properties are at risk of flooding under extreme water levels due to the opening of the lock gates under

extreme conditions. Some properties on the southern arm of Shoreham Locked Section are at risk of flooding from both sources.

3.1.4. The appendices to the NAI report (Appendix J) provide detailed erosion trendline mapping and flood extent mapping for different return periods (for no defences and for wave overtopping).

3.1.5. The properties at risk from flooding and erosion by Year 100 are shown in Table 3.1.

Table 3.1 Properties at risk from flooding and erosion under NAI

Property Type	Number of properties and infrastructure at risk (Units 1, & 2)		Number of properties and infrastructure at risk (Unit 3)
	At risk from flooding	At risk from coastal erosion	At risk from flooding (no erosion risk)
Residential	19	260	808
Commercial	25	266	22
Critical Infrastructure	0	1	10

3.1.6. The current standard of protection from wave overtopping along the open coast varies from 100 % AEP to greater than 0.2 % AEP. The varying standard of protection for the frontage is summarised in Table 3.2 below.

Table 3.2 Standard of Protection on Open Coast

Section of Open Coast Frontage	Standard of Protection 2012	Standard of Protection 2112
Southwick Beach to Portslade	>0.2 % AEP (1 in 500)	0.3 % (1in 300) to 50 % AEP (1 in 2)
Western Esplanade	5 % AEP (1 in 20)	100 % AEP (1 in 1)
Hove Lagoon near Hove Deep Sea Anglers' Buildings	100 % AEP (1 in 1)	100 % AEP (1 in 1)
Western Lawns	>0.2 % AEP (1 in 500)	0.3 % AEP (1 in 300)
Kings Esplanade	5 % AEP (1 in 20)	100 % AEP (1 in 1)
Hove Lawns	>0.2 % AEP (1 in 500)	2 % AEP (1 in 50)
Lower Promenade, west of Palace Pier	>0.2 % AEP (1 in 500)	100 % AEP (1 in 1)
Lower Promenade, east of Palace Pier	0.1 % AEP (1 in 100)	100 % AEP (1 in 1)
Kemp Town beaches	>0.2 % AEP (1 in 500)	>0.2 % AEP (1 in 500)

3.1.7. The open coast frontage is also at risk of flooding due to wave overtopping. Significant variation in defence heights and beach widths along the frontage have resulted in a number of weak points susceptible to flooding. Poorly maintained and deteriorated assets along the Southwick to Hove frontage have resulted in a poorly controlled beach susceptible to significant storm draw down and breach risk. Wave overtopping can occur at Hove Deep Sea Anglers' beach due to a low crest level; this can result in flooding of Western Esplanade and Basin Road. The poor beach alignment at Kings Esplanade has resulted in a promontory along the frontage with a narrow steep beach susceptible to wave overtopping.

3.1.8. The lack of a consistent and sustained beach management programme has exacerbated the imbalance of beach material along the open coast affecting both erosion and flood management. Bypassing at Shoreham of approximately 11,000 m^3 a year is insufficient to replace the lost material as the net eastwards drift along the frontage from Shoreham is estimated to be 16,000 m^3. Continued accretion of material at the eastern end of the frontage has caused operational issues for the Southern

Water outfall but the lack of an agreed beach management framework has resulted in an infrequent recycling programme.

3.1.9. The lock gates at Shoreham Locked Section provide a current standard of protection of <100 % AEP (1 in 1). The impacts of increasing sea level rise will reduce the ability of the port to manage land use with increasing impacts on businesses that use the port. With time, this will lead to a reduced use of the port. The financial restrictions of the port have limited the potential to improve flood defence within this area, which in turn has impacted potential development opportunities within the port. In the longer term, inadequate defence of the port will threaten the A259 and properties in the area. Refer to Figure 3.1 (overleaf) for a schematic of potential failure mechanisms of the locked basin's quay walls and the A259 road embankment.

3.1.10. The outer breakwaters and inner flood defences of Brighton Marina are currently well maintained by the Brighton Marina Company. The standard of protection is 0.5 % (1 in 200).

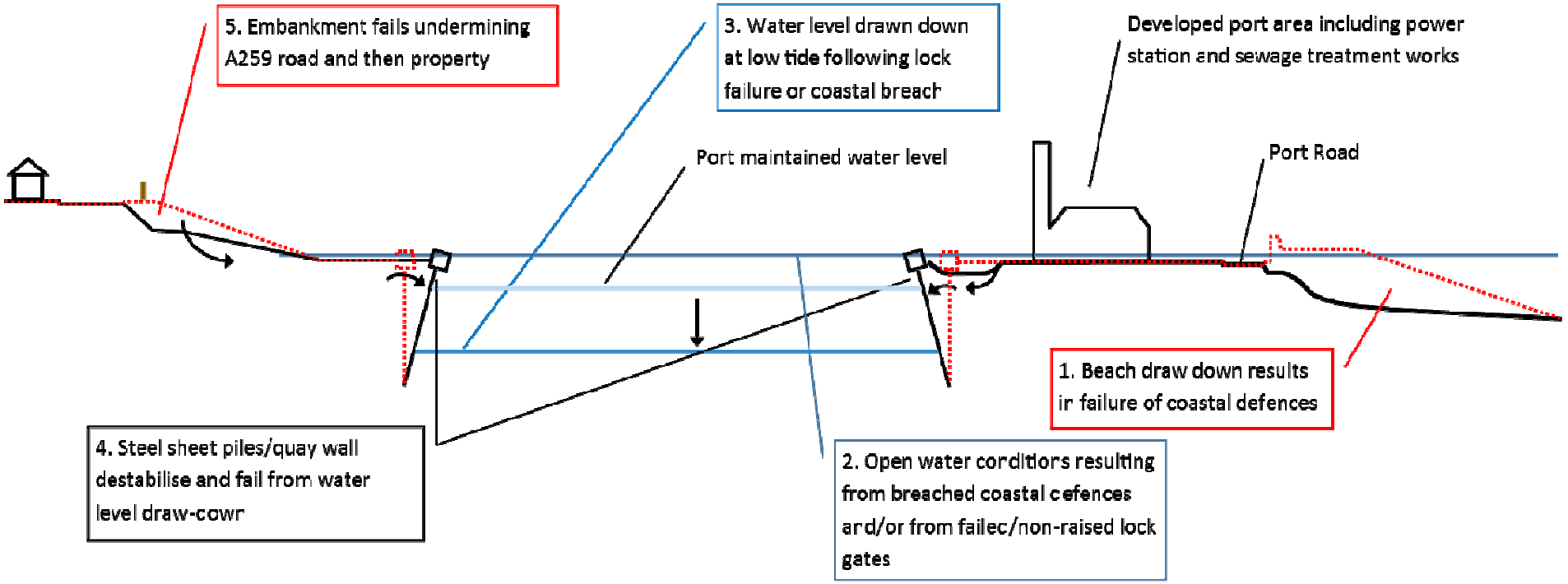


Figure 3.1 – Step by step schematic showing consequences of lock gate failure or breach of coastal flood defences at Shoreham Port

3.2 Consequences of doing nothing

3.2.1. The No Active Intervention Report (Appendix J) provides an overview of the likely impacts of the NAI scenario on risks of flooding and erosion.

3.2.2. The estimated rates of coastal erosion under the NAI scenario take into account historical recession rates and future sea level rise. Where existing defences are in place, the predicted erosion rates take into account the remaining residual life of the defences to build a comprehensive estimation of future erosion risks. The predicted erosion trend lines are included in Appendix A of the NAI Report (Appendix J).

3.2.3. It is predicted that 22 residential and 167 commercial properties would be lost to erosion within the first 20 years including Shoreham Sewage Pumping Station (serving 60,000 population equivalent from Shoreham and Portslade) and Shoreham Power Station (420 mW, sufficient to power 250,000 homes. An additional 30 mW power station is due to be commissioned on the adjacent site in 2015). It is estimated that within 20 years, the open coast would have breached through to the Shoreham Locked Section resulting in open water conditions (Figure 3.1). Communications from Shoreham Port Authority indicate that if a constant water level is not maintained within the basin, then the lack of hydrostatic pressure would result in failure of the quay walls. The quay walls have previously failed when water levels in the basin were lowered during works on the lock gates in the 1960s. Works were undertaken to address the resulting landslip which led to slumping and undermining of the A259 which had to be closed for some time.

3.2.4. By the end of 100 years a total of 260 residential properties and 266 commercial properties, including the majority of businesses and land forming Shoreham Port, would be lost. The north bank of the locked section will also have collapsed resulting in loss of a significant section of the A259. The erosion of Southwick Beach fronting Shoreham Port would also result in release of potential contaminants from the sewage works and the decommissioned CEGB power station, and expose other sites, including the Shoreham Oil Terminal to frequent inundation.

3.2.5. Under the NAI scenario, it is expected that beaches to the east will continue to accrete. It is considered that because of the formidable structure of the Marina that it will still act to impede sediment drift eastwards for at least the first 50 years of the Strategy, after which beach material will no longer be constrained, and sediment drift to the east will resume, thus reducing beach width in eastern Brighton. However, this is a theoretical position as the Marina Company is legally obliged under the terms of its lease to maintain the Marina structure.

3.2.6. Sea level rise due to climate change will result in increasing wave overtopping along the open coast frontage. Under NAI, the flood damages to open coast properties along the frontage east of the Palace Pier to the Marina have not been included in the economic assessment due to the likelihood that increasing beach width would actually improve flood protection. The reducing standard of protection of the remaining open coast sections are summarised in Table 3.2. Under NAI, it is expected that in Year 0, 6 residential and 8 commercial properties are affected under a 0.5 % AEP (1 in 200) event. By Year 100, 10 residential properties and 2 commercial properties would be affected by wave overtopping. This may be compared with the Maintain option, whereby erosion is avoided, where in Year 0, 6 residential properties and 8 commercial properties are affected under a 0.5 % AEP (1 in 200) event and by Year 100, 12 residential properties and 21 commercial properties are affected under a 0.5 % AEP (1 in 200) event. Note, that the numbers of properties at risk from wave overtopping in Year 100 are higher under the Maintain option because under NAI these additional properties would have been lost to erosion before Year 100.

3.2.7. Under a NAI scenario at Brighton Marina, damages would primarily occur through the deterioration and failure of the outer breakwaters exposing marina assets to open water conditions. Based upon consultation with Brighton Marina Company Ltd, it is considered probable that without the annual maintenance work that is currently undertaken that failure of the breakwaters as a result of toe scour would occur after twenty years. The inner walls and structures within the Marina, such as pontoons, are not designed to withstand wave action and it is assumed that if not maintained, they would fail almost immediately following a full breach of the outer breakwaters. This would result in significant wave overtopping and overflow of the Marina walls with flooding and, ultimately, erosion of all assets.

3.2.8. Once the breach has occurred and the inner walls have failed, all the Marina assets would be permanently flooded. All Marina assets are assumed lost under this scenario as land levels are below the level of high tides however, floating facilities such as concourses, harbour berths and the floating restaurant would be assumed to have been removed from the marina prior to failure. It is estimated that 808 residential and 22 commercial properties are at risk of write-off due to flooding in Year 20.

3.3 Strategic issues

3.3.1. The Brighton Marina to River Adur frontage has a complex mix of land uses ranging from heavy commercial at Shoreham Port, to one of the UKs most iconic tourist beaches at Brighton, to the largest marina in the UK at Brighton Marina. The frontage is linked primarily by its standing as one closed independent coastal process unit.

3.3.2. A strategic approach to beach management is required to make best use of available beach material and to manage imbalances within the unit. The management of beach material is of immense importance to long term flood and coastal erosion risk management across the Strategy extent. The importance of beach management and the benefits to the entire frontage of an appropriate beach management programme has informed the decision to examine the open coast as one Unit. It is important to stress however, that recommendations to address flood risk have taken into account the variation in current and predicted standard of protection across the various open coast sections.

3.3.3. The SMP divided the open coast frontage into two policy units. This was based on the primary risk type: erosion and flooding due to low lying land in the west and erosion in the east. However at strategy level this was felt to be over simplistic due to the coastal process and defence management links between the units. It has been decided in the Strategy to go further by considering the longer term risks from both flooding and erosion within the entire Strategy frontage. Firstly, material eroding from the west moves east. To properly capture the benefits or dis-benefits from the loss and gain of material in each area, the two SMP units must be considered as one. The one unit assumption is led by the overriding impact of erosion on this frontage and ensures beach management and coastal processes are properly represented. In terms of wave overtopping and flooding, the open coast has been considered in smaller subsections to define necessary works.

3.3.4. The boundary between the two units in the SMP was also based on the apparent boundary between erosion and accretion. The Regional Shingle Sediment Budget for Selsey Bill to Brighton Marina prepared by Canterbury City Council in 2013 (supporting study to the developing South East Coast Beach Management Plan) indicates that in recent years the open coast frontage has eroded except at two sections – west of Brighton Pier and Kemp Town. A review of beach profiles and volumes for the Strategy also indicate the current approximate boundary between accretion and erosion, but there is insufficient evidence available to indicate that this boundary may not naturally fluctuate. Therefore any assumption that this may be taken as a ‘fixed’ boundary is misleading.

3.3.5. The variety of land uses and owners along the frontage also required a strategic, partnership approach. If each land owner managed their section of coast in isolation then there would be variations in the standard of flood protection with possible impacts of outflanking.

3.3.6. The SMP2 preferred option for the Brighton policy units is hold the Line (HTL).

3.3.7. Some of the properties within the Strategy area are at risk from flooding from tidal inundation (via the locked section of Unit 1) and wave overtopping and erosion risk on the open coast (Unit 2). A key reason for developing the Strategy is to ensure a holistic approach to managing flood and erosion risk for the whole Strategy area. To avoid double counting of damages and ensure management schemes consider linkages between units, one benefits area has been adopted for Strategy Units 1 and 2. A strategic approach to the management of the combined benefit areas is required. A significant discrepancy in the standard of protection afforded to each Unit will significantly compromise the benefits of works provided in the other. There are no other surface water, groundwater or sewerage flood risks in the Strategy area which have schemes planned.

3.4 Key constraints

3.4.1. The Brighton Marina Company is a commercial organisation with a long term tenancy agreement with Brighton & Hove City Council (the freeholder). As such, it has a legal obligation to keep the marina (including the sea walls and breakwaters) in good repair and condition. The Brighton Marina Company agreed to change the preferred option for the Marina from Maintain to Sustain during the 2003 Strategy. Therefore, the outer breakwaters and flood defences will be improved to sustain a 0.5 % (1 in 200) standard of protection throughout the Strategy. Brighton Marina Company has undertaken a review of the impacts of climate change on the Marina and has developed a maintenance programmes to ensure its long-term viability. No FDGiA funding is being sought by Brighton Marina to implement the preferred management option.

3.4.2. The coastal processes assessment (refer to Appendix I) has indicated that in order to hold the line an annual average requirement of 16,000 m^3 per year for combined bypassing and beach recycling is required for all active intervention options. This requirement will need to be reviewed in the future in line with any changes to advice on climate change and sea level rise. Currently approximately 11,000 m^3 per year is bypassed from Shoreham Beach. The available volume from Shoreham is dependent on the rate of natural accretion on an annual basis. To ensure that the 16,000 m^3 per year target is met, combined bypassing from Shoreham Beach and recycling from Kemp Town (Black Rock) is recommended. This ensures a flexible approach that can meet natural variations in material supply from both sources. Recycling from Kemp Town alone is not feasible for all active intervention options. In the longer term, an addition of material into Unit 2 is required to meet the beach widening requirements and ongoing beach maintenance. It is proposed this is met by continuing the current bypassing operation from Shoreham Beach.

3.4.3. There are a number of environmental designations as presented in Section 2.3.13 that constitute constraints. These include three SNCIs located on the shoreline within the Strategy area (Basin Road, Volks Railway and Black Rock Beach). Shoreham Beach SNCI lies outside the Strategy area to the west of the River Adur mouth. There are also three mSNCIs (South West Rocks, Looe Gate and Brighton Marina SNCI) and one MCZ (Beach Head West) along the coast. Brighton to Newhaven SSSI is located just outside but adjacent to the Strategy area, to the immediate north and east of Brighton Marina, and the Adur Estuary SSSI is also located just outside the Strategy area to the west (within the River Adur).

3.4.4. The Strategy area contains many Scheduled Monuments, Conservation Areas and listed buildings as well as several Registered Parks and Gardens and wreck sites. There are three Grade II listed groynes on the Brighton frontage (East Street groyne, Albion groyne and Banjo groyne).

3.4.5. Other key constraints include the high visual and townscape quality, the amenity value of the coast, as well as the commercial interests of the fishing, Shoreham Harbour, Brighton Marina and the local business community, all of which are major contributors to the local economy. Some sources of potential contamination have been identified, particularly associated with industrial land use in the vicinity of Shoreham Port, and the need to maintain the quality of ground and coastal waters will be important.

3.5 Objectives

3.5.1. The overall aim of the Strategy is to establish a strategic plan that sets out sustainable, technically sound, environmentally acceptable and economically viable flood and erosion risk management for the study area between Brighton Marina and the River Adur for the next 100 years. Brighton & Hove City Council and Adur & Worthing Councils' overall objective is defined as "to defend the frontage from erosion and encroachment from the sea as outlined in the Coastal Protection Act 1949 in order to protect people, property, the environment and the local economy"

3.5.2. The objectives established for the 2003 Strategy were reviewed and updated. The updated Strategy objectives were set through consultation with the Steering Group and with representatives from key national and local organisations. These are:

- To review the generic coastal risk management risk policies proposed in the Beachy Head to Selsey Bill SMP2 2006 in order to ensure that the most appropriate and sustainable policies have been applied;
- To develop strategic tidal and coastal defence options that are sustainable, technically sound, environmentally acceptable and economically viable in accordance with current Environment Agency Flood and Coastal Erosion Risk Management – Appraisal Guidance (FCERM-AG);
- To establish a long term sustainable framework for the next 100 years for the management of the Strategy frontage;
- To develop a fully integrated 5-year detailed programme of work for individual frontages, in line with the overall management framework;
- To identify outcome measures in accordance with current FCERM Grant in Aid (GiA) criteria;
- To ensure that the Strategy plan is related to neighbouring strategies and other high level plans.

3.5.3. The Strategy objectives are closely linked to the objectives developed through the SEA process (Appendix O).

4 Options for managing flood and coastal erosion risk

4.1 Potential FCERM measures

4.1.1. The potential FCERM measures for the Strategy included all of the available high level options:

- No Active Intervention – Walk away from the defences, undertaking no further work, including no maintenance or repair. The defences would deteriorate over time and fail and natural processes would be allowed to take their course. Flood and erosion risk increases over time as defence condition worsens and climate change occurs. This option would not meet the strategic objectives but is included as a baseline to measure the benefits of the 'do something' options;
- Do Minimum – This is a minimum intervention action. Reactive repair and patch up the existing defences with breaches fixed once they have occurred. Flood and erosion risk will increase over time as defences deteriorate and climate change occurs;
- Maintain – Maintenance and repairs do not change the defence or its performance, but simply maintain it in good working order or restore it to its previous condition in the event of a breakdown. The standard of protection would reduce over time due to sea level rise (flood risk would increase);
- Sustain – Sustain the defences and current standard of flood protection through works, including mitigation for climate change, constructing new defences where necessary. The level of flood risk would stay constant over time;
- Improve – Improve the standard of flood protection, including mitigation for climate change, usually through replacement with a new structure or the addition of new defence elements. The current standard of flood protection is increased (flood risk is reduced).

4.1.2. Options that involve 'Advance the Line' were considered inappropriate for all frontages and were not assessed further due to the potential for significant loss of intertidal habitat and the disruption to coastal processes along the frontage under such a policy.

4.1.3. The presence of dense urban development including many commercial businesses of significant importance to the local and regional economy along the Brighton seafront means that in this location a policy of 'Managed Realignment' would not be economically viable. The higher ground which backs much of the Brighton seafront coastline would also limit the extent of realignment making this option the least technically favourable. For these reasons, this policy option was not assessed further.

4.2 Long list of options

4.2.1. A long list of options considered technically suitable for providing continued and improved flood and erosion risk management for the study area was drawn up by the Project Team. This built on work in the previous coastal strategy and the SMP2. A barrier option at the mouth was discounted from the outset on technical and cost grounds.

4.2.2. The Long List of options was appraised in respect of high level economic, technical, social and environmental factors related to each option to select the short list options. Whether an option was considered further or not was related to the relative performance against these factors or whether there were any 'showstoppers' which precluded the option further. Table 4.1 to Table 4.3 summarise the long list options and those taken forwards to the short list.

Table 4.1 Unit 1 (Shoreham Locked Section)

Option		Description	Short-listed	Reasons for Rejection at Long List Stage
1	No Active Intervention	No further works or repairs would be undertaken. The defences would be left to deteriorate and fail over time. Baseline option.	Y	
2	Do Minimum	Reactive repairs to the defences.	Y	
3	Maintain	Maintain and replace, as necessary, the existing lock gates.	Y	

4	Sustain	Upgrade the existing lock gate area to a higher level to sustain the standard of protection in the long term.	N	Lock gates currently provide 100 % AEP (1 in 1) SoP. Sustaining such a low SoP would require some raising to the lock gate area but result in no economic benefit to warrant such expenditure.
5	Improve	Upgrade the existing lock gate area to a higher level to improve the standard of protection in the long term.	Y	

Table 4.2 Unit 2 (Open Coast)

Option		Description	Short-listed	Reasons for Rejection at Long List Stage
1	No Active Intervention	No further works or repairs would be undertaken and beach recycling and bypassing operations would stop. The defences would be left to deteriorate and fail over time. Ongoing erosion would breach the frontage at Southwick Beach eventually resulting in open water conditions within the locked section, resulting in wall failure when water drains out of the basin. Baseline option.	Y	
2	Do Minimum	Reactive repair of seawalls and some movement of shingle to protect vulnerable seawall sections. The groynes will continue to deteriorate and will eventually fail. Reactive repair would only delay onset of breach. Ongoing erosion would breach the frontage at Southwick Beach eventually resulting in open water conditions within the locked section, resulting in wall failure when water drains out of the basin.	Y	
3	Maintain 1	The existing groynes, seawalls and other defences will be refurbished and repaired as required. The movement of shingle from west to east across the river mouth will continue to feed the beach at Southwick Beach.	N	Option 3 would result in accretion at Kemp Town with material that could potentially be used to feed neighbouring frontages. This option does not make best use of beach material within the coastal process unit. Option 5 – Maintain 3 provides the best flexibility to beach management. No difference in cost between transportation from each source.
4	Maintain 2	As Option 3, except beach material will not be moved across the Adur river mouth. Shingle will be taken from the beaches at Kemp Town to recharge the beaches at the west end of Shoreham Port.	N	Option 4 would result in the reduction of Kemp Town beaches increasing flood risk along this frontage. Option 5 – Maintain 3 provides the best flexibility to beach management. No difference in cost between transportation from each source.
5	Maintain 3	As Option 3, except shingle to feed the Shoreham frontage will be sourced from both Kemp Town and also moved across the Adur river mouth, as current operations.	Y	
6	Sustain 1	The existing groynes will be upgraded with higher and/or longer groynes to increase the size of the beaches to sustain the current standard of protection. Groynes, seawalls and other defences will be refurbished and repaired as required. Continue with beach bypassing from Shoreham Beach and recycling from Kemp Town.	N	The current SoP along the coast varies from 100 % (1 in 1 year event) at some locations to greater than 0.2 % (1 in 500 year event) at others. Sustaining such extreme standards of protection would not ensure the most economical and appropriate option for the frontage. Sustain option were not shortlisted.
7	Sustain 2	Seawalls and other defences will be raised where appropriate to sustain the current standard of protection. Groynes and other defences will be refurbished and repaired as required. Continue with beach bypassing from Shoreham Beach and recycling from Kemp Town.	N	As for Option 6
8	Improve 1	The existing groynes will be upgraded with higher and/or longer groynes to increase the size of the beaches to improve the current standard of protection. Groynes, seawalls and other defences will be refurbished and repaired as required. Continue with beach bypassing from Shoreham Beach and recycling from Kemp Town.	Y	
9	Improve 2	Seawalls and other defences will be raised where appropriate to improve the current standard of protection. Groynes and other defences will be refurbished and repaired as required. Continue with beach bypassing from Shoreham Beach and recycling from Kemp Town.	Y (combined with beach Improve 1)	Significant wall raising would have impacts on some more sensitive areas, for example, the tourist areas of Brighton beach. These options are carried through to short list but have been developed so that combinations of wall raising and beach widening have been considered within each option.

10	Improve 3	The existing groynes will be removed at the end of their residual life. Offshore breakwaters will be constructed to control sediment transport and maintain the beach. Seawalls and other defences will be refurbished and repaired as required. Continue with beach bypassing from Shoreham Beach and recycling from Kemp Town.	N	Offshore breakwaters are not a technically preferred option along this frontage. Offshore breakwaters afford protection by helping to build the beach leeward of the breakwaters. This relies on a constant source of beach material feeding the system. This frontage is a closed system. The only material being moved into the system is from bypassing and this volume is not sufficient to beach build behind offshore breakwaters. This option would also be considerably more expensive than other improve options and have considerable impacts on the local environment and amenity.
11	Improve 4	The existing groynes will be removed at the end of their residual life. Revetments will be constructed in front of the seawall to improve the standard of protection. The beach would not be maintained.	Y (combined with beach Improve 1)	Reduction of the beach at the Southwick end and ceasing of any bypassing would result in a loss of beach and increasing maintenance requirements to prevent revetments undermining. This option would not be sustainable in the long term and would have significant impact on amenity and tourism interests. Option is not taken through to short list, but revetments to improve the standard of protection or as coastal erosion defences have been considered within the more detailed short list options along short lengths in combination with beach management.
12	Improve 5	The existing groynes would be removed at the end of their residual life. Raised seawalls will be constructed to improve the standard of protection. The beach would not be maintained.	Y (combined with beach Improve 1)	As for Option 11

Table 4.3 Unit 3 (Brighton Marina)

Option		Description	Short-listed	Reasons for Rejection at Long List Stage
1	No Active Intervention	No further works or repairs would be undertaken and the breakwaters would be left to deteriorate and eventually fail. Baseline option.	Y	All options were carried forward to the Short-list; Option 1 was required to provide a baseline for comparison of the Options 2, 3 and 4.
2	Do Minimum	Reactive repair of breakwaters and inner harbour walls delays failure of breakwaters by 20 years.	Y	
3	Maintain	The breakwaters and inner harbour walls would be maintained.	Y	
4	Sustain	The breakwaters will be maintained and the height of the inner harbour wall increased to sustain the standard of protection in the long term.	Y	

4.3 Options rejected at preliminary stage

4.3.1. Table 4.1 to Table 4.3 summarise the reasons for rejection of some options at the long list stage. Full details are available in Appendix K Options Report.

4.4 Options short-listed for appraisal

4.4.1. The short-listed options below have been appraised alongside the No Active Intervention (do nothing) option, in which no further works would be undertaken and the existing defences would deteriorate over time, resulting in eventual failure. The No Active Intervention option provides the baseline for the economic appraisal.

4.4.2. The relative cost of options was also taken into consideration within the appraisal, alongside environmental, technical and sustainability issues.

4.4.3. The strategic options have been developed for the 100 year appraisal period, with a staged precautionary approach to the predicted effects of climate change incorporated into the Improve options. For each section within Unit 2 (Open Coast), the current standard of protection and timing of work required to improve the standard of defence has been considered. For some sections of the frontage, where the standard of

protection remains greater than the proposed, this has resulted in no requirement for works within the 100 years other than maintenance.

4.4.4. As described above the short list of options was developed from assessment of the long list of options (Section 4.2). In this section a summary is provided of each short listed option.

Unit 1 – Shoreham Locked Section

Option 1 – No Active Intervention (NAI)

4.4.5. No further works or repairs would be undertaken. The defences would be left to deteriorate and fail over time.

Option 2 – Do Minimum

4.4.6. Reactive repairs to the lock gates.

Option 3 – Maintain

4.4.7. Maintain and replace, as necessary, the existing lock gates.

Option 4 – Improve

4.4.8. This option includes the construction of a new third caisson gate on the main lock facing the sea which is only to be deployed to resist surge; at the secondary lock the seaward radial gate would also be strengthened and the crest level raised and a flood wall (with vehicle/man gates) would be constructed connecting the raised gates to the existing high ground to the north and south.

4.4.9. Three options are assessed; Improve to a 1.33 % AEP (1 in 75 years) standard of protection, Improve to a 1 % AEP (1 in 100 years) standard of protection and Improve to a 0.5 % AEP (1 in 200 years) standard of protection.

Unit 2 – Open Coast

Option 1 – No Active Intervention (NAI)

4.4.10. No further works or repairs would be undertaken and beach recycling and bypassing operations would be stopped. The defences would be left to deteriorate and fail over time. Ongoing erosion would breach the frontage at Shoreham eventually resulting in open water conditions within the locked section, resulting in quay wall failure when water drains out of the basin.

Option 2 – Do Minimum

4.4.11. Reactive repair of seawalls and some movement of shingle to protect vulnerable seawall sections. The groynes will continue to deteriorate and will eventually fail. Reactive repair would only delay onset of breach. Ongoing erosion would breach the frontage at Shoreham eventually resulting in open water conditions within the locked section, resulting in quay wall failure when water drains out of the basin.

Option 3 – Maintain

4.4.12. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the River Adur mouth and Kemp Town beaches. With predicted sea level rise, flood risk will increase over time.

4.4.13. In addition to assets required to address flood risk, along the Shoreham frontage new assets are also required to address erosion risk problems with potential release of contaminated material, for example, at the lorry park to the west of Western Villas.

4.4.14. The following new works are required:

- New access ramp for access to beach for recycling works between 574/3912 and 574/3913 in Year 2;

- New groyne field – VG1-VG5 in Year 2;
- New rock revetment at 574/3814 and 574/3702 in Year 2;
- New rock groynes 1 & 2 between PG4 and S22 in Year 2;
- New flood gate and ramp for access to beach for recycling works between 574/3702 and 574/3701 in Year 2.

Option 4A – Improve 1.33 % (1 in 75 years) standard of protection – Wall Raising and Beach Widening

4.4.15. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.16. The locations of assets for the Improve Wall Raising options are shown in Appendix A of the Options Development Report (Appendix K).

4.4.17. The following works are also required:

- New access ramp for access to beach for recycling works between 574/3912 and 574/3913 in Year 2;
- Groynes B8 and B9 – Raise groynes to widen beach in Year 6;
- Groyne B5 & B6 – Raise groynes to widen beach in Year 42 and Year 94 respectively;
- Groynes H1 to H9 inclusive – Extend and raise groynes to widen beach in Year 97;
- Groynes H10 to H16 inclusive – Extend and raise groynes to widen beach in Year 2 and again in Year 92;
- Groyne H30 – Extend and raise groyne to widen beach Year 2 and again in Year 92;
- Hove Lagoon Outfall – Extend in Year 2 and again in Year 92;
- Groyne H31 – Extend and raise groyne to widen beach in Year 2 and again in Year 92;
- New groyne field – VG1-VG5 in Year 2. Extend in Year 82;
- New rock revetment at 574/3814 and 574/3702 in Year 2;
- New rock groynes 1 & 2 between PG4 and S22 in Year 2. Extend in Year 65;
- New flood gate and ramp for access to beach for recycling works between 574/3702 and 574/3701 in Year 2;
- Groyne PG 1 –Extend groyne to widen beach in Year 2 and again in Year 85;
- Groyne S20 – Build up at inner end and extend to widen beach Year 2;
- Wall 574/3703 – Raise wall in Year 30 and again in Year 95.

Option 4B – Improve 1.33 % (1 in 75 years) standard of protection – Beach Widening

4.4.18. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.19. The locations of assets for the Improve Wall Raising options are shown in Appendix A of the Options Development Report (Appendix K).

4.4.20. The following works are also required:

- Works as described above for Option 4A, except replacement of "Wall 574/3703 – Raise wall in Year 30 and again in Year 95" with the following:
- Groynes T1, S4, S6, S8, S10, S11, S12, S13, S14, S15 – Extend groynes to widen beach in Year 30 and again in Year 94;
- Southern Water Outfall S16 – Extend in Year 94.

Option 5A – Improve 1 % (1 in 100 years) standard of protection – Wall Raising and Beach Widening

4.4.21. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.22. The following works are also required:

- New access ramp for access to beach for recycling works at between 574/3912 and 574/3913 in Year 2;
- Groynes B8 and B9 – Raise groynes to widen beach in Year 2 and again in Year 95;
- Groyne B5 & B6 – Raise groyne to widen beach in Year 40 and Year 90 respectively;
- Groynes H1 to H9 inclusive – Extend and raise groynes to widen beach in Year 94;
- Groynes H10 to H16 inclusive – Extend and raise groynes to widen beach in Year 2 and again in Year 90;
- Groyne H30 – Extend and raise groyne to widen beach in Year 2 and again in Year 90;
- Hove Lagoon Outfall – Extend in Year 2 and again in Year 90;
- Groyne H31 – Extend and raise groyne to widen beach in Year 2 and again in Year 90;
- New groyne field – VG1-VG5 in Year 2. Extend in Year 65;
- New rock revetment at 574/3814 and 574/3702 in Year 2;
- New rock groynes 1 & 2 between PG4 and S22 in Year 2. Extend in Year 50;
- New flood gate and ramp for access to beach for recycling works between 574/3702 and 574/3701 in Year 2;
- Groyne PG 1 – Extend groyne to widen beach in Year 2 and again in Year 75;
- Groyne S20 – Build up at inner end and extend to widen beach in Year 2;
- Wall 574/3703 – Raise in Year 20 and again in Year 90.

Option 5B – Improve 1 % (1 in 100 years) standard of protection – Beach Widening

4.4.23. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.24. The following works are also required:

- Works as described above for Option 5A, except replacement of "Wall 574/3703 – Raise wall in Year 20 and again in Year 90" with the following:
- Groynes T1, S4, S6, S8, S10, S11, S12, S13, S14, S15 – Extend groynes to widen beach in Year 20 and again in Year 90;
- Southern Water Outfall S16 – Extend in Year 90.

Option 6A – Improve 0.5 % (1 in 200 years) standard of protection – Wall Raising and Beach Widening

4.4.25. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.26. The following works are also required:

- New access ramp for access to beach for recycling works between 574/3912 and 574/3913 in Year 2;
- New rock revetment at 574/3814 and 574/3702 in Year 2;
- New rock groynes 1 & 2 between PG4 and S22 in Year 2;
- New flood gate and ramp for access to beach for recycling works between 574/3702 and 574/3701 in Year 2;
- Groynes B8 and B9 – Extend and raise to widen beach in Years 2 and 85;
- Groyne B5 – Extend and raise to widen beach in Year 30;
- Groyne B6 – Extend and raise to widen beach in Year 80;
- Groynes H1 to H9 inclusive – Extend and raise to widen beach in Year 83;
- Groynes H10 to H16 inclusive – Extend and raise to widen beach in Years 2 and 80;
- Groynes H30, H31 and Hove Lagoon Outfall – Extend and raise groyne to widen beach in Year 2 and again in Year 80;
- Groynes VG1 to VG5 inclusive – Replace groyne field in Year 2;
- Groyne PG1 – Replace groyne in Year 2;

Option 6B – Improve 0.5 % (1 in 200 years) standard of protection – Beach Widening

4.4.27. Maintain and replace groynes and defences as required. Annual bypassing and recycling of 16,000 m^3/year of shingle to feed Shoreham and Brighton beaches sourced from west of the Adur river mouth and Kemp Town beaches. Movements of beach material taken from Kemp Town would be required to feed the widened beaches.

4.4.28. The following works are also required:

- Works as described above for Option 6A, except replacement of "Wall 574/3703 – Raise wall in Year 10 and again in Year 70" with the following:
- Groynes T1, S4, S6, S8, S10, S11, S12, S13, S14, S15 – Extend groynes to widen beach in Year 10 and again in Year 80;
- Southern Water Outfall S16 – Extend in Year 80.

Unit 3 – Brighton Marina

Option 0 – No Active Intervention (NAI)

4.4.29. No further works or repairs would be undertaken and the breakwaters would be left to deteriorate and eventually fail.

Option 1 – Do Minimum

4.4.30. Reactive repair of breakwaters and inner harbour walls delays failure of breakwaters by 20 years.

Option 2 – Maintain

4.4.31. Maintenance of the inner harbour wall is required, which will involve occasional repointing and other minor works. The outer breakwaters also require maintenance, which comprises continuation of the existing annual survey and repair of scour damage. Concrete repair of the breakwaters and lock maintenance would also continue as currently.

Option 3 – Sustain

4.4.32. Sustain involves maintenance of the outer breakwaters, inner harbour wall and lock as undertaken in the Maintain option. In addition, the crest level of the existing inner wall would be increased in line with sea level rise to sustain the standard of protection.

5 Options appraisal and comparison

5.1 Technical issues

5.1.1. The Strategy development has been supported by a number of ongoing and previous studies on defence condition, sediment movements, numerical and physical modelling and monitoring. This provides increased confidence that the complex natural systems are understood as much as possible, providing confidence in the prediction of the impact of the options considered. A list of key studies is provided in Appendix B**.**

5.1.2. Using these studies, the options have been developed to a conceptual design stage. The options have used the latest available information from the Coastal Flood Boundaries project (SC060064, Environment Agency, 2011) for design conditions, alongside an allowance for climate change in accordance with Environment Agency Guidance (2011) “Adapting to Climate Change” using the UKCP 09 predictions.

5.1.3. All of the options considered feature conventional construction types, well-tested and understood in the field of FCERM. The options seek to make best use of the existing assets, building on top of them where possible to reduce breakout and waste.

5.1.4. The cost for improving the lock gate area in Unit 1 for each of the Improve options is the same. This is because at strategy stage the cost variation due to the minimal increases in size for the proposed structures is within the range of uncertainty in the capital cost estimate.

5.1.5. In developing the Improve options for the open coast the proposed programme of works to deliver the different standards of protection vary primarily by the year of intervention for each element of works. A strategic approach to the improvement in standard of defence delivered by each type of intervention was taken. The improvement in flood protection for wall raising, for example, was examined by assessing wall raising in 0.5 m intervals. Knowledge of the current standard of protection and how this reduces over the 100 year horizon, then informed the year of intervention required to provide each option’s standard of protection.

5.2 Environmental assessment

5.2.1. A SEA has been undertaken alongside the technical and cost appraisal in accordance with EC Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment (the SEA Directive). This process is documented in the SEA Environmental Report (Appendix O). A Water Framework Directive assessment has been carried out in consideration of the EU Water Framework Directive, transposed into law in England by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. This forms an appendix to the SEA Environmental Report (Appendix O).

5.2.2. Within the SEA strategy-specific environmental objectives have been defined to address the key environmental issues with potential to influence the decision-making process and to be in accordance with the SMP2 and local planning policies. Each short-listed strategy option was subject to comparative appraisal against these objectives. The results reported in the SEA Environmental Report (Appendix O) have directed the selection of preferred options.

5.2.3. Options involving construction of a rock revetment to protect contaminated land from erosion would affect Basin Road South SNCI due to potential loss of vegetated shingle. This is contrary to the Shoreham Harbour Regeneration Joint Area Action Plan (JAAP) objective to 'enhance the SNCI'. However, a properly designed rock revetment along this frontage (together with groynes) would, in the medium term, re-stabilise the beach-top slope at this location and would enable the vegetated shingle plants to populate the slope once again, thus meeting the JAAP objective. Much of the vegetated shingle at this site was eroded during the 2014 storms.

5.2.4. No works to the Albion or Banjo groyne other than continued maintenance are proposed for any of the active intervention options. Works to raise the toe of the East Street groyne to assist in beach widening are proposed for Year 80 or later in the active intervention options.

5.2.5. It is assumed that recycling of material from Kemp Town (Black Rock) to Shoreham would not affect the crest of the beach – material would be extracted at Kemp Town from the active beach slope. Therefore, it is considered there would be no impact on Volks Railway SNCI. Material by-passed from west of the River Adur would also not be taken from the crest – this is a continuation of current practices and therefore there would continue to be no impact on Shoreham Beach SNCI. Material placed at Southwick Beach would not be in the area of the Basin Road South SNCI therefore there would be no impact from the recycling and bypassing operations. Placement of recycled and bypassed material would not affect any ecologically designated sites.

5.2.6. The impact of raising the locked section lock gates on the Adur Estuary SSSI has been considered by examining the flood modelling works undertaken by JBA Consulting (JBA, 2011). JBA undertook a number of modelling scenarios for the Shoreham Regeneration work and one of the options examined was a dual purpose lock gate/tidal barrier (River/Canal Flood Defence Option C) which is similar to the strategy proposed option. This is detailed in Shoreham Harbour Regeneration: Design and Flood Risk Study, Final Report, January 2011. This was tested in conjunction with a new flood wall (also 0.5 % AEP) which was included from the lifeboat station to the pedestrian bridge. Testing under current water levels showed that there would be no increase in flood extent or depth due to the inclusion of the schemes under a 5 % AEP tidal event. When tested under a 0.1 % AEP 2115 scenario increases in sea level of between 0.02 and 0.05 m were noted in the Kingston Beach area. This may be considered to be within the levels of uncertainty of the flood model itself.

5.2.7. Therefore preliminary modelling indicates that under large tidal events both for a current situation and considering sea level rise over the next 100 years, there would be

no impact on extent or depth of flooding in the River Adur mouth area due to inclusion of the lock gate works. However, further exploratory modelling would be undertaken at the next stage to further investigate the wider implications of such an option.

5.2.8. The Key environmental impacts, mitigation and opportunities are summarised in Table 5.1.

Table 5.1 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/enhancement opportunity
UNITS 1, 2 and 3: Option 1 No Active Intervention		
None, except a neutral short term impact.	Major adverse impacts in short term as defences deteriorate and fail on ecology, cultural heritage, geology and ground conditions, land use (including amenity, tourism, flood risk and local economy) and landscape/ townscape; moderate adverse impact on commercial fishing &water quality.	None identified.
UNITS 1, 2 and 3: Option 2 Do Minimum		
As Option 1.	As Option 1.	As Option 1.
UNIT 1: Option 3 Maintain		
A neutral effect on biodiversity and cultural heritage.	Minor to moderate adverse impacts in the long term, with sea level rise, on geology, land use (including amenity, tourism, flood risk and the local economy) the landscape/townscape and water quality.	None identified.
UNIT1: Option 4 Improve		
A neutral effect on biodiversity, cultural heritage, landscape /townscape and water quality; minor beneficial impacts on commercial fishing and access to land use (amenity); and moderate to major beneficial impacts on geology and ground conditions, land use (including tourism, infrastructure, flood risk and local economy).	None.	None identified, but would encourage future development and investment in Shoreham Port in accordance with planning policy objectives.
UNIT 2: Option 3 Maintain		
A neutral effect on biodiversity geology and ground conditions; possible minor beneficial impacts on water resources.	Minor adverse impacts in the long term with sea level rise on commercial fishing, infrastructure (land use) and possibly on water resources; a moderate adverse impact in the long term on cultural heritage, land use (local economy, flood risk); and a major long term impact on landscape/townscape.	The temporary impact of Basin Road South SNCI (5.2.3). Defence improvement schemes would present an opportunity to contribute to WFD mitigation measures.
UNIT 2; Options 4A, 4B, 5A, 5B, 6A & 6B		
A neutral effect on biodiversity, commercial fishing, geology and ground conditions, landscape/ townscape; a minor beneficial impact on amenity and possibly water resources; a moderate beneficial impact on infrastructure (land use); and a major beneficial impact on cultural heritage, the local economy and flood risk (land use).	A possible minor adverse impact on water resources.	As Option 3 Maintain.
UNIT 3: Option 3 Maintain		

Key positive impacts	Key negative impacts	Mitigation/enhancement opportunity
A neutral effect on biodiversity, cultural heritage and water resources.	A minor adverse impact in the long term with sea level rise on geology and ground conditions, amenity and infrastructure (land use); a moderate adverse impact in the long term on the landscape/townscape; and a major adverse impact in the long term on the local economy & flood risk (land use).	None identified.
UNIT 3: Option 4 Sustain		
A neutral effect on biodiversity, commercial fishing, geology and ground conditions, land use, water resources and landscape/townscape.	None.	None identified, but would encourage future development and investment in Brighton Marina in accordance with planning policy objectives.

Water Framework Directive

5.2.9. An assessment has been completed to comply with the Water Framework Directive (WFD) (Appendix O). The Directive's main objectives are to prevent deterioration in the status of all surface and ground waters and try to achieve at least good status (or potential where the water body is considered to be heavily modified or artificial) for all water bodies by 2015. Where this is not possible and subject to the criteria set out in the WFD, aim to achieve good status or potential by 2021 or 2027.

5.2.10. Water bodies considered included the Sussex coastal water body, the Adur (Transitional), other surface water bodies, groundwater bodies and Protected Areas. The assessment (refer to 6.3.14) concluded that there would be moderate adverse impacts associated with the No Active Intervention and Do Minimum options, neutral or minor adverse impacts associated with the Maintain options, and generally neutral, but rising to either minor adverse of minor beneficial associated with the Improve or Sustain options in Unit 2, where it was considered that the improvement options could provide opportunity to contribute to Heavily Modified Water Bodies mitigation measures.

5.3 Social and community impacts

5.3.1. Maintenance and improvements to the defences throughout the Strategy area will reap benefits in terms of reduced health and stress impacts within the floodplain and will preserve the presence of Shoreham Port and Brighton Marina, which both have significant economic importance in the region.

5.3.2. Improvements to the conditions of the defences in conjunction with the beach management works will greatly improve the visual appearance of the coastal strip and contribute towards key aspects of the Brighton and Hove Council's strategic vision to 2028.

5.3.3. Consultation has been carried out throughout the Strategy development. Stakeholder engagement was initiated at the start of the Strategy update in 2012 and the public were consulted on the short listed options in 2013 and the proposed Strategy in 2014. The public consultation for the proposed Strategy in 2014 included the exhibition of static displays at four locations (Hove Town Hall, Brighton Library, the King Alfred Leisure Centre and Adur Civic Centre) for a week each time. In 2014, 28 consultation responses were received from local residents and interested parties on the proposed Strategy. Further support was provided by Brighton and Hove City Council Sustainability Officer, Brighton Marina and Shoreham Port. Shoreham Harbour Regeneration (in relation to the Draft Joint Area Action Plan) provided general support, but raised concerns about the potential impacts on local surfing conditions and local business along the open coastal frontage. Other consultees had no objections to the

Strategy work but some concerns were raised regarding the effect on Basin Road South Site of Nature Conservation Interest, views from a local café. It is envisaged that these concerns can be further investigated and mitigated to an acceptable level at scheme development stage. It was noted that the scheme has the potential for improving provisions for cyclists.

5.4 Option costs

5.4.1. Costs have been estimated for each shortlisted option. These are summarised in Table 5.2 to Table 5.4 with full cost breakdowns available in Appendix E. The base date for the costs is 2014 Q1. In accordance with the guidance, costs (and benefits) have been estimated over the 100 year appraisal period and discounted at the approved rates (3.5 % for Years 0-30, 3.0 % for Years 31-75, and 2.5 % thereafter) to derive a Present Value (PV) cost for each option. This PV cost includes all costs that can reasonably be foreseen over the appraisal period including: design costs (consultancy, site investigation and client fees); Project Appraisal Study (PAR) costs; capital works costs; and maintenance costs.

5.4.2. All options were costed using a combination of cost information provided by Brighton and Hove City Council, Shoreham Port Authority, Western Esplanade Management Company and the Brighton Marina Company. The Environment Agency's 'Flood Risk Management Estimating Guide – Update 2010' and an internal costs database compiled by Halcrow were used to augment this information. In addition, due to the prevalence of concrete groynes along the Brighton frontage, Mackleys Construction were consulted to confirm construction cost estimates for refurbishment works to the groynes.

5.4.3. The total PV cost over the life of the strategy is subjected to an Optimism Bias (OB) adjustment. The recommended OB allowance of 60 % at strategy stage has been applied for the capital costs. An OB allowance of 20 % has been applied to the maintenance costs, as these have been informed by ongoing maintenance activities, the cost of which are well-understood.

Table 5.2 Summary of options present value (PV) costs (£k) – Unit 1

Element	Option 2 – Do Minimum (£k)	Option 3 - Maintain (£k)	Option 4 – Improve 1.33 % (1 in 75) (£k)	Option 5 – Improve 1 % (1 in 100) (£k)	Option 6 – Improve 0.5 % (1 in 200) (£k)
Initial implementation cost (Year 0-5)					
Capital	0	1,082	10,888	10,888	10,888
Non-capital	260	834	1,029	1,029	1,029
Sub Total	260	1,917	11,917	11,917	11,917
Future Costs (Year 6-100)					
Capital	0	4,141	5,265	5,265	5,265
Non-capital	1,705	4,827	6,637	6,637	6,637
Sub Total	1,705	8,968	11,902	11,902	11,902
Total PV Cost	1,965	10,884	23,818*	23,818*	23,818*

* The total cost for Options 4, 5 and 6 is the same for Unit 1 as the difference in gate height required to provide the Improved standard of protection is very small and has no impact on the gate cost. Additionally, the same range of maintenance activities are required in each option and thus the non-capital costs are the same.

Table 5.3 Summary of options present value (PV) costs (£k) – Unit 2

Element	Option 2 - Do Minimum (£k)	Option 3 – Maintain (£k)	Option 4A - Wall Raising* 1.33 % (1 in 75) (£k)	Option 4B - Beach Widening 1.33 % (1 in 75) (£k)	Option 5A - Wall Raising* 1 % (1 in 100) (£k)	Option 5B - Beach Widening 1 % (1 in 100) (£k)	Option 6A - Wall Raising* 0.5 % (1 in 200) (£k)	Option 6B - Beach Widening 0.5 % (1 in 200) (£k)
Initial cost (Year 0-5)								
Capital	253	6,134	10,350	10,350	10,593	10,593	10,593	10,593
Non-capital	168	3,299	3,299	3,299	3,299	3,299	3,299	3,299
Sub Total	421	9,432	13,648	13,648	13,891	13,891	13,891	13,891
Future costs (Year 6-100)								
Capital	1,201	3,394	4,423	5,074	4,382	5,214	4,793	6,299
Non-capital	675	16,027	16,027	16,027	16,027	16,027	16,027	16,027
Sub Total	1,876	19,421	20,450	21,101	20,409	21,240	20,820	22,326
Total PV Cost	2,297	28,853	34,099	34,749	34,300	35,132	34,711	36,218

* Includes some beach widening

Table 5.4 Summary of options present value (PV) costs (£k) – Unit 3

Element	Option 2 – Do Minimum (£k)	Option 3 - Maintain (£k)	Option 4 - Sustain (£k)
Initial cost (Year 0-5)			
Capital	0	0	0
Non-capital	0	1,273	1,273
Sub Total	0	1,273	1,273
Future Costs (Year 6-100)			
Capital	0	0	244
Non-capital	10,853	6,850	6,850
Sub Total	10,853	6,850	7,094
Total PV Cost	10,853	8,123	8,367

5.5 Options benefits (Damages avoided)

5.5.1. Flood and erosion damages have been calculated in accordance with the Defra and Environment Agency guidance FCERM-AG and Supplementary Guidance Notes and use flood damage data from the Multi Coloured Manual (MCM) (Middlesex Flood Hazard Research Centre 2010 update). Values in the MCM have been updated to the 2014 Q1 baseline date. The analysis also takes into account the latest guidance in "Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities", Sept 2011.

5.5.2. Cost benefit assessments have been undertaken for Unit 1 and 2 combined because of the shared assets and Unit 3 as shown in Key Plan 1. Full details of the economic appraisal are contained in the Economics Report in Appendix E and this section contains a summary only.

5.5.3. Human related intangible benefits have not been valued in monetary terms in the economic damages assessment. The human related intangible benefits guidance calculates an economic value for the benefit of avoiding flooding based on the number of households and the standard of flood protection prior to and after implementation of the management option. Due to the low number of residential properties affected by

wave overtopping and the great variation in current flood defence protection standard along the frontage, the stress related benefits are likely to be negligible and have therefore not been considered.

5.5.4. Risk of injury or loss of life from flooding has not been valued in monetary terms in the economic damages assessment. The FCERM-AG Risk to Life guidance calculates an economic value for the risk to life in the flood area based on the number of properties at risk, the likely flood water velocity at those properties and the probability of failure of the defence. Due to the low number of residential properties affected by wave overtopping and therefore small population at risk of flooding, the risk to life economic damages would be negligible and have therefore not been considered.

5.5.5. The present value (PV) damage of the baseline No Active Intervention option for Units 1 and 2 is approximately £195 million over the 100 year Strategy appraisal period. The damages comprise erosion losses and recurring flood damages to residential and non-residential properties, with PV damages being capped using the average market value for each category. The dominant mechanism within the Strategy area is erosion, with flood damages contributing about £19 million.

5.5.6. The present value (PV) damage of the baseline No Active Intervention option for Unit 3 is approximately £122 million over the 100 year Strategy appraisal period. The damages comprise permanent flooding and therefore write-off to residential and non-residential properties, with PV damages being capped using the average market value for each category.

Table 5.5 Summary of options present value (PV) damages and benefits (£k)

Unit	Option	Damage (PVd) (£k)	Damage Avoided (£k)	Benefits (PVb) (£k)	Key non-monetised benefits
1 and 2	1 - No Active Intervention	194,733	-	-	
	2 - Do Minimum	110,344	84,388	84,388	
	3 - Maintain	24,839	169,893	169,893	
	4A - Wall Raising* 1.33 % (1 in 75)	6,279	188,454	188,454	Risk of injury or loss of life from wave overtopping,
	4B - Beach Widening 1.33 % (1 in 75)	6,279	188,454	188,454	
	5A - Wall Raising* 1 % (1 in 100)	5,579	189,154	189,154	
	5B - Beach Widening 1 % (1 in 100)	5,579	189,155	189,154	
	6A - Wall Raising* 0.5 % (1 in 200)	4,357	190,376	190,376	
	6B - Beach Widening 0.5 % (1 in 200)	4,357	190,377	190,376	
3	1 - No Active Intervention	121,929	-	-	
	2 - Do Minimum	61,278	60,652	60,652	
	3 - Maintain	1,042	120,887	120,887	
	4 - Sustain	0	121,929	121,929	

* Includes some beach widening

6 Selection and details of the preferred option

6.1 Selecting the preferred option

6.1.1. The short listed options for each benefit area were compared against the Strategic Objectives (Appendices K and L), environmental issues (Appendix O) and economic indicators (Appendix E), leading to the identification of the preferred option. The economic assessment is provided in full in Appendix E and is summarised in Table 6.1 to Table 6.8 below (includes allowance for climate change).

Table 6.1 Benefit-cost assessment for Units 1 and 2

Unit	Option	PV Costs (inc. OB) (£k)	PV Benefits (£k)	Av. Benefit/ Cost Ratio	Incremental BCR	Option for Incremental Calculation
1 and 2	2 - Do Minimum	3,560	84,388	23.7	-	-
	3 - Maintain	33,962	169,893	5.0	2.8	2
	4A - Wall Raising* 1.33 % (1 in 75)	51,641	188,454	3.6	1.1	3
	5A - Wall Raising* 1 % (1 in 100)	51,842	189,154	3.6	3.5	4A
	6A - Wall Raising* 0.5 % (1 in 200)	52,253	190,376	3.6	3.0	5A

* Includes some beach widening

6.1.2. Option 2 has the highest bcr (23.7). The incremental cost benefit ratio (ibcr) for Options 3 and 4 are >1 and, hence in accordance with the FCERM-AG decision rule we can move up through these options. The options providing improved standards of protection can be progressed through, as the next options on from those with a SoP of 1.33 % have a bcr of >1 and those with a SoP of 0.5 % have an ibcr>1 and a bcr of >3. Therefore Option 6A (Improve – Wall Raising 0.5 % (1 in 200) becomes the preferred option, with the highest bcr of Options 6A and 6B. This option would implement the SMP preferred policy of Hold the Line in Units 1 and 2 and is also identified as the environmentally preferred option for these Units.

6.1.3. Option 6A - Wall Raising 0.5 % (1 in 200) is the preferred option for Units 1 and 2.

6.1.4. Contributions are available from Brighton and Hove City Council, Shoreham Port Authority and Western Esplanade Management Company (WemCo) for all options as detailed in Section 6.3. These contributions are significant and have been included in the partnership funding calculator (available in Appendix E Economics Report). Potentially, additional contributions for capital works may be forthcoming in the future.

Table 6.2 Benefit-cost assessment for Unit 3

Unit	Option	PV Costs (incl. OB) (£k)	PV Benefits (£k)	Av. Benefit/Cost Ratio	Incremental BCR	Option for Incremental Calculation
3	2 - Do Minimum	8,140	60,652	7.5	-	-
	3 - Maintain	6,093	120,887	19.8	29.4	2
	4 - Sustain	6,336	121,929	19.2	4.3	3

6.1.5. For Unit 3, the Option 3 has the highest bcr (19.8) and this would implement a standard of protection of 0.5 % (1 in 200). The next option – Option 4 - has an incremental benefit cost ratio of >3, and therefore, following the decision rule this is the preferred option and provides a standard of flood protection of 0.5 % (1 in 200). Option 4 would implement the SMP preferred policy of Hold the Line in this Unit and is also the overall preferred environmental option.

6.1.6. The entire costs for the preferred management option will be met by the Brighton Marina Company. The Brighton Marina Company has a legal obligation with Brighton & Hove City Council (in a lease dated 12th March 1980) to keep the marina (including the sea walls and breakwaters) in good repair and condition.

6.2 Sensitivity testing

6.2.1. Five sensitivity tests were carried out for Units 1 and 2 (delay erosion by 10 years, double overtopping damages, 25 % increase in construction costs, no recycling from Shoreham and exclusion of the power station). Two sensitivities were carried out for

Unit 3 (Delay Brighton Marina failure and 25 % increase in maintenance costs). Due to the similarity of the engineering inputs for each of the shortlisted Improve options there were limited appropriate sensitivities to consider.

6.2.2. For Units 1 and 2, erosion damages dominate the economic assessment. The first sensitivity test looked at the impact of the timing of erosion. The other main aspect of the damages is flooding due to wave overtopping. To reflect the potential variability in the assessment of overtopping damages, the impact of doubling all wave overtopping damages was assessed. Neither of these two sensitivity tests changed the preferred option.

6.2.3. Shoreham Power Station is the most valuable asset within Units 1 and 2 and therefore has a large impact on the erosion damages. The fifth sensitivity test for Units 1 and 2 replaces this asset with the unit cost of an adjacent property (Parker Steel). The preferred option reduced to Wall Raising 1 % (1 in 100) for this sensitivity test.

6.2.4. The total option costs for Unit 2 includes significant amounts for the maintenance and replacement of existing control structures and construction of new groynes. The large majority of costs are also from recharge and recycling. For all options it has been assumed that the current practice of bypassing from Shoreham Beach to the west of the Port entrance onto Southwick Beach will continue, supplemented by additional material from the beach at Kemp Town, at the eastern end of the open coast frontage. Two further sensitivity tests were undertaken. A 25 % increase in the costs of construction/maintenance works (e.g. groynes, walls, revetments, etc.) was applied in the third sensitivity test and in the fourth test, it was assumed that material could not be obtained from bypassing at Shoreham, and that instead the shortfall of material required to sustain annual drift replacement and undertake beach widening would be met from an offshore source. A unit cost of £7.29 /m^3 for bypassing material and a unit cost for sourcing material from an offshore location of £28 /m^3 was assumed. Availability of shingle was discounted as a sensitivity as the feed from the west would not be critical to the frontage as material would be available from Kemp Town. The preferred option reduced to Wall Raising 1 % (1 in 100) in both sensitivity tests.

6.2.5. For Unit 3, Brighton Marina two sensitivity tests similar to those used for Units 1 and 2 were undertaken. A delay in failure of the breakwaters of 10 years was applied in the first test and in the second the maintenance costs were increased by 25 %. Neither option changed the preferred option from Sustain.

6.2.6. Full details of all sensitivity tests are provided in Appendix E Economics Report.

6.3 Details of the preferred option

6.3.1. A summary of the preferred options for the Strategy are detailed in Table 6.3.

Table 6.3 Summary of Preferred Options for Strategy

Unit	Option	Option Details			PV cost (£k)	PV cost (£k) (with OB)
		Short term (0-20yrs)	Medium term (20-50yrs)	Long term (50-100yrs)		
1	Improve 0.5 % (1 in 200)	Raise top of radial gate and installation of new mitre gates, flood wall and pier raising. Continue maintenance of lock gates.	Maintenance of lock gates and new enhancements.	Maintenance of lock gates and new enhancements.	**14,886**	**21,981** (12,434 FDGiA & 9,547 contributions*)
2	Wall Raising 0.5 % (1 in 200)	Install access ramps at Southwick Beach and Kemp Town. Widen beach using beach material from Kemp Town and groyne raising/ lengthening at lower promenade east of pier, Kings Esplanade, Hove Deep Sea Anglers' Buildings, and Western Esplanade. Wall raising between lock gates and outfall. Construction of two rock revetments and two rock groynes at Southwick Beach to Portslade. Extension of rock groyne. Refurbishment of timber groynes and maintenance to defence structures. Annual bypassing from Shoreham and recycling from Kemp Town.	Widen beach using beach material from Kemp Town and groyne raising/ lengthening at Lower Promenade west of pier and two rock groynes between Shoreham and Portslade. Refurbishment of groynes along frontage and maintenance to defence structures. Annual bypassing from Shoreham and recycling from Kemp Town.	Widen beach and groyne raising/ lengthening at lower promenade east and west of pier, Hove Lawns, Kings Esplanade, Hove Deep Sea Anglers' Buildings, and Western Esplanade. Extend one groyne between Southwick Beach and Portslade.	**21,695**	**30,273** (13,399 FDGiA & 16,874 contributions*)
1 + 2 sub-total					**£36,581k (no OB)**	**£52,254k (with OB)**
3	Sustain	Continue current maintenance to outer breakwaters, inner harbour wall and lock gates.	Continue current maintenance to outer breakwaters, inner harbour wall and lock gates.	Raise inner harbour wall and lock gates in 2080. Continue current maintenance to outer breakwaters, inner harbour wall and lock gates.	**5,230**	**6,336** (0 FDGiA & 6,336 contributions*)
1 + 2 + 3 TOTAL Cost					**£41,811k**	**£58,590k**
1 + 2 + 3 TOTAL Contributions*						**£32,757k**
1 + 2 + 3 TOTAL FDGiA Funding						**£25,833k**

* Refer to Table 6.6 for a breakdown of contributions.

Technical aspects

6.3.2. Capital works are required at six sites in the first five years of the Strategy to address key weaknesses in the current defences and flood risk – Shoreham Locked Section, Southwick Beach to Portslade, Western Esplanade, Hove Deep Sea Anglers' beach, Kings Esplanade and Lower Promenade east of the Pier.

6.3.3. At the Hove Deep Sea Anglers' beach, Kings Esplanade and Lower Promenade east of the Pier the capital works involve the lengthening / raising of existing concrete groynes. There is a risk that existing structures may be unsuitable for raising methods. Ground investigations will be undertaken as part of the detailed design stage and a review undertaken to confirm the detailed design. Tests can also be undertaken at stages through construction to test the integrity of the underlying structure prior to loading if necessary.

6.3.4. Brighton and Hove City Council and Shoreham Port Authority already have an established procedure for undertaking shingle bypassing from Shoreham Beach to Southwick Beach and recycling from Kemp Town (Black Rock). A formalised collection and monitoring programme will be established in discussion with the CCO to support the annual frequency of these operations. Works will be assisted by the installation of access ramps at Southwick Beach and Kemp Town (Black Rock).

6.3.5. The beach forms a critical part of the open coast frontage and its effective management is crucial to implementing the Strategy. A Beach Management Plan (BMP) will be developed under the South East BMP Programme at the design phase of the initial works.

6.3.6. It is recommended that a Flood Risk Warning system is implemented in areas at flood risk, with updates to take account of the deteriorating defences in future and giving consideration to increased flood risk with climate change.

Environmental aspects

6.3.7. The environmental impacts and sustainability considerations of the proposed Strategy have been identified in the SEA Environmental Report (Appendix O). Natural England's letter of support for the Strategy states that Natural England has no objection to the proposed Strategy. The letter states that although there is unlikely to be any adverse impact on designated sites, they recommend further monitoring of possible downstream effects on Beachy Head West MCZ due to lengthening the groynes along the open coast. A copy of the letter is provided in Appendix P. English Heritage also provided a letter supporting the proposed Strategy, and the Environment Agency has indicated that they have no comment.

6.3.8. The opportunities for incorporating environmental enhancements into capital and maintenance works are limited for this frontage, although beach widening will bring amenity enhancements. Alternative funding sources for further landscape/amenity enhancements will be explored during scheme development.

6.3.9. The environmental appraisal has taken a number of mitigation measures into account. Examples of mitigation measures include:

- Sensitive ecological features to be protected from disturbance and damage, with opportunities sought to establish new habitats where possible;
- Careful design to reduce visual impact from the promenade and beach;
- Adverse impacts on listed groynes to be avoided;
- Public access to beach to be maintained for fishing vessels, residents, leisure pursuits and visitors;
- Management of construction practices to avoid release of fines, and programming to avoid impacts during the sensitive bathing season;
- Release of contaminants resulting from construction near to potentially contaminated sites (notably at Shoreham Port) to be examined and addressed;
- Suitable access arrangements, management of traffic and considerate site practices during construction.

6.3.10. It has been assumed that the majority of potential temporary impacts that could arise during the construction of the works (such as impacts resulting from possible disturbance of ecological habitats, soils, sediments, noise, temporary visual impacts etc.) and certain potential impacts on the townscape and visual amenity, can be adequately mitigated by adoption of good construction practice, and appropriate and sensitive design.

6.3.11. The resultant environmental appraisal of the proposed Strategy showed that the significant improvements to flood protection will benefit the townscape and the historic value of Brighton, infrastructure, land use, local amenity and provide a platform to assist the local economy.

6.3.12. Some minor adverse impacts have been identified, but most are associated with the construction works, and it is proposed that these can be adequately mitigated by good site practices and careful, sensitive design following further assessment of the Strategy at project level. These are not envisaged to conflict with the environmental objectives of the Strategy.

6.3.13. No significant conflicts with the environmental objectives were identified.

6.3.14. The Water Framework Directive Assessment (Appendix O) also concluded that the preferred options will not compromise the ability to comply with the Water Framework Directive. Specifically, it concluded that the Strategy is not expected to cause deterioration in the potential or status of any of the water bodies within or adjacent to the Strategy area, or prevent water bodies from achieving their objectives including future Good potential or status. Therefore no further assessment of the strategy against the conditions listed in Article 4.7 is required. The specific assessments for each water body are shown in Table 6.4.

Table 6.4 WFD water body assessment

Water body	Assessment
Sussex	Beach management will help maintain vegetated shingle and intertidal habitats and off-set natural coastal squeeze and could improve the condition of the beach for representative flora. New revetments will encroach into the shingle habitat locally, but will be offset by beach widening. One revetment will impact an area of vegetated shingle, mitigated by establishing / expanding this habitat elsewhere along the frontage. Loss of sub tidal habitat from beach widening considered to be not significant. Maintaining and extending groynes and other defences will not contribute directly to the achievement of good potential but does not conflict with morphological mitigation measures needed to achieve this. Any future technologies that combine these structures with habitat improvements could contribute to these measures.
Adur	Improvement works and continued maintenance of the lock gates will sustain conditions for biological quality elements that have colonised the relatively deep water harbour, whilst not affecting the remainder of the water body.
Other surface water bodies	No other surface water bodies with the potential to be affected.
Groundwater bodies	No effect.
Protected Areas	Status not affected.

6.3.15. The Strategy proposes no changes that will cause failure to meet surface water Good ecological status/potential or result in a deterioration of ecological status/potential, permanently prevent or compromise the environmental objectives being met in other water bodies, cause failure to meet good groundwater status or result in deterioration in groundwater status or cause failure to meet specific quality standards associated with Protected Area status and defined in other EU Directives.

6.3.16. As such, the Strategy is considered to fulfil the environmental objectives set out during the early stages of the Strategy. The Strategy is considered a technically feasible and environmentally acceptable and sustainable plan.

6.3.17. In terms of going forward, no formal screening letter has been sought to date on the need for formal EIA. The requirement for formal EIA under the Town and Country Planning (EIA) Regulations, the Marine Works (EIA) Regulations and the EIA (Land Drainage Improvement Works) Regulations (1999) will need to be determined in consultation with the local planning authority, the Marine Management Organisation and the Environment Agency, early during the scheme delivery stage.

6.3.18. However, it is likely that further liaison with key stakeholders (including Adur and Worthing councils, Brighton and Hove City Council, West Sussex County Council, Shoreham Harbour Regeneration, Environment Agency, Natural England, English Heritage, Marine Management Organisation, Brighton Marina, Shoreham Port Authority, Sussex Wildlife Trust, utilities and infrastructure bodies, local landowners, occupiers and interest groups) will be required alongside further assessment, irrespective of the requirement for formal EIA, as the details of the strategy are developed at Project Appraisal stage. The scope of the assessment will need to be defined to cover those issues identified in the SEA (Appendix O). In particular, the following issues will need to be addressed: sensitive ecological features; coastal landscape and views; listed buildings; public access to the coast; release of contaminants; and timing and methods of construction.

6.3.19. As the strategy moves forward, strategic level environmental monitoring will be required to allow comparison of predicted effects with actual monitored effects. At this stage, it is proposed that all factors scoped into the SEA are monitored against the environmental-specific objectives, indicators and targets presented in the SEA Environmental Report (Appendix O). It is envisaged that the scope, methods and responsibilities for the monitoring will be further developed following the further assessment of the strategy at the project level. However, certain specific issues may need additional monitoring; notably, it is proposed to monitor potential impacts on Basin Road South SNCI resulting from disturbance and possible effects of lengthening the groynes along the open coast on Beachy Head West MCZ, as requested by Natural England. The details and practicalities of this may be discussed with the Channel Coastal Observatory as part of the south east regional monitoring programme or following further assessment of the strategy at project level.

Costs of the preferred option

6.3.20. Table 6.5 presents the summary costs of the preferred option for the Strategy units. Full cost breakdowns are provided in Appendix F.

Table 6.5 Costs of Preferred Option (Cash with Optimism Bias excluded)

Unit and Option	Cost	2014/15 (£K)	2015/16 (£K)	2016/17 (£K)	2017/18 (£K)	2018/19 (£K)	Future Years (£K)	Total (£K)
1	**Capital**	0	0	6,565	750	0	12,750	20,065
Improve 0.5 % (1 in	**Non-Capital**	100	100	165	165	165	15,675	16,370
200)	***Sub- Total***	*100*	*100*	*6,730*	*915*	*165*	*28,425*	*36,435*
2	**Capital**	0	0	7,092	0	0	15,653	22,745
Wall Raising 0.5 % (1	**Non-Capital**	500	500	398	398	398	37,853	40,048
in 200)	***Sub-Total***	*500*	*500*	*7,490*	*398*	*398*	*53,506*	*62,793*
3	**Capital**	0	0	0	0	0	1,277	1,277
Sustain 0.5 % (1 in	**Non-Capital**	171	170	170	170	170	16,177	17,028
200)	***Sub-Total***	*171*	*170*	*170*	*170*	*170*	*17,454*	*18,305*
	Capital	0	0	13,657	750	0	29,680	44,087
Total Strategy Area	**Non-Capital**	771	770	733	733	733	69,705	73,446
	Total Cost	771	770	14,390	1,483	733	99,385	117,533

Contributions and funding

6.3.21. The capital and maintenance works in this Strategy will be met through a combination of Flood Defence Grant in Aid and significant local contributions. The breakdown of the partnership contributions is given in Table 6.6.

6.3.22. Table 6.7 gives a breakdown of the benefits and costs for residential and commercial properties in Units 1 and 2. Where possible these have been separated into Unit 1 and Unit 2; however, due to the combined benefit area this was not always possible. To reflect this, Table 6.7 shows Unit 1, Unit 1+2 and Unit 2, which is further split down into

the number of properties in each unit expressed as a percentage. This shows that although there are large commercial beneficiaries, it is not possible to separate these as they are in the combined benefit area of Unit 1 & 2.

Table 6.6 Breakdown of Contributions and Funding

Unit	Funding Source	Annual budget (£k)	Whole Life Cost (£k)	PV Cost (£k)
1	Shoreham Port Authority Contributions	225	22,460	9,547
	FDGiA Funding	N/A	29,287	12,434
	Subtotal Unit - 1	***N/A***	***51,747***	***21,981***
2	Shoreham Port Authority Contributions	400	40,000	11,925
	Brighton and Hove CC Contributions	164	16,400	4,889
	WemCo. Contributions	2	200	60
	FDGiA Funding	N/A	27,849	13,399
	Subtotal Unit - 2	***N/A***	***84,449***	***30,273***
3	Brighton Marina Contributions	225	22,477	6,336
	FDGiA Funding	N/A	0	0
	Subtotal Unit – 3	***N/A***	***22,477***	***6,336***
1+2+3	Total Contributions	N/A	101,537	32,757
	FDGiA Funding	N/A	57,137	25,833
	Total Units 1+2+3	***N/A***	***158,675***	***58,590***

Table 6.7 Breakdown of Benefits and Costs by Unit and Property Type

Property Type	Unit 1	Unit 1+2	Unit 2	Total
Benefits (based on PV)				
Residential	5.0 %	0.0 %	0.4 %	5.4 %
Commercial	7.5 %	71.5 %	10.9 %	89.9 %
Other	4.7 %	0.0 %	0.0 %	4.7 %
TOTAL	**17.1 %**	**71.5 %**	**11.4 %**	**100.0 %**
Costs (based on PV without OB and inflation)				
TOTAL	**20.3 %**	**46.1 %**	**33.5 %**	**100.0 %**
Property Number Distribution				
Residential	48.6 %	0.0 %	1.9 %	50.5 %
Commercial	41.3 %	4.9 %	3.4 %	49.5 %
TOTAL	**89.9 %**	**4.9 %**	**5.2 %**	**100.0 %**

6.3.23. The Partnership Funding contributions outlined above have all been agreed with each organisation and are affordable as they are typically in line with current financial obligations. These contributions will fund all future maintenance works in Units 1 & 2 and additional funding towards capital costs (within these budget commitments) will be explored at scheme development (PAR) stage.

6.3.24. FDGiA funding in Unit 1 only includes works to protect the A259 and property as Shoreham Port Authority continue to maintain and replace existing lock structures.

6.3.25. Shoreham Port Authority and Brighton and Hove City Council contributions for Unit 2 are in line with previous maintenance spend.

6.3.26. The annual contributions from Western Esplanade Management Company (WemCo.) in Unit 2 have been agreed over the course of this Strategy review.

6.3.27. As the schemes progress, additional contributions for funding of capital works will be sought from these contributors and the major beneficiaries, namely Southern Water

and Shoreham Power Station. Table 6.7 shows that the benefits and costs for the commercial properties are not aligned. A small number of commercial properties (4.9%) in shared Unit 1 & 2 are benefiting most with 71.5% of the benefit for a 46.1% share of the cost. Conversely, Unit 2 claims 11.4% of the benefit for a share of 33.5% of the costs. It should be noted that the power station has a major impact on these figures as explored further in the economic sensitivity testing (refer to Appendix E) This information will be used at PAR stage in negotiations with these major beneficiaries to seek additional contributions. However, these organisations are already indirectly contributing to coastal protection works as their tenancy payments are partly financing the Port's contributions (the Port considers it necessary to fund maintenance of the coastal defences, even though it is not required to under the Harbour Acts).

6.3.28. Contributors will share in any cost escalations or savings during the duration of the strategy according to their respective contribution commitments i.e. on a percentage basis. This will be determined on a case-by-case basis. Maintenance cost increases will be wholly met by the respective contributors.

6.3.29. Capital works, maintenance and associated risk at Brighton Marina, estimated as £18,305k over the strategy period will be funded by the Brighton Marina Company. No FDGiA funding is sought for Unit 3.

6.4 Summary of preferred strategy

6.4.1. Table 6.8 presents a summary of the preferred strategy.

6.4.2. The total implementation value in current cash cost terms of the Strategy (Units 1, 2 & 3) preferred options excluding inflation is £158,675k (inc. 60 % optimism bias on capital works and 20 % on maintenance works) over 100 years.

6.4.3. Capital and maintenance costs for Unit 3 (£22,477k inc. OB) are to be met solely by the Brighton Marina Company.

Table 6.8 Summary of preferred strategy

	Units 1 and 2	Unit 3	Total
Standard of Protection provided by Preferred Strategy	0.5 % (1 in 200)	0.5 % (1 in 200)	
PV Costs (£k)			
Capital	19,711	152	19,864
Non-capital	16,870	5,077	21,947
Optimism Bias (60 % on capital, 20 % on non-capital)	15,673	1,107	16,779
Total PV Costs (£k) incl. OB	52,253	6,336	58,590
PV Benefits (£k)	190,376	121,929	312,306
Average Benefit/Cost Ratio	3.64	19.24	
Cash Costs (£k)			
Capital	42,810	1,277	44,087
Non-capital	56,418	17,028	73,446
Optimism Bias (60 % on capital, 20 % on non-capital)	36,969	4,172	41,141
Total Cash Costs (£k) incl. OB	136,197	22,477	158,675

7 Implementation

7.1 Project planning

Phasing and approach

7.1.1. The appraisal and supporting modelling of coastal processes and flooding has clearly shown that a strategic approach to the management of the defences is required to reduce erosion and flood risk. Regional beach management needs to be undertaken on the open coast.

7.1.2. The first phase of coastal works from the Strategy comprises capital schemes in Year 2 at Southwick Beach to Portslade, Western Esplanade, Hove Deep Sea Anglers' beach, Kings Esplanade and Lower Promenade east of the Pier, plus beach management. In addition, to address flood risk within Shoreham Locked Section a capital scheme is also required in Year 2. Undertaking the works in Year 2 ensures that the high risk of erosion and wave overtopping is addressed whilst allowing time for the detailed design and PARs to be completed. Brighton and Hove City Council will work with Adur and Worthing councils, Shoreham Port Authority and WemCo to ensure coherence of delivery of works along the coast, seeking efficiencies, environmental benefits and savings from packaging the schemes.

7.1.3. Brighton and Hove City Council and Shoreham Port Authority already have an established procedure for undertaking shingle bypassing from Shoreham and recycling from Kemp Town (Black Rock). A formalised collection and monitoring programme will be established to support the annual frequency of these operations.

Programme and spend profile

7.1.4. Table 7.1 shows the key dates for the appraisal and delivery stages for the six priority schemes arising from the Strategy. This programme is considered viable due to the relative simplicity of the design works proposed and due to the absence of significant environmental barriers. The most complex engineering relates to the works to the locks and some design work is already being progressed by the port (without FDGiA).

Table 7.1 Key dates

Activity	Date
Unit 1 – Shoreham Locked Section	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17
Unit 2 – Open Coast	
Southwick Beach to Portslade	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17
Western Esplanade	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17
Hove Deep Sea Anglers' beach	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17

Activity	Date
Kings Esplanade	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17
Lower Promenade east of Pier	
Commence detailed appraisal	2014/15
Approval	2015/16
Construction start	2016/17
Construction completion	2016/17

7.1.5. There are no known environmental constraints on the timing of these works at this stage, but minimising impact on tourism will be an important factor. This will be confirmed as the schemes progress through the detailed design phase with mitigation to reduce the impacts of any constraints adopted as necessary.

7.1.6. Table 7.2 shows the annualised spend profile (cash cost) for Units 1, 2 & 3 requiring capital works over the next five years. All costs for Unit 3 will be met by Brighton Marina Company.

Table 7.2 Annualised cash spend profile (Units 1, 2 & 3)

Costs (£k)	2014/15	2015/16	2016/17	2017/18	2018/19	Future Years	Total
Units 1 and 2 – Shoreham Locked Section and Open Coast Partnership Funding Score = 29 % (108 % with contributions)							
Capital	0	0	13,657	750	0	28,403	42,810
Non-capital	600	600	563	563	563	53,528	56,418
Optimism Bias*	120	120	8,307	562.6	112.6	27,747	36,970
Inflation**		14	910	115	56	11,415	12,510
Total	**720**	**734**	**23,437**	**1,990**	**731**	**121,094**	**148,708**
Total (excluding inflation)	*720*	*720*	*22,527*	*1,876*	*675.6*	*109,678*	*136,198*
Unit 3 – Brighton Marina Partnership Funding Score = Not Applicable (fully funded by contributions)							
Capital	0	0	0	0	0	1,277	1,277
Non-capital	171	170	170	170	170	16,177	17,028
Optimism Bias*	34.2	34	34	34	34	4,002	4,172
Inflation**		4	4	4	4	429.112	449.536
Total	**205**	**208**	**208**	**208**	**208**	**21,885**	**22,926**
Total (excluding inflation)	*205.2*	*204*	*204*	*204*	*204*	*21,456*	*22,477*
Total (Units 1,2&3 inc. inflation)	**925**	**942**	**23,645**	**2,199**	**939**	**142,978**	**171,634**
Total (Units 1,2&3 exc. inflation)	*925*	*924*	*22,731*	*2,080*	*880*	*131,134*	*158,674*
Note* 60 % for capital works and 20 % for maintenance costs **Inflation applied at 2 %							

Outcome measures contributions

7.1.7. The implementation of the works recommended in this Strategy will depend on adequate funds being available. Under the Flood and Coastal Erosion Resilience Partnership Funding (FCERPF) policy, the funding will be expected to be made up from Flood Defence Grant in Aid (FDGiA) together with substantial external contributions. The amount of FDGiA money available depends on the outcomes delivered by the works.

7.1.8. Outcome measure scores have been calculated for the preferred options selected for Units 1 and 2 where the need for a capital scheme has been identified in the first five years following adoption of this Strategy. These are shown in Table 7.3. The FDGiA calculator published by Defra and the Environment Agency in April 2013 has been used to calculate the scores. As the schemes presented in Table 7.1 are proposed to be packaged (refer to 7.2), the outcome measures should be allocated together. The strategy has looked at the overall case for Units 1 and 2 to ensure there is no double counting of properties for the OM scoring.

7.1.9. As previously noted, capital and maintenance costs for the schemes will be funded by a combination of FDGiA funding and contributions. Brighton and Hove City Council, Shoreham Port Authority and WemCo's contributions will provide £26,420k for the works in Units 1 and 2, and FDGiA funding will be required for the remaining £25,833k (PV costs). As the schemes progress, additional contributions for funding may be sought from these contributors and potentially Southern Water.

Table 7.3 Medium term outcome measures contributions

Outcome Measure 1 – Economics					
Duration of Benefits		100 years			
PVb (£k)	190,376k	PVc (£k)	52,253k	BCR	3.6
Units 1 & 2 Partnership Funding Score = 29 % (108 % with contributions) Unit 3 Partnership Funding Score = Not Applicable (fully funded by contributions)					

Outcome Measure 2 – Probability of households at risk of flooding						
Number of households moved out of any flood probability category to a lower category = 19						
Number of households in -	Before			After		
	Moderate Risk	Significant Risk	Very Significant Risk	Moderate Risk	Significant Risk	Very Significant Risk
20 % most deprived areas	-	1	7	-	-	-
21-40 % most deprived areas	-	1	10	-	-	-
60 % least deprived areas	-	-	-	-	-	-

Outcome Measure 3 – Households better protected against erosion		
Number of households at risk before	Long Term	Medium Term
20 % most deprived areas	238	22
21-40 % most deprived areas	-	-
60 % least deprived areas	-	-

Outcome Measure 4 – Statutory Obligations Met
N/A - No habitat created

7.2 Procurement strategy

7.2.1. The Strategy has been developed by Brighton and Hove City Council and Adur and Worthing councils with consultancy support provided by CH2M HILL (formerly Halcrow Group Ltd.) following a competitive tender process using the Environment Agency's NEECA2 framework.

7.2.2. On approval of this Strategy, given that the works in Units 1 and 2 cross administrative, political and ownership boundaries, it is intended that a partnership delivery team will be immediately established by the two councils and Shoreham Port Authority. A Memorandum of Understanding will be drawn up between the stakeholders outlining a commitment to the project governance and the details of contributions. Brighton and Hove City Council to take the lead on behalf of the project board, which will be

represented by Brighton and Hove City Council, Adur and Worthing councils, Shoreham Port Authority and Western Esplanade Management Company.

7.2.3. The team will be headed by an appointed project manager whose role will be to co-ordinate and drive forward the approval and delivery phase up to Year 5 of the strategy delivery plan (Appendix G). The project manager will be responsible for developing the schemes and gaining all approvals and will report direct to the project board

7.2.4. The appointed project manager will recommend the appropriate procurement process for detailed design and construction. At this stage the most likely option is to continue use of appropriate local or national frameworks accessible to local authorities such as the Environment Agency WEM framework, South East 7 framework or other appropriate framework. The works presented in Table 7.1 will be packaged to deliver efficiency savings.

7.3 Delivery risks

High level risk register

7.3.1. The key risks to the implementation of the Strategy are listed in Table 7.4, along with the mitigation measures identified to date. A copy of the risk register compiled for the Units 1 2 capital works is provided in Appendix M.

Table 7.4 High level risk schedule and mitigation

Key project risk	Adopted mitigation measure
Delay or difficulty in obtaining funding	Liaise with relevant organisations to secure external funds and developer contributions. Failure to secure funding will require plans to be prepared by the Environment Agency and Local Authorities for affected communities to adapt. Work with local communities to update emergency plans, increase local preparedness and resilience. Continue annual maintenance.
Unforeseen ground conditions (e.g. contaminated material, voids, steel, etc.)	Site Investigation at PAR/detailed design stage.
Beach material no longer available from Shoreham bypassing. Alternative source required for recycling/beach widening	Confirmation of source and grading at Project Appraisal Stage. Liaison with Shoreham Port Authority and Environment Agency.
Working limited by habitat designations, leading to delays and/or more expensive construction methods.	Liaison with Natural England and other key stakeholders early on and throughout PAR and construction process.
Variation in inflation	Monitor inflation and allow risk budget.

Safety plan

7.3.2. At the strategy level the consideration of health, safety and environmental risks has been paramount in the appraisal of options. Options assessment has included assessment of buildability, operation and maintenance and risks to the public accessing the frontage.

7.3.3. During the PAR development for the packaged priority coastal works, Brighton and Hove City Council will be the Client under the CDM Regulations, with the CDMc role being fulfilled by a suitably experienced and qualified consultant. The Preferred Bidder team identified via the current procurement process for the delivery phase will act as Principal Contractor and Designer for the packaged priority schemes as they move forward.

7.3.4. Public Safety Risk Assessments will be established prior to construction works.

Appendix A Project appraisal report data sheet

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):	
Project Name (60 characters max.):	Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review
Promoting Authority: Defra ref (if known)	
Name	Brighton and Hove City Council
Emergency Works:	No Yes/No
Strategy Plan Reference:	Brighton Marina to River Adur Strategy Plan (not approved)
River Basin Management Plan	South East River Basin District
System Asset Management Plan	N/A
Shoreline Management Plan:	Beach Head to Selsey Bill Shoreline Management Plan 2 (2006)
Project Type:	Strategy

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

CONTRACT DETAILS

Estimated start date of works/study:	2016/7
Estimated duration in months:	Various
Contract type*	Design/Construct

(*Direct labour, Framework, Non Framework, Design/Construct)

COSTS

	APPLICATION (£000's)
Appraisal:	
Costs for Agency approval:	
Total Whole Life Costs (cash):	£158,674k

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:	Nil
Deductible Contributions:	£88,738k (from BHCC, SPA, WemCo and Brighton Marina)
ERDF Grant:	Nil
Other Ineligible Items:	Nil

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	Southern
Name of watercourse (fluvial projects only):	n/a
District Council Area of project (all projects):	Brighton and Hove City Council; Adur and Worthing councils
EA Asset Management System Reference:	
Grid Reference (all projects):	TQ236045 to TQ343028

(OS Grid reference of typical mid point of project in form ST064055)

DESCRIPTION

Specific town/district to benefit:	Southwick, Fishersgate, Portslade-by-Sea, Hove, Brighton.

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

Unit 1: Improvement to Shoreham lock gate area including new lock gate, raising of existing radial gate and construction of new flood wall.

Unit 2: Beach management and beach widening using beach material from Kemp Town and Shoreham Beach (west of the River Adur) to improve the standard of defence.
Continued maintenance of defences with lengthening and raising of some groynes, construction of two new rock revetments and two new rock groynes.

DETAILS

Design standard (chance per year):	0.5 % (1 in 200)		yrs
Existing standard of protection (chance per year)	100 % (1 in 1) to >0.2 %(1 in 500)		yrs
Design life of project:	100 years		yrs
Fluvial design flow (fluvial projects only):	n/a		m^3/s
Tidal design level (coastal/tidal projects only):	Varies		m
Length of river bank or shoreline improved:	~10km		m
Number of groynes (coastal projects only):	~85		
Total length of groynes* (coastal projects only):	~10.2km		m
Beach Management Project?	Yes	Yes/No	
Water Level Management (Env) Project?	No	Yes/No	
Defence type (embankment, walls, storage etc.)	Walls, groynes, revetments, lock gates		

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

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):	Not Applicable		Not Applicable/Received/Awaited
EA Region Consent (LA Projects only):	Awaiting		Not Applicable/Received/Awaited
Non Statutory Objectors:	No	Yes/No	
Date Objections Cleared:	Not Applicable		
Other:	Not Applicable		Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:	Received	Not Applicable/Received/Awaited
Date received	12/05/14	

SITES OF INTERNATIONAL IMPORTANCE
(Answer Y if project is within, adjacent to or potentially affects the designated site)

Special Protection Area (SPA):	No	Yes/No
Special Area of Conservation (SAC):	No	Yes/No
Ramsar Site	No	Yes/No
World Heritage Site	No	Yes/No
Other (Biosphere Reserve etc.)	No	Yes/No

SITES OF NATIONAL IMPORTANCE (Answer Y if project is within, adjacent to or potentially affects the designated site)

Environmentally Sensitive Area (ESA):	No	Yes/No
Site of Special Scientific Interest (SSSI):	Yes	Yes/No
National/Regional Landscape Designation:	No	Yes/No
National Park/The Broads	No	Yes/No
National Nature Reserve	No	Yes/No
AONB, RSA, RSC, other	No	Yes/No
Scheduled Ancient Monument	Yes	Yes/No
Other designated heritage sites	No	Yes/No

OTHER ENVIRONMENTAL CONSIDERATIONS

Listed structure consent	Not Applicable	Not Applicable/Received/Awaited
Water Level Management Plan Prepared?	No	Yes/No
FEPA licence required?	Not Applicable	Not Applicable/Received/Awaited
Statutory Planning Approval Required	No	Yes/No/Not Applicable

COMPATIBILITY WITH OTHER PLANS

Shoreline Management Plan	Yes	Yes/No/Not Applicable
River Basin Management Plan	Yes	Yes/No/Not Applicable
Catchment Flood Management Plan	Yes	Yes/No/Not Applicable
Water Level Management Plan	n/a	Yes/No/Not Applicable
Local Environment Agency Plan	n/a	Yes/No/Not Applicable

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

SEA	Statutory required	Statutory required/Agency voluntary/not applicable
EIA	For future schemes	Yes (schedule 1); Yes (schedule 2); SI1217; not applicable
SEA/EIA status	Final	Scoping report prepared/draft/draft advertised/final

Other agreements (Not Applicable/Received/Awaited for each)

Detail	Result

Costs, benefits and scoring data

(Apportion to this phase if part of a strategy)

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

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

LAND AREA

Total area of land to benefit:			Ha
of which present use is:	FRM	CERM	
Agricultural:			Ha
Developed:			Ha
Environmental/Amenity:			Ha
Scheduled for development			Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
[1]Residential	827	260	155,266	59,081
Commercial/industrial	47	266	121,218	309,184
Critical Infrastructure	10	1	8,604	939
Key Civic Sites				
Other (description below):				
Description:				

costs and Benefits

[1]Present value of total project whole life costs (£'000s):	£66,896
Project to meet statutory requirement? *Y/N*	N

	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	77,528	9,440
Present value of commercial/industrial benefits:	51,035	165,130
Present value of public infrastructure benefits:	8233	939
Present value of agricultural benefits:	-	-
Present value of environmental/amenity benefits:	-	-
[1]Present value of total benefits (FRM & CERM)	312,305	
Net present value:	245,409	
Benefit/cost ratio:	3.6 (Unit 1 & 2) & 19.2 (Unit 3)	

Base date for estimate:	2014	
FCERM-AG Decision Rule stage 3 applied	No	Yes/No
FCERM-AG Decision Rule stage 4 applied	No	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*: 3026 Indicate if deprived: Yes Yes/No

(*as ranked by Indices of Multiple Deprivation)

Risk: n/a VH, H or N/A

	Wetland	Saltmarsh/ Mudflat	
Net gain of BAP habitat:	-	-	Ha
SSSI protected:	-		Ha
Other Habitat:	-		Ha
Heritage Sites:	II		"I or II" , "II or other" or "N/A"

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: Yes/No

Reason (max 100 chars):