

Strategy Appraisal Report

Authority scheme reference	IMSW001625
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Promoting authority	Environment Agency
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Strategy name	Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy
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- 1) Erosion causing loss of 60m section of seawall at Bournemouth, 1989
- 2) Flooding at Wareham Quay, December 2012
- 3) Flooding near Sandbanks, Poole, March 2008
- 4) Erosion near Sandbanks, January 2013

Date	January 2014
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Version	Final v6.3a
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StAR for Poole Harbour, Poole Bay and Wareham Flood and Coastal Erosion Risk Management Strategy

Ver sion	Status	Signed off by:	Date signed	Date issued
1.0	1 st Draft for ncpms/NEAS comment	Adam Schofield	12/04/13	12/04/13
2.0	2 nd Draft for ncpms/NEAS/Area comments	Adam Schofield	17/05/13	17/05/13
3.0	3rd Draft for Steering Group	Adam Schofield	24/05/13	24/05/13
4.0	4 th Draft for Internal Review	Adam Schofield	14/06/13	14/06/13
5.0	Final Draft before LPRG submission	Adam Schofield	01/07/13	01/07/13
6.0	Final submission for LPRG	Adam Schofield	04/07/13	04/07/13
6.1	Final submission for LPRG	Adam Schofield	16/07/13	16/07/13
6.2	Revised final submission inc LPRG comments	Adam Schofield	13/09/13	16/09/13
6.3	Revised final submission inc additional LPRG comments	Adam Schofield	11/12/13	11/12/13
6.3a	Final	Russell Corney	28/01/14	28/01/14

Template version – April 2011

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For technical approval of the business case

Environment Agency Region: South West

Project name: Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy

**Approval Value: £ 381 million (100 yr whole life cost)
 £ 53.5 million FDGiA (10 year cost)**

Sponsoring Director: David Jordan Director of Operations

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.

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Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy		Project Code: IMSW001625	
Project Manager: Fiona Geddes		Date of Submission: July 2013	
Lead Authority: Environment Agency		Version No: 6.3a	
Consultant Project Manager: Russell Corney & Adam Schofield		Consultant: Atkins/Halcrow Alliance	
<p><i>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.</i></p>			
Position	Name	Signature	Date
Project Executive	Graham Quarrier		
	Job Title:	Project Team Manager	
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 <i>Officers in accordance with the NFSoD.</i>			
Version No:		Date:	
Project Approval	By: In the sum of: £	Date:	
4. Defra or WAG approval <i>(Delete as appropriate)</i>			
Submitted to Defra / WAG or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		Date:	
Comments:			

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


1. Project name	Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy		Start date	January 2010
			End date	September 2013
Business unit	South West	Programme	FDGiA	
Project ref.	IMSW001625	Regional SoD ref.	Head Office SoD ref.	-

2. Role	Name	Post Title
Project Sponsor	Nick Lyness	FCRM Manager
Project Executive	Graham Quarrier	ncpms Project Executive
Project Manager	Steve Rendell	ncpms Project Manager

3. Risk Potential Assessment (RPA) Category	Low	<input checked="" type="checkbox"/>	Medium	<input type="checkbox"/>	High	<input type="checkbox"/>
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4. NFSoD value	£k
Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	£381m

5. Required level of Environmental Impact Assessment (EIA) Strategic Environment Assessment (SEA)	SEA	Low	Medium	High
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. NFSoD approver name	Post title	Signature	Date
David Jordan	Director of Operations		
NFSoD consultee name	Post title	Signature	Date
Richard Nunn	LPRG Chair		
Miles Jordan	Head of AOS		
Nick Lyness	Area Flood and Coastal Risk Manager		29.12.14

1 Executive summary

1.1 Introduction and background

- 1.1.1 This Strategy Appraisal Report (StAR) presents the business case and implementation plan for the Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management (PWFCERM) Strategy (referred to as the Strategy). This Strategy has been developed in partnership with Bournemouth Borough Council (BBC), Borough of Poole (BoP) and Purbeck District Council (PDC), who are operating authorities under the Coast Protection Act 1949.
- 1.1.2 The study area (refer to Key Plan 1) is located in Dorset, Southern England. It extends from Hengistbury Head to Durlston Head and includes the whole of Poole Harbour – a total frontage of 152km. There are existing flood and coastal erosion management assets for about 60km (40%) of this frontage. The open coast frontage is approximately 34km and includes Poole Bay, Studland Bay, Swanage Bay and Durlston Bay. Poole Harbour includes 118km of coastline. The Strategy has been sub-divided into 13 cells to enable appraisal of options for different locations. Cell boundaries are dictated either by natural contours or coastal erosion processes.
- 1.1.3 The Poole and Christchurch Bay Shoreline Management Plan (SMP2) covers this Strategy frontage, and was adopted in 2011. Information developed for this Strategy has drawn on the policy making process within the SMP2. The Strategy also covers the frontage addressed by the BoP Flood Risk Management Strategy (2011), and broadly confirms the outcome from this previous study.
- 1.1.4 The Strategy identifies an expenditure profile for the recommended management options over the next 10 years, within the context of a 100-year overall plan. The Strategy considers the longer term implications of coastal change, climate change and sea level rise, enabling the Environment Agency and local authorities to understand the technical environmental and financial constraints when making local choices in protecting local communities. The objectives of the Strategy are to:
- Identify the optimum sustainable flood and coastal erosion risk management solutions to protect local communities, with associated priority and funding approach for project implementation in the short term.
 - Identify and prioritise other flood risk management activities such as providing advice to planning authorities to control development.
 - Minimise adverse environmental impacts caused by Strategy recommendations and seek ways to enhance the environmental and recreational value of the area.
 - Maintain the integrity of the Natura 2000 network, and identify preferred locations for new inter-tidal habitat to compensate for losses caused by rising sea levels where attributable to the presence of coastal defences.

1.2 Problem

- 1.2.1 The Strategy area contains assets at risk of erosion or tidal flooding with Present Value damages (PVd) of £967million over the next 100 years (Do Nothing option).
- 1.2.2 The total number of properties at risk of erosion by 2110 is 7,025. About 90% of these are between Hengistbury Head and Sandbanks (Cell 1). If no further work were undertaken the existing beach and seawall provides an estimated residual 20 years of protection before the first cliff-top properties would be lost to erosion.
- 1.2.3 The total numbers of properties at risk of tidal flooding for a 1% Annual Exceedance Probability (AEP) for a Do Nothing scenario is 772 now, increasing to 3,367 by 2110. About 75% of these are in Central Poole. The small tidal range in the study area means that future sea level rise causes a relatively significant increase in numbers.

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Table 1-1 Summary of properties at risk and PV Damages for Do Nothing

Property at Risk	Heng Hd to Sandbanks	Luscombe Valley	Lower Parkstone	Central Poole	Hamw'thy	Rockley Sands	Lytchett Bay	Wareham Banks & Ridge	Poole Harbour South	Brownsea Island	Studland & Ballard Down	Swanage	Durleston Bay	Total
Flood risk now (1% AEP)	75	11	23	573	8	0	12	35	4	17	0	14	0	772
Flood risk 2110 (1% AEP)	174	23	166	2,116	200	0	401	149	16	19	0	103	0	3,367
Erosion risk (2110)	6,423	105	131	78	113	67	0	0	0	0	0	47	61	7,025
Total at risk (2110)	6,597	128	297	2,194	313	67	401	149	16	19	0	150	61	10,392
PV Damages (£m, rounded)	615	9.6	10.1	284	11.2	0.1	8.5	9.6	3.9	3.3	0	5.6	6.8	967

- 1.2.4 Critical infrastructure at risk includes sections of the A35(T), A351 and parts of the south coast railway from Poole to Weymouth.
- 1.2.5 Within Poole there are significant proposed regeneration areas which front onto Poole Harbour (specifically around Holes Bay) where the BoP are working with private developers. Any future improvement scheme will need to be integrated with this regeneration to take advantage of shared objectives.
- 1.2.6 Tourism is a significant part of the local economy throughout the Strategy area, with numerous attractions, beaches and facilities. An estimated 3.7m visitors a year use the beach between Hengistbury Head and Sandbanks. Studland and Brownsea Island are owned by the National Trust (NT) and also attract significant tourism.
- 1.2.7 At Wareham Banks and Ridge (cell 8) there are several legal agreements between the landowners and the local River Board dated between 1957 and 1992. These may in some cases, require the Environment Agency, as a successor organisation, to maintain in perpetuity the large majority of the system of tidal embankments for the purpose of land drainage. These embankments protect some 370ha of low grade grazing marsh (largely designated SPA / Ramsar for freshwater features) but no property. Maintenance of the embankments is becoming increasingly expensive, technically challenging and unsustainable.
- 1.2.8 There are several sites of international nature conservation importance in and around Poole Harbour and Poole Bay shown on Key Plan 2, including Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar sites.
- 1.2.9 There will be a loss of up to 44ha of internationally designated inter-tidal habitat as a result of Hold the Line options within Poole Harbour due to coastal squeeze processes over the next 20 years. This will require compensatory inter-tidal habitat to be developed by undertaking Managed Realignment. It has not been possible to find sites outside of locations already designated for their freshwater interest features due to the extensive coverage of designations across the Strategy area. Secondary compensatory freshwater habitat is therefore required.
- 1.2.10 There are also predicted losses of 6ha of designated terrestrial habitats as a result of rising sea levels in front of defences or flooding behind failing defences which will also require compensatory habitat to be established. This has been addressed by working with the Forestry Commission to identify lowland heath restoration sites as part of the (Defra sponsored) 'Wild Purbeck' programme.

1.3 Options considered

- 1.3.1 A three staged process was adopted to appraise options with our partners; a) review of SMP2 outcomes and identification of preferred High Level Options; b) development of a long-list of technically viable options defining type and alignment to

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select a short-list of options and; c) selection of the preferred option based on the outcome of economic analysis and the Strategic Environmental Assessment (SEA).

1.3.2 Compensatory habitat opportunities were considered within Poole Harbour. Two sites have been identified as preferred locations, with other sites either technically complex or expensive, having insufficient salinity levels, or lack of landowner interest. The preferred sites are an area within Wareham Banks & Ridge known as Arne Moors, and Lytchett Bay North.

1.3.3 Non structural measures include influencing the planning system to focus on long term re-development out of the floodplain and Flood Incident Management initiatives to improve flood resilience of properties and community response to flooding.

1.4 Recommended Strategy

1.4.1 The recommended Strategy combines the preferred options for each of the 13 cells to provide a strategic solution. Investment over the next 10 years is focussed on:

1.4.2 **Hengistbury Head to Sandbanks:** The preferred option is to Sustain the current beach and groyne erosion defence, with capital investment required to replace existing life-expired timber groynes and terminal groyne at Hengistbury Head, together with periodic beach renourishment at frequent intervals (every 3 to 5 years).

1.4.3 **Central Poole:** The preferred option is to reduce tidal flood and erosion risk by implementing an improvement scheme. This will integrate with the proposed waterside regeneration developments within Poole, providing a notable part of the investment needed. Part of the wider scheme will include joining the 'gaps' between the existing defences and the proposed development, as well as improving existing defences.

1.4.4 **Wareham Banks and Ridge:** The preferred option is to undertake Managed Realignment at Arne Moors, while continuing with Do Minimum maintenance for the remainder of the cell where legal agreements require it. The Managed Realignment will deliver, as a minimum, 44ha of inter-tidal habitat to provide compensation, but with potential to increase the area to in excess of 100ha if sufficient additional secondary freshwater compensation habitat can be identified and implemented.

1.4.5 **Other schemes:** Other cells have preferred options of Sustain (but with no significant capital investment within the next 10 years), Maintain or No Active Intervention. The opportunity for additional Managed Realignment at Lytchett Bay North may be realised, subject to landowner agreement in the future. Investigation of combined surface water and tidal flooding on existing drainage outfalls in Poole and Upton is also recommended. Should the opportunity for dredging material from Poole Harbour entrance become available to renourish the beach at Swanage, then this scheme may be brought forward to take advantage of significant efficiency savings.

1.4.6 **Non structural measures:** Flood warning improvements, planning and development control changes are recommended to continue. Local property protection may need to be considered by private property owners for isolated properties in cells where No Active Intervention (NAI) has been adopted.

1.4.7 The preferred Strategy options are in accordance with SMP2 policy, except that the policy of full Managed Realignment for Wareham Banks and Ridge is amended to Partial Managed Realignment now at Arne Moors, with delay of the wider Managed Realignment policy until the medium term (Year 20+).

1.5 Economic case

1.5.1 Table 1.2 summarises the 100 year economic case for the preferred Strategy options and the capital costs for the next 10 years. The preferred option SoP is quoted as the lowest standard over the 100 year appraisal period taking account of climate change.

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Table 1-2 Benefit-cost assessment and summary of Strategy

	Heng Hd to Sandbanks	Luscombe Valley	Lower Parkstone	Central Poole	Hamworthy	Rockley Sands	Lytchett Bay	Wareham Banks & Ridge	Poole Harbour South	Brownsea Island	Studland & Ballard Down	Swanage	Durleston Bay	Terrestrial Comp Habitat	Total
Lead Authority	BBC & BoP	EA & BoP	EA & BoP	EA & BoP	EA & BoP	Private	EA	EA	Private	NT	NT	PDC	PDC	EA	
Preferred Option	Sustain	Sustain	Sustain	Improve	Sustain	MR	Sust & MR	MR & Do Min	NAI	NAI & Maint	NAI	Sustain & NAI	MR	-	
SoP (%AEP)	erosion	1%	0.5%	1%*	0.5%	erosion	0.5%	5 to 100%	erosion	erosion	erosion	erosion	erosion	n/a	
PV Costs (£k)	72,000	2,600	569	19,200	3,060	107	4,450	24,500	0	0	0	6,810	0	-	133,000
PV Benefits (£k)	912,000	9,460	9,790	260,000	11,100	117	7,640	11,000	0	0	0	52,800	0	-	1,270,000
Habitat creation (ha)							24 inter-tidal	44 to 110, inter-tidal & fresh						6ha terrestrial	118 to 250ha
Average BC Ratio	12.7	3.7	17.2	13.5	3.6	1.1	1.7	0.4	n/a	n/a	n/a	7.8	n/a	n/a	9.5
10yr Scheme Cost (£k)	26,700	0	0	13,900	0	0	2,360**	17,200	0	0***	0***	0+	0	60	60,200
Whole Life Cost (£k)	237,000	8,100	2,860	34,700	8,950	352	12,200	44,800	0	0	0	31,900	0	60	381,000

Notes: Costs include 60% Optimism Bias; exclude inflation.

* Potential to consider increased SoP to 0.5% at detailed appraisal.

** Potential opportunity to undertake MR at Lytchett Bay North, subject to future landowner agreement.

*** Costs may be incurred by NT in undertaking transition to NAI (e.g. removal of existing defences) and local maintain

+ Opportunity for renourishment at reduced cost to be brought forward, subject to Poole Harbour dredgings being available

1.6 Environmental Considerations

- 1.6.1 The Strategy includes large areas designated within the Natura 2000 network. An SEA has been prepared which informed the selection of the preferred options (refer to Appendix E).
- 1.6.2 Our Habitat Regulations Assessment “Appropriate Assessment” (approved by Natural England) concludes that the preferred ‘hold the line’ options are likely to have an adverse effect on the integrity of some European Sites, but they also represent the least damaging environmental solutions for the area given the economic, social and environmental constraints. There are no alternatives to the preferred solutions where adverse effect is concluded, and that there are imperative reasons of overriding public interest (and public safety) for the strategy to be implemented. An Appendix 20 (statement of case) has been prepared with Natural England.
- 1.6.3 Assessment of compatibility with the Water Framework Directive (WFD) has concluded that the preferred options will not cause deterioration in any water body nor prevent any from reaching future good status or potential. The Strategy’s combined NAI and MR policies will make positive contributions to WFD objectives.
- 1.6.4 Consultation has been undertaken throughout the preparation of this Strategy, including public exhibitions at Bournemouth, Poole, Wareham and Swanage. Feedback has been positive with support for the options presented. In addition, a Steering Group comprising local authorities, statutory consultees, NT and the RSPB enabled the key stakeholders to inform, influence and guide development. RSPB will continue to be a key partner for delivery of the proposed MR.
- 1.6.5 A strategic environmental monitoring plan (Appendix L) has been drafted addressing uncertainties surrounding the future effects of coastal squeeze (such as the actual rate of sea level rise) and the need for and success of compensatory habitat creation.

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This will be finalised in discussion with Natural England once the Strategy has been recommended for approval.

1.7 Implementation and Outcome Measures

- 1.7.1 The recommended Strategy subject to funding will reduce tidal flood and erosion risk to the most vulnerable communities and meet the legal obligation for replacement habitat for the short term. Table 1-3 shows the annualised spend profile (capital cost), total capital costs to 10 and 100 years, and the Partnership Funding score.

Table 1-3 Annualised Spend Profile for next 10 years

	2014-15	2015-16	2016-17	2017-18	2018-19	2019 - 2024	Total for 10 years	Total for 100 years
Hengistbury Head to Sandbanks; Sustain; PF score 105%; Groyne & Beach Nourishment.								
Operating authorities: BBC, BoP								
Capital Cost (£k)	3,780	3,780	3,750	2,000	2,200	11,200	26,700	220,000
Central Poole; Improve 1%; PF score 107%; Seawalls and urban flood defences, combined investigation								
Operating authorities: BoP, Environment Agency								
Capital Cost (£k)	1,570	1,750	1,930	1,930	0	0	7,180	28,400
Contribution - Non FDGiA		0	0	0	0	6,730+	6,730+	
Capital Cost (£k)								
Wareham Banks & Ridge; PF score 36%; Inter-tidal and freshwater compensatory habitat (option 5b)								
Operating authorities: Environment Agency								
Capital Cost (£k)	672	1,770	1,770	1,770	1,770	9,450	17,200	38,300
Lytchett Bay North; Potential inter-tidal compensatory habitat scheme; subject to landowner agreement								
Operating authorities: Environment Agency								
Capital Cost (£k)	0	0	0	0	0	2,360	2,360	2,360
Total Strategy area (sum of the above plus other cells)								
Capital Cost (£k)	6,020	7,300	7,450	5,700	3,970	29,740	60,200	343,000

Notes: Costs include capital cost only (no maintenance), 60% Optimism Bias, excludes inflation

1.8 Contributions and funding

- 1.8.1 Bournemouth Borough Council (BBC) and Borough of Poole (BoP) contribute to Hengistbury Head to Sandbanks by undertaking annual maintenance. Additional contribution in proportion to the beach amenity benefits (18%) is being negotiated.
- 1.8.2 It is envisaged that the proposed regeneration development in Poole will deliver a significant proportion of the capital investment for the Central Poole flood cell. In addition the BoP has a robust policy of contributions being sourced by a Community Infrastructure Levy (CIL). Funding for the scheme to complete gaps in defences would therefore be likely to proceed with FDGiA and potentially contribution from the CIL. Timing of the delivery of the various elements of the improvement option should optimise delivery efficiency, and the annual spend profile adjusted accordingly.
- 1.8.3 The proposed Managed Realignment at Wareham Banks and Ridge (Arne Moors) and associated secondary compensation freshwater habitat in the Wareham area will be funded by FDGiA, given the strategic requirement for these schemes.
- 1.8.4 Environment Agency Area and Regional teams are pursuing initiatives to help secure external contributions (direct or in kind) from our key partners such as the local authorities, RSPB (land owner at Arne Moors) and Poole Harbour Commissioners.
- 1.8.5 Procurement for capital works will be through the Environment Agency frameworks or through BBC/BoP as the operating authorities for Hengistbury Head to Sandbanks.

1.9 Recommendations

- 1.9.1 It is recommended that the PWFCERM Strategy is approved at a Whole Life Cost (excluding inflation) of £381m.
- 1.9.2 Contribution plans should be developed to secure funding ahead of implementing the individual schemes recommended in this Strategy.

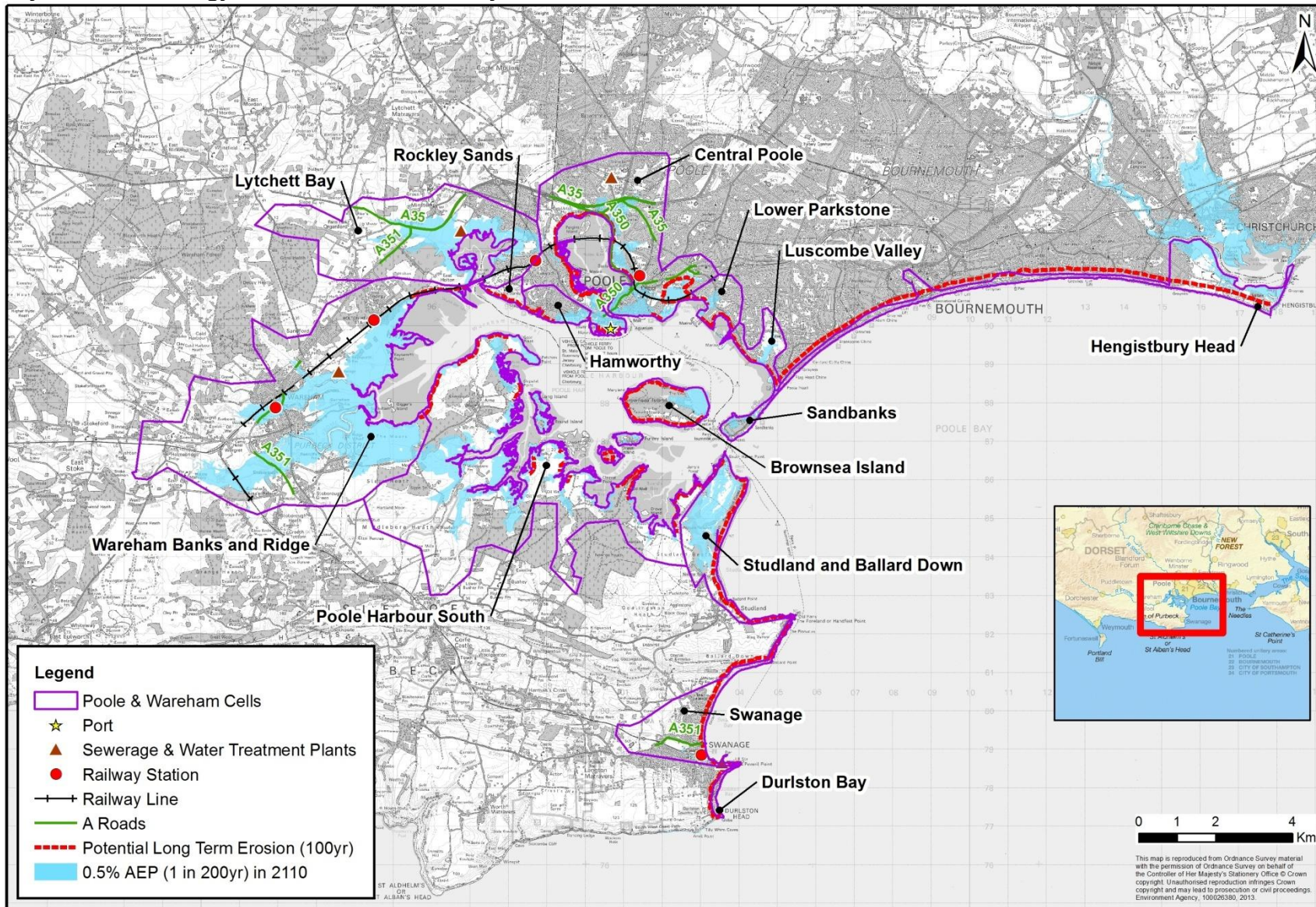
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Director Briefing Paper

Region:	South West	Project Executive:	Graham Quarrier		
Function:	Flood & Coastal Risk Management	Project Manager:	Steve Rendell		
Project Title:	Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy		Code:	IMSW001625	
NEECA Consultant:	Atkins & Halcrow Alliance	NCF Contractor:	n/a	Cost Consultant:	n/a
The Problem:	Assets at risk of flooding and coastal erosion with present value damages of £967million over the next 100 years. Sea level rise causing coastal squeeze, loss of inter-tidal habitat. Historic legal agreements near Wareham requiring maintenance of tidal embankments.				
Assets at risk from flooding and erosion:	Total 10,392 properties at risk; - 7,025 from erosion over year 20-100, and 772 from tidal flooding (3,367 by 2110), together with freshwater SPA / Ramsar sites.				
Existing standard of flood protection:	Erosion residual life: typically 20 years, 10 years in places. Tidal flood risk: Varies 100% to 0.5% AEP	Proposed standard of flood protection:	Erosion: Sustain, where properties at medium term risk. Tidal flood risk: Varies, 1% to 0.5% AEP for Poole, lower in other locations		
Description of proposed schemes:	<p>Hengistbury Head to Sandbanks: Sustain – beach nourishment and groyne refurbishment</p> <p>Central Poole: Improve 1% AEP or better – integrating with future regeneration development</p> <p>Poole & Upton: Investigation of combined surface/tide-lock flood risk.</p> <p>Wareham Banks & Ridge: Do Minimum maintenance for majority of tidal embankments (legal obligation). Managed Realignment at Arne Moors (44 to 110ha) with associated secondary freshwater habitat compensation to replace losses.</p> <p>Swanage: Sustain – future beach renourishment with groyne maintenance</p>				
Costs (PVC): (100 year life inc. maintenance)	£133m	Benefits: (PVb)	£1,270m (including beach amenity benefits)	Ave. B: C ratio: (PVb/PVc)	13.2
NPV:	£1,620m	Incremental B:C ratio:	n/a	Whole life cost (cash value):	£381m
Choice of Preferred Option:	Combination of Sustain and Improve for urban areas (Bournemouth, Poole & Swanage), with Do Minimum, Managed Realignment, No Active Intervention and local maintain for rural areas (Wareham Banks, Poole Harbour South, Brownsea Island and Studland)				
Total cost for which approval is sought:	£ 381m whole life cost (100 years) (including OPTIMISM BIAS)				
Delivery programme:	<p>Hengistbury Head to Sandbanks: Year 1+, continuous programme of annual spend</p> <p>Central Poole: Year 1-5 scheme appraisal and implementation. Adjust programme to gain efficiency opportunities & wider outcomes with the regeneration development.</p> <p>Poole & Upton: Year 1-3 - Surface Water & Tide-Lock Investigation & implementation</p> <p>Wareham Banks & Ridge: Year 1-5 Freshwater Habitat Creation, followed by Year 6-10 Managed Realignment at Arne Moors.</p>				
Are funds available for the delivery of this project?	Yes				
External approvals:	Natural England has provided a letter of support for the Strategy recommendations.				
Defra approval:	N/A				

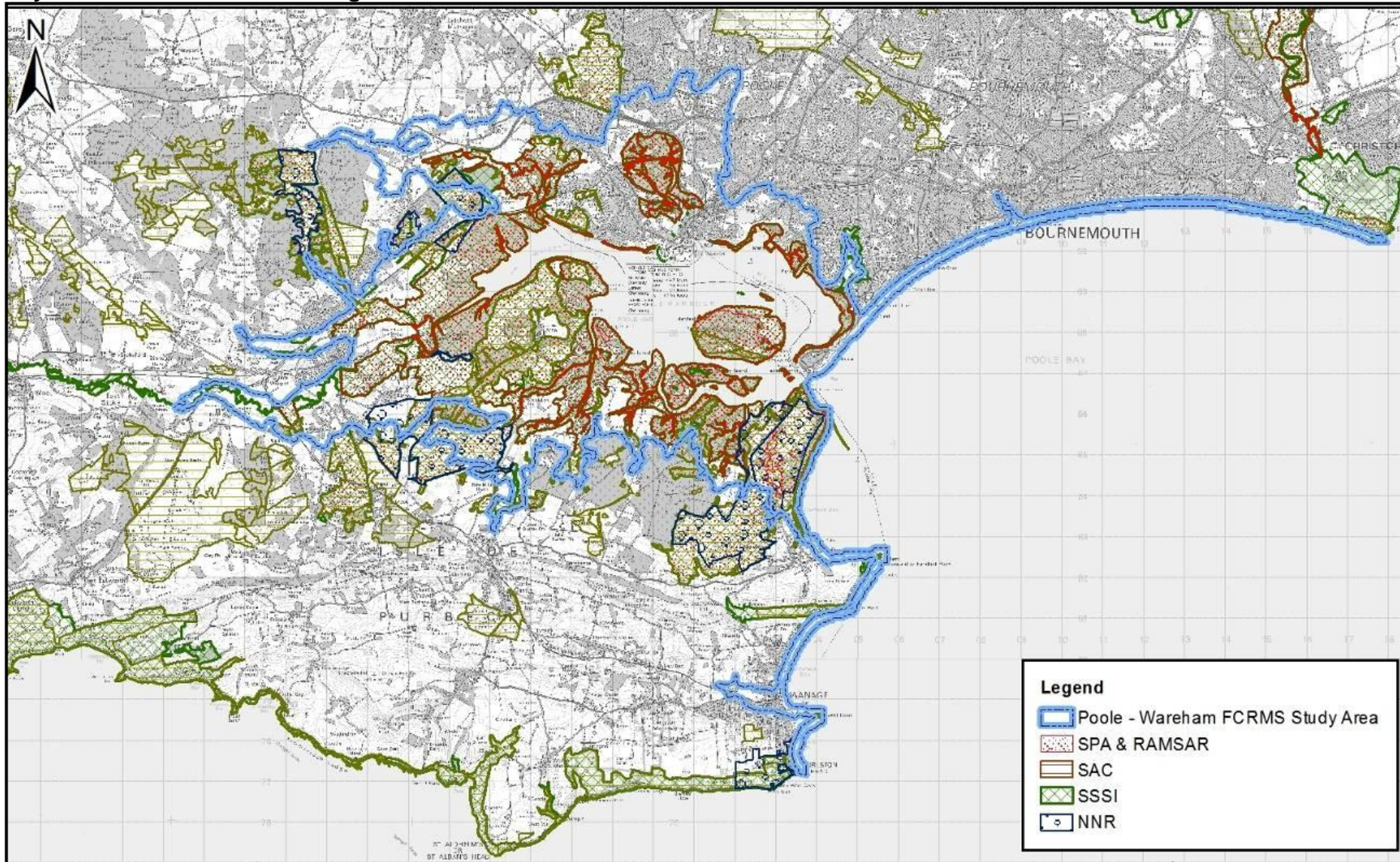
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Key Plan 1 – Strategy Cell boundaries and key assets



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Key Plan 2 – Environmental Designations



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2 Introduction and background

2.1 Purpose of this report

- 2.1.1 The Poole Harbour, Poole Bay and Wareham Flood and Coastal Erosion Risk Management (PWFCERM) Strategy has been developed to identify the preferred strategic tidal flood and erosion risk management approach for an area of Dorset extending from Hengistbury Head to Durlston Head, and including the whole of Poole Harbour.
- 2.1.2 The Strategy identifies the recommended management options for a 10-year programme within the context of a 100-year overall plan. The Strategy considers the longer-term implications of coastal change, climate change and sea level rise, and therefore enables the Environment Agency, local authorities and interested parties to understand the various technical environmental and financial constraints when making local choices. Following Strategy approval, scheme Project Appraisal Reports (PARs) will be developed for the recommended short term programme.
- 2.1.3 This Strategy has been developed in partnership with Bournemouth Borough Council (BBC), Borough of Poole (BoP), Purbeck District Council (PDC) and Dorset County Council (DCC), who are all risk management operating authorities. This StAR has been submitted in June 2013 for adoption or endorsement (as required) by all four authorities in accordance with their respective procedures.
- 2.1.4 The Strategy has been developed in accordance with Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) and associated Environment Agency policies and procedures. A strategic approach is required as the problems are long-term and large-scale, have linked coastal processes, multiple benefit areas and require a consistent approach to management of internationally designated habitats within Poole Harbour.

2.2 Background

Strategic and legislative framework

- 2.2.1 The Poole and Christchurch Bay Shoreline Management Plan (SMP2) (sometimes referred to as the 'Two Bays SMP') covers this Strategy frontage, and was adopted in 2011. Information developed for this Strategy has drawn on the policy making process within the SMP2.
- 2.2.2 The preferred policy from SMP2 is generally Hold the Line for Poole Bay, Swanage Bay and the northern side of Poole Harbour and a combination of Managed Realignment (MR) and No Active Intervention (NAI) elsewhere. The specific SMP2 policies relevant to this Strategy are identified in Table 3.2.
- 2.2.3 In addition, the Frome and Piddle Catchment Flood Management Plan (CFMP) published in 2011 addresses the main two rivers flowing into Poole Harbour. This Strategy does not address fluvial issues and there is minimal overlap in fluvial and tidal flood risk. The recommendations of this Strategy do not impact the future implementation of preferred policies of the CFMP, other than negating the need for a Water Level Management Plan within the area proposed for Managed Realignment.
- 2.2.4 Works identified by this Strategy will be implemented using powers under Section 165 of the Water Resources Act 1991 and the Coast Protection Act, 1949. Schemes will be subject to the Town and Country Planning regulations and Land Drainage regulations where required.

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Previous studies

- 2.2.5 Various related studies and strategies have been completed or are on-going within the study area. Where appropriate these studies have been taken into account whilst producing this Strategy. Particularly relevant studies include:
- BoP Flood Risk Management Strategy (BoP, 2011) – to inform decisions relating to BoP planning policy and contribution policy
 - Poole Bay and Harbour Strategy (BBC, 2004)
 - Bournemouth Seafront Strategy (BBC, 2013)
 - Poole Seafront Strategy (BoP, 2013)
 - Brownsea Island Management Plan (National Trust, 2010)
 - A Strategy for Managing Coastal Change in Purbeck (National Trust, 2010)
 - South East Dorset Green Infrastructure Strategy (Draft 2011)
 - Port of Poole Master Plan (Poole Harbour Commissioners)
 - River Frome Rehabilitation Plan (Environment Agency and Natural England)
 - Wareham Tidal Banks studies (Environment Agency, 2006, 2007, 2008)

Social and political background

- 2.2.6 BBC, BoP and PDC are coastal operating authorities under the Coast Protection Act. In addition, BBC and BoP are unitary authorities and are therefore also respective Lead Local Flood Authorities (LLFA). DCC fulfils the LLFA responsibility for PDC.
- 2.2.7 The main areas of high population density in the Strategy area are the coastal urban areas of Bournemouth and Poole, with areas of smaller population density including Swanage, Wareham, and villages and hamlets located around the coastline. There are also small populations on Furzey and Brownsea Islands. The economy in the Strategy area is dominated by Bournemouth and Poole.
- 2.2.8 Within Poole there are a number of sites which front onto Poole Harbour (specifically around Holes Bay) where the BoP are working with private developers to encourage regeneration. Development is anticipated to be a mixture of commercial, residential and community facilities. A planning application has recently been submitted for the Hamworthy Power Station site for 1,350 residential dwellings and other facilities.
- 2.2.9 Poole Harbour is renowned for being one of the largest natural harbours in the world. As well as extensive leisure boating facilities and yacht construction, the harbour is home to the port of Poole, providing passenger ferry, freight and cargo handling operations. Navigation in Poole Harbour is the responsibility of the Poole Harbour Commissioners (PHC). There is no navigation authority for the well-used tidal River Frome to Wareham, although the Environment Agency own the river beds and mooring rights of the tidal reaches of the Frome and Piddle (known as the Wareham Royalty), from which an income is derived.
- 2.2.10 Tourism within the whole of the Strategy area is a significant part of the local economy, with numerous attractions, beaches and facilities for various water sports. The estimated number of coastal visitors is 5 million per year.
- 2.2.11 The Wytch Farm oilfield has been producing oil and natural gas since 1979 with a number of oil wells located on the south coastline of Poole Harbour and on Furzey Island. Peak production occurred in 1998, and although now declining, production (currently about 16,000 barrels/day) is anticipated to continue for at least 15 years.
- 2.2.12 The National Trust is the landowner for Brownsea Island and Studland, and manages these sites for both their wildlife interests and tourism. Similarly the RSPB is the landowner for much of the Arne peninsula and own/lease other sites in Lytchett Bay.

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- 2.2.13 A Steering Group was formed to provide oversight and engagement in the development of this Strategy. Members included the local authorities, DCC, Natural England (NE), PHC, National Trust (NT), RSPB, and English Heritage.
- 2.2.14 The Dorset Coast Forum (DCF) is a strategic coastal partnership, established in 1995 with the principal objective of promoting a sustainable approach to the management, use and development of Dorset's coastal zone. The Swanage Coastal Change Forum (SCCF) was formed in 2012 to provide a platform for increased understanding of coastal change adaptation specific to Swanage. These organisations have been involved as stakeholders for this Strategy.
- 2.2.15 Development of this Strategy was undertaken in combination with the Living with Coastal Change (LiCCo) project – a part-European funded project focussed on specific sites across France and the UK to raise awareness of coastal change and how communities can adapt successfully. The Environment Agency and NT are both active participants, with Poole Harbour and Swanage a focus for the UK sites.

Location and designations

- 2.2.16 The study area (refer to Key Plan 1) extends from Hengistbury Head to Durlston Head and includes the whole of Poole Harbour. The open coast frontage is approximately 34km and includes Poole Bay, Studland Bay, Swanage Bay and Durlston Bay. Poole Harbour has an additional 106km of coastline, plus a further 12km associated with 4 islands, the largest of which is Brownsea Island. The area is extensively designated covering a wide range of environmental features.
- 2.2.17 There are several sites of international nature conservation importance in the Strategy area shown on Key Plan 2, including Special Areas of Conservation (SAC), designated under the Habitats Directive (92/43/EEC), Special Protection Areas (SPA) designated under the Birds Directive (79/409/EC) and Ramsar sites designated under the Convention on Wetlands (Ramsar, 1971). These sites are listed below:
- Dorset Heathlands - SPA and Ramsar
 - Dorset Heaths - SAC
 - Dorset Heaths (Purbeck & Wareham) and Studland Dunes - SAC
 - Poole Harbour - SPA and Ramsar. These two designations share the same boundary except at Arne Moors, where the Ramsar site is larger.
 - Isle of Portland to Studland Cliffs – SAC
 - Lyme Bay and Torbay – candidate SAC
- 2.2.18 There are 23 Sites of Special Scientific Interest (SSSI) within the Strategy area, of which 16 overlap the 1% AEP flood event. A number of the SSSIs are also internationally important for their wildlife and habitats and are also designated SAC, SPA and Ramsar sites.
- 2.2.19 In addition to the SSSIs, there are seven National Nature Reserves (NNRs) within the Strategy area: Durlston, Hartland Moor, Studland and Godlingston Heath, Stoborough Heath, Arne Reedbeds, Holton Heath and Morden Bog. The NNRs were established to protect the most important areas of wildlife habitat and geological formations in Britain as places for scientific research. All are at risk from either tidal flooding or erosion.
- 2.2.20 The Strategy also encompasses the Wild Purbeck Nature Improvement Area (NIA), which is not a designated site but is a national area selected by Defra to help deliver wildlife restoration and management, and improve existing wildlife sites.
- 2.2.21 Parts of the coastline between Durlston Head and Studland Bay in the Strategy area form part of the Dorset and East Devon Coast World Heritage Site (WHS), commonly known as The Jurassic Coast. This WHS is internationally recognised for its important geological formations and earth heritage features designated as SSSI and Geological Conservation Review (GCR) sites.

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- 2.2.22 There are 15 Scheduled Monuments within the Strategy area, of which 6 may be at risk of tidal flooding or erosion over the duration of the Strategy. In addition there are 12 Conservation Areas, 3 Registered Parks and Gardens and over 300 listed buildings within the Strategy area, including 3 Grade I and 16 Grade II* designated structures. The greatest concentrations of Listed Buildings are those within the towns and villages including Swanage, Wareham, Studland, Brownsea Island, Bournemouth and Poole.
- 2.2.23 The Strategy area also falls within part of the national designation of the Dorset Area of Outstanding Natural Beauty (AONB). The Dorset AONB covers 44% of Dorset including over half of Poole Harbour, including Brownsea and the smaller islands. In addition there are two National [landscape] Character Areas which fall within the Strategy area; Dorset Heaths and South Purbeck, and the Purbeck Heritage Coast.

History of Flooding and Erosion

- 2.2.24 Coastal erosion has been actively managed and controlled at both Poole Bay (Bournemouth and Poole) and at Swanage for about 100 years. However, major failures to the seawall at Bournemouth have occurred during that period, notably in 1972, 1988 and 1989 when beach levels were low. The latter event caused extensive damage, loss of about 100 beach huts and required costly repairs. More damage to the promenade and seawall was narrowly avoided in November 2006 by the commencement of a previously planned renourishment operation (known as BIS4). Historic rates of erosion of the cliffs in the 1800's before the beach management and seawall were completed are understood to have been about 1 to 1.5m per year.
- 2.2.25 There are many locations where formal flood or erosion defences are not present – notably Studland, north of Swanage and within Poole Harbour areas such as Ham Common, Brownsea Island and parts of the Arne peninsula. Within the Harbour the rate of erosion is relatively low due to the low level of wave energy and tidal current process (up to 0.5m/year).
- 2.2.26 Erosion and landslides in Dorset have been well publicised during 2012 and 2013. At North Swanage there were a number of landslides in the winter of 2012/13 adjacent to the seawall, causing material to fall on to the beach. Despite the proximity to the coastline, the North Swanage landslides are outside the scope of this Strategy because the toe of the slope is protected against coastal erosion by the seawall. Landslides experienced were a result of upper slope instability exacerbated by the high level of rainfall experienced during 2012.
- 2.2.27 Historical maps indicate that the Studland peninsula and heath has evolved and grown notably over the past 300 years. The current dune coastline erodes and accretes each year in different locations dependent on the incident storm events. Erosion has affected some of the amenity facilities and beach huts, which have required occasional relocation as a result.
- 2.2.28 Due to the presence of existing defences, there has been limited flooding within the Strategy frontage, and there have been no extreme tidal surge events in recent years. However the reducing residual life of existing tidal flood defence and erosion defence assets, coupled with sea level rise, is exposing an increasing number of properties to risk.
- 2.2.29 Recent low order tidal surge events (up to 20% AEP) have caused shallow tidal flooding to roads in the Poole area, (Shore Road, Sandbanks Road, West Quay Road, Hazelbury Road, Upton Road and local access roads in the port) and Swanage (Shore Road, Mowlem Lane) when accompanied by an easterly wind direction. Flooding in some locations is caused by a combination of inadequate drainage and tide-locking on high tide events.

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- 2.2.30 Some of the tidal river embankments near Wareham overtop regularly (most spring tides), causing local saline influence to designated freshwater grazing marsh, but not threatening any property.

2.3 Current approach to flood and erosion risk management

Measures to manage the probability of flood and erosion risk

- 2.3.1 Defences are owned and maintained by a range of organisations including BBC, BoP, PDC, PHC, NT, Network Rail (NR), Environment Agency and private property landowners.
- 2.3.2 As a result of the number of owners and overall Strategy frontage length, the defence system has a range of standards of protection and condition grades.
- 2.3.3 Over the past 10 years, the following capital investment schemes have been undertaken in the Strategy area as indicated in Table 2.1:

Table 2-1 Recent Capital Investment Schemes

Frontage	Year	Cost	Capital Investment Scheme
Hengistbury Head to Sandbanks	2005-2009	£10m	Four separate phases of beach renourishment and groyne replacement, including: 2005/6 - 1,050,000m ³ ; 2006/7 - 700,000m ³ ; 2008 - 75,000m ³ ; 2009: 75,000m ³ .
	1970-2000	Est. £12m+	Estimated 2million m ³ of beach renourishment placed between 1970 and 2000.
Poole	2001, 2004	£1.9m	Two phase improvement scheme including new flood walls and other defences.
Hamworthy	2005-06	£0.9m	Improvement scheme, comprising upgrading existing walls and new embankment.
Swanage	2005	£2.2m	Beach renourishment of 90,000m ³ and 18 replacement timber groynes.

- 2.3.4 Table 3.2 summarises the nature and condition of the existing defences for each cell. Further information is included in Appendix B and C (Baseline Report and Option Assessment Report).
- 2.3.5 There are seven legal agreements between the landowners and the local River Board dated 1957 to 1992, which may require the Environment Agency, as a successor organisation, to maintain in perpetuity the large majority of the Wareham Banks and Ridge tidal embankments. Some of the agreements reference a specific embankment profile, whereas others identify that they should be managed ‘...as may be required in the interest of land drainage’.
- 2.3.6 The Environment Agency’s current legal opinion on the requirements of these agreements considers that they are enforceable. The Area team will continue to engage with the landowners concerning their future management.

Measures to manage the consequences of flood and erosion risk

- 2.3.7 The Environment Agency’s Flood Warning system covers the Strategy area. The adoption of this service has recently been locally promoted to encourage participation.
- 2.3.8 Management of flood risk through Development Control will continue to regulate development to avoid putting new assets at risk in accordance with the National Planning Policy Framework (NPPF), together with specific guidance such as Purbeck Planning Guidance on erosion/land instability risk zones (CCMA).
- 2.3.9 Emergency planning is a vital part of managing the risks to coastal communities and the relevant authorities constantly update their procedures to account for changing circumstances. It will be necessary to ensure the Strategy outcomes and identified risks are fed into the local emergency planning system.

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3 Problem definition and objectives

3.1 Outline of the problem

3.1.1 The large size and nature of the Strategy area is such that there is a range of tidal flood and erosion risk problems of differing nature, scale and urgency.

3.1.2 In order to structure the analysis of flood and erosion risk management options for the Strategy, the 152km total frontage length was originally divided into 22 flood and erosion risk management units (FRMCUs). The appraisal process started with these units, but they have been combined and presented in this report as 13 analysis cells (refer to Key Plan 1) – separated by either natural contours or tidal / coastal erosion process linkages. Each cell has limited hydraulic or asset linkage to other cells, confirmed by hydraulic and sediment modelling assessments (refer to Appendix B). The cells are listed below:

- Cell 1: Hengistbury Head to Sandbanks FRMCU1-4:
- Cell 2: Luscombe Valley FRMCU 5
- Cell 3: Lower Parkstone FRMCU 6
- Cell 4: Central Poole FRMCU 7
- Cell 5: Hamworthy FRMCU 8
- Cell 6: Rockley Sands FRMCU 9
- Cell 7: Lytchett Bay FRMCU 10
- Cell 8: Wareham Banks & Ridge FRMCU11-13
- Cell 9: Poole Harbour South FRMCU14-15
- Cell 10: Brownsea Island FRMCU 16-17
- Cell 11: Studland & Ballard Down FRMCU 18-20
- Cell 12: Swanage FRMCU 21
- Cell 13: Durlston Bay FRMCU 22

3.1.3 Table 3.2 summarises the tidal flood and coastal erosion risk for each cell, the nature and performance of the existing defences where present, and the receptors at risk now and in future with climate change.

3.1.4 This Strategy has assessed coastal erosion and tidal flood risk. There are some locations (primarily in Poole, Upton and Swanage) where combined surface water drainage and tidal lock on flap valves or back-up can cause increased levels of flood risk to property. These local combined flood risk issues have not been modelled within this Strategy due to their local scale and complexity, but have been identified for further investigation.

3.1.5 The areas of designated habitat gains and losses calculated for Poole Harbour SPA and Ramsar site (refer to Appendix D - Habitat Predictions and Cause Allocation in Poole Harbour) are shown in Table 3.1. Habitat change is a result of human influences (in particular coastal squeeze from the presence of flood and erosion defences) or uncertain causes and is based on a working assumption of holding the line at all locations. The range of uncertainty in losses is due to the lower and upper end of sea level rise scenarios.

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Table 3-1 Predicted cumulative habitat changes from FCERM influences within Poole Harbour SPA

Habitat	Predicted cumulative habitat change (ha) from 2010 to:		
	2030	2060	2110
Sub-tidal	+20 to +40	+71 to +95	+133 to +268
Inter-tidal (rock, boulders, mud, sand flats)	-44 to -14	-77 to -57	-79 to +9
Reed bed, Saltmarsh and transitional saltmarsh	+1 to +7	-9 to -4	-234 to -37
Grazing marsh, heath, fen and acid grass	-2	-3 to -2	-4 to -3
Scrub, broad leaved woodland, molinia meadow and non classified habitats (terrestrial)	-6 to -5	-11 to -7	-30 to -13

3.1.6 In the short term, the main loss is up to 44ha of inter-tidal habitat. Other losses are 2ha of grazing marsh and 6ha of woodland/molinea meadow terrestrial habitat. As a result of failure of embankments, by the end of the long term the key loss will switch from inter-tidal to reedbed and saltmarsh, and an increasing loss of terrestrial habitat.

3.2 Consequences of doing nothing

3.2.1 The total number of properties at risk of erosion by 2110 for a Do Nothing scenario is 7,025. About 90% of these are in Cell 1 – Hengistbury Head to Sandbanks. The existing beach and seawall provides an estimated residual 20 years of protection before the first cliff-top properties would be lost to erosion.

3.2.2 The total numbers of properties at risk of tidal flooding (1% AEP) for a do nothing scenario is 772 now, increasing to 3,397 by 2110. About 75% of these are in Cell 7 – Central Poole. Critical infrastructure at risk includes sections of the A35(T), A351 and parts of the South Coast railway from Poole towards Weymouth.

3.2.3 There are 20 historic landfill sites within the Strategy area, notably in Poole, such as Baiter Park, and Whitecliff Recreation Ground. Erosion or flooding of any land affected by contamination has the potential to affect environmental features including designated conservation sites, which would require management at project level.




3.2.4 Other notable impacts of the failure of existing defence structures would include:




3.2.5 Erosion of the neck of Sandbanks peninsula, causing loss of community on Sandbanks, loss of the Sandbanks ferry access to Studland, and increased exposure to coastal wave and tide levels within Poole Harbour. The scale of impact of increased coastal forces was tested by hydraulic modelling, identifying relatively minor impact to the wider Poole Harbour and moderate velocity increase locally near Sandbanks. Erosion of Hengistbury Head was also assessed, but considered to be less likely than 0.5% AEP (2110) and therefore not taken further.

3.2.6 Hengistbury Head to Sandbanks – degradation of the beach from a high amenity value to a very low amenity natural erosion cliff line would have major detrimental tourist impact of the current 2.7m visitors per year and associated business impact.





3.2.7 Wareham Banks to Ridge – failure of embankments would lead to permanent tidal inundation of c.370ha of low grade freshwater grazing marsh (largely designated SPA and Ramsar) and potential legal proceedings against the Environment Agency. In addition there would be loss of some public rights of way footpaths. The navigation of the tidal River Frome to Wareham is likely to be impacted, with reduced draught as a natural unconstrained river may gradually establish a wider and shallower profile. The hydraulic impact of the increased tidal prism on water levels in the wider Poole Harbour is assessed as relatively minor

Table 3-2 Summary of Existing Defences, Standard and Assets at Risk for each Cell




Cell & FRMCU	SMP2 policy	Length	Problem	Existing Defences	Photo	Condition & SoP / Erosion Life	Assets at Erosion & Tidal Flood Risk		
							Residential Props Erosion Risk 2110 Flood Risk 1% AEP	Non Res. Props Erosion Risk 2110 Flood Risk 1% AEP	Other Key Assets
Hengistbury Head to Sandbanks FRMCU1-4	HtL	18.3km	Erosion risk to cliffs, causing loss of property in Bournemouth and east Poole (Branksome to Sandbanks). Erosion of neck of Sandbanks peninsula, loss of access and therefore community. Some property also at flood risk on Sandbanks.	Managed sandy beach with 53 timber groynes and 10 rock groynes protecting concrete sea wall. Local privately owned erosion defences at Sandbanks.		Timber groynes - grade 5 to 2. About 25 need replacing within 5 yrs. Beach requires renourishment due to coastal process losses Erosion Life: 20 yrs before property at risk Sandbanks flood risk: 5-2% AEP to property	5,810 at risk of erosion from Yr 20-100 63 at flood risk now, 130 by 2110	613 at risk of erosion from Yr 20-100 12 at flood risk now, 44 by 2110	Bournemouth Int. Centre (BIC). Also two piers, 2,528 beach huts, & many tourist amenity facilities. Beach used by estimated 2.7m per year Sandbanks Ferry providing access to Studland. Poole Harbour channels
Luscombe Valley FRMCU5	HtL	2.4km	Combination of erosion and flood risk. Shore Road floods relatively frequently, estimated 10-20% AEP. Road provides main access to Sandbanks	Mixture of concrete or sheet piled seawall and some rock revetment. Local trials to encourage salting vegetation and beach dune accretion.		Tidal flood risk: 1% AEP to property, but overtopping impacts Shore Road at about 10-20% AEP. Seawall generally in fair to good condition.	34 at risk of erosion from Yr 50-100 8 at flood risk now, 1r by 2110	71 at risk of erosion from Yr 50-100 3 at flood risk now, 6 by 2110	Shore Road (access to Sandbanks)
Lower Parkstone FRMCU6	HtL	3.2km	Combination of erosion and flood risk. Sandbanks Road (near Whitecliff Rec. Ground) floods relatively frequently due to pluvial & high tide combined flood risk	Mixture of concrete or masonry seawall and some rock revetment, mostly privately owned, some BoP.		Tidal flood risk: <0.5% AEP to property, but combined surface & tidal lock flood risk to Sandbanks Road at about 10% AEP. Seawall generally in fair to good condition.	115 at risk of erosion from Yr 50 12 estimated at comb. flood risk now, 126 by 2110	16 at risk of erosion from Yr 50 11 estimated at comb. flood risk now, 40 by 2110	Whitecliff Recreation ground is known to be a 1930s uncontrolled rubbish tip

Cell & FRMCU	SMP2 policy	Length	Problem	Existing Defences	Photo	Condition & SoP / Erosion Life	Assets at Erosion & Tidal Flood Risk		
							Residential Props Erosion Risk 2110 Flood Risk 1% AEP	Non Res. Props Erosion Risk 2110 Flood Risk 1% AEP	Other Key Assets
Central Poole FRMCU7	HtL, with some NAI for parts of Holes Bay	17.7km	Flood risk to urban areas of Poole (Old Town, Creekmoor, Stanley Green and Lower Hamworthy), but with some localised erosion risk – controlled by existing revetments. Combination of surface water & tidal lock on drainage cause flood risk to roads and property.	Mixture of various constructions including approx. 2.1km of revetment, 1.3km of concrete, masonry / blockwork flood walls and 700m of sheet piled walls. Numerous marinas, quays and port. 6nr pumping stations and / or drainage outfalls.		Tidal flood risk: 2% AEP to property. Tidal flood walls in fair to good condition. Erosion revetment in fair to good condition. Combined surface drainage / high tide flood risk	64 at risk of erosion from Yr 50-100 471 at flood risk now, 1,527 by 2110	14 at risk of erosion from Yr 50-100 102 at flood risk now, 589 by 2110	Sections of A35 and A350 highways within Poole South coast railway from Poole crosses Holes Bay on raised embankment. 6 historic landfill sites and 1 waste management site 3 scheduled monuments and 42 listed buildings
Hamworthy FRMCU8	HtL	2.3km	Combination of erosion and flood risk.	Mixture of set-back grass embankment and flood wall (2005 scheme) with sea walls and small groyne field and beach. 400m section of privately managed seawall in rear of gardens (outside of 2005 improvement scheme)		Tidal flood risk: <0.5% AEP to property (other than properties outside of 2005 scheme) Seawall generally in fair to good condition.	92 at risk of erosion from Yr 50-100 8 at flood risk now, 166 by 2110	21 at risk of erosion from Yr 50-100 0 at flood risk now, 34 by 2110	MoD operational base
Rockley Sands FRMCU9	MR, with future NAI	1.4km	Erosion risk to Ham Common and Rockley Sands Holiday caravan park. Natural erosion rate estimated to be 0.5m/yr	Gabion wall at toe of small cliff fronting Rockley Sands Caravan park. Privately maintained. Gabions removed from Ham Common in 2005, erosion being monitored.		Gabion wall in fair condition	67 static home caravans at risk of erosion from Yr 20-100	Infrastructure of Rockley Sands Caravan Park, inc Sailing club building	Ham Common SSSI (geological) Dorset Heaths SAC (Ham Common)

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Cell & FRMCU	SMP2 policy	Length	Problem	Existing Defences	Photo	Condition & SoP / Erosion Life	Assets at Erosion & Tidal Flood Risk		
							Residential Props Erosion Risk 2110 Flood Risk 1% AEP	Non Res. Props Erosion Risk 2110 Flood Risk 1% AEP	Other Key Assets
Lytchett Bay FRMCU10	NAI, with future MR & HtL (east)	6.4km	Flood risk to urban areas of Turlin Moor & Upton on east side of bay. Flood risk to grazing marsh on west side both banks of River Sherford.	East side – no specific flood defences, flood management by natural and artificially raised ground levels. West side – 3.2km of earth embankments		East side: 1% AEP West side: Tidal flood risk: 20% AEP. Earth embankments (west side) in poor condition.	12 at flood risk now, 337 by 2110	0 at flood risk now, 64 by 2110	70ha (increasing to 230ha) predominantly Grade 4 & 5 land Sewage treatment Works near Upton. A35 and A351 highway and South coast railway
Wareham Banks & Ridge FRMCU11-13	MR	31.8km	Tidal flood risk to grazing marsh. Land drainage becoming restricted. Historic legal agreements for maintenance of land drainage embankments.	21.7km of earth embankment providing land drainage (flood defence) to grazing marsh. Difficult to access embankments to undertake effective maintenance.		Tidal flood risk: Varies 100% to 10%, but typically 20% AEP. Earth embankments in poor to fair condition, overtop regularly (MHWS at locations)	19 at flood risk now, 101 by 2110 Largely isolated or in small groups	16 at flood risk now, 48 by 2110	450ha predominantly Grade 4 & 5 land, designated SPA / Ramsar. Sewage treatment Works, Keysworth. Navigation of tidal River Frome, and pRoW
Poole Harbour South FRMCU14-15	NAI	46.3km	Tidal flood and erosion risk in some locations, individual isolated properties at risk	No man-made defences.		No defences	4 at flood risk now, 6 by 2110	0 at flood risk now, 10 by 2110	Landing access to islands including Furzey Island Conservation designation sites
Brownsea Island FRMCU16-17	NAI, with local management	6.5km	Tidal flood risk to saline lagoon and property near ferry access point. Minor erosion risk Branksea Castle	Lagoon seawall (partially revetted). Access jetty and hard standing at ferry point. 15nr timber groynes near Branksea Castle.		Tidal flood risk: Lagoon seawall regularly overtops and seepage, but generally in good condition against breach. However property at about 5-10% risk.	10 at flood risk now, 10 by 2110	7 at flood risk now, 9 by 2110	Lagoon is key feature of Poole Harbour SPA. Ferry access is only current access location to island. Popular National Trust tourist attraction. Branksea Castle listed building.

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Cell & FRMCU	SMP2 policy	Length	Problem	Existing Defences	Photo	Condition & SoP / Erosion Life	Assets at Erosion & Tidal Flood Risk		
							Residential Props Erosion Risk 2110 Flood Risk 1% AEP	Non Res. Props Erosion Risk 2110 Flood Risk 1% AEP	Other Key Assets
Studland & Ballard Down FRMCU18-20	NAI	5.7km	Natural sand dunes, subject to erosion and accretion. Loss of beach amenity facilities and beach huts Ballard Down: Natural cliffs with erosion risk.	About 150m of gabion wall and concrete walls. Critical Third Party Asset: 1km long navigation training wall (rock) controls navigation channel off Shell Bay & influences coastal process		Gabion in poor condition. Training wall considered to be in good condition.	1 at risk of erosion from Yr 20-100	7 at risk of erosion from Yr 20-100	Beach used by estimated >1m people per year, major regional tourist attraction. 260 beach huts, Car-parking and beach amenity facilities. South West Coast path trail
Swanage FRMCU21	HtL & NAI with MR long term	7.6km	Swanage: Combination of erosion, tidal flood risk (both overtopping of seawall and via Swan Brook) and local surface water flood risk.	Swanage: 18nr timber groynes and sandy/shingle beach foreshore. Concrete & masonry seawalls. Northern section of wall privately owned. North Beach to Ballard Point: No defences.		Beach and groyne system in good condition. Concrete seawall in good to fair condition, poor in places to north section.	18 at risk of erosion from Yr 20-100 9 at flood risk now, 93 by 2110	29 at risk of erosion from Yr 20-100 5 at flood risk now, 10 by 2110	Swanage beach used by estimated 250,000 people per year, major regional tourist attraction. South West Coast path trail, 60nr beach huts, Beach amenity facilities
Durlston FRMCU22	MR with NAI long term	2.1km	Natural cliffs, subject to erosion. Land slippage causing local property issues	None other than rock placed at toe of cliff over short section		Not applicable	60 at risk of erosion from Yr 20 - 100	1 at risk of erosion from Yr 20 - 100	Dorset & East Devon Coast World Heritage Site (Jurassic Coast). South West Coast path trail
Total		152km					6,260 at risk of erosion 616 at flood risk, 2,513 by 2110	765 at risk of erosion 156 at flood risk, 854 by 2110	

3.3 Strategic issues and objectives

- 3.3.1 A strategic approach has been adopted for the Poole to Wareham FCERM Strategy area for the following reasons:
- Complex interdependencies between natural systems and physical processes within Poole Harbour and Poole Bay need to be reviewed together in order to assess the environmental constraints and opportunities of proposed works.
 - The strategic nature of assets such as the terminal groyne at Hengistbury Head and Sandbanks peninsula in managing flood and erosion risk across a wide area.
 - The extensive European designations within the Strategy area, particularly for Poole Harbour, and need to resolve the IROPI case for habitat losses related to coastal squeeze identified in the SMP.
 - Responsibilities of managing the existing tidal flood and erosion defence assets are held by different organisations. A joint approach by all stakeholders is required to promote any works from this Strategy. This Strategy has been developed through involvement of these organisations and consultation with landowners and wider representation to identify the preferred approach to manage tidal flood and erosion risk and its consequences to the benefit of the local community.
 - Established partnerships between the different risk management authorities, with significant potential for contributions, efficiencies and funding from developing the relationships further.
- 3.3.2 The Strategy promotes and encourages long term sustainable and strategic management of tidal flood and erosion risk. It will help the Environment Agency and local authorities prioritise future investment and ensure the best use of public funds by providing a plan to implement capital projects, routine maintenance, further studies, surveys and investigations.
- 3.3.3 The principal aim of this Strategy is to identify the long-term integrated approach to tidal flood and erosion risk management, defining a 10 year prioritised plan of investment within the context of a 100 year analysis period, and reinforcing the mutual benefits of partnership and collaboration.
- 3.3.4 This Strategy also identifies and prioritises other flood and erosion risk management activities such as providing advice to planning authorities to control development, investment in flood warning and potential resilience approaches where tidal flood or erosion risk will be relatively high but the potential for capital improvement schemes is relatively low.
- 3.3.5 The Strategy does not include detailed risk assessment of combination surface water and high tide flooding, which will be addressed where necessary by the respective Lead Local Flood Risk Authority.
- 3.3.6 A Water Framework Directive (WFD) assessment was undertaken as an integral component of the Strategy, being used to influence decision making throughout the SEA and to guide the identification and development of environmentally acceptable solutions.
- 3.3.7 The Strategy identifies how to manage the loss of various habitat types within sites designated under European Birds and Habitats Directives where caused by flood risk management assets (coastal squeeze) and direct footprint area of improvements to existing or new defences.
- 3.3.8 The Strategy objectives are: -
- Identify the optimum sustainable tidal flood and coastal erosion risk management solutions to protect local communities within the context of a 100 year plan, with an associated prioritisation and funding approach for project implementation for the next 10 years.

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- Identify and prioritise other flood risk management activities such as providing advice to planning authorities to manage development, to utility companies to protect important infrastructure, and investment in flood warning.
- Minimise adverse impact caused by Strategy recommendations and seek ways to enhance the environmental, amenity and recreational value of the study area.
- Maintain the integrity of the Natura 2000 network, and identify preferred locations for new inter-tidal habitat to compensate for losses caused by rising sea levels where attributable to the presence of coastal defences, with specific requirements to compensate for losses of habitats resulting from implementing the Strategy.

3.4 Key constraints and opportunities

- 3.4.1 A Strategic Environmental Assessment (SEA) has been undertaken reflecting the high environmental sensitivity of the natural and built environment within the Strategy area, in accordance with current Defra and Environment Agency policy. The SEA report (Appendix E) includes an Indicative Landscape Plan illustrating the key environmental constraints and opportunities, as summarised below.
- 3.4.2 Population and human health - Safety, security and well-being for people living at risk of erosion or in the tidal floodplain within the urban areas of Bournemouth, Poole, Upton, Wareham and Swanage. The potential for flooding can affect human health. Options which provide low risk (less than 1.3% AEP) have a beneficial impact on human health in this respect.
- 3.4.3 Development of some of the waterfront in Central Poole is planned, with local regeneration schemes incorporating tidal flood and coastal erosion risk management improvements. This will represent a significant saving to the public purse, but important 'gap-filling' will be required between and adjacent to development sites.
- 3.4.4 Biodiversity, Flora and Fauna – Poole Harbour and surrounding parts of heathland are designated internationally (SAC/SPA/Ramsar site) and nationally (SSSI) for their nature conservation importance.
- 3.4.5 Climate change, sea level rise and development pressure are key issues for the designated habitats in the Strategy area. The survival of particular flora and fauna is dependent on whether there is sufficient space available for these communities to move landward in response to sea level rise. The HRA has determined that there will be loss of internationally designated habitat as a result of Hold the Line options due to coastal squeeze, in addition to any loss from the footprint of any new defences. Additionally, there will be loss of designated terrestrial and freshwater wetland habitats including internationally important heathland and fen habitat where NAI or Managed Realignment policies are proposed.
- 3.4.6 The Government is committed to maintaining the integrity of the Natura 2000 network of European Sites. The Strategy can only progress if: there are no reasonable alternatives; there are imperative reasons of overriding public interest; and compensation is successfully provided prior to scheme implementation.
- 3.4.7 Material Assets (infrastructure) - There is critical infrastructure such as A-roads, railways, shipping and ferry routes at risk of tidal flooding or erosion. The A35(T) and A351 highways are at risk of flooding and erosion in parts of Poole. The South Coast railway line (Poole to Weymouth) is at risk of flooding. The rail line crosses both Holes Bay and Lytchett Bay on revetted embankments, managed by Network Rail. Large numbers of shipping and ferry services use Poole Harbour and dredging is required to maintain these services. These road and railway transport links provide a strategic transport network for the region. These require ongoing protection from flooding and erosion as sea levels rise.

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- 3.4.8 There are four main sewage treatment works within the Strategy area, operated by Wessex Water. The sites are not at flood risk currently, but will be exposed with increased sea level rise.
- 3.4.9 Soils and Geology – The Strategy area overlaps the internationally important Dorset and East Devon Coast WHS (Jurassic Coast), designated for its earth heritage value. Other geological designations include SSSIs and GCR site, which covers the majority of the cliff frontage. Natural coastal processes are important in the conservation of the majority of these sites.
- 3.4.10 Landfill sites in the Poole area (e.g. Baiter and Whitecliff recreation areas) will require continued protection from erosion.
- 3.4.11 Land Use and Land Management – Significant areas of residential, commercial and industrial development are at tidal flood risk within the large and rapidly growing conurbations around Poole Harbour. There are industrial estates on the north-western shore at Holton Heath and major oil workings on the southern shores of the harbour. Approximately 67% of the land area within the Strategy comprises agricultural land (predominantly grades 4 and 5 i.e. poor to very poor).
- 3.4.12 Water and Hydromorphology – Poole Harbour is hypereutrophic i.e. showing abnormally high levels of nutrients. This leads to an algal cover to about 5% of the inter-tidal mudflats. New inter-tidal habitat areas (as compensation for loss of designated habitat areas) could also be vulnerable to this impact, which will be monitored through the strategic monitoring plan. For the strategy to meet Habitat Regulations and WFD in successfully establishing new coastal habitats, additional effort to protect and improve water quality in the catchment is likely to be required.
- 3.4.13 There are four designated shellfish waters in the Strategy area: Poole Bay, Poole Harbour South, Poole Harbour North and Poole Harbour West. Each is required to meet the standards set in the EC Shellfish Waters Directive and the Shellfish Hygiene Directive. Beach recharge may affect these standards unless appropriately designed and managed. There are also numerous designated bathing waters under the Bathing Waters Directive in the strategy area.
- 3.4.14 Under the WFD there are a number of relevant water bodies in the study area: Poole Harbour is a Highly Modified Water Body (HMWB) due to its coastal protection and navigation, and is currently identified as poor overall potential; Dorset/Hampshire coastal is also HMWB due to coastal protection, currently identified as good overall potential. There are also three groundwater bodies: Lower Dorset Stour and Lower Hampshire Avon (poor status); Lower Frome and Piddle (poor); and Brownsea Island (good). One lake water body and numerous upstream river water bodies flow into the transitional or coastal water body, but only two are directly affected due to overlap with the Strategy area: Piddle Lower (HMWB due to flood protection and urbanisation, currently poor overall potential); and Frome Dorset (Lower) & Furzebrook Stream (poor overall status).
- 3.4.15 Cultural Heritage and Archaeology - The coastline is rich in terms of its cultural heritage and archaeological remains, with high archaeological potential at Brownsea Island, the eastern shore and inter-tidal zone of Poole Harbour, Hamworthy, Poole Old Town, Sandbanks and Wareham. The Strategy considers options to reduce the risk of flooding to these assets. Development of flood risk management projects (particularly wetland habitat creation through managed realignment) will need to consider the potential for archaeological deposits and appropriate mitigation at a project stage to ensure no significant adverse effect on the setting of heritage assets.
- 3.4.16 Landscape and Visual Amenity - There are international, national, regional and local designations for landscape value within the study area. These include the nationally designated Dorset AONB, the Jurassic WHS coastline, and Wild Purbeck which will require further consideration at a project level where defences are raised to manage flood risks from rising sea levels, or realigned.

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4 Options for managing tidal flood risk and coastal erosion

4.1 Potential FCERM measures

- 4.1.1 A three stage process was undertaken for option appraisal: High Level Option (HLO), Long-List assessment, Short-List detailed appraisal and selection of preferred option. The outcome of each stage was endorsed by the Steering Group.
- 4.1.2 The HLO stage comprised a review of the policies identified at SMP2 level, and applied to a Flood and Coastal Risk Management Unit (FCRMU) scale. A range of HLOs was considered for each Unit.
- 4.1.3 The range of HLOs are defined as:
- No Active Intervention (NAI). No further works would be carried out to manage flood and erosion risk, except relating to legal compliance such as public health and safety.
 - Maintain. Maintenance of flood / erosion defence assets, ensuring structural integrity and standard of service, but not accounting for climate change impacts.
 - Sustain. Improvements to assets that would be carried out to ensure the Standard of Protection remains consistent, and keeps pace with climate change.
 - Improve. Improvements to existing or construction of new assets, increasing the Standard of Protection, taking into account future climate change.
 - Managed Realignment (MR). Realigning the location of the existing assets, either through a partial or full set-back to high ground. Where applied to erosion defences, it typically refers to assets slowing the rate of erosion that would otherwise occur with no defence.
- 4.1.4 For each unit, the HLOs were considered based on policy context, present day flood and erosion risk, opportunities for habitat creation, environmental issues and socio-economic viability. The outcome of this was the identification of two or three HLOs which proved suitable for further examination. From these HLOs, a long list of potential options for each unit was identified.

Table 4-1 Summary of Preferred High Level Options

FRMCU	Cell	Preferred High Level Option
1	1: Hengistbury Head to Sandbanks	Improve & MR
2		Improve / Sustain
3		Improve / Sustain
4		Sustain
5	2: Luscombe Valley	Sustain / Improve
6	3: Lower Parkstone	Sustain
7	4: Central Poole	Improve
8	5: Hamworthy	Sustain / Improve
9	6: Rockley Sands	MR
10	7: Lytchett Bay	Sustain / Improve & MR
11	8: Wareham Banks & Ridge	MR with localised Improve
12		MR with localised Improve
13		MR with localised Improve
14	9: Poole Harbour South	No Active Intervention, Sustain (locally)
15		No Active Intervention
16	10: Brownsea Island	No Active Intervention (transition) & local maintain
17		No Active Intervention
18	11: Studland Bay & Ballard Down	No Active Intervention
19		No Active Intervention (transition)
20		No Active Intervention
21		Sustain / Improve and MR
22	13: Durlston Bay	NAI / MR

4.2 Long list of options

- 4.2.1 Informed by the HLO for each unit, a ‘long-list’ of tidal flood and erosion risk management technical solutions was developed and assessed for each FCRMU. The Options Assessment Report (Appendix C) details this ‘Alignment and Type’ process fully with a tabulated process for selection onto the short-list of options. Options selected for the short-list were determined based on assessment of the suitability of each option to the specific problem(s) for each unit.

4.3 Options short-listed for appraisal

- 4.3.1 The short-listed options identified through the long list assessment process were developed into more detailed flood and erosion risk management options for appraisal. A description of each option for each cell is detailed in Tables 4.2 to 4.11.
- 4.3.2 Do Nothing and Do Minimum options have been short-listed, but for brevity are not detailed within the tables below. For tidal defences in Poole Harbour, Do Minimum and Maintain are generally equivalent, as existing defences either become regularly overtopped with sea level rise, causing similar impacts over the course of the strategy period, or defences are at the end of their residual life already (parts of Central Poole). For erosion defences (notably Hengistbury Head to Sandbanks and Swanage), Maintain and Sustain are equivalent, as the cost of additional reactive repairs to hold the line for Maintain in the medium to long term would be similar to the cost of proactive beach management for Sustain. A separate Maintain option has therefore not been short-listed.

Cell 1: Hengistbury Head to Sandbanks (erosion cell)

Table 4-2 Short-listed Options for Hengistbury Head to Sandbanks

Option	Description Summary
<p>3a: Sustain Existing Defence</p>	<p>Short term: Rock groynes, timber groynes and gabions will be maintained, including replacing about 25 timber groynes and 350m gabion wall over next 5 years. Upgrade the Terminal Groyne at Hengistbury Head (currently in poor condition).</p> <p>Beach management with regular renourishment proposed in Year 3 (and then typically every 5 years, to be confirmed with detailed Beach Management Plan. To maintain current beach volume, replacing typical annual loss of c.60,000m³. Renourishment volume will increase with sea level rise.</p> <p>Replace 80m section of poor condition sheet pile wall at Sandbanks (privately owned).</p> <p>Medium & Long Term: Incremental improvements to existing seawall structures from year 20 onwards, raise seawall in response to sea level rise in year 50.</p> <p>Existing privately owned seawalls along the shoreline of Sandbanks strengthened in the medium and long term, together with potential use of temporary flood barriers and walls at local access points to sustain the existing standard of flood protection (privately managed).</p>
<p>3b: Sustain (delayed recharge)</p>	<p>This option is the same as Option 3a but with the first beach recharge delayed until the middle of the short term (about year 12), then following the same 5 year pattern as Option 3a. Natural losses would be allowed to continue until the current beach volumes reduced back to a reduced design profile.</p>
<p>4: Improve - Open Beach</p>	<p>Short term: Removal of existing beach control structures (groynes & gabion wall) and placement of increased beach volume to manage erosion without groynes, accepting increased annual losses. Upgrade the Terminal Groyne at Hengistbury Head.</p> <p>Existing rock and timber groynes would remain until the end of their useful life and would not be replaced. Failed groynes would be removed on safety grounds.</p> <p>Replace 80m section of poor condition sheet pile wall at Sandbanks.</p> <p>Beach renourishment of about 855,000m³ required every 5 years,</p> <p>Medium & Long Term: Beach nourishment increasing to 1.05 million m³ every 5 years in the medium term and 1.1 million m³ every 5 years in the long term. Incremental improvements to existing seawall structures from year 20 onwards, raise seawall in response to sea level rise in year 50.</p> <p>Existing privately owned seawalls along the shoreline of Sandbanks strengthened in the medium and long term, together with potential use of temporary flood barriers and walls at local access points to sustain the existing standard of flood protection (privately managed).</p>
<p>5: Improve - Open Beach, Realign forward</p>	<p>This option is the similar to Option 3a but correcting the variation in seawall alignment to provide a smooth improved arc to reduce annual erosion losses. This would require extending the beach width and groyne length.</p> <p>Short term: Rock groynes, timber groynes and gabions will be improved, extending as locally required to suit new profile. Improve the Terminal Groyne at Hengistbury Head, increasing length.</p> <p>Beach management with single 1.6million m³ Improve renourishment in Year 3 to produce new profile, (and then typically every 5 years, to be confirmed with detailed Beach Management Plan) to maintain current beach volume, replacing annual loss. Renourishment volume will increase with sea level rise.</p> <p>Replace 80m section of poor condition sheet pile wall at Sandbanks.</p> <p>Medium & Long Term: Incremental improvements to existing seawall structures from year 20 onwards, raise seawall in response to sea level rise in year 50.</p> <p>Existing privately owned seawalls along the shoreline of Sandbanks strengthened in the medium and long term, together with potential use of temporary flood barriers and walls at local access points to sustain the existing standard of flood protection (privately managed).</p>
<p>6: Improve – Rock revetment</p>	<p>Short term: A rock revetment would be constructed in Year 5-10 along the full length of the existing seawall to provide erosion protection in year 10-15 to protect from scour and undermining of the foundations due to loss of the protective beach. Some reprofiling and recycling of existing beach material would be undertaken but no further recharging of new beach material would be undertaken.</p> <p>Existing groynes would be removed at the end of their residual life with the remaining groynes removed at the beginning of the medium term.</p> <p>Medium & Long Term: The existing seawall would be raised by around 0.5m in the short term and raised by a further 0.4m in the long term to sustain the standard of protection against rising sea levels.</p>

Cell 2: Luscombe Valley (combined erosion/flood cell)

Table 4-3 Short-listed Options for Luscombe Valley

Option	Description Summary
3: Sustain (Min 1.3% AEP)	<p>Short term: Maintain existing assets. Continue to undertake salt marsh regeneration trials to extend the effective life of the sea wall.</p> <p>Medium Term: Year 20 - Replace existing seawall adjacent to Shore Road, raising by 0.3m.</p> <p>Long Term: Year 50 - Raise seawall by further 0.4m to sustain against sea level rise.</p>
4: Improve (Min 0.5% AEP)	<p>Short term: Replace seawall by 0.6m to 0.8m higher, providing 0.5% AEP (SoP to be optimised if Improve option preferred).</p> <p>Medium term: Maintain existing assets.</p> <p>Long term: Year 50 - Raise seawall by further 0.4m to sustain against sea level rise.</p>
5: Managed Realignment	<p>Short term: This option would be undertaken in combination with Option 3 (Sustain) and comprises enabling the existing concrete culvert beneath Shore Road to allow tidal exchange from Poole Harbour into Luscombe Valley in the short term, thus creating a small area of inter-tidal habitat. Two new 500m long flood embankments would be constructed in the short term (year 1) along the property boundaries on the east and west sides of Luscombe Valley.</p> <p>Medium Term: Year 20 - Replace existing seawall adjacent to Shore Road, raising by 0.3m.</p> <p>Long Term: Year 50 - Raise seawall by further 0.4m to sustain against sea level rise. Raise embankments in Luscombe Valley similarly.</p>

Cell 3: Lower Parkstone (combined erosion/flood cell)

Table 4-4 Short-listed Options for Lower Parkstone

Option	Description Summary
3a: Sustain (medium term) (Min 0.5% AEP)	<p>Short term: Maintain existing assets. Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: Year 20 – Replace and upgrade existing seawall and other assets, raising by 0.3m.</p> <p>Long Term: Raise seawall as required to sustain against sea level rise.</p>
3b: Sustain (long term) (Min 1.3 % AEP)	<p>Short term: Maintain existing assets. Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: Maintain existing assets.</p> <p>Long Term: Raise seawall as required to sustain against sea level rise.</p>

Cell 4: Central Poole (combined erosion/flood cell)

Table 4-5 Short-listed Options for Central Poole

Option	Description Summary
3: Sustain (2% AEP)	<p>Short term: Replace seawalls near Lifting Bridge and at West Quay Road and Power Station site (potential private development areas). Establish cut-off flood defence between port / Sunseekers site and rest of Lower Hamworthy. Investigate local drainage outfalls causing combined surface water/tidal flood risk (e.g. Creekmoor, Stanley Green, Stert) and develop business case to manage accordingly.</p> <p>Medium Term: Raise (or replace) existing defence walls between Lifting Bridge and Baiter. Raise quay wall between Dolphin Quay and Fishermen Landing Stage.</p> <p>Long Term: Raise existing defence walls typically by further 0.4m to sustain against sea level rise.</p>
4a: Improve (1.3% AEP)	<p>Short term: Replace seawalls near Lifting Bridge and at West Quay Road and Power Station site (potential private development areas). Raise quay wall between Dolphin Quay and Fishermen Landing Stage. Establish cut-off flood defence between port / Sunseekers site and rest of Lower Hamworthy. Raise (or replace) existing defence walls between Lifting Bridge and Baiter to design standard.</p> <p>Investigate local drainage outfalls causing combined surface water/tidal flood risk (e.g. Creekmoor, Stanley Green, Stert) and develop business case to manage accordingly.</p> <p>Medium Term: Local defence improvements at Holes Bay (west).</p> <p>Long Term: Raise existing defence walls typically by further 0.4m to sustain against sea level rise.</p>
4b: Improve (1.0% AEP)	As Option 4a but increased defence level.
4c: Improve (0.5% AEP)	As Option 4a but increased defence level.
4d: Improve (0.33% AEP)	As Option 4a but increased defence level.

Cell 5: Hamworthy (combined erosion/flood cell)

Table 4-6 Short-listed Options for Hamworthy

Option	Description Summary
3: Sustain (Min 0.5% AEP)	<p>Short term: Maintain existing assets.</p> <p>Medium Term: Local beach management & groyne replacement in front of Hamworthy Park, as required.</p> <p>Long Term: Raise existing 2005 defence scheme to sustain similar level of SoP. Improve seawall next to beach. Consider requirement for new defence at seaward end of Lake Road.</p>

Cell 6: Rockley Sands (erosion cell)

Table 4-7 Short-listed Options for Rockley Sands

Option	Description Summary
3: Managed Realignment	<p>Short to Long term: Maintain existing gabion wall and hard standing at Rockley [Holiday] Park. Replace as and when needed, at private expense.</p> <p>Monitor & manage erosion at Ham Common cliff frontage.</p>

Cell 7: Lytchett Bay (flood cell)

Table 4-8 Short-listed Options for Lytchett Bay

Option	Description Summary
3a: Sustain (medium term) (Min 2% AEP)	<p>Short term: Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: Set back alignment of new embankment (Border Drive), flood wall (Furzey Road / Sandy Lane) and embankment near A35/A351 Bakers Arms roundabout</p> <p>Long Term: Set back alignment of new embankment along property boundary at Turlin Moor. Raise other defences from medium term typically by further 0.4m to sustain against sea level rise.</p>
3b: Sustain (long term) (Min. 10% AEP)	<p>Short term: Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: None</p> <p>Long Term: Set back alignment of new embankment (Border Drive), flood wall (Furzey Road / Sandy Lane) and embankment near A35/A351 Bakers Arms roundabout. Set back alignment of new embankment along property boundary at Turlin Moor.</p>
4: Improve (0.5% AEP)	<p>Short term: Set back alignment of new embankment (Border Drive), flood wall (Furzey Road / Sandy Lane) and embankment near A35/A351 Bakers Arms roundabout. Providing 0.5% AEP (SoP to be optimised if Improve option preferred).</p> <p>Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: Set back alignment of new embankment along property boundary at Turlin Moor.</p> <p>Long Term: Raise defences typically by further 0.4m to sustain against sea level rise.</p>
5: Managed Realignment (Lyt. Bay North) Subject to landowner agreement	<p>Short term: Implement MR at Lytchett Bay North to create 24ha of inter-tidal habitat, with excavation of a tidal creek network, allowing regular tidal flooding of the land area between the river and the A35.</p> <p>Investigate local drainage outfall causing combined surface water/tidal flood risk.</p> <p>Medium Term: Maintain.</p> <p>Long Term: Raise defences typically by further 0.4m to sustain against sea level rise.</p>

Cell 8: Wareham Banks and Ridge (primarily flood cell)

Table 4-9 Short-listed Options for Wareham Banks & Ridge

Option	Description Summary
<p>2: Do Minimum (legal compliance baseline) (100 to 5% AEP) Future wider Managed Realignment (medium term)</p>	<p>Short term: Manage the embankments to continue land drainage function, with minimum spend to achieve end of residual life (c.20 yrs).</p> <p>Medium Term: Implement MR option across all sites to create c. 370ha of inter-tidal habitat, new alignment detail to be determined (e.g. potentially retain Wareham to Ridge south bank of Frome section).</p> <p>Identify and implement freshwater habitat compensation (approx. 370ha) to enable MR inter-tidal habitat to proceed. Develop improved understanding of habitat transition wrt sea level rise, salinity levels, and sediment impacts.</p> <p>Address local property flood risk level with resistance/resilience measures or local flood walls where possible.</p> <p>Long Term: Address local property flood risk level with resistance/resilience measures or local flood walls where possible.</p>
<p>3a: Managed Realignment (Keysworth) – subject to landowner agreement Future wider MR (medium term)</p>	<p>Short term: Identify and implement about 81ha of freshwater habitat compensation. Implement MR at Keysworth to create similar area of inter-tidal habitat.</p> <p>Do Minimum level of maintenance for all other sections.</p> <p>Medium Term: Implement MR option across all other sections to create about 290ha of inter-tidal habitat, new alignment detail to be determined (e.g. potentially retain Wareham to Ridge south bank of Frome section).</p> <p>Identify and implement about 290ha of freshwater habitat compensation to enable MR inter-tidal habitat to proceed at all other sections.</p> <p>Address local property flood risk level with resistance/resilience measures or local flood walls where possible.</p> <p>Long Term: Address local property flood risk level with resistance/resilience measures or local flood walls where possible.</p>
<p>4a: Managed Realignment (Bestwall Estate) – subject to landowner agreement</p>	<p>As Option 3a, but Bestwall Estate (31ha), replaces Keysworth.</p>
<p>4b: Managed Realignment (Bestwall Meadows) – subject to landowner agreement</p>	<p>As Option 3a, but Bestwall Meadows (56ha), replaces Keysworth.</p>
<p>4c: Managed Realignment (Bestwall Estate & Meadows) – subject to landowner agreement</p>	<p>As Option 3a, but Bestwall Estate & Meadows (87ha), replaces Keysworth.</p>
<p>5a: Partial Managed Realignment (Arne Moors) – subject to landowner agreement</p>	<p>As Option 3a, but partial realignment route at Arne Moors to create 44ha of inter-tidal habitat, replaces Keysworth.</p>
<p>5b: Managed Realignment (Arne Moors) – subject to landowner agreement</p>	<p>As Option 3a, but larger realignment route at Arne Moors to create 110ha of inter-tidal habitat, replaces Keysworth.</p>
<p>5c: Full Managed Realignment (Redcliffe, Ridge, Moors River, Arne Moors) – subject to landowner agreement</p>	<p>As Option 3a, but partial realignment route on south bank of Frome to create 210ha of inter-tidal habitat, replaces Keysworth.</p>

4.3.3 There is no benefit cost assessment for Cell 9 (Poole Harbour South), Cell 10 (Brownsea Island), Cell 11 (Studland & Ballard Down) and Cell 13 (Durlston Bay). No Active Intervention has been selected based on the High Level Option assessment and environmental appraisal. However Table 4-10 provides detail of specific local issues where limited future actions may be undertaken by the local landowner or local authority to manage the assets at risk.

Table 4-10 Preferred Option for Poole Harbour South, Brownsea Island, Studland & Ballard Down, and Durlston Bay

Cell	Preferred Option
Poole Harbour South	NAI to all of coastline, except: Local Sustain to isolated property where required (by private owners)
Brownsea Island	NAI to Brownsea Island, except: Lagoon Seawall: Structure does not serve a direct FCERM purpose, and future management to be taken forward for detailed consideration by NT and NE. No compensatory habitat required as a result of NAI, agreed by NE. Jetty area & Branksea Castle: Local Maintain in short-medium term, including existing resilience measures (by NT and private tenant).
Studland & Ballard Down	NAI to Studland & Ballard Down, except: Existing defence at Middle & South Beach: Transition to NAI over short term (by NT) Maintain navigation Training Wall (by PHC) Ferry Road (next to Sandbanks Ferry): Local Sustain, not anticipated to require works within the short term. Local property flood resilience measures to be considered in the long term as risks increase.
Durlston Bay	NAI to Durlston Bay, except: Local monitoring and cliff stabilisation measures (by PDC & private owners)

Cell 12: Swanage (erosion cell)

Table 4-11 Short-listed Options for Swanage

Option	Description Summary
3: Sustain Existing Defences	Short Term: Timber and stone groynes maintained. Undertake beach renourishment in about Year 10-15, pending beach level/volumes. If opportunity arises, consider undertaking recharge before Year 10 with Poole Harbour dredging material to take advantage of lower cost. No active intervention needed for north Swanage Bay and the Pinnacles. Medium Term: Beach management with renourishment c.20,000m ³ proposed in about Year 20 and then typically every 7 years, to maintain design beach volume. Renourishment volume will increase with sea level rise. Replace timber groynes as they reach end of residual life. Long Term: Raise seawall in response to sea level rise in year 50. Increase beach volume of renourishment.
4: Improve - Open Beach	Short Term: Timber and stone groynes maintained. No active intervention needed for north Swanage Bay and the Pinnacles. Medium Term: Removal of existing beach control structures (groynes) and placement of increased beach volume to manage erosion without groynes, accepting increased annual losses. Beach renourishment of about 100,000m ³ required every 5 years. Long Term: Raise seawall in response to sea level rise in year 50. Increase beach volume of renourishment.
5: Improve – Rock revetment	Short Term: Timber and stone groynes maintained. No active intervention needed for north Swanage Bay and the Pinnacles. Medium Term: A rock revetment would be constructed along the full length of the existing seawall to provide erosion protection. Existing groynes would be removed at the end of their residual life. Long Term: Raise seawall in response to sea level rise in year 50.

5 Options appraisal and comparison

5.1 Technical issues

- 5.1.1 The staged approach of identifying the preferred HLO and assessment of technical long-list of options has provided confidence in identifying options which fulfil the technical objectives for each part of the Strategy area.
- 5.1.2 There are no technical coastal processes or notable inter-connectivity between different cells, other than those already addressed by the combination of the 22 FRMCUs into 13 cells.
- 5.1.3 The tidal range in Poole Bay and Poole Harbour is micro-tidal (less than 2m), with a spring tidal range in Poole Harbour of 1.6m and neap tidal range of 0.5m. Future sea level rise has more significance in micro-tidal areas than locations where the tidal range is greater.
- 5.1.4 Hydraulic modelling has indicated that the tidal prism of Poole Harbour at HAT, MHWS and Neap tides is about 70million m³, 46million m³ and 15million m³ respectively, compared to 23million m³ total water volume at low tide. The additional tidal prism caused by failure of the existing embankments at Wareham and Lytchett is not a significant issue in causing increased scour at the Sandbanks – Studland channel entrance to Poole Harbour.
- 5.1.5 Hydraulic modelling and analysis of sediment balance indicates that Poole Harbour has a net annual balance of sediment loss, estimated to be in the region of 56,000 to 76,000m³. This results in an inability of the inter-tidal habitat within the Harbour to respond fully to future sea level rise.
- 5.1.6 As noted in Section 2.3.6, there are seven historic legal agreements for much of the tidal embankments of Wareham Banks and Ridge. Implementation of the Managed Realignment options (3a, 4a-4c and 5a-5c) can therefore only be implemented in agreement with landowners. Various combinations of Managed Realignment could potentially be implemented, subject to landowner agreement.

5.2 Environmental assessment

- 5.2.1 The Environmental Assessment of Plans and Programmes Regulations 2004 (the Strategic Environmental Assessment (SEA) Regulations) do not formally require a SEA of flood and erosion risk management strategies. However, due to the environmental sensitivity of the Strategy area, and in accordance with the current Environment Agency and Defra policy and best practice, a non-statutory SEA Environmental Report has been prepared.
- 5.2.2 The key environmental constraints including environmental baseline features in the Strategy area are discussed in Section 3.2 and are presented on Key Plan 2.

Habitat Regulations

- 5.2.3 The Habitat Regulations Assessment (HRA) Screening, prepared to fulfil the requirements of The Conservation of Habitats and Species (Amendment) Regulations 2012, identified the potential for the Strategy to have significant impacts on several internationally designated sites. A subsequent Appropriate Assessment concluded no adverse effect on all sites except Poole Harbour Ramsar site and Poole Harbour SPA. The adverse impact on the SPA is habitat loss due to coastal squeeze and some small scale direct losses from scheme footprints (44ha attributable to man-made change in the short term). The adverse effect on the Ramsar site is the result of managed realignment within the Wareham Banks and Ridge Cell, impacting directly on freshwater habitat. Therefore compensatory intertidal habitat (to address man-made losses in the SPA) and secondary

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compensatory freshwater habitat (to address losses in the Ramsar site) is required to ensure the strategy remains compliant with the Habitats Regulations.

- 5.2.4 Natural England (NE) have signed-off the HRA and provided a letter of support for the Strategy. A Stage 4 HRA Statement of Case demonstrates that there are ‘no alternatives’ to the preferred solutions, that there are imperative reasons of overriding public interest (IROPI) and public safety for the proposed Strategy and that the preferred options represent the ‘least damaging’ environmental solutions given the economic, social and environmental constraints.
- 5.2.5 The Strategy identified two preferred sites within Poole Harbour which offer habitat creation opportunities for managed realignment to compensate for the inter-tidal losses within the SPA. These are Lytchett Bay North and Arne Moors (latter is part of the Wareham Banks and Ridge cell). The Strategy is proposing that the Arne Moors site is advanced in the short term, since this site has potential for medium to long term realignment opportunity, and the landowner (RSPB) is in agreement to take this option forward. Additionally, small areas of terrestrial habitat (woodland and heath) are predicted to be lost to coastal squeeze. Compensatory habitat areas have been allocated by the Forestry Commission in their local Forest Management Plan as part of the Wild Purbeck scheme.
- 5.2.6 The exact area of freshwater habitat loss and inter-tidal habitat gain at Arne Moors will be determined at project appraisal, but will be less than the area of intertidal habitat created since some of the freshwater habitat loss will coincide with areas lost to coastal squeeze as indicated in 5.2.5. Suitable locations for freshwater compensatory habitat (East Stoke and Sunnyside Farm) in the Wareham area have been identified and land owner discussions are being progressed. The cost of providing this secondary compensatory habitat has been incorporated in the proposed option for these sites.

Water Framework Directive

- 5.2.7 A detailed description of the surface water bodies and groundwater bodies potentially affected by the Strategy is provided in the WFD Assessment Report (Appendix E), which also assesses the Strategy’s compliance with the requirements of the WFD.
- 5.2.8 The assessment concludes that implementation of the Strategy preferred options is not expected to cause deterioration in the status of any water bodies or prevent them from achieving their objectives. There should be no changes relevant to the quality requirements of the WFD Protected Areas related to the Bathing Water Directive or the Shellfish Water Directive designated shellfisheries.
- 5.2.9 Defence maintenance and improvements may result in small additional encroachment of engineered structures into the Poole Harbour transitional water body, and attention will be needed at scheme level to ensure that these are delivered with appropriate mitigation measures. For example, defences could be designed to include areas of natural accretion. However, when considering the harbour’s overall complement of inter-tidal areas, squeeze on narrow urban frontages will be offset by the proposals for managed realignment.
- 5.2.10 Additionally, defending urban frontages will reduce risks that could arise from flooding of areas that may be contaminated or occupied by landfill around Poole.
- 5.2.11 Further assessment of the Strategy against Article 4.7 is not required.

Stakeholder Involvement and Consultation

- 5.2.12 Consultation was undertaken with statutory and other stakeholders and comprised email updates, newsletters, consultation documents, project website, targeted stakeholder meetings and public exhibitions.

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- 5.2.13 The specific issues arising from the early stages of consultation included:
- Need to consider County Wildlife Sites, Site of Nature Conservation Interest (SNCI) and Regionally Important Geological Sites (RIGS).
 - Consider impact on Hengistbury Head Scheduled Monument and round barrows
 - Consider impact on boating and recreation use of rivers
 - Consider flooding of small communities
 - Concerns that macro-algal mats may develop on the inter-tidal habitats in newly created managed realignment sites
 - Consider saltmarsh loss in the Strategy area
 - Consider impact of dredging, coastal squeeze and erosion on the historic environment.
- 5.2.14 Formal consultation with internal and external stakeholders on the SEA and the Strategy Consultation summary ran from 18th February to 1st April 2013. Strategy documentation was published on the Environment Agency website and on the e-consultation tool, and placed in Council offices and at the Environment Agency office for viewing. Documentation and letters were sent to those who responded to the original consultation, as well as key stakeholders and organisations.
- 5.2.15 There was broad support from the majority of the consultees, with some localised specific concerns which will be addressed at scheme level. Responses to the SEA and consultation have been documented in the Consultation Report (Appendix F). The concerned responses largely related to a local surface and highway drainage issue near Lytchett Minster, which will be addressed outside of this Strategy.
- 5.2.16 Table 5.1 identifies the key environmental impacts associated with each cell for the short-listed options, and potential mitigation or enhancement opportunities identified. The significant environmental benefits of the Strategy are outlined in Section 6.

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Table 5-1 Key environmental impacts, mitigation and opportunities for short-listed options

Option	Key positive impacts	Key negative impacts	Mitigation and <i>enhancement opportunities</i>
Hengistbury Head to Sandbanks			
No Active Intervention	Allows more naturally functioning system & maintains geological & nature conservation features	Unacceptable flood & erosion risk to people & properties	
Hold the line (various options)	Protects in excess of 6,000 properties, 2,500 beach huts, infrastructure, agricultural land, heritage assets & terrestrial habitats. Sustains amenity value of beach	Groynes and gabions may interrupt natural processes, increased land-take in footprint of groynes & defences, Change in landscape & potential loss of views. Potential impacts on Poole Bay Cliffs SSSI. Inter-tidal narrowing of beach and inter-tidal habitats in some areas. Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar, SSSI & SNCI & Christchurch Harbour SSSI	Compensatory inter-tidal habitat required for designated sites (and WFD). SM consent required for gabion works at Hengistbury Head. Impacts on Poole Bay Cliffs SSSI can likely be avoided at project level, works do not obscure geological exposures or restrict cliff erosion.
Luscombe Valley			
No Active Intervention	Allows more naturally functioning system	Unacceptable flood & erosion risk to people & properties	
Managed Realignment	Protects properties & golf course. Allows more naturally functioning system with potential to create wetland habitat. Supports WFD objectives.	Change in landscape & increasing risk to properties & terrestrial habitats. Potential contaminated land issues. Loss of beach amenity.	
Hold the line (various options)	Protects people, properties, terrestrial habitats & recreational assets.	Gradual narrowing of beach, & coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI. Contrary to WFD objectives.	Compensatory inter-tidal habitat required. Research into encouraging accretion may identify local mitigation for WFD impacts. Project level planning constraints may require road raising to protect harbour views.
Lower Parkstone			
No Active Intervention	Allows more naturally functioning system, benefitting nature conservation & geological interests	Unacceptable flood & erosion risk to people & properties	
Hold the line: sustain	Sustains current level of flood and erosion protection to properties	Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI, which may be contrary to objectives of WFD. Change in landscape & views, increased area of land-take.	Compensatory inter-tidal habitat required. Research into encouraging accretion may identify local mitigation for WFD impacts. Impacts on RIGS can likely be avoided at project level by avoiding works obscuring the exposures.
Central Poole			
No Active Intervention	Allows more naturally functioning system	Unacceptable flood & erosion risk to people & properties	
Hold the line: (various options)	Protects properties (& new developments), areas behind quay, town centre, infrastructure & heritage assets (listed buildings, SMS & Poole Park) Protection of Grades 4 & 5 agricultural land	Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI, which may be contrary to objectives of WFD. Potential conflicts with new development at former power station site. Change in landscape character & deterioration in views.	Compensatory inter-tidal habitat required. Research into encouraging accretion may identify local mitigation for WFD impacts. Impacts on RIGS can likely be avoided at project level by avoiding works obscuring the exposures.

Option	Key positive impacts	Key negative impacts	Mitigation and enhancement opportunities
Hamworthy			
No Active Intervention	Allows more naturally functioning system, benefitting designated biodiversity & geological sites	Unacceptable flood & erosion risk to people & properties	
Hold the line: sustain	Protects properties & infrastructure & sustains existing beach.	Increased area of land-take. Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI, which may be contrary to objectives of WFD. Potential change in landscape & views.	Compensatory inter-tidal habitat required. Research into encouraging accretion in front of defences may identify local mitigation for WFD impacts.
Rockley Sands			
No Active Intervention	Allows more naturally functioning system, benefitting geological sites.	Potential saline inundation of freshwater habitats in Dorset Heaths SAC, Dorset Heathland SPA & Ramsar & national/local sites. Caravan site properties at risk.	Compensatory habitat required.
Managed Realignment by management of gabions and NAI	Reduces erosion rate at Rockley Sands caravan site & allows natural processes, thus supporting WFD objectives. Maintains geological interests of Ham Common SSSI.	Caravan properties at risk.	Implement principles of 'Be prepared' and 'Adapt to Flooding' to ensure people are sufficiently aware, informed & prepared for increasing flood & erosion risks.
Lytchett Bay			
No Active Intervention	Allows more naturally functioning system, benefitting inter-tidal conservation sites. Supports WFD	Increasing flood risk to properties, critical infrastructure, agricultural land, landfill site & listed buildings. Change in landscape. Impacts on designated heathland habitats.	
Hold the Line	Protects properties, infrastructure, agricultural land, heritage assets & historic landfill. Protects Dorset Heaths Natura 2000 sites.	Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI, which may be contrary to objectives of WFD. Change in landscape.	Compensatory habitat required.
Managed Realignment at Lytchett Bay North	Continued protection of properties, infrastructure & agricultural land around Turlin Moor. Allows more natural processes to continue; beneficial to Natura 200 sites, & contributes to WFD measures. Creates up to 9ha of mudflat, 15ha saltmarsh, 7ha of grazing marsh & reedbed. Reduced saline intrusion at Dorset Heaths designated sites.	Change in landscape due to new set-back defences & large land-take. Potential impacts on Dorset Heaths designated sites. Saline inundation of Grades 4 & 5 agricultural land.	Secondary compensatory freshwater habitat required. Consultation with English Heritage (EH) to develop MR that appraises heritage risks. Use of EH's Rapid Coastal Zone Assessment Realignment needs to consider landfill.
Wareham Banks and Ridge			
No Active Intervention	Allows a more naturally functioning system, benefitting nature conservation sites.	Potential saline inundation of freshwater SPA/Ramsar habitats. Increasing flood risk to properties, infrastructure, heritage assets & agricultural land. Change in AONB landscape & estuary morphology. Major change to navigation viability on Wareham Channel.	

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Option	Key positive impacts	Key negative impacts	Mitigation and enhancement opportunities
Hold the line (various options)	Protects properties, key transport routes, agricultural land, landfill, navigational assets in Wareham, Quay & some heritage assets. As maintaining integrity of banks becomes unsustainable, more natural processes will operate, benefitting nature conservation sites	Coastal squeeze of inter-tidal habitat in Poole Harbour SPA, Ramsar & SSSI, which may be contrary to objectives of WFD when aggregated with other effects in Poole Harbour.	Compensatory habitat required.
Managed Realignment	Potential to create large areas of wetland habitat at Keyworth, Bestwall, Moors River, Redcliffe, Stoborough & Moors Estuary. Allows more natural processes. Progressive implementation of MR will contribute directly to WFD for the Poole Harbour HMWB. Controls flood risks.	Increasing flood risk to historic landfill and to listed buildings & SM, potential change in navigational assets on River Frome, reduced window for navigation, H&S issues & potential loss of existing moorings. MR at Keyworth in medium to long-term would result in loss of historic landscape/water meadows & low grade agricultural land, with change in AONB landscape	Implement principles of 'Be prepared' and 'Adapt to Flooding'. Project level consultation with EH to develop any MR schemes. <i>The EA funded 'Wareham Coastal Change' project (2013 – 2015) will form part of the Strategy delivery Plan, & provide opportunities for environmental enhancement.</i>
Poole Harbour South - no other options considered as there are limited assets to protect			
No Active Intervention	Continuation of natural processes, benefitting Poole Harbour designated conservation sites. Supports WFD objectives	Increasing flood/erosion risk to isolated properties, Sustrans cycle way & bridge, & historic landfill site	Some local raising of Arne Road & further consideration of oil wells. Implement principles of 'Be prepared' and 'Adapt to Flooding'.
Brownsea Island			
No Active Intervention (with local maintain around quayside & jetty)	Allows more natural processes, benefitting Poole Harbour designated conservation sites. Supports WFD objectives. Meets NT's policy of moving towards a more natural coast	Potential uncertainties with increasing sedimentation of lagoon & requirement for management of navigation channel. Increasing flood risk to NT assets Change in habitat in lagoon over time	NT may relocate some of their amenity assets in short to medium-term. Implement principles of 'Be prepared' and 'Adapt to Flooding'.
Studland & Ballard Down			
No Active Intervention (local sustain for ferry access & local maintain for training wall)	Allows more natural processes, benefitting Poole Harbour designated conservation sites & supports WFD objectives. Retains beach amenity & maintains recreational assets. Meets NT's policy of moving towards a more natural coast	Coastal squeeze of inter-tidal dunes where defences are sustained, may affect international conservation sites. Increasing flood risk to limited number of properties & infrastructure. Potential loss of Fort Henry in long-term	NT may relocate some of their amenity assets in short to medium-term. Implement principles of 'Be prepared' and 'Adapt to Flooding'.
Swanage			
No Active Intervention	Increased cliff exposure will maintain geological value of coast including WHS. Supports WFD objectives.	Increased erosion to South West Coast Path & large areas of moderate to poor agricultural land. No protection to properties and assets in Swanage.	Implement principles of 'Be prepared' and 'Adapt to Flooding' in areas of NAI.
Managed Realign't by cliff stabilisation	Reduces rate of cliff erosion	Restricts natural processes, with impacts on designated geological sites. Limited protection to properties and assets	For North Beach adopt cliff top stabilisation and drainage policy, landowner's expense.
Hold the Line	Protects properties, infrastructure & designated heritage assets in Swanage. Maintains beach amenity.	Coastal squeeze of inter-tidal habitat & potential impacts on Isle of Portland to Studland Cliffs SAC. May be contrary to WFD. Reduced geological value of cliffs.	Mitigation potentially needed for impacts on WFD water body.
Durlston Bay			
Managed Realignment by cliff top stabilisation	Allows coastal system to function naturally, supporting WFD objectives & maintaining geological value of cliffs.	Gradual increase in erosion to properties, Durlston Castle landscape & historic park & garden	Implement principles of 'Be prepared' and 'Adapt to Flooding'.

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5.3 Option costs

- 5.3.1 This section contains a summary of the approach taken to costing flood and coastal erosion risk management options. The Options Assessment Report (Appendix B) includes details of the costs for each option for each cell over the 100 years.
- 5.3.2 Construction and maintenance unit costs were developed for this Strategy using the Unit Cost Database and verified against other recent projects. The quantities for each option were derived using a Bill of Quantities style of approach. Capital costs were determined based on the unit rates described. Remaining costs such as design and supervision costs have been determined based on a percentage of the capital construction costs, dependent on scale of construction.
- 5.3.3 Maintenance requirements and costs for the various strategic options have been identified and have been included in the whole life present value costs. Costs are also included for options where future works are required to enable the option to adapt for climate change.
- 5.3.4 Costs for privately owned or managed frontages have generally not been included since the costs are relatively small, and the decision to incur cost and the nature of the preferred option are individual to local landowner preference. Option costs have been estimated for the privately managed Rockley Sands cell where the on-going management of an existing asset is established,
- 5.3.5 For Managed Realignment options causing loss of existing SPA or Ramsar freshwater designations, the cost includes for land purchase and the additional cost of creating secondary freshwater compensatory habitat where needed. Costs to address any impact of the legal agreements specific to Wareham Banks and Ridge have not been included since it is assumed the agreements would be nullified by any potential land purchase.
- 5.3.6 An optimism bias of 60% has been applied globally to all capital and maintenance costs in line with recommendations of the Flood and Coastal Risk Management Appraisal Guidance (FCERM-AG, 2010).

5.4 Options benefits (Damages avoided)

- 5.4.1 Depth damage data has been taken from the Multi Coloured Manual (MCM) Handbook, updated to a 2013 Q1 price date.
- 5.4.2 Residential and Non-Residential property market values were obtained from the Land Registry rateable values. Threshold levels were obtained from LiDAR data with adjustment for floor level. These values were used to cap recurrent flood damages, such that the sum of PV damage over time did not exceed the market value of the asset.
- 5.4.3 For Cell 1 Hengistbury Head to Sandbanks, the Local Land and Property Gazetteer (LLPG) from BBC and BoP was used as the property database source, replacing the National Receptor Database used elsewhere. The LLPG is used by BBC and BoP for council taxation purposes and was found to be more accurate, especially with regard to the number of flats within single buildings along this intensively developed frontage.
- 5.4.4 There are about 100 properties in Sandbanks and Poole at both erosion risk and tidal flood risk for Do Nothing option over the course of the next 100 years. Double counting has been avoided by removal of flood risk damages to properties lost to erosion. The proposed option provides protection against both risks. Only ground floor flats have incurred flood damages. Upper floor flats were included in all write-off valuations to ensure capture of all losses.

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- 5.4.5 Following guidance from the Flood Hazard Research Centre, temporary accommodation costs of £6,695 for residential properties and £5,461 for non-residential properties have been applied.
- 5.4.6 There are a large number of beach huts in Bournemouth and Poole (2,528) and Swanage (60). These have been included in the economic appraisal as a capital write off, and have been assumed to be written off in both the Do Nothing and Do Minimum scenarios in year 19 with an assumed value of £12,700 each.
- 5.4.7 Distributional impact factors have been calculated and applied to the market value of the residential property. Property flood and erosion damages have been capped at this adjusted market value.
- 5.4.8 Risk to life has been assessed in accordance with recent guidance and included within the analysis. Valuation was based on fatalities in accordance with the guidance. A value per fatality of £1.3m was used. The present values for the Do Nothing and Do Minimum options were determined assuming 20 years of potential fatalities due to the typical residual life of existing assets of between 10 and 20 years. The additional damages from the Risk to Life calculations have contributed up to 1.5% of the total damages, but have not affected the business case in the decision of option selection.
- 5.4.9 The Multi Coloured Manual (MCM) recommends using a variable factor to account for the costs of emergency services. The 5.6% adjustment has been applied for FCRM units 1-10 (i.e. from Bournemouth to Poole/Upton); elsewhere the 10.7% factor has been applied.
- 5.4.10 Agricultural damages have been calculated following Defra guidance, and applying average market values by agricultural grade provided in the MCM. Under the Do Nothing and Do Minimum scenarios agricultural land is written off since the progressive ingress of saline water would make the land unsuitable for agriculture.
- 5.4.11 The amenity values of the renourished beach recreational asset at both Hengistbury Head to Sandbanks and at Swanage have been determined based on annual visitor numbers and a 'Willingness to Pay' value. Visitor numbers have been sourced from the South West Tourism report "The Value of Tourism (2008)" and Purbeck District Council tourism data, giving estimated number of 2.7 million and 150,000 respectively. A value for Willingness to Pay (WtP) has been determined from the MCM2010 using beach visitor valuation data, at £12.10 for beach 'hold the line' per person per visit (pppv). The amenity value for the Do Nothing (natural cliff line) erosion foreshore is £0.53pppv. Present Value of amenity beach asset has been determined by degrading the current beach amenity to a reduced value with time, with WtP value dependent on the option.
- 5.4.12 The resulting present value for the amenity benefit of the Hengistbury Head to Sandbanks beach (if sustained for 100 years) is £774m – in excess of the erosion based property benefit of £614m. This represents the importance of the beach as a major asset to the region and, given the visitor numbers, to the UK as a whole. For Swanage, the amenity benefit is about 9 times greater than the size of the erosion based benefits.
- 5.4.13 Confidence in the level of certainty of the amenity benefit value as representative of a genuine loss to the UK is considered strong, since the WtP value used is about the same as the cost of travel to the next nearest beach (Studland Bay). It is noted that this alternative has a lower level of amenity facilities compared with Hengistbury Head to Sandbanks or Swanage, and is already heavily used with annual visitor numbers of about 1 million. A sensitivity test on amenity value has been included in Section 6.2.4.
- 5.4.14 An estimate of the tourism value of navigation to Wareham (based on a WtP approach) and the Wareham Royalty recreational mooring facilities on the River Frome (based on cost of relocation) has been included for the Wareham Banks and

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Ridge cell. The estimate of national economic loss is conservative in relation to the actual annual income from the mooring rights to the Environment Agency of about £110k.

- 5.4.15 For locations where Managed Realignment has been short-listed as an option, an additional value of inter-tidal habitat created (based on a value of £35k/ha, from creation of Outcome Measure 4 inter-tidal habitat minus loss of freshwater habitat) has been included as a benefit, discounted accordingly at the future time of creation.

Gains not quantified

- 5.4.16 Estimation of losses to transport infrastructure have not been included since the roads affected by tidal flooding are either relatively minor, or have short diversion routes, and as a result would incur minimal economic damages. Damages to the railway lines have not been included since these are only at direct risk from tidal flooding at extreme events from 2060.
- 5.4.17 The loss of existing public Right of Way footpaths on the Wareham Banks (which would be lost for Do Nothing, Do Minimum and Managed Realignment options) have not been determined since there are alternative routes for recreational value, and the loss to the UK would be negligible. However one particular route (Wareham to Ridge, South Frome) is of significant local importance since it is extensively used by the local community. The impact of loss of this short section of path may need to be considered in further detail if realignment were selected as the preferred option.
- 5.4.18 Regeneration development around Central Poole (Holes Bay and port) has not been included, although is a notable opportunity for funding of risk management assets.
- 5.4.19 There are several landfill sites located in Poole (FCRM unit 6 to 10) which could potentially be at risk of erosion without the erosion defences present. Damages for the consequence of release of landfill to the harbour have not been quantified, since compliance with the Habitat Regulations Assessment implies a legal requirement to prevent any failure of the erosion defences and avoid significant negative impact on the surrounding Natura 2000 designated sites.

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6 Selection and details of the preferred option

6.1 Selecting the preferred option

6.1.1 This section details the identification of the preferred option for each cell. In each case a benefit cost assessment table is presented to determine the preferred economic option in compliance with the decision process of FCERM-AG.

6.1.2 The environmental issues detailed in Appendix G is summarised for each cell below, and used to determine the overall preferred option.

Cell 1: Hengistbury Head to Sandbanks

Table 6-1 Benefit-cost assessment for Hengistbury Head to Sandbanks

		PV Costs (£k)	PV Damages (£k)	PV Amenity Value (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	614,726	76,039			
Option 2	Do Minimum	4,303	441,757	118,943	215,873	50.2	
Option 3b	Sustain (delayed recharge)	67,715	317	336,346	874,716	12.9	10.4
Option 3a	Sustain	72,040	317	373,718	912,088	12.7	8.6*
Option 4	Improve (open beach)	85,400	317	373,718	912,088	10.7	2.1*
Option 5	Improve (manage realign fwd)	133,074	317	373,718	912,088	6.9	0.6*
Option 6	Improve (revetment)	89,759	317	150,652	599,263	7.7	-8.4*

* Inc BCR wrt Option 3b

6.1.3 Table 6.1 shows that the option with the highest benefit cost ratio (BCR) is Do Minimum. In accordance with the decision rule, Option 3b Sustain (delayed recharge) can be selected as the Incremental BCR is 10.4 and Do Minimum will ultimately lead to failure of the beach and erosion losses. Option 3a Sustain has an Incremental BCR of 8.6 with respect to Option 3b, and is therefore selected as the preferred option and delivers wider outcomes through enhanced amenity benefits. Improve Options 4, 5 and 6 have lower Incremental BCRs than Option 3a and are therefore not selected - although named 'Improve' options, they provide no additional benefit with respect to Sustain for this erosion dominated cell. Excluding the amenity benefits the Option 3a BCR would be 8.5 (refer to Section 6.2.5).

6.1.4 The preferred environmental option is Option 3a Sustain. This will provide continued protection to infrastructure, properties and beach huts, heritage assets and locally designated terrestrial habitats. Additionally, it will sustain the existing amenity value of the beach and also support WFD environmental objectives by offsetting beach loss that would otherwise occur. However, continuing to hold the line of the existing defences will continue to interrupt natural erosion processes, and has potential to obscure the geological features of Poole Bay Cliffs SSSI – a moderate negative impact.

6.1.5 On the Poole Harbour side of Sandbanks, options to hold the line will continue to cause inter-tidal habitat loss within Poole Harbour SPA, Ramsar site, SSSI and SNCI due to coastal squeeze – a major adverse impact. In addition, inter-tidal narrowing (beach and mud/sandflats) combined with sustaining defences on northern side will result in minor loss of features contributing to Poole Harbour transitional water body's overall ecological potential. Compensatory habitat, which can be provided elsewhere in the Strategy area, will be required to replace coastal squeeze losses of inter-tidal habitat.

6.1.6 The overall preferred option is therefore Sustain.

Cell 2: Luscombe Valley

Table 6-2 Benefit-cost assessment for Luscombe Valley

		PV Costs (£k)	PV Damages (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	9,613			
Option 2	Do Minimum / Maintain	465	6,065	3,548	7.6	
Option 3	Sustain 2032 (1.3% AEP min)	2,603	150	9,463	3.7	2.8
Option 4	Improve (0.5% AEP min)	6,228	47	9,566	1.5	0.03
Option 5	Manage Realign (with Sustain)	5,800	150	9,463	1.6	1.1

6.1.7 The option with the highest BCR is Do Minimum. Sustain 2032 can be selected since this has an incremental benefit cost ratio of 2.8, and will provide a standard of protection in excess of 1.3% AEP for property, unlike Do Minimum. Options 4 and 5 do not have sufficient IBCR to justify stepping up further to these options, therefore the economically preferred option is Option 3 Sustain.

6.1.8 The preferred environmental option is Option 5 – Managed Realignment in combination with Sustain. This would enable development of some inter-tidal habitat reducing the continued coastal squeeze within the Poole Harbour SPA, Ramsar site and SSSI by holding the line. The area of potential inter-tidal habitat at Luscombe Valley is estimated to be about 1ha, and would provide contribution to WFD objectives.

6.1.9 **The overall preferred option is Option 3 – Sustain.** The additional area of inter-tidal habitat generated by Option 5 is small in comparison with the addition PV Cost, relative to other areas where Managed Realignment can be implemented. Option 5 would require extensive embankment control structures to limit the extent of managed realignment and avoid impacts on property, roads, landfill site and other current local designations at Luscombe Valley, and is therefore not a preferred strategic site for Managed Realignment. Compensatory habitat, which can be provided elsewhere in the Strategy area, will be required to replace coastal squeeze losses of inter-tidal habitat.

6.1.10 This preferred option broadly complies with the Borough of Poole Flood Risk Management Strategy (2011). This report identifies a preferred strategy (unit 6A) of Improve (0.5% AEP) by 2026 with subsequent adaptation for climate change, but noting the estimated benefit cost ratio would not reach unity until about 2060 and implementation of the Improve scheme likely to be delayed accordingly.

Cell 3: Lower Parkstone

Table 6-3 Benefit-cost assessment for Lower Parkstone

		PV Costs (£k)	PV Damages (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	10,127			
Option 2	Do Minimum / Maintain	53	5,819	4,308	81	
Option 3a	Sustain 2032 (2% AEP)	1,255	117	10,010	8.0	4.7
Option 3b	Sustain 2062 (10% AEP)	569	340	9,787	17.2	10.6

6.1.11 The option with the highest BCR is Do Minimum. Sustain 2032 can be selected since this has an incremental benefit cost ratio greater than 3. Sustain 2062 has a higher net present value than Sustain 2032 and can therefore be selected, delaying the

implementation of tidal flood defence improvements but retaining a standard of protection in excess of 1.3% AEP for property.

- 6.1.12 The preferred environmental option is Sustain, but with no preference on timing. This option will have significant moderate to major beneficial impacts by sustaining the current level of flood and erosion protection to properties. However, negative impacts include continued inter-tidal habitat loss due to coastal squeeze within Poole Bay SPA, Ramsar site and SSSI (a major adverse impact). Compensatory habitat, which can be provided elsewhere in the Strategy area, will be required to replace coastal squeeze losses of inter-tidal habitat.
- 6.1.13 **The overall preferred option is therefore Sustain (2062).** This preferred option broadly complies with the Borough of Poole Flood Risk Management Strategy (2011) (unit 5A and 5B) which identifies a preferred strategy of local improvements in the short term (by 2026) with future adaptation for climate change in the long term, but noting the estimated benefit cost ratio for adaptation would not be viable until about 2035 or beyond.

Cell 4: Central Poole

Table 6-4 Benefit-cost assessment for Central Poole

		PV Costs (£k)	PV Damages* (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	263,660			
Option 2	Do Minimum / Maintain	1,556	254,453	9,207	5.9	
Option 3	Sustain (2% AEP min)	18,853	7,384	256,276	13.6	14.3
Option 4a	Improve (1.3% AEP min)	19,062	5,135	258,525	13.6	10.8
Option 4b	Improve (1.0% AEP min)	19,180	3,999	259,661	13.5	9.6
Option 4c	Improve (0.5% AEP min)	19,903	2,430	261,230	13.1	2.2
Option 4d	Improve (0.33% AEP min)	20,386	1,768	261,892	12.8	1.8

* Excluding Poole Port

- 6.1.14 The options with the highest BCR are Sustain and Improve (1.3%). Since Improve (1%) has an IBCR of 9.6, this can be selected. However it is not possible to step up to Improve (0.5%) as the IBCR is below 3. Therefore the economically preferred option is Improve (1%). Further detailed appraisal would consider whether this can be increased to enable a higher SoP to be selected by, for example, managing cost and risk down, additional local benefits not quantified, or by contributions.
- 6.1.15 The environmental appraisal of the two options (Sustain and Improve) identified similar impacts, and there is no preference. Both will have significant major benefits on population, health, material assets and the historic environment. Flood risk will be reduced to residential properties (including new developments), areas behind the quay, town centre, historic assets and infrastructure. However, there will be major adverse impacts due to continued inter-tidal habitat loss due to coastal squeeze within Poole Harbour SPA, Ramsar site and SSSI. Coastal squeeze will also result in minor loss of features contributing to Poole Harbour transitional water body's overall ecological potential. Compensatory inter-tidal habitat, which can be provided elsewhere in the Strategy area, will be required to replace coastal squeeze losses.
- 6.1.16 **The preferred option is Improve (1%) AEP**, but with potential to consider a higher SoP at detailed appraisal stage. Poole Port has been excluded from the analysis – Poole Harbour Commissioners and local industry will continue their private investment of a managed adaptive approach.
- 6.1.17 This preferred option broadly complies with the Borough of Poole Flood Risk Management Strategy (unit 2C to 4E) which identifies a preferred strategy of a

mixture of improvement now, investigate potential for improvement and future adaptation, but with lower benefit cost ratios.

Cell 5: Hamworthy

Table 6-5 Benefit-cost assessment for Hamworthy

		PV Costs (£k)	PV Damages (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	11,213			
Option 2	Do Minimum / Maintain	723	6,372	4,841	6.7	
Option 3	Sustain 2062 (0.5% AEP)	3,055	136	11,077	3.6	2.7

- 6.1.18 The option with the highest BCR is Do Minimum, however the SoP for this option would decline below 1.3% AEP by about 2060. Sustain in 2062 can be selected since this option would provide the future improvement to mitigate sea level rise, and has an IBCR greater than 1.
- 6.1.19 The preferred environmental option is Sustain. However, there will be major adverse impacts due to continued inter-tidal habitat loss due to coastal squeeze within Poole Harbour SPA, Ramsar site and SSSI. Compensatory habitat, which can be provided elsewhere in the Strategy area, will be required to replace coastal squeeze losses of inter-tidal habitat.
- 6.1.20 The overall preferred option is therefore Sustain.
- 6.1.21 This broadly complies with the Borough of Poole Flood Risk Management Strategy (unit 2B) which identifies a preferred strategy of maintain in the short term with future adaptation for climate change in the long term, noting the estimated benefit cost ratio for adaptation would not be viable until about 2060 or beyond.

Cell 6: Rockley Sands

Table 6-6 Benefit-cost assessment for Rockley Sands

		PV Costs (£k)	PV Damages (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	117			
Option 2	Do Minimum	10	106	11	1.1	
Option 2	Managed Realignment	107	0	117	1.1	1.1

- 6.1.22 There are two options with the same BCR of 1.1. As Option 2, Managed Realignment has an IBCR of 1.1 above the Do Minimum option, Managed Realignment is the economically preferred option. Over recent years this has been undertaken (and will continue to be) at private expense.
- 6.1.23 The preferred environmental option is Managed Realignment by local maintenance. This would allow the coastal system to function more naturally, and have significant major beneficial impacts on the designated conservation sites and would maintain the geological interest features of Ham Common SSSI. The option will help to manage the erosion risk to approximately 67 static homes within the Rockley Sands caravan site.
- 6.1.24 **The overall preferred option is therefore Managed Realignment.** This complies with the Borough of Poole Flood Risk Management Strategy (unit 2A) which identifies a preferred strategy of private owner management.

Cell 7: Lytchett Bay

Table 6-7 Benefit-cost assessment for Lytchett Bay

		PV Costs (£k)	PV Damages (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Upton & Turlin Moor						
Option 1	Do Nothing	0	8,454			
Option 2	Do Minimum	No existing defence structures, not applicable				
Option 3a	Sustain 2032 (2% AEP min)	3,341	1,446	7,008	2.1	2.1
Option 3b	Sustain 2062 (10% AEP min)	2,174	1,616	6,838	3.1	3.1
Option 4	Improve (0.5% AEP min)	6,428	1,426	7,028	1.1	0.0
Lytchett Bay North						
Option 1	Do Nothing	0	107			
Option 5	Managed Realign - Lytchett Bay North	2,278	111	801*	0.4	

* Benefits derived from eco-system habitat creation

- 6.1.25 The preferred economic option for Upton and Turlin Moor is Sustain 2062 as this has the highest BCR. The preferred economic option for Lytchett Bay North is Do Nothing since the only alternative (Managed Realignment) has a benefit cost ratio less than 1.
- 6.1.26 The preferred environmental option for Upton & Turlin Moor is Sustain (no preference on timing), and for Lytchett Bay North is Managed Realignment. Continuing to protect properties will have significant beneficial impacts. Managed realignment at Lytchett Bay North will have significant beneficial impacts by creating up to 24ha of inter-tidal habitat. Allowing natural processes is likely to be beneficial to the internationally designated conservation sites as well as Poole Harbour transitional water body, and potentially provide strategically required inter-tidal compensation.
- 6.1.27 **The overall preferred option is therefore Sustain 2062 and Managed Realignment** – however the latter is subject to future landowner agreement. Currently the land is not available for implementing MR, and therefore this is a future opportunity rather than a confirmed deliverable strategic option.

Cell 8: Wareham Banks & Ridge

Table 6-8 Benefit-cost assessment for Wareham Banks & Ridge

		PV Costs (£k)	PV Damages (£k)	PV Eco-System Benefits (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
North Wareham - Tide Banks							
Option 1	Do Nothing	0	387				
Option 2a	Do Minimum (short term), MR (medium term)	2,261	342	1,460	1,505	0.7	
Option 3a	Manage Realign Keyworth	8,101	401	2,905	2,891	0.4	0.2
South Wareham - Tide Banks							
Option 1	Do Nothing	0	604				

		PV Costs (£k)	PV Damages (£k)	PV Eco-System Benefits (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 2a	Do Minimum (short term) MR (medium term)	2,434	505	1,479	1,577	0.6	
Option 4a	Manage Realign; Bestwall Estate	4,630	307	2,037	2,334	0.5	0.4
Option 4b	Manage Realign; Bestwall Meadows	6,337	470	2,487	2,621	0.4	0.4
Option 4c	Manage Realign; Bestwall Estate & Meadows	8,202	543	3,045	3,106	0.4	0.3
Ridge – Tide Banks							
Option 1	Do Nothing		1,083				
Option 2a	Do Minimum (short term) MR (medium term)	10,302	995	3,536	3,624	0.4	
Option 5a	Partial Manage Realign Moors Estuary	15,397	1,019	4,302	4,366	0.3	0.2
Option 5b	Full Manage Realign Moors Estuary	18,614	1,054	5,451	5,480	0.3	0.2
Option 5c	Full Manage Realign Moors Estuary & River, Ridge & Redcliffe	25,684	1,093	7,035	7,025	0.3	0.2
Wareham Banks & Ridge - Property							
Option 1	Do Nothing		7,520				
Option 2b	Do Minimum (short term) Local Improve / resistance (medium to long term)	1,150	5,132	0	2,388	2.1	

- 6.1.28 This cell has been split into four separate sub-cells; the first three address the existing tidal banks (FRMCU11, 12 & 13 respectively), and the agricultural land that these embankments serve. The fourth sub-cell captures all the property (buildings) at risk, since the existing tidal embankments do not offer any protection to property and therefore warrants a separate assessment.
- 6.1.29 For all three tide bank units, the preferred economic option for each unit is Do Nothing, since none of the other options have a benefit cost ratio greater than 1.
- 6.1.30 The legal agreements described previously require the embankments to be maintained for land drainage purposes, and option selection is dictated by the least cost to implement Do Minimum. Option 2 is therefore selected by default.
- 6.1.31 The environmental appraisal indicates that Managed Realignment is the preferred environmental option, primarily due to the habitat creation benefits and establishment of more natural processes likely to be beneficial to the Poole Harbour international and national conservation sites. Managed Realignment will have significant major beneficial impacts by creating up to 370ha of inter-tidal and brackish habitat.
- 6.1.32 Implementing Managed Realignment now would not be viable unless the landowners were willing to participate, terminating the legal agreements, and if an equivalent area for freshwater secondary compensation were also identified.
- 6.1.33 The landowner for Arne Moors (RSPB) at the eastern end of the cell has expressed agreement to the principle of Managed Realignment, enabling Option 5a and 5b to both be considered. Option 5a would provide the minimum 44ha of inter-tidal habitat compensation to cover worst case inter-tidal losses for the short term (year 20). Option 5b would provide up to 110ha of inter-tidal habitat to cover worst case losses

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for the medium term and beyond (year 50+), before additional managed realignment compensation habitat would be required.

- 6.1.34 Option 5a has a lower PV cost than Option 5b, but a higher Whole Life Cost to deliver the same total inter-tidal habitat over the medium to long term. Option 5b has strategic advantages in that it would deliver an improved legacy, avoiding the need to construct mid-embankments which would require additional realignment in Year 20, and hence has a lower net impact on the designated area.
- 6.1.35 Further detailed outline design for Option 5a/5b is required to confirm how the whole of the Arne Moors site could be configured to deliver a sustainable approach to gradually transition from freshwater to inter-tidal habitat, with more detailed analysis of the salinity gradient for various options to define the area of freshwater secondary compensation needed, with the objective to avoid future major interventions.
- 6.1.36 A site adjacent to Arne Moor (Sunnyside Farm) has been identified as suitable for secondary freshwater compensation, with the potential to provide some 38ha. The landowner (Natural England) is willing to consider developing the site accordingly. A further site near East Stoke in the Lower Frome valley is owned by the Environment Agency and will provide up to a further 13ha. Other sites in the Lower Frome valley totalling in excess of 100ha have been identified as technically suitable, with further landowner discussions to confirm potential agreement in combination with agri-environment stewardship schemes.
- 6.1.37 By 2060 there will be 11 residential properties at tidal flood risk of 10% AEP, increasing to 41 by 2110. A Local Improve option to reduce flood risk in the long term for property around Wareham by undertaking a mixture of local flood defence improvements and property flood resistance and resilience, indicates that scheme(s) may be viable, with an approximate benefit cost ratio of 2.1. This is a broad brush assessment, and local decisions will be needed in the future to determine the viability on an individual property basis.
- 6.1.38 The preferred combined appraisal option is to provide the strategic compensatory habitat within this cell, with the following:
- Option 5a/5b Partial or Full Managed Realignment at Arne Moors, with corresponding freshwater compensation habitat, and with the preference towards Option 5b (Full Managed Realignment) if sufficient secondary freshwater compensation habitat can be secured; and
 - Do Minimum elsewhere in order to comply with the legal requirements, with future Managed Realignment when maintenance of embankments ceases to be practically viable, in agreement with landowners;
 - Local management measures in the medium to long term, such as local defence to individual or small groups of property, or individual resistance and resilience measures.

Cells 9, 10, 11 & 13

- 6.1.39 There is no benefit cost assessment for the Poole Harbour South, Brownsea Island, Studland & Ballard Down and Durlston Bay cells where there are no notable assets at risk, and No Active Intervention has been selected based on the High Level Option assessment and environmental appraisal. However Table 6-9 provides detail of specific local issues where limited future actions may be undertaken by the local landowner.

Table 6-9 Option assessment for Poole Harbour South, Brownsea Island, Studland & Ballard Down, and Durlston Bay

Cell	Preferred Option					
Poole Harbour South	NAI to all of coastline, except; Local Sustain to isolated property where required (by private owners)					
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Cell	Preferred Option
Brownsea Island	NAI to Brownsea Island, except: Lagoon Seawall: Structure does not serve a direct FCERM purpose, and future management to be taken forward by NT and NE. No compensatory habitat required as a result of NAI, agreed by NE. Jetty area & Branksea Castle: Local Maintain in short-medium term (by NT and private tenant)
Studland & Ballard Down	NAI to all of coastline, except; Existing defence at Middle & South Beach: Transition to NAI over short term (by NT) Maintain navigation training wall (by PHC)
Durlston Bay	Managed Realignment through; Local monitoring and cliff stabilisation measures such as surface drainage control and development control (by PDC & private owners)

Cell 12: Swanage

Table 6-10 Benefit-cost assessment for Swanage

		PV Costs (£k)	PV Damages (£k)	PV Amenity Value (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	5,568	5,620			
Option 2	Do Minimum	575	3,685	21,235	17,498	30.4	
Option 3	Sustain	6,809	34	54,257	52,785	7.8	5.7
Option 4	Improve Open beach manage	9,548	34	54,257	54,171	5.7	0.5
Option 5	Improve Revetment	10,987	34	26,540	26,454	2.4	-6.3*

* Inc BC ratio wrt Sustain

- 6.1.40 Do Minimum has the highest benefit cost ratio, however in accordance with the FCERM-AG decision rule, the preferred economic option is Sustain since this option has an incremental benefit cost ratio of 5.7 and Do Minimum would lead to failure of defences and erosion of property. Without the amenity benefits the BCR would fall to 0.8 and Do Minimum would be selected.
- 6.1.41 The preferred option includes a section of Managed Realignment and Do Nothing (or NAI) for the cliff section at North Swanage and towards Ballard Point respectively. It does not address the cliff stabilisation measures needed to manage landslides which have recently occurred at New Swanage as a result of high rainfall causing saturated conditions. A separate consultation exercise has been undertaken, co-ordinated by the Environment Agency, to assist the local community to manage these issues.
- 6.1.42 The preferred environmental option is Sustain for the Swanage seafront; No Active Intervention to north of seafront, with a short section of transition Managed Realignment in between. This will protect properties and infrastructure in Swanage (moderate to major significant beneficial impacts), with policies that maintain the natural earth heritage features of the cliff frontage (significant major beneficial impacts).
- 6.1.43 **The preferred option is therefore Sustain** for the Swanage seafront, with Do Nothing for the cliff section at North Swanage and The Pinnacles, and a short transition Managed Realignment section between.
- 6.1.44 The timing of the next beach renourishment at Swanage is dependent on trigger levels from the on-going monitoring of beach profiles and losses, but is not estimated to be required for at least 10 years. However, there may be an opportunity before then to consider making beneficial use of dredging arisings from the Poole Harbour navigation channels, with significant cost savings relative to standard beach renourishment rates.

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6.2 Sensitivity assessment

- 6.2.1 A sensitivity analysis has been undertaken on the benefit cost analysis for the key variables where there is uncertainty, and where that variable may have an effect on the selection of the preferred short listed option, or the timing of implementation. The following five variables have been examined:
- Climate change scenarios (Lower and Upper bounds) – all cells
 - Unit rate for beach recharge operations increased from £12/m³ to £22/m³ – applied to Hengistbury Head to Sandbanks and Swanage cells
 - Local valuation of property (instead of regional) in benefit assessment – for cells where increase estimated to be potentially greater than 10%
 - Amenity valuation of beach reduced by halving the WtP valuation – applied to Hengistbury Head to Sandbanks and Swanage
 - Timing (urgency) of Improvement works – Central Poole. Other units not considered since either no capital investment recommended in short term, or implementation needed now due to evident poor condition.
- 6.2.2 The outcomes of all the sensitivity analyses undertaken are detailed in Appendix C - Option Assessment Report, Section 6.1.
- 6.2.3 Selection of the preferred option remains robust for all sensitivity tests – none of the options change as a result of the calculations. However, the following tests are of particular note:
- 6.2.4 Reducing the amenity valuation of the beach by half reduces the benefit cost ratio of the preferred option for Hengistbury Head to Sandbanks (from 12.7 to 10.6) and Swanage (from 7.8 to 4.2). Selection of Sustain through the IBCR remains robust.
- 6.2.5 Removing the amenity valuation completely reduces the benefit cost ratio of Option 3b from 12.7 to 8.5. Option 3b (delayed recharge) would be selected since the Incremental BCR for Option 3a is zero.

Table 6-11 Benefit-cost assessment for Hengistbury Head to Sandbanks with zero amenity benefit

		PV Costs (£k)	PV Damages (£k)	PV Amenity Value (£k)	PV Benefits (£k)	BC Ratio	Inc BCR
Option 1	Do Nothing	0	614,726	0			
Option 2	Do Minimum	4,303	441,757	0	172,969	40.2	
Option 3b	Sustain (delayed recharge)	67,715	317	0	614,409	9.1	7.0
Option 3a	Sustain	72,040	317	0	614,409	8.5	0.0*
Option 4	Improve (open beach)	85,400	317	0	614,409	7.2	0.0*
Option 5	Improve (manage realign fwd)	133,074	317	0	614,409	4.6	0.0*
Option 6	Improve (revetment)	89,759	317	0	614,409	6.8	0.0*

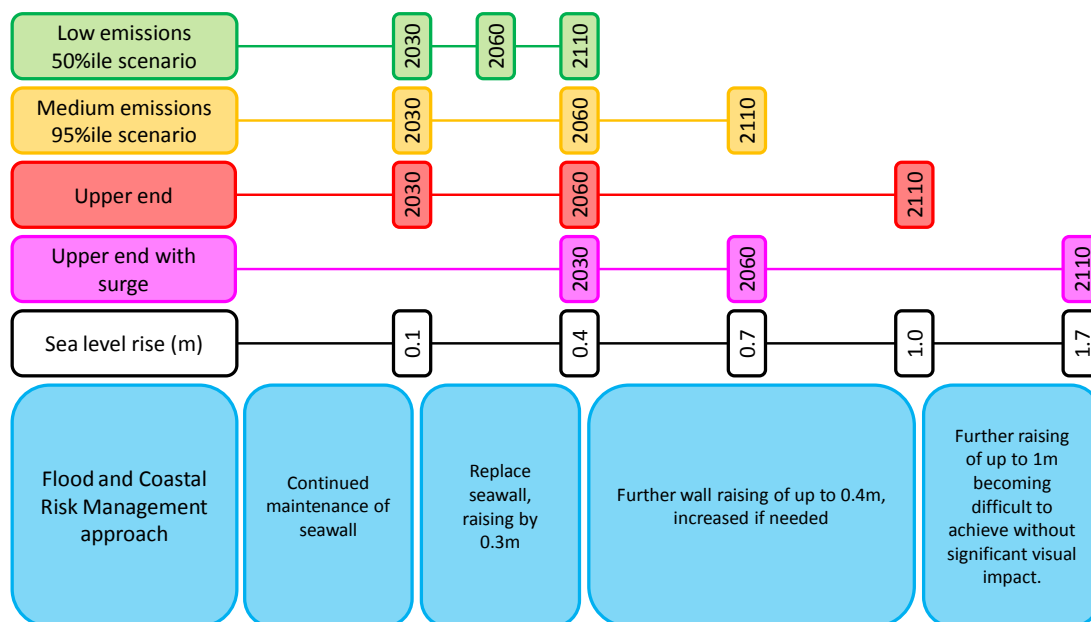
* Inc BCR wrt Option 3b

- 6.2.6 For Central Poole, selection of Option 4b (1% AEP) as a minimum remains robust, but this SoP should be confirmed at detailed appraisal, with potential to increase to Option 4c (0.5% SoP) with a relatively small variation in option costing and risk. In addition, the level of urgency is relatively low, and delay towards the end of the short

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term (i.e. year 10-20) would be economically preferable. It is anticipated that the scheme will be combined with private development, which will ultimately provide opportunities for wider outcomes and contribution funding.

6.2.7 Climate change sensitivity for precautionary type preferred options is generally best managed by varying the timing of future intervention of raising defence levels. An example (Luscombe Valley) is indicated below:



6.2.8 The preferred beach management options for Hengistbury Head to Sandbanks and Swanage are managed adaptive solutions and are not particularly sensitive to climate change lower and upper bound scenarios since the beach renourishment volumes can be adjusted.

6.3 Details of the preferred option

Technical & Environmental aspects

6.3.1 The preferred option for each cell can be selected in line as identified in Section 6.1, with the exception of the requirement for the inter-tidal compensatory habitat needs, as identified in Table 3.1. This will be fulfilled by implementation of Managed Realignment at Wareham Banks and Ridge (Option 5a at Arne Moors), providing a minimum of 44ha, and potential to increase this beyond 100ha.

6.3.2 The Ramsar site at Arne Moors is designated for its freshwater features (notably peatland mires and their transitions from saltmarsh), and therefore the proposed Managed Realignment option at this location requires secondary compensation habitat to be in place prior to implementation of the managed realignment.

6.3.3 An HRA Statement of Case demonstrates that: there are 'no alternatives' to the preferred solutions; there are IROPI and public safety for the proposed Strategy; and

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that the preferred options represent the 'least damaging' environmental solutions given the economic, social and environmental constraints.

- 6.3.4 The opportunity for an additional Managed Realignment at Lytchett Bay (24ha) may be realised in the future, subject to landowner agreement. This option has been selected in Section 6.4 Summary of Preferred Strategy, to include the costs for approval should the opportunity become available at a future stage.
- 6.3.5 It is proposed that the secondary compensation of freshwater habitat is delivered through a combination of Sunnyside Farm (near Arne Moors) and East Stoke (Lower Frome valley). A letter of support indicating this is provided in Appendix H. Costs for the secondary habitat compensation are included in the option costs.
- 6.3.6 The 6ha of compensatory habitat for "Scrub, broad leaved woodland, *Molinia meadow*" losses as identified in Table 5.1 will be provided through the designation of part of the much larger restoration areas within the Purbeck Forest Design Plan for the local area. Through meetings and discussions in the formation of the Wild Purbeck Nature Improvement Area bid during 2012 it became apparent that the Environment Agency and the Forestry Commission would be able to collaborate in the restoration of natural habitats within the local forestry estate. This collaboration will enable the compensatory habitat targets for terrestrial habitat losses as a result of coastal squeeze to be recreated in a sustainable location through the Forest Design Plan.
- 6.3.7 The proposed works at Hengistbury Head to Sandbanks are urgent, given the poor condition of many of the timber groynes. The proposed scheme at Central Poole should be undertaken in conjunction with the proposed private development of key sections within Poole, to maximize the potential contributions from the development. Although synchronizing with the development increases the risk of delay of implementation of the scheme, the sensitivity test indicates that the urgency rating for this cell is not high.
- 6.3.8 Investigation is recommended to determine how best to manage the combined surface water and tidal lock flood risk issues at Lower Parkstone, Central Poole (Sterte, Stanley Green and Creekmoor) and Lytchett Bay (Recreation Ground and Upton). The complexity of combined event flood risk on these ordinary watercourse drainage points is beyond the scope of assessment at strategy level, and more detailed analysis is required to determine the viability of technical solutions and potential funding sources.
- 6.3.9 The Strategy will manage tidal flood and erosion risks to the majority of properties in towns and villages around the harbour and bays, through an adaptive approach to rising sea levels.
- 6.3.10 The significant Strategy-wide environmental benefits of the preferred options include:
- Reduced tidal flood and erosion risk to people, in excess of 10,000 residential and commercial properties (in the long-term), community, recreational and amenity facilities, and historic assets in the major centres of population e.g. Bournemouth, Poole, Swanage and Wareham.
 - Improved tidal flood protection to about 570 properties in the short-term.
 - Reduced tidal flood and erosion risk to critical infrastructure Continued protection of areas designated for future development.
 - Where NAI and MR policies form part of the Strategy, the coastal system will be allowed to function more naturally, which will significantly benefit existing designated inter-tidal habitats in most parts of the Strategy area. The area of intertidal habitat gain could exceed the minimum requirement for compensatory habitat.
 - HTL throughout the majority of the Strategy area will protect most of the terrestrial and freshwater habitats within designated nature conservation sites (short term).

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- Continued maintenance of the geological exposures of the Jurassic Coast WHS and the Purbeck Ridge SSSI, Studland Cliffs SSSI and Ham Common SSSI, through a combination of MR and NAI policies.
- Reduced tidal flood and erosion risks to most landfill sites bordering the estuary and areas of former historical activity.
- Positive contributions to WFD objectives with NAI and MR to allow restoration of a more natural system and tidal conditions and improved fish feeding and breeding opportunities.

6.3.11 Negative environmental impacts of the Strategy include:

- Some isolated properties, minor roads and moderate to very poor agricultural land will continue to be affected by increased tidal flood risk.
- Potential for adverse impacts on landscape character, where the standard of flood protection will be maintained, sustained or increased through varying means, including the introduction of new structures and the increased height of existing hard defences.
- Reduced amenity/recreational use of the Frome and Piddle Rivers when a 'do minimum' option at Wareham Tidal Banks becomes unsustainable in the medium term.
- Loss of recreational facilities and access at Brownsea Island, when the current visitor centre is no longer usable in the medium-term.
- Where defence alignments will be maintained, there will be likely loss of internationally designated inter-tidal habitat in the footprint of new defences and due to coastal squeeze within the Poole Harbour SPA and Ramsar site.
- Loss of freshwater wetland including internationally designated heathland and fen habitat, in some areas where NAI or MR policies are proposed.

6.3.12 Uncertain impacts include:

- Changes in coastal processes in areas of NAI have potential to affect fishing activities and the distribution of commercial fish/shellfish in the harbour and surrounding Strategy area – these impacts (which may be positive and negative) remain uncertain but would occur in the absence of the Strategy.
- Potential changes in landscape character, which will require further consideration at project level.
- Strategy implementation will result in long-term geomorphological change in the Strategy area, as parts of the Strategy area evolve naturally.

6.3.13 Mitigation measures have been proposed for all negative effects identified, and these are detailed in the SEA Environmental Report. The mitigation measures will be reviewed and assessed as projects are taken forward and design details become available (e.g. visual appearance, alignment of flood defences etc).

6.3.14 A strategic environmental monitoring plan has been drafted addressing uncertainties surrounding the future outcome of coastal squeeze (e.g. actual sea level rise compared with predicted) and the need for and success of compensatory habitat creation. This will be finalised in discussion with Natural England as part of the SEA Statement of Environmental Particulars once the Strategy has been recommended for approval.

6.4 Summary of preferred strategy

6.4.1 Table 6-12 below shows a summary of the costs for each cell preferred option, split by capital and non-capital expenditure for maintenance.

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Table 6-12 Summary of preferred strategy

	Heng Hd to Sandbanks	Luscombe Valley	Lower Parkstone	Central Poole	Hamw'thy	Rockley Sands	Lytchett Bay	Wareham Banks & Ridge	Poole Harbour South	Brownsea Island	Studland & Ballard Down	Swanage	Durlston Bay	Other Comp Habitat	Total
Preferred Option	Sustain	Sustain	Sustain	Improve	Sustain	Manage Realign	Sustain & **Manage Realign	Manage Realign 5a/b & Do Min	NAI	NAI & local maintain	Transition to NAI	Sustain & NAI	Manage Realign	Terrest. habitat	
SoP (% AEP)	erosion	1%	0.5%	1%*	0.5%	erosion	0.5%	5 to 100%	erosion	2 to 5%	erosion	erosion	n/a	n/a	
Lead Authority	BBC & BoP	EA & BoP	EA & BoP	EA & BoP	EA & BoP	Private	EA	EA	Private	NT	NT	PDC	PDC	EA	
PV Costs (£k)	72,040	2,603	569	19,180	3,055	107	4,452	24,459	0	0	0	6,809	0	100	133,374
PV Benefits (£k)	912,088	9,463	9,787	259,661	11,077	117	7,639	10,950	0	0	0	52,785	0	0	1,273,567
Habitat creation (ha) benefit (compensation)							**24 inter-tidal	44 to 110 inter-tidal 44 to 110 f/water						6 terrest.	118ha to 250ha various
Average BC Ratio	12.7	3.7	17.2	13.5	3.6	1.1	1.7	0.4	n/a	n/a	n/a	7.8	n/a	n/a	9.5
10yr Scheme Cost Capital (£k)	26,681	0	0	13,914	0	0	2,360**	17,192	0	0***	0***	0 ⁺	0	60	60,248
Future Cost - Capital (£k)	193,536	6,130	2,618	14,466	6,218	320	8,974	21,123	0	0	0	29,577	0	0	282,963
Maintenance Cost (£k)	16,603	1,967	244	6,285	2,730	32	890	6,529	0	0	0	2,309	0	0	37,589
Whole Life Cost (£k)	236,820	8,097	2,862	34,665	8,948	352	12,224	44,844	0	0	0	31,886	0	60	380,799

* Potential to consider increased SoP to 0.5% at detailed appraisal, marginal cost increase

** Potential opportunity to undertake MR at Lytchett Bay North, subject to future landowner agreement

*** Costs may be incurred by NT in undertaking transition to NAI (e.g. removal of existing defences) and local maintain, private expense

⁺ Potential opportunity for capital cost spend from Poole Harbour dredging, if suitable

Contributions and funding

- 6.4.2 Different organisations are responsible for flood and coastal erosion risk management within the Strategy areas, as identified in Table 6.11. As partners in this Strategy the respective local authorities will promote their frontages, applying for FDGiA where appropriate. Private landowners will undertake their own local management activities with no FDGiA at the following locations: Sandbanks (frontage between Sandbanks chain ferry and Royal Yacht Club), Rockley Sands, Poole Harbour South, Brownsea Island (NT/tenant), Studland (NT) and Durlston Bay – although should a problem affect a number of properties and solution(s) be located on other landowners land, the PF model will be applied.
- 6.4.3 The Flood and Coastal Resilience Partnership Funding model has been applied to the schemes recommended for Hengistbury Head to Sandbanks, and Central Poole. Table 7.3 provides the key Outcome Measure data and shows the amount of FDGiA available for each Capital Improvement Scheme.
- 6.4.4 Contribution from BBC and BoP has been and will continue to be provided for Hengistbury Head to Sandbanks through the maintenance operations undertaken by both authorities. BBC has recently contributed £400k to the Bournemouth Beach Management Scheme.
- 6.4.5 In addition, further contribution from BBC is being negotiated for the amenity benefit proportion of the Partnership Funding score, representing 18% of scheme cost (approximately £4.8m over the next 10 years). Further efficiency will be provided by BBC and BoP combining their coastal engineering and procurement approach and use of Poole Harbour maintenance dredging material if available.
- 6.4.6 A significant proportion of the proposed scheme at Central Poole will be funded by regeneration development, and therefore the proposed detailed appraisal needs to fit with the programme by the private developer(s) to take advantage of the direct and indirect contribution opportunity. A minimum direct contribution estimate of £6.7m for erosion and flood risk management structures has been estimated at this stage; however this could be increased with Community Infrastructure Levy.
- 6.4.7 Poole Harbour Commissioners are planning a new piled frontage at Poole Dolphin Quay, potentially reducing future capital expenditure needed for Central Poole.
- 6.4.8 In addition, contribution funding from BoP and Wessex Water will continue to be provided for the maintenance and operation of the existing outfall structures.
- 6.4.9 The Managed Realignment scheme at Wareham Banks & Ridge (Arne Moors) will be fully funded by FDGiA since this scheme is driven by the strategic and legal requirement to provide compensation inter-tidal habitat. This over-rides the Partnership Funding score of 36% (refer to Table 7-3). However it will benefit from RSPB contribution of land (avoiding need for land purchase). In addition, NE is proposing to contribute reserve land at Arne.
- 6.4.10 Funding of the Do Minimum option for the Wareham Banks & Ridge has traditionally been sourced from flood defence revenue budget. An internal Environment Agency contribution from the “Wareham Royalty” navigation mooring income will be explored.

Health, safety and sustainable construction

- 6.4.11 Health and safety elements form a key consideration in design development. At this stage the options are not sufficiently developed to allow a comprehensive assessment of all the health and safety issues. However, the solutions proposed are not inherently high risk in nature, and good management in planning and during construction will address the major health and safety risks to people (public and construction staff).

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6.4.12 A fundamental aim of option development has been to identify and achieve integrated engineering, environmental and sustainable solutions. This approach will be further developed within the future scheme detailed appraisal development and subsequent detail design stages.

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7 Implementation

7.1 Project planning

Phasing and approach

- 7.1.1 The Strategy aims to promote and encourage long term sustainable and strategic management of flood and erosion risk. With our partners, it provides a framework for planning the implementation of capital projects, further studies, surveys and investigations, and will help with targeting and prioritisation of day-to-day activities.
- 7.1.2 Capital investment at Hengistbury Head to Sandbanks is a relatively continuous rolling programme of annual expenditure, but with increased spend levels in the first few years. A 5-year scheme appraisal is proposed to seek approval for the funding required for the whole frontage including all groyne and beach renourishment needs, instead of several short sections with separate appraisal applications, which has been the previous approach. The main source of beach nourishment is anticipated to be from Area 451 off the Isle of Wight where large reserves are present.
- 7.1.3 The 5-year appraisal should not hinder any opportunity to use local dredgings from Poole Harbour (navigation channels) when available and of appropriate quality. This would provide significant cost efficiency, although on its own is unlikely to provide the total beach renourishment volume required. Dredged material has been used for beach nourishment on several occasions in the past, most notably when a navigational deepening programme in 2005/6 yielded 1.8million m³ shared between Swanage (100,000m³) and Hengistbury Head to Sandbanks (1.2million m³). Maintenance dredging is anticipated to yield about 60,000m³ every 2 to 3 years.
- 7.1.4 Capital investment at Central Poole will need to be programmed to maximize the private development opportunities to realise contributions, but scheme appraisal should be taken forward to address other areas of Poole (e.g. Creekmoor) where no development is planned.
- 7.1.5 Planning for the proposed Managed Realignment at Arne Moors will need to be developed in more detail to confirm the requirement for and availability of freshwater secondary habitat compensation for different detailed options to identify the optimum sustainable solution. It is envisaged that the implementation of the secondary freshwater habitat would be delivered over the first 5 years, and the implementation of the primary inter-tidal habitat at Arne Moors would be delivered from Year 5 to Year 10.
- 7.1.6 Preferred options for the other cells do not require capital expenditure in the first 10 years, subject to future monitoring, for example in the event of increased beach losses at Swanage.
- 7.1.7 Engagement with communities and stakeholders will need to continue in order to manage the risk and consequences of flooding, and this includes:
- Encourage all parties with responsibility for maintenance of defences, including private landowners, to monitor and maintain their defences.
 - Continuing to engage the local community through partner groups such as LiCCO, DCF and SCCF.
 - Promotion of resilience measures for properties at risk in the future where no formal flood risk defence has been proposed.

Programme and spend profile

- 7.1.8 The key actions recommended by this Strategy are presented in Table 7.1, which identifies the outline programme for the next 10 years for FCERM projects.

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7.1.9 Funding for these schemes is anticipated to be through FDGiA, with the exception of Central Poole which will include a substantial private development contribution. The Environment Agency will continue to work with the local authorities, other partners, riparian owners and local communities to identify and secure contribution funding sources wherever possible.

7.1.10 Key actions for Year 10 to 20 are not identified below, but are anticipated to include continued investment at Hengistbury Head to Sandbanks, and a 'top-up' beach nourishment at Swanage. Investment actions beyond Year 20 are not identified since it is anticipated that a Strategy review will have been undertaken, improving the certainty of actions in the medium term.

Table 7-1 Key dates

Activity	Date
Hengistbury Head to Sandbanks – Groyne and Beach Nourishment Phase A (Year 1-5) and Phase B (Year 6-10)	
Commence detailed appraisal, Phase A	2014
PAR Approval	2015
Construction start	2015
Construction completion	2019
Commence detailed appraisal, Phase B	2018
PAR Approval	2019
Construction start	2020
Construction completion	2024
Central Poole	
Improve 1% (Creekmoor, Old Town and Port)	
Commence detailed appraisal (pending development)	2014
PAR Approval	2015
Construction start	2017
Construction completion	2019
Poole & Upton	
Combined Surface & Tidal Flood Risk Drainage	
Commence detailed investigation & appraisal	2014
PAR Approval (if scheme viable)	2015
Construction start	2016
Construction completion	2016
Wareham Banks & Ridge	
Arne Moors Habitat Creation	
Commence outline design at Arne Moors and validate the secondary compensation sites	2014
Wareham Freshwater Habitat PAR Approval	2014
Construction start for Wareham Freshwater Habitat	2015
Construction completion	2016
Arne Moors PAR Approval	2019
Construction start at Arne Moors	2020
Construction completion	2021

Table 7-2 Annualised spend profile and OM priority score

	2014-15	2015-16	2016-17	2017-18	2018-19	2019 – 2024 5 years	Total 10 years	Total 100 years
Hengistbury Head to Sandbanks; Sustain; PF score 105%; Groyne & Beach Nourishment.								
Operating authorities: Bournemouth Borough Council, BoP, Environment Agency								
Capital Cost (£k)	3,777	3,777	3,749	1,997	2,197	11,184	26,681	220,218
Maint Cost (£k)	164	164	164	164	164	822	1,644	16,603
Central Poole; Improve 1%; PF score 107%; Seawalls and urban flood defences								
Operating authorities: BoP, Environment Agency								
Capital Cost (£k)	1,569	1,748	1,933	0	0	1,934	7,184	28,381
Est. Contribution non-FDGiA	0	0	0	0	0	6,730+	6,730+	
Capital Cost (£k)								

	2014-15	2015-16	2016-17	2017-18	2018-19	2019 – 2024 5 years	Total 10 years	Total 100 years
Maint Cost (£k)	62	62	62	62	62	311	622	6,285
Poole & Upton; Combined Surface and Tidal flood risk Investigation								
Operating authorities: BoP, Purbeck District Council, Wessex Water, Dorset County Council, Environment Agency								
Capital Cost (£k)	Costs include above							
Wareham Banks & Ridge; Inter-tidal and freshwater compensatory habitat scheme (option 5b cost)								
Operating authorities: Environment Agency, Purbeck District Council								
Capital Cost (£k)	672	1,766	1,766	1,766	1,766	9,454	17,192	38,315
Maint Cost (£k)	126	98	99	97	93	429	942	6,529
Potential scheme at Lytchett Bay North; Inter-tidal compensatory habitat scheme Subject to future landowner agreement								
Operating authorities: Environment Agency, Purbeck District Council								
Capital Cost (£k)	0	0	0	0	0	2,360	2,360	2,360
Maint Cost (£k)	0	0	0	0	0	0	0	0
Remaining Strategy Cells: ongoing maintenance, refurbishment								
Operating authorities: All relevant authorities								
Capital Cost (£k)	0	0	0	0	0	0	0	53,936
Maint Cost (£k)	77	77	77	77	77	386	773	8,172
Total Strategy area (sum of the above)								
Capital Cost (£k)	6,018	7,291	10,814	9,062	3,964	22,999	60,148	343,210
Maint Cost (£k)	430	402	403	401	397	1,948	3,981	37,589

Note: Figures include Optimism Bias, exclude inflation

Outcome measures contributions

Table 7-3 Partnership Funding Summary

Calculator Outputs	HH to Sandbanks Sustain	Central Poole Improve	Wareham Banks Managed Realignment 5b
Duration of Benefits (period of intervention; years)	20	20	10
PV Costs for duration of benefits (£k)	30,827	14,451	15,172
PV Benefit for duration of benefits (£k)	166,892	149,506	0
OM2 Total households (now) with reduced flood risk	0	63	0
OM3 Total households (future) with reduced erosion risk	5,682	64	0
OM4 Environmental benefits	0	0	110ha
Raw OM Score (%)	97 (76 excl amenity)	61	36
Estimated Contribution (£k)	2,333+ BBC/BoP maintenance plus	6,730+ Developer contribution	0
FDGiA Contribution (£k)	28,493	7,721	5,500
Partnership Funding PF Score (%)	105 (82 excl amenity)	107	36

7.2 Procurement strategy

7.2.1 Table 7.4 summarises the key staff involved in the preparation of the Strategy. The Steering Group included representatives from all Local Authorities, the Area Flood Risk Manager, NEAS Principal Environmental Project Manager (South-West), ncpms (Project Executive) and the NEECA2 consultant alliance project directors.

7.2.2 A Procurement Strategy meeting will take place during the start-up of any funded projects from the Strategy. BBC and BoP are the lead authorities for Hengistbury

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Head to Sandbanks and will develop their own procurement strategy accordingly. The Environment Agency will use their WEM Framework Suppliers to undertake the other capital investment projects with local Operations Delivery teams to undertake maintenance activities, as appropriate.

Table 7-4 Key staff

Environment Agency		Framework Suppliers	
Client		NEECA2 Team – Atkins / Halcrow Alliance	
Project Sponsor (Area Flood Risk Manager)	Nick Lyness	Project Director	Richard Samphier Jonathan Rogers
Senior Business User	Neil Watson	Project Manager	Russell Corney
Project Executive	John Taberham	Environmental Consultant	Corinna Morgan
Project Manager	Fiona Geddes	Technical Advisors	Adam Schofield
NEAS Officer	Amy Cocker		Paul Canning
Bournemouth Borough Council		Purbeck District Council	
Steering Group member	David Harlow	Steering Group member	Mike Goater
Borough of Poole		Dorset County Council	
Steering Group member	David Robson Stuart Terry	Steering Group member	Brian Richards
National Trust		Natural England	
Steering Group member	Tony Flux	Steering Group member	Simon Thompson
RSPB		Poole Harbour Commissioners	
Steering Group member	Renny Henderson	Steering Group member	Andy Ramsbottom

7.3 Delivery risks

High level risk register

7.3.1 The key risks and mitigation measures are shown in Table 7.5.

Table 7-5 Risk Schedule and Mitigation Measures

Key project risk	Adopted mitigation measure
Landowner: Objections to proposed Managed Realignment options.	<ul style="list-style-type: none"> Continued engagement with landowners and planning authority (PDC)
Political: Area of freshwater habitat compensation cannot be delivered, delaying ability to promote MR scheme at Arne Moors	<ul style="list-style-type: none"> Continued engagement with landowners. Undertake outline design of Arne Moors to determine area required
Financial: Cost estimates based on broad assessment of principal quantities and rates; and confirmation required of potential benefits achievable.	<ul style="list-style-type: none"> Optimism bias of 60% applied to all costs Use of unit data base and verified by recent local schemes
Environmental: Presence of potential environmental constraints e.g. protected or invasive species, buried archaeology, particularly at MR sites	<ul style="list-style-type: none"> Carry out desk-based assessments and field surveys at project level to identify constraints Continued consultation with relevant stakeholders Review lessons from other MR sites
Political: Development opportunities in Poole are delayed, reducing contribution or delaying project completion.	<ul style="list-style-type: none"> Continue engagement with BoP local planners to understand regeneration programme and enable us to take account of any impact on the Strategy recommendations.
Delivery: Central Poole scheme cannot be delivered in entirety, leading to separation and reducing chance whole scheme can be completed	<ul style="list-style-type: none"> Initiate detailed planning with BoP to determine best approach to different elements of whole scheme, ensure single budget approval
Delivery: Implementation, including the level of funding available and change in procedures.	<ul style="list-style-type: none"> Ensure that non-structural measures such as flood warning are continued in case of funding shortfall for structural options.

Safety Plan

- 7.3.2 The design decisions made at this strategic stage of the process have considered the possible solutions for minimising the health and safety risks whilst still achieving the required flood and coastal erosion risk management. It was important to consider risks at the start of a project in order to achieve a successful outcome. The risks associated with the options considered include:
- construction and buildability issues;
 - operation and maintenance activities;
 - foreseeable emergency requirements;
 - alterations to the existing situation;
 - adjacent land users.
- 7.3.3 On the basis of the initial risk assessment, the development of any PAR should include:
- early input from the Resident CDM co-ordinator;
 - use of ECI;
 - health and safety input into detailed design, buildability and planning;
 - identification by the designers of specific risks and mitigation as part of the Design Risk Register;
 - identification of specific residual risks to the contractor;
 - inclusion of SHE boxes on design drawings;
 - high quality Pre-construction Information to the contractor;
 - Public Safety Risk Assessment.
- 7.3.4 During the construction phase, site health and safety will be the responsibility of the principal contractor supported by the Resident CDM co-ordinator, supervisor, designers and client. The site will be subject to regular checks and audit by the principal contractor, supervisor and the client.

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Appendix A Project appraisal report data sheet

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):	IMSW001625
Project Name (60 characters max.):	Poole Bay, Poole Harbour and Wareham Flood and Coastal Erosion Risk Management Strategy
Promoting Authority: Defra ref (if known)	
Name	Environment Agency
Emergency Works:	<input type="checkbox"/> No <input type="checkbox"/> Yes/No
Strategy Plan Reference:	n/a
River Basin Management Plan	n/a
System Asset Management Plan	n/a
Shoreline Management Plan:	Poole and Christchurch Bay
Project Type:	Strategy Plan
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:	2014
Estimated duration in months:	On-going
Contract type*	Framework
(*Direct labour, Framework, Non Framework, Design/Construct)	

COSTS

	APPLICATION (£000's)
Appraisal:	867
Costs for Agency approval:	381,000
Total Whole Life Costs (cash):	381,000

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:	6,730
Deductible Contributions:	None
ERDF Grant:	None
Other Ineligible Items:	None

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	South West
Name of watercourse (fluvial projects only):	n/a
District Council Area of project (all projects):	Bournemouth BC, Borough of Poole, Purbeck DC
EA Asset Management System Reference:	Varies
Grid Reference (all projects):	SZ 02071 87906

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

DESCRIPTION

Specific town/district to benefit:

Poole Bay and Poole Harbour

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

Strategy recommends a range of projects in the next 15-20 years including beach management at Bournemouth, improvements to defences at Poole and managed realignment at Arne Moors. Beyond this incremental improvements are recommended to address climate change.

DETAILS

Design standard (chance per year):	Varies	yrs
Existing standard of protection (chance per year)	Varies; 1 in 1 to 1 in 200	yrs
Design life of project:	Varies	yrs
Fluvial design flow (fluvial projects only):	n/a	m ³ /s
Tidal design level (coastal/tidal projects only):	Tide levels + medium 95%ile sea level rise	m
Length of river bank or shoreline improved:	~ 28,000 (Sustain)	m
Number of groynes (coastal projects only):	60	
Total length of groynes* (coastal projects only):	4200	m
Beach Management Project?	No	Yes/No
Water Level Management (Env) Project?	No	Yes/No
Defence type (embankment, walls, storage etc)	Primarily beach, seawalls & embankments	

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

ADDITIONAL AGREEMENTS:

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

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:	Received	Not Applicable/Received/Awaited
Date received	17/07/2013	

SITES OF INTERNATIONAL IMPORTANCE

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

Special Protection Area (SPA):	Yes	Yes/No
Special Area of Conservation (SAC):	Yes	Yes/No
Ramsar Site	Yes	Yes/No
World Heritage Site	Yes	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:	Yes	Yes/No
National Park/The Broads	No	Yes/No
National Nature Reserve	Yes	Yes/No
AONB, RSA, RSC, other	Yes	Yes/No
Scheduled Ancient Monument	Yes	Yes/No
Other designated heritage sites	Yes	Yes/No

OTHER ENVIRONMENTAL CONSIDERATIONS

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

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

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

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

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:	Approx. 755		Ha
of which present use is:	FRM	CERM	
Agricultural:	18	0	Ha
Developed:	178	378	Ha
Environmental/Amenity:	66	95	Ha
Scheduled for development	20	0	Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
¹ Residential	2,595	6,178	2,415,761	2,116,812
Commercial/industrial	922	697	566,893	182,741
Critical Infrastructure	9	23	Inc. above	Inc. above
Key Civic Sites	3	7	Inc. above	Inc. above
Other (description below):				
Description:				

costs and Benefits

¹ Present value of total project whole life costs (£'000s):	133,000	
Project to meet statutory requirement? Y/N	Y	
	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	228,998	569,740
Present value of commercial/industrial benefits:	71,224	48,934
Present value of public infrastructure benefits:		
Present value of agricultural benefits:		
Present value of environmental/amenity benefits:	7,241	346,316
¹ Present value of total benefits (FRM & CERM)	1,270,000	
Net present value:	1,138,000	
Benefit/cost ratio:	9.5	
Base date for estimate:	2013 Q1	
FCERM-AG Decision Rule stage 3 applied		Yes/No
FCERM-AG Decision Rule stage 4 applied		Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*:	Varies	Indicate if deprived:	Yes	Yes/No
(*as ranked by Indices of Multiple Deprivation)				
Risk:	n/a	VH, H or N/A		
Net gain of BAP habitat:	Wetland	Saltmarsh/ Mudflat	Ha	
		74-140		
SSSI protected:		Ha		
Other Habitat:		Ha		
Heritage Sites:		"I or II", "II or other" or "N/A"		

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: **No** Yes/No

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