



## Strategy Appraisal Report

Authority Scheme  
Reference

Defra / WAG LDW  
Number

Promoting  
Authority

Southend-on-Sea Borough Council

Strategy  
Name

Southend-on-Sea Shoreline Strategy Plan



Date

December 2017

Version

V 1.0



## StAR for *Southend-on-Sea Shoreline Strategy Plan*

<b>Version</b>	<b>Status</b>	<b>Signed off by:</b>	<b>Date signed</b>	<b>Date issued</b>
1.0	Draft – SBC Review	Z Hutchison	15/12/2017	15/12/2017
1.1	Draft – SBC Review	Z Hutchison	26/01/2018	26/01/2018

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# For technical approval of the business case

**Environment Agency Region: Anglian**

**Project name: Southend-on-Sea Shoreline Strategy Plan**

**Approval Value: £410 million (PV Costs: £134 million)**

**Sponsoring Director: Andrew Lewis Deputy Chief Executive, Southend-on-Sea Borough Council**

## 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)			
<b>1. Submission for review (to be completed by team)</b>			
Project Title: Southend-on-Sea Shoreline Strategy Plan		Project Code:	
Project Manager: Milaila Bentz		Date of Submission: April 2018	
Lead Authority: Southend-on-Sea BC		Version No: 1.1	
Consultant Project Manager: Tom Dix		Consultant: Mott MacDonald	
<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>			
Position	Name	Signature	Date
Project Executive	Andrew Lewis		
	Job Title:	Deputy Chief Executive	
<b>2. Review by: Large Projects Review Group (LPRG)</b>			
Date of Meeting(s):		Chairman:	
Recommended for approval: In the sum of £:		Date:	Version No:
<b>3. Environment Agency NFSoD approval</b> <i>Officers in accordance with the NFSoD.</i>			
Version No:		Date:	
Project Approval	By: In the sum of: £	Date:	
<b>4. Defra</b>			
Submitted to Defra or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra or Not applicable (as appropriate)		Date:	
Comments:			



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

1. <b>Project name</b>	Southend-on-Sea Shoreline Strategy Plan		<b>Start date</b>	March 2016
			<b>End date</b>	April 2018
<b>Business unit</b>	Anglian Region, Flood Risk Management (FRM)	<b>Programme</b>	FDGiA	
<b>Project ref.</b>		<b>Regional SoD ref.</b>	<b>Head Office SoD ref.</b>	-

2. <b>Role</b>	<b>Name</b>	<b>Post Title</b>
<b>Project Sponsor</b>	Mark Johnson	Area Coastal Manager
<b>Project Executive</b>	Andrew Lewis	Deputy Chief Executive
<b>Project Manager</b>	Milaila Bentz	Coastal Defences Engineer

3. <b>Risk Potential Assessment (RPA) Category</b>	<b>Low</b>	<input checked="" type="checkbox"/>	<b>Medium</b>	<input type="checkbox"/>	<b>High</b>	<input type="checkbox"/>
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4. <b>NFSoD value</b>	<b>£k</b>
<b>Whole Life Costs (WLC) of Complex Change Project / Strategic Plan</b>	134,214

5. <b>Required level of Environmental Impact Assessment (EIA)</b>	<b>N/A</b>	<b>Low</b>	<b>Medium</b>	<b>High</b>
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. <b>NFSoD approver name</b>	<b>Post title</b>	<b>Signature</b>	<b>Date</b>
	Regional Director/Director Wales		
	Director of Operations		
<b>NFSoD consultee name</b>	<b>Post title</b>	<b>Signature</b>	<b>Date</b>
	LPRG Chair		
Mark Johnson	Coastal Manager, Anglian Eastern		

## Foreword

Southend-on-Sea Borough Council appointed engineering consultancy Mott MacDonald Ltd. to prepare this 2017 submission of the Southend-on-Sea Shoreline Strategy. This 2017 Shoreline Strategy represents a revision of a previously prepared and submitted document by Black & Veatch Ltd in 2012 and again in 2014.

This 2017 Shoreline Strategy makes use of material previously prepared by Black and Veatch Ltd on behalf of Southend-on-Sea Borough Council. Full recognition is given to the material developed by Black and Veatch Ltd. and used in this 2017 Shoreline Strategy.

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## Glossary / Abbreviations

Abbreviation / Term	Definition
AEP	Annual Exceedance Probability
AST	Appraisal Summary Table
Av.BCR	Average Benefit Cost Ratio
BA	Benefit Area
BCA	Built Conservation Area
BCR	Benefit Cost Ratio
Defra	Department for Environment, Food and Rural Affairs
CIRIA	Construction Industry Research and Information Association
ECC	Essex County Council
EIA	Environmental Impact Assessment
EU	European Union
FCERM-AG	Flood and Coastal Erosion Risk Management Appraisal Guidance
FCS	Favourable Conservation Status
FDGiA	Flood Defence Grant in Aid
FLAG	Fisheries Local Action Group
HRA	Habitat Regulation Assessment
HTL	Hold the Line
iBCR	Incremental Benefit Cost Ratio
IROPI	Imperative Reason of Overriding Public Interest
LA	Local Authority
LDF	Local Development Framework
LLFA	Lead Local Flood Authority
LPRG	Large Project Review Group
MCM	Multi-coloured Manual
MoD	Ministry of Defence
MMO	Marine Management Office
NAI	No Active Intervention
OB	Optimism Bias
OBC	Outline Business Case
OM	Outcome Measures
PAR	Project Appraisal Report
PDZ	Policy Development Zone
PF	Partnership Funding
PFRA	Preliminary Flood Risk Assessment
PRoW	Public Right of Way
PV	Present Value
PVb	Present Value benefits

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PVc	Present Value Costs
PVd	Present Value Damages
RL	Residual Life
RBMP	River Basin Management Plan
RHCP	EA Regional Habitat Creation Programme
SAC	Special Area of Conservation
SBC	Southend-on-Sea Borough Council
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SoP	Standard of Protection
SOA	Super Output Areas
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
StAR	Strategy Appraisal Report
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100
UK	United Kingdom
UKCP 09	UK Climate Projections 09
WFD	Water Framework Directive

# 1 Executive Summary

## 1.1 Introduction and Background

- 1.1.1 This coastal flood and erosion risk management Strategy covers approximately 12 km of coastline within the jurisdiction of Southend-on-Sea Borough Council (SBC). Southend-on-Sea is located on the Essex coast, in the outer Thames estuary (see Figure 1).
- 1.1.2 The purpose of the Southend-on-Sea Shoreline Strategy (“the Strategy”) is to plan and co-ordinate a technically sound, environmentally acceptable and economically viable proposal for coastal flood and erosion risk management over the next 100 years in the Borough of Southend-on-Sea.

## 1.2 Problem

- 1.2.1 Low-lying areas of the frontage are at risk of tidal flooding and the soft London Clay geology puts the coastline at risk of erosion. The existing coastal defences are ageing, having been constructed largely over 100 years ago. The existing SoP across the frontage varies considerably from 100% AEP to 0.5% AEP and will reduce further with sea level rise.
- 1.2.2 In the absence of an agreed long-term Strategy and sufficient financial resources to institute pro-active maintenance procedures, a reactive approach to the management of the frontage has been maintained. Due to the aging defences, local failures of the revetment and of sections of the seawall have occurred, together with a gradual deterioration of the timber groynes. To date some ad-hoc repairs and general maintenance have been undertaken using SBC’s own internal budgets. This is not a sustainable solution; hence an agreed Strategy is required.
- 1.2.3 Southend-on-Sea benefits from extensive intertidal saltmarsh and mudflats that are designated Natura 2000 sites. The TE2100 Plan and SMP2 have identified that the present and continued operation of coastal flood defences will lead to the loss of intertidal habitat over the course of the next 100 years through coastal squeeze.
- 1.2.4 Based on the complex and key delivery aims for the project, two primary and three secondary objectives to deliver the Shoreline Strategy have been developed in conjunction with SBC, the EA and Natural England. These are outlined in Table 1-1.

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**Table 1-1: The Strategy Objectives**

Primary Objectives	Secondary Objectives
Objective 1: Maximise the reduction of coastal flood and erosion risk to properties and infrastructure at significant or very significant risk of flooding in light of coastal change over the next 100 years.	Objective 3: Support regeneration of Southend-on-Sea and the viability and sustainable development of the tourist industry in accordance with local development policy.
Objective 2: Contribute to a functional, healthy estuary while maintaining and improving the integrity of designated habitats. Aim to offset the impact of coastal squeeze and achieve a net environmental gain in support of the delivery of the Thames River Basin Management Plan.	Objective 4: Align with the objectives of TE2100 and Essex SMP2 to ensure a coherent approach to coastal flood and erosion risk in the region where appropriate.
	Objective 5: Develop a realistic implementation plan that favours options that reduce the whole-life costs and liabilities to the tax payer and utilise partnership funding sources, subject to the consideration of wider community benefits.

## 1.3 Options Considered

1.3.1 The Strategy area has been divided into five 'Benefit Areas', as shown in Figure 1. These Benefit Areas are hydraulically independent, meaning if coastal flooding were to occur within the Benefit Area, flood waters would not extend into adjacent Benefit Areas. Within each Benefit Area are Defence Sections, which are sections of the frontage with similar flood defence structures. The following options have been considered for each Benefit Area:

- **No Active Intervention:** No flood or coastal erosion risk management activity. The No Active Intervention option is the baseline against which all other options are assessed.
- **Hold the Line (HTL) – Maintain (Do Minimum – Patch and Repair):** Continued routine maintenance of flood defences for the remainder of their useful life.
- **Hold the Line (HTL) – Maintain:** The existing defences are to be maintained, replaced and improved as required to their existing crest level. The SoP will deteriorate throughout the lifetime of the Strategy due to sea level rise and increased storminess associated with the effects of climate change.
- **Hold the Line (HTL) – Sustain:** The existing defences are to be maintained, replaced and improved as required to continue to provide their current level of protection for the next 100 years.
- **Hold the Line (HTL) – Upgrade:** In this option, the existing defences would be maintained, replaced and improved as required to provide a higher standard of protection than they do at present for the next 100 years.
- **Managed Realignment (retreat or advance the line):** This option involves the creation of a new line of defence landward or seaward (dependant on the type of realignment) from the existing alignment.
- **Adaptation Measures:** Not developing the front-line defence and instead improving flood resilience and resistance through demountable defences or at an individual property level (e.g. flood doors). It also includes measures such as development control to minimise the impacts of a flood event.

1.3.2 A summary of the options shortlisted for detailed assessment is provided in Table 1-2.

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**Table 1-2: Summary of Shortlisted Options**

Benefit Area	Defence Section	No Active intervention	HTL (Do Minimum – Patch & Repair)	HTL Maintain	HTL Sustain	HTL Upgrade	Managed Realignment	Adaptation Measures*
A	1		✓					
B	2	✓		✓	✓	✓		✓
C	3	✓		✓	✓	✓		✓
	4	✓		✓	✓	✓		✓
	5	✓		✓	✓	✓		✓
D	6	✓		✓	✓	✓		✓
	7	✓		✓	✓	✓		✓
	8	✓		✓	✓	✓		✓
E	9	✓		✓	✓		✓	

\*To be considered as a component of the HTL options

## 1.4 Preferred Option

1.4.1 The Strategy defined the preferred options for each Benefit Area as:

- Benefit Area A: Two Tree Island.** A programme of patch and repair works will be undertaken during the first epoch of the Strategy (to 2034 only). An annual assessment and inspection of defences in this Benefit Area will be undertaken to ensure maintenance works are carried out in a proactive manner. During the first epoch of the Strategy, it is proposed that a working group is formed with key stakeholders and interested parties to identify a long-term approach to managing this issue.
- Benefit Area B: Old Leigh Port – HTL Sustain.** Defences will be raised to provide a consistent SoP against coastal flooding in light of climate change. The risk of coastal erosion will be negated, a 10% AEP SoP will be provided in 2116. Adaptation measures should be applied including temporary and demountable defences to achieve a consistent 10% AEP SoP. Wherever possible development should be compatible with potential flooding, thereby limiting the consequence of these events.
- Benefit Area C: Cinder Path to Three Shells – HTL Upgrade.** Defences will be upgraded to provide a 0.5% AEP against coastal flooding in 2116 in light of climate change. The risk of coastal erosion will be negated. Adaptation measures should be applied including development and planning control. Temporary and demountable defences are only deemed suitable to provide property level protection at Chalkwell. At Cinder Path and Westcliff, the presence of long expanses of key infrastructure adjacent to the coastal defences make temporary and demountable defences unsuitable.
- Benefit Area D: Three Shells to the Old Ranges – HTL Upgrade.** Defences will be upgraded to provide a 0.5% AEP against coastal flooding in 2116 in light of climate change. The risk of coastal erosion will be negated.

Adaptation measures should be applied including development and planning control. Temporary and demountable defences to be considered in localised areas to achieve a consistent 0.5% AEP SoP.

- **Benefit Area E: East Beach – HTL Sustain.** Defences will be raised to provide a consistent SoP against coastal flooding in light of climate change. A 10% AEP SoP will be provided in 2116. The risk of coastal erosion will be negated. Adaptation measures should be applied including development and planning control. Temporary and demountable defences to be considered in localised area to achieve a consistent 10% AEP SoP.

1.4.2 The economic case for the preferred Draft Strategy is presented in Table 1-3.

**Table 1-3: Summary of Preferred Strategy (£k)**

Benefit Area (BA)	BA A	BA B	BA C	BA D	BA E	Total
<b>Standard of Protection in 2116</b>	N/A	10% AEP	0.5% AEP	0.5% AEP	10% AEP	
<b>PV Costs, inc. risk (60% OB) (£k)</b>						
<b>Other Costs (£k)</b>	£0	£463	£2,532	£2,379	£323	<b>£5,697</b>
<b>Capital Costs (£k)</b>	£0	£7,571	£45,923	£45,567	£6,059	<b>£105,120</b>
<b>Maintenance Costs (£k)</b>	£1,957	£161	£4,630	£6,741	£1,489	<b>£14,978</b>
<b>Compensatory Habitat Costs (£k)</b>	£2,133	£437	£2,036	£3,413	£400	<b>£8,419</b>
<b>Total PV Costs (£k)</b>	£4,090	£8,633	£55,121	£58,100	£8,270	<b>£134,214</b>
<b>PV Benefits (£k)</b>	£0	£69,678	£175,704	£355,076	£17,598	<b>£618,056</b>
<b>Average Benefit/Cost Ratio (BCR)</b>	N/A	8.07	3.19	6.11	2.13	<b>4.61</b>
<b>Cash Costs (£k) – not including risk</b>						
<b>Other Costs</b>	£0	£911	£3,729	£4,401	£358	<b>£9,399</b>
<b>Capital Costs</b>	£0	£17,168	£70,256	£84,707	£6,349	<b>£178,480</b>
<b>Maintenance Costs</b>	£1,554	£627	£9,033	£16,285	£2,972	<b>£30,471</b>
<b>Compensatory Habitat Costs</b>	£9,411	£1,929	£9,585	£15,058	£1,765	<b>£37,748</b>
<b>Total Cash Costs (£k)</b>	£10,966	£20,635	£92,603	£120,452	£11,443	<b>£256,098</b>
<b>Initial Benefit Period</b>						
<b>Benefit Period</b>	0 - 17	0 – 100 years	0 – 100 years	0 – 100 years	0 – 100 years	<b>0 – 100 years</b>
<b>PV Costs (£k)</b>	£4,090	£8,633	£55,121	£58,100	£8,270	<b>£134,214</b>
<b>PV Benefits (£k)</b>	£0	£69,678	£175,704	£355,076	£17,598	<b>£618,056</b>
<b>Raw Score (%)</b>	0%	77%	39%	38%	12%	<b>38%</b>
<b>Contributions Required (£k)</b>	£2,133	£1,936	£30,788	£31,610	£5,980	<b>£73,494*</b>
<b>Contributions Achieved (£k)</b>	£0	£0	£0	£0	£0	<b>£0</b>
<b>Adjusted PF Score (%)</b>	0%	77%	39%	38%	12%	<b>38%</b>

\*Note: This figure has been taken from the Strategy wide PF Calculator. This does not equal the sum of the individual PF calculations due to internal calculation and rounding within the PF Calculator

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1.4.3 An implementation plan has been developed as part of the Strategy Plan. During the first five years of the Strategy, capital works are planned at:

- Benefit Area D: Shoebury Common works planned for year one of the Strategy to improve the SoP against coastal flooding
- Benefit Area B: Bell Wharf works planned for year four of the Strategy to replace a length of degraded sea wall
- Benefit Area D: Replacement of Timber Groynes in Defence Section 6 in year four of the Strategy
- Benefit Area E: Replacement of existing defences in year four of the Strategy

1.4.4 At this strategic stage contributions from other sources have not been included. However, some contributions (i.e. other than FDGiA) will be needed to fully implement the Strategy. Possible sources for contributions (capital and maintenance) are identified in Table 1-4 along with the applicable funding mechanism and the section(s) of defence that this funding source is suitable for.

**Table 1-4: Possible Sources of Funding**

Possible Funding Source	Applicable Defence Sections	Funding Mechanism
Network Rail	2, 3 & 4 (Leigh-on-Sea to Chalkwell).	Riparian owner, with existing responsibility for maintaining defence.
MoD	8 & 9 (foreshore)	MoD own foreshore and have responsibility for its upkeep and maintenance. The defences and hinterland in Defence Section 9 are also owned by the MoD.
Private Developers	All sections - capital works with commuted sum to SBC for maintenance.	Section 106 agreements (similar to that for the Old Ranges Garrison development) and other partnership working.
Utility providers	All sections where utility asset is protected by defence) – capital works.	Financial contribution to be made for continued protection.
Essex County Council (ECC)	Defence Section 1 where ECC had involvement in legacy landfill activities	Financial contribution to be made for continued protection.
SBC	All sections, but most likely those where SBC is the lead authority – capital and maintenance works.	Financial contribution and on-going maintenance budget.
Local businesses	All sections, but most likely those in the higher amenity areas (around the pier) - capital and maintenance works.	Innovative mechanism such as Infrastructure levy.
Local residents	All sections - capital and maintenance works.	Innovative mechanism such as council tax levy.
Environment Agency (EA)	Two Tree island	Part of a collaborative approach for works on contaminated land in the area including Two Tree Island and Hadleigh Marsh.

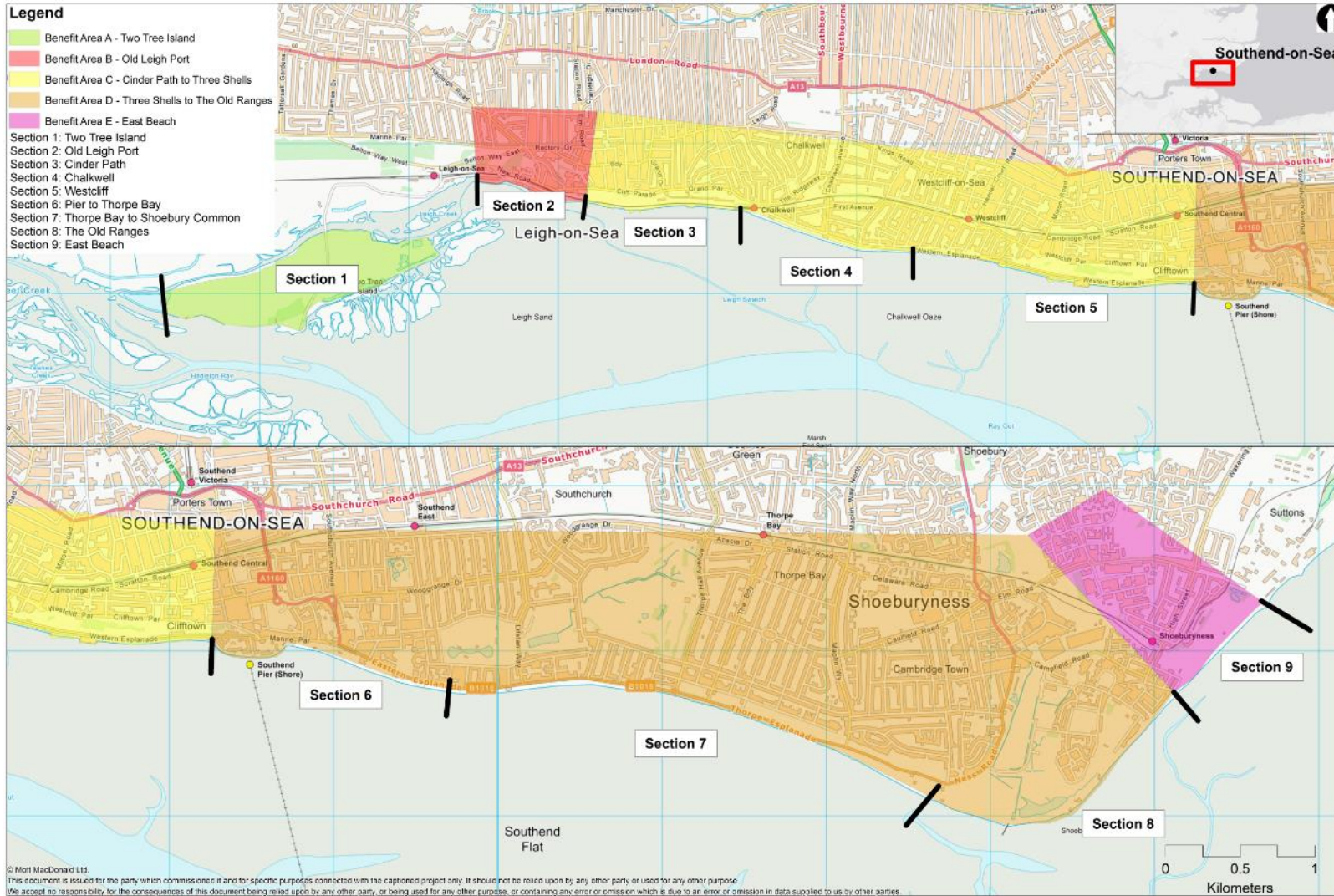
North Thames FLAG	2 (Old Leigh)	Alignment of coastal works with delivery of works to upgrade working port facilities. Providing opportunities to tie into wider national and international funding sources.
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## 1.5 Recommendation

- 1.5.1 It is the recommendation of this report that this Southend-on-Sea Shoreline Strategy Plan is approved for a total value of £410 million (PV Cost £134 million). Scheme details will be developed through subsequent project appraisal, which will take into account any updates to policy and guidance. With an approved Strategy in place SBC will have a technically sound, environmentally acceptable and economically viable proposal for coastal flood and erosion risk management over the next 100 years in the borough of Southend-on-Sea. A clear strategic approach will enable SBC to develop effective working partnerships with stakeholders and potential financial contributors.

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**Figure 1 - Southend-on-Sea Shoreline Strategy Plan**



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## 2 Introduction and Background

### 2.1 Purpose of this Report

- 2.1.1 The purpose of the Southend-on-Sea Shoreline Strategy (“the Strategy”) is to plan and co-ordinate a technically sound, environmentally acceptable and economically viable proposal for coastal flood and erosion risk management over the next 100 years in the borough of Southend-on-Sea.
- 2.1.2 Southend-on-Sea Borough Council have prepared this Strategy Appraisal Report (StAR) as part of their vested responsibility as a Maritime District Council under the Coast Protection Act, 1949. The StAR details required capital, maintenance and other costs to ensure effective management of the Southend-on-Sea coastline over the next 100 years and is seeking technical approval for a total value of £410 million (PV Costs £134 million).
- 2.1.3 The continued need for reactive urgent/emergency works to various lengths of the Southend-on-Sea frontage and the need for major future investment to replace the aging assets have highlighted the need for an approved Strategy to be adopted for this length of coast. This will allow SBC to take a proactive and coordinated approach to the management of the frontage.
- 2.1.4 The Strategy has been undertaken in accordance with Defra / Environment Agency guidance, particularly the Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) (Environment Agency, 2010b).
- 2.1.5 Within the Strategy, three time periods (referred to as epochs) have been defined to enable planning in the short, medium and long term (Table 2-1). To fit within the strategic and legislative context of the region (See Section 2.2) the timing of these epochs has been aligned with those defined in the TE2100 Plan. This will ensure better alignment with the Environment Agency’s Regional Habitat Creation Programme.

**Table 2-1: Time Periods of the Strategy**

	<b>SMP2</b>	<b>TE2100 Plan</b>	<b>Southend-on-Sea Shoreline Strategy</b>
<b>Epoch 1</b>	2010-2025	2010-2034	<b>2017-2034</b>
<b>Epoch 2</b>	2026-2055	2035-2049	<b>2035-2049</b>
<b>Epoch 3</b>	2056-2105	2050-2100	<b>2050-2116</b>

### 2.2 Background

#### Strategic and Legislative Framework

- 2.2.1 The Southend-on-Sea shoreline is covered by the 2010 Essex and South Suffolk Shoreline Management Plan (SMP2), Management Unit J (Southend-on-Sea). The preferred policy of the SMP2 for the Southend-on-Sea shoreline in the short (now to 2025), medium (2025-2055) and long (2055-2105) term is to hold the current alignment of coastal defence and to sustain or upgrade the existing standard of protection in line with sea level rise (Environment Agency, 2010).

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2.2.2 The Thames Estuary 2100 project (TE2100) was published by the Environment Agency in 2012 with the aim of developing a strategic flood risk management plan for London and the Thames Estuary through to the end of the century. There is an overlap between the SMP2 and TE2100 at Southend-on-Sea (between Two Tree Island and Shoeburyness). This overlap was allowed so that issues related to coastal/estuarine erosion could be reviewed. TE2100 defines eight action zones, of which three are relevant for the Shoreline Strategy (see map in Technical Appendix C):

- Action Zone 0 (estuary-wide): maintain, improve, and replace the existing defences, with habitat creation to provide replacement habitat for lost Natura 2000 sites in parallel with the development of an “end of the century” option for implementation by 2070, which may consist of a new tidal barrier.
- Action Zone 6 (lower estuary marshes): Due to the contaminated land on Two Tree Island (western end of the Strategy frontage) the approach is to maintain the flood defences at their current level, accepting that as sea level rises flood risk will increase.
- Action Zone 8 (seaside/fishermen’s frontage – Leigh Old Town and Southend-on-Sea): Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).

2.2.3 The entire inter-tidal area of the Strategy frontage is internationally designated for nature conservation purposes. Active legislation includes:

- Habitats Directive
- Birds Directive
- Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar)

2.2.4 Any schemes resulting from the Strategy and that are promoted by Southend-on-Sea Borough Council will be carried out under the **Coast Protection Act 1949** or **Land Drainage Act 1991** (depending on whether the works are predominantly for protection against coastal erosion or coastal flooding).

## Previous Studies

2.2.5 Previous revisions of the Southend-on-Sea Shoreline Strategy have been produced:

- The Southend-on-Sea Shoreline Strategy Plan was prepared on behalf of SBC by Mouchel Consulting Ltd, which was published in 1998 (referred to hereafter as the “1998 Strategy”). However, this 1998 Strategy was not formally approved by Defra. Where relevant, information from the 1998 Strategy has been used and updated as appropriate, in the development of this Strategy.
- A revision of the 1998 Strategy was prepared on behalf of SBC by Black and Veatch Ltd and submitted to the Environment Agency in 2012 (referred to hereafter as the “2012 Strategy”). This was not formally approved by Defra.
- A revision of the 2012 Strategy was submitted in 2014, This was not formally approved by Defra. Where relevant, information from the 2012 Strategy (and 2014 updated) has been used and updated as appropriate, in the development of this Strategy.

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- 2.2.6 In parallel to finalising this current revision of the Shoreline Strategy, SBC has also developed a scheme appraisal for coastal defences at Shoebury Common. An Outline Business Case (OBC) is being prepared for a scheme at this site. Where appropriate, information from the Shoebury Common OBC has been used in developing this 2017 Shoreline Strategy.
- 2.2.7 Given the highly urbanised nature of the SBC area, on-going development and climate change, there is the risk of surface water flooding, particularly in the low-lying areas adjacent to the coast (historic valleys). The Southend-on-Sea Surface Water Management Plan (AECOM for SBC, 2015) identifies that surface water flood events have been recorded in the borough in 2013 and 2014, resulting from intense rainfall events. Refer to Technical Appendix S for more detail on flood risks from other sources.
- 2.2.8 As part of SBC's role as the Lead Local Flood Authority (LLFA), SBC have improved methods of recording flood incidents. In the 2013 and 2014 surface water flood events, 368 incidents of flooding were recorded (AECOM for SBC, 2015). Along the coastal frontage, flooding was prevalent at Chalkwell and along Eastern Esplanade and Marine Parade. As such SBC are currently developing surface water flood management schemes in these areas. These schemes are taken into consideration within this Shoreline Strategy. Any works to manage coastal flooding and erosion will need to be compatible with any identified actions to manage surface water (and vice versa).
- 2.2.9 In addition to the aforementioned studies, the following reports are of particular relevance to the Strategy:
- Essex and South Suffolk Shoreline Management Plan 2 (Environment Agency, 2010)
  - Greater Thames CHAMP (APB Mer and Natural England, 2008)
  - Leigh Creek Realignment Technical Feasibility Study (Halcrow for SBC, 2011)
  - Southend-on-Sea Surface Water Management Plan (AECOM for SBC, 2015)
  - Southend-on-Sea Cliffs Quantitative Risk Assessment (Halcrow for SBC, 2014)
  - Southend-on-Sea Borough Council Flood Plan (SBC, 2005)
  - Southend-on-Sea Development Management Document (SBC, 2015b)
  - Southend-on-Sea Core Strategy (SBC, 2007)
  - Thames Estuary 2100 Plan (Environment Agency, 2012)

## Social and Political Background

- 2.2.10 Southend-on-Sea is a Unitary Authority within the administrative county of Essex. SBC are a Maritime District Council and the LLFA and as such responsible for managing flood risk within the borough pursuant to the Coastal Protection Act (1949) and Flood and Water Management Act (2010). The borough of Southend-on-Sea is bordered on the west by Castle Point District Council to the north by Rochford District Council and to the east by Great Wakering Parish Council. Any schemes to be delivered at the boundaries of the Strategy area would need to work collaboratively with the respective adjacent authorities.
- 2.2.11 Southend-on-Sea is a densely populated area with assets adjacent to the coastline, resulting from the region's historical and ongoing popularity as a seaside resort. The entire coastline is at risk from erosion and with significant areas of the hinterland low lying, properties behind the defences in many areas are at risk from

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coastal flooding. Southend-on-Sea is the largest urban centre in the county of Essex and is subsequently the focus of much of the economic activity in the region. The provision of coastal protection is therefore paramount to continuing economic activity not just locally, but regionally.

- 2.2.12 25% of the properties within the Strategy Area are classified as deprived (defined as the lowest 20% of Super Output Areas in terms of deprivation ranking), the highest concentrations being in Benefit Areas C (Cinder Path to Three Shells) and D (Three Shells to the Old Ranges).
- 2.2.13 The Southend-on-Sea Borough Council Core Strategy (2007) and Southend-on-Sea Development Management Document (2015b) both identify the seafront as an important part of the future social and economic development of Southend-on-Sea. These policy documents also identify the importance of ensuring any such development is done in a manner appropriate to the residual risk of flooding along the frontage.

## Location and Designations

- 2.2.14 Southend-on-Sea is located in Essex on the north bank of the Outer Thames Estuary. The Southend-on-Sea coastline is approximately 12km long and extends from Two Tree Island in the west to East Beach in the east (see Figure 1). The coastal defences at Hadleigh Marshes located to the west of Old Leigh and running adjacent to Two Tree Island are not included within this Shoreline Strategy as these are under the management of the Environment Agency through TEAM2100. The eastern extent of the Shoreline Strategy is the submarine boom located at East Beach. To the north of this point, defences are managed by the Ministry of Defence and are covered by the Crouch and Roach Strategy (currently unapproved).
- 2.2.15 The Strategy area sits within Management Unit J of the SMP2 and represents the southernmost management unit of the SMP2. Southend-on-Sea also sits within Action Zone 8 (Leigh Old Town and Southend-on-Sea) at the eastern extent of the TE2100 Plan (extending east as far as Shoeburyness only).
- 2.2.16 Existing coastal defences are currently in place along the full length of frontage. The coastal defence assets include a natural dune system, beaches, seawalls, embankments, and revetments. There are also several structures which extend onto the beaches including groynes, outfalls and slipways.
- 2.2.17 The coastal frontage covered by this Strategy is a continuous coastline and therefore the management approach of adjacent sections of coast need to be compatible with each other. It is also important that expenditure on flood defence / coastal protection assets is proportional to the assets that are actually protected. The Strategy area has therefore been divided into five different 'Benefit Areas', as shown in Figure 1. These Benefit Areas are hydraulically independent, meaning if coastal flooding were to occur within one Benefit Area, flood waters would not extend into adjacent Benefit Areas. The benefit areas are described in Table 2-2.

**Table 2-2: Benefit Areas**

Benefit Area	Description					
A - Two Tree Island	Two Tree Island is a National Nature Reserve and important site of recreation and leisure within the borough of Southend-on-Sea. The site also falls within the Benfleet and Southend Marshes Special Protection Area (SPA), Ramsar site and SSSI. The island covers approximately 257 hectares. The Island was purchased by Southend Borough Council in 1936 and until 1974, the entire island was used as a landfill site. After 1974 a smaller section of the island was used for landfill, until the licence was rescinded in 1994. Contamination risks remain a major concern in this Benefit Area.					
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B - Old Leigh Port	<p>Old Leigh Port is a fishing village and working port for local anglers and fishermen. The frontage has an array of uses including: marine industries; landing and working areas for local fishermen; retail outlets; eateries and residential areas. The mainline railway between Fenchurch Street and Shoeburyness runs behind existing defences and is at risk of coastal flooding and erosion.</p> <p>Leigh Old Town is designated as a Conservation Area. The area has been built up with a strong connection to the estuary and access to the water is an important factor for the local community. Funding has been secured to form the North Thames Fisheries Local Action Group (NTFLAG), focused on the long-term prosperity of Old Leigh as a fishing area.</p>
C – Cinder Path to Three Shells	<p>Benefit Area C contains three discrete coastal defence sections: Cinder Path; Chalkwell Beach; and Westcliff Beach. Cinder Path, sees the mainline Shoeburyness to Fenchurch Street railway line pass immediately behind the existing defence line. The coastal defence forms part of Network Rail’s Coastal, Estuarine and River Defences (CERDs). The railway line is backed by steep London Clay cliffs and the coastal defences predominantly protect against toe erosion of the stabilised cliff. Clifftop properties would be vulnerable to re-activation of historic cliff erosion.</p> <p>Chalkwell Beach extends from Chalkwell Railway Station to Grosvenor Road. This section is a historic valley and sees a lowering of the London Clay cliffs in the hinterland, increasing the risk posed by coastal flooding in this area. A secondary setback wall was built in the 1970s.</p> <p>Westcliff, extending from Grosvenor Road to Three Shells Beach sees a return to steep London Clay cliffs behind the defences. The coastal defence predominantly protects against toe erosion to this stabilised cliff. Clifftop properties would be vulnerable to re-activation of historic cliff erosion. Western Esplanade, an important transport route in the borough runs behind the coastal defences in this section. A recreational tidal lagoon was constructed at Three Shells Beach in 2016.</p>
D – Three Shells to the Old Ranges	<p>Benefit Area D contains three discrete coastal defence sections: Three Shells to Thorpe Bay; Thorpe Bay to Shoebury Common and The Old Ranges. Three Shells to Thorpe Bay section, which extends eastward to Camper Road sees the hinterland transition from steep London Clay cliffs to low-lying land. The area is of vital importance to the tourist economy of Southend-on-Sea with assets including Adventure Island, Southend Pier and the Sea Life Centre</p> <p>The Thorpe Bay to Shoebury Common section extends from Camper Road to the HM Coastguard Station at Shoebury Common. A scheme is currently under investigation at Shoebury Common looking to improve the SoP of existing defences. There are extensive areas of lower ground in the hinterland of this section, increasing the impact of a coastal flood event to the predominantly residential and commercial properties found in this area. Shoeburyness is identified in the Core Strategy (2007) as a priority urban area.</p> <p>The Old Ranges section which extends from the HM Coastguard Station at Shoebury Common to Rampart Street is a former artillery barracks previously owned by the Ministry of Defence. The site was transferred to a private property developer in 2000 and has been under development since. The foreshore remains in the ownership of the Ministry of Defence and access to the public is restricted. However, the coastal defences are undergoing a transition of ownership from the developer to SBC, which is due to be completed in 2018.</p>
E - Old Ranges to East Beach	<p>Benefit Area E extends from Rampart Street to the submarine boom extending from East Beach. East Beach is currently leased to SBC by the MoD. To the north of the submarine boom, the frontage is operated by the Ministry of Defence. The area has a large amenity value with a wide beach and open grassland and is used extensively for leisure and recreational purposes.</p>

- 2.2.1 The shoreline is mostly highly developed. The seafront either side of the pier is largely dedicated to amenity and tourism related businesses. A promenade (designated in places as a Public Right of Way and National Cycle Path) runs adjacent to the existing coastal defences for much of the shoreline. The pier itself is designated as a Grade II Listed Building.
- 2.2.2 Tourism is one of the main sources of revenue to the local economy in Southend-on-Sea, mostly concentrated around the pier. In 2015, more than 6.8 million tourists came to Southend-on-Sea (Jarques, 2015). Fisheries are also an important source of income to the local economy in particular at Leigh-on-Sea, with the cockle beds around Southend-on-Sea accounting for approximately 40% of the UK's cockle landings in 2015 (MMO, 2015)
- 2.2.3 The beaches of Southend-on-Sea are popular for recreation and bathing. The large tidal range exposes a vast expanse of mudflat at low tide, extending up to 2km offshore. A recreational tidal lagoon was built at Three Shells beach in 2016, comprising sheet piling covered with a rock armour layer. The tidal mudflats at Shoeburyness (Old Ranges) were until recently used for long-range testing of artillery shells, but this activity has now moved further north (to the New Ranges, outside of the Strategy area). However, the area is still subject to known and unknown unexploded ordnance risk. Two Tree Island is a former landfill site within a clay embankment, which would be an environmental or health and safety risk were the material to be exposed.
- 2.2.4 The natural environment, in particular the extensive intertidal habitat in the Strategy area benefits from national and international designations. Two Natura 2000 sites exist; Benfleet and Southend Marshes and Foulness. These sites are also designated Ramsar sites and Sites of Special Scientific Interest (SSSIs).
- 2.2.5 Also within the Strategy area, there are some habitats and species of local conservation importance as identified by the Essex Biodiversity Action Plan. Other important ecological features include the Leigh National Nature Reserve, Local Nature reserves and Local Wildlife Sites and two Important Bird Areas.
- 2.2.6 The Natura 2000 network of sites must be maintained *in situ*, if it is sustainable to do so, and where it is not sustainable, compensatory measures (usually in the form of habitat) must be provided prior to its loss (provided that there are no feasible alternative solutions and the adverse impacts cannot be avoided, i.e. there is an imperative reason of overriding public interest (IROPI)). A Strategic Environmental Assessment (SEA) Habitat Regulations Assessment (HRA) and Water Framework Directive (WFD) Assessment have been produced and reports are included in Appendices N, O and P respectively.
- 2.2.7 Southend-on-Sea is served by two railway lines, both connecting the town with London providing important commuter links to the capital city. Southend-on-Sea Borough Council also controls 2000 moorings along the coastline and there are numerous yacht clubs and sailing clubs that use these moorings.
- 2.2.8 There are 14 Built Conservations Areas (BCAs) within the Strategy area, recognising areas of special architectural and historic interest, the character or appearance of which is desirable to preserve or enhance. There are several Listed Buildings (mostly located within the BCAs). There are also four Scheduled Monuments within the Strategy area, which are all of military significance (See Technical Appendix N).

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## History of Coastal Flooding and Erosion

- 2.2.9 Until the end of the 19<sup>th</sup> century the western half of the Southend-on-Sea coastline consisted of actively eroding soft cliffs, 30m high in places, with re-entrant valleys. The erosion of these cliffs under wave action and natural shoreline retreat provided a plentiful supply of sediments to the area for the formation of natural beaches. Construction of coast protection works at about that time halted the supply of sediment. To counteract this lack of sediment input, until about the 1970's SBC operated their own dredger, which was constantly engaged in returning sediment to the beaches from the areas of the foreshore where it had accreted.
- 2.2.10 Due to the historic presence of coastal defences, there is no recent history of coastal flooding and/or erosion. However, the beaches have continued to lower and the condition of the existing defences has deteriorated. SBC undertake annual inspections of foreshore levels along the frontage (see Technical Appendix F).
- 2.2.11 There have been two major flood events within the Strategy area. The first recorded major flooding event in 1897 led to flooding in the areas around Old Leigh (Defence Sections 2 and 3), along Western Esplanade (Defence Section 5) and at East Beach (Defence Section 9) (Mouchel, 1998). In 1953, the "Great Flood" of the east coast also caused flooding in the Southend-on-Sea area (see Technical Appendix D) that is believed to have been more extensive than that in 1897 to Old Leigh (Defence Sections 2 and 3) and Western Esplanade (Defence Section 5), and extending relatively far inland at Southchurch (Defence Section 6) and Shoeburyness (Defence Sections 7 and 8).
- 2.2.12 In past years, there have also been several flood events of a relatively minor nature along the frontage at the same locations where the flooding over the past century took place. Old Leigh and sections of the Cinder Path and the revetment fronted length at the western Esplanade occasionally overtop.
- 2.2.13 Despite there being a lack of a recent history of coastal flooding, coastal flood risk remains a key concern of SBC, particularly given the reliance of the local economy and community on the shoreline. Southend-on-Sea has benefited from coastal defences since the Victorian era. The limited coastal flood events on record may be a recognition of effective defence of the coastline as opposed to any perceived view of an absence of coastal flood risk. With an ageing stock of coastal defence assets, SBC recognises the importance of ensuring an effective and coherent approach to managing coastal flood and erosion risk in the future.

## 2.3 Current Approach to Coastal Flood and Erosion Risk Management

### Measures to Manage Coastal Erosion and the Probability of Coastal Flooding

- 2.3.1 The main mechanisms which could cause tidal and coastal flooding within the Southend-on-Sea area are described below and include:
- **Overtopping of defences** – caused when high energy waves or high-water levels exceed the height of the defences/structures present along the coastline. This is a particular risk in the Southend-on-Sea area because the defences are relatively old and have not been designed with the latest sea level rise estimates.




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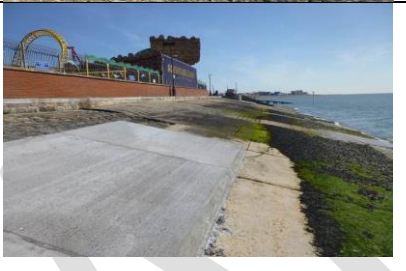


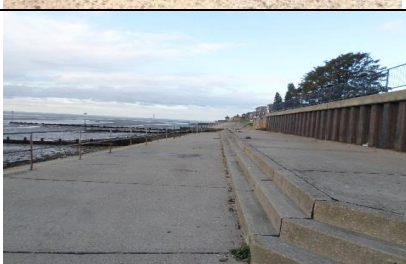
- **Breach in defences** - A large impact flood event may occur due to a breach in the coastal defences caused by failure of the defences. A breach in the defences is more likely to cause a higher impact flood event (when compared to overtopping) as inundation is likely to be rapid and in large quantities. Similar to the risk of overtopping, in the Southend-on-Sea area the defences are in poor condition, so the risk of a breach is increased.
- **Storm surges** – Southend-on-Sea is vulnerable to storm surges. There are two main mechanisms which cause storm surges: westerly surges generated by depressions in the Atlantic and easterly surges generated in the North Sea (Environment Agency, 2006).

2.3.2 The entirety of the Strategy coastline is currently defended from coastal erosion and flooding. The coastal defence assets include a natural dune system, beaches, seawalls, embankments, revetments and floodgates. There are also several structures which extend onto the beaches including groynes, outfalls and slipways.

2.3.3 Nine coastal defence sections (shown in Figure 1) have been defined along the coastal frontage. These represent sections of defences similar in their nature. An overview of the defences is provided in Table 2-3 and the condition, standard of protection and residual life of the defence sections is summarised in Table 3-1.

**Table 2-3: Coastal Defence Sections**

Benefit Area	Section	Typical Photograph	Description
A Two Tree Island	1 - Two Tree Island		Mixture of earth embankments and revetments. Mudflats and saltmarsh comprise the foreshore. No groynes.
B – Old Leigh Port	2 - Old Leigh Port		Primarily consist of concrete walls and sheet steel piles. Mudflats comprise the foreshore.
C – Cinder Path to Three Shells	3 – Cinder Path		The majority of the defence is bitumen covered revetment and in some locations, have been piled through. Small sand beach with timber groynes.

Benefit Area	Section	Typical Photograph	Description
	4 - Chalkwell		Consists of a blockwork seawall fronted by beach supported with timber groynes. A clad sheet-piled floodwall is set back from promenade.
	5 - Westcliff		Mainly blockwork sea wall and revetment fronted by a shingle beach of varying width. Timber groynes are in place along the foreshore.
D – Three Shells to the Old Ranges	6 - Three Shells to Thorpe Bay		Blockwork revetment around the foot of the pier and a combined revetment and sea wall along the rest of the frontage. Sand/Shingle beach with some timber groynes that are mostly buried as a result of the 2001/02 recharge scheme at Jubilee Beach.
	7 - Thorpe Bay to Shoebury Common		Defences consist mainly of blockwork revetments and sea walls, with a large number of timber groynes present.
	8 – The Old Ranges		Generally formed of concrete seawalls and revetments. Repairs have been undertaken to the revetment to cover in Open Stone Asphalt. Wave wall located on top of existing defence (built as part of development behind). Timber groynes present.
E – Old Ranges to East Beach	9 - East Beach		Sand/shingle beach backed by defences including: gabion baskets, rock armour revetment, steel sheet piling and sand dunes.

2.3.1 SBC currently manage the majority of the shoreline within their jurisdiction under the Coast Protection Act (1949), but other organisations also have responsibility, as defined in Table 2-4.



**Table 2-4: Coastal Defence Sections not Owned by SBC**

<b>Benefit Area and Defence Section</b>	<b>Organisation</b>	<b>Description</b>
BA C: Section 3	Network Rail	Bell Wharf to Chalkwell Beach
BA D: Section 8	Avant Homes, SBC and Ministry of Defence (MoD)	Shoeburyness has been improved by the developer Avant Homes, who will hand over responsibility for the seawall to SBC on payment of a commuted sum under a Section 106 agreement, The MoD will retain responsibility for the foreshore due to the residual UXO risk.
BA E: Section 9	MoD	East Beach is currently leased to SBC by the MoD who retain the freehold for this area.

2.3.2 Other organisations, such as Anglian Water and local business, also have assets within the Strategy area and could potentially contribute towards protection from flooding and/or erosion.

2.3.3 The continued management of the existing coastal defences is mostly undertaken on a reactive basis as there is no agreed management Strategy in place. SBC currently undertake annual maintenance to the defences, which largely consists of renewal of damaged, worn or missing groyne planks, minor beach recycling, concrete repairs and reactive repairs to stone pitched revetments. Annual maintenance is currently funded from SBC's own internal revenue budget with an approximate annual cost of £25,000 per km.

## **Measures to Manage the Consequences of Flood Risk**

2.3.4 Southend-on-Sea is covered by the Environment Agency's Flood Information Service which is used to monitor flood warning information. The Southend Flood Plan (2005) is SBC's response plan to major flood events within the borough to ensure a coordinated response to any flood events.

2.3.5 SBC have appointed a Term Service Contractor to manage the maintenance of their coastal assets. As part of this agreement the Contractor will provide 24-hour response to flood events and will be available to undertake emergency works if necessary. The Contractor will also hold in stock 2000 sandbags.

2.3.6 The Southend-on-Sea Borough Council Core Strategy (2007) and Southend-on-Sea Development Management Document (2015b) both identify the seafront as important to the future social and economic development of Southend-on-Sea. These policy documents also identify that any such development is done in a manner appropriate to the residual risk of flooding along the frontage.

## 3 Problem Definition and Objectives

### 3.1 Outline of the Problem

- 3.1.1 The existing coastal defences are ageing, having been constructed largely over 100 years ago. The existing SoP across the frontage varies considerably from 100% AEP to 0.5% AEP and will reduce further with sea level rise (see Table 3-1).
- 3.1.2 The general condition, SoP and residual life (RL) are summarised in Table 3-1. A range is given for the SoP in the present day as this reflects that coastal flooding is found to occur at a point between these modelled storm events. The SoP for the future assumes the defences are the same as those currently in place. Further description of the condition of the existing defences can be found in Technical Appendix G.

**Table 3-1: Standard of Protection Provided by Existing Coastal Defences**

Defence Section	Minimum Residual Life (years)	Standard of Protection (AEP in any year)		Notes
		Current	Future (100 years' time)	
1 - Two Tree Island	20	2% - 1%	100%	The minimum RL (10 years) is associated with a short section of concrete wall subject to scour. Otherwise RL > 20 years. Vertical timber baseplate embedded in salt marsh and salt marsh channels are reinforced by willow spilling to mitigate scour risk.
2 – Old Leigh Port	5	100% - 10%	>100%	The minimum RL (5 years) is due to a section of concrete wall just before the start of Cinder Path that shows damage. For other defences RL of approximately 20 years.
3 – Cinder Path	10	100%	>100%	Primary function is to protect against erosion of the soft-cliff toe. Therefore, low SoP against coastal flooding. The minimum RL of 10 years is the result of a section of grouted stone revetment which has seen significant loss of bitumen. One small section of masonry brick wall is experiencing voiding resulting in a RL of 0 years. This can be resolved with a simple patch repair so it was concluded that 0 years was not representative as the minimum RL.
4 – Chalkwell	25	0.5%	10%	Consists of two defence lines, both in good condition. Groynes are partly buried hence low residual lives.
5 - Westcliff	8	100%	>100%	Primary function is to protect against erosion of the soft-cliff toe. Therefore, low SoP against coastal flooding. The 8-year minimum RL is attributed to a 500m section of blockwork seawall with blockwork missing. Defences located to the east of the Genting Club in a better condition with an approximate RL of 30 years.
6 - Three Shells to Thorpe Bay	15	2%-1%	10%	Grouted stone revetment at the base of the pier has an estimated RL of 15 years due to damage and loss of blocks. Defences at Jubilee Beach in a better condition with an estimated RL of 35 years.
7 – Thorpe Bay to Shoebury Common	5	2%-1% / 10%-2%*	10% / 100%*	The 5-year minimum RL is due to risks associated with beach drawdown at Shoebury Common. The Thorpe Bay seawall is showing signs of cracking with an estimated RL of 15 years.
8 – The Old Ranges	5	10% - 2%	100%	The minimum RL (5 year) is due to the part of the defence being undermined by erosion at

Defence Section	Minimum Residual Life (years)	Standard of Protection (AEP in any year)		Notes
		Current	Future (100 years' time)	
				the sea wall toe and damage to the Open Stone Asphalt covering. Work is being undertaken by a developer on this section of the defences, which is likely to provide a 30 RL of the defences. The flooding only looks at the frontline defence and does not consider the setback bund in place.
9 - East Beach	0	100% - 10% AEP	>100%	A 0-year RL minimum is due to the corroded nature of the sheet piled walls at this site.

\*West/east of the Thorpe Bay Yacht Club

- 3.1.1 In the absence of an agreed long-term Strategy and sufficient financial resources to institute pro-active maintenance procedures, a reactive approach to the management of the frontage has been maintained. Due to the aging defences, local failures of the revetment and of sections of the seawall have occurred, together with a gradual deterioration of the timber groynes. To date some ad-hoc repairs and general maintenance have been undertaken using SBC's own internal budgets. This is not a sustainable solution; hence an agreed Strategy is required.
- 3.1.2 Within the first two epochs of the Strategy (Table 2-1), many of the defences within the Study Area will reach the end of their residual life and require replacement. Any replacement of defences will also need to also consider raising the crest level in order to continue to provide an acceptable SoP as sea levels rise.
- 3.1.3 Southend-on-Sea benefits from extensive intertidal saltmarsh and mudflats that are designated Natura 2000 sites. The TE2100 Plan and SMP2 have identified that the present and continued operation of coastal flood defences will lead to the loss of intertidal habitat over the course of the next 100 years through coastal squeeze. A summary of the predicted loss of intertidal habitat within the Strategy area through coastal squeeze is provided in Table 3-2.

**Table 3-2: Predicted Loss of Intertidal Habitat, and Therefore Amount of Compensation Required for Each Epoch**

	Hectares of intertidal habitat replacement required for each epoch		
	Epoch 1 (2017 - 2034)	Epoch 2 (2035 - 2049)	Epoch 3 (2050 - 2116)
Intertidal habitat	11	24	708

## 3.2 Consequences of Doing Nothing

- 3.2.1 Under the baseline scenario of No Active Intervention, all maintenance, repair and renewal work on the existing coastal defences throughout Southend-on-Sea would cease. Without maintenance, the existing defences will either fail due to their poor condition, undermining due to beach loss or when being overtopped (or through a combination of these). Without continued intervention, it is estimated that the defences will begin to fail within five years, with all sections of defence having failed within 30 years.



3.2.2 Without coastal defences, the Southend-on-Sea shoreline would be subject to coastal erosion, as it was prior to the construction of the existing coastal defences. The immediate landward erosion would first affect the promenade and the coastal road, impacting the services located along them and cutting off many properties from vital facilities. This would impact on key transport routes within the borough and affect emergency service routes. Loss of the coastal road will reactivate the natural erosion processes of the soft cliffs, putting communities at risk and resulting in the loss of key transport links including one of the main rail links with London. Without coastal defences coastal flooding will also significantly increase, in particular to the low-lying areas found to the east of the pier. The number of properties at risk from coastal flooding and erosion under a no active intervention scenario is summarised in Table 3-3 and details as to how these figures were derived can be found in Technical Appendix K.

**Table 3-3: Number of Properties at Risk from Coastal Erosion and Flooding Under a No Active Intervention Scenario**

Benefit Area	Defence Section	Number of Properties at Risk from Coastal Flooding and Erosion*			
		Present Day (2017)		Future (2116)	
		Flooding	Erosion	Flooding	Erosion
A	1 - Two Tree Island	0	0	1	0
B	2 - Old Leigh Port	70	0	70	378
C	3 - Cinder Path	32	0	56	1,862
	4 - Chalkwell				
	5 - Westcliff				
D	6 - Three Shells to Thorpe Bay	2583	0	3110	500
	7 - Thorpe Bay to Shoebury Common				
	8 - The Old Ranges				
E	9 - East Beach	2	0	68	31

\* Note: The figures stated here are both commercial and residential properties combined. Additionally, some properties are included twice as at risk from coastal flooding and erosion. This table also excludes properties identified as being at risk from surface water flooding in Chalkwell and at Eastern Esplanade/Marine Parade.

3.2.3 Erosion of beaches will lead to them becoming inaccessible and unsafe (due to failing structures). Erosion and deterioration of the seafront area will lead to a loss of the seafront amenities, and businesses. This will in turn have detrimental consequences on the local and regional economy. A summary of the wider impacts of no active intervention along the frontage are summarised in Technical Appendix K.

3.2.4 Due to the presence of historical landfill stored in-situ at Two Tree Island (see Table 2-2), defences at this location are vital in avoiding contaminated material escaping into the wider estuary. If the defences were allowed to fail, then widespread pollution of the marine environment would occur due to the potential release of large volumes of contaminated waste. Release of such contaminants into the marine environment could potentially adversely affect the conservation status of the Natura 2000 sites and the future status of the Thames Lower water body.

## 3.3 Strategic Issues

3.3.1 A strategic approach has been adopted at Southend-on-Sea for the following reasons:

- To provide a coherent long-term approach to the management of an ageing stock of coastal defence assets within the borough. A strategic approach will ensure proactive management of defences, ensuring timely intervention and allowing efficiencies in programme alignment to be identified. The Strategy will ensure the best use of public funds by providing a plan to implement capital projects, routine maintenance, further studies, surveys and investigations.
- To ensure consistency at a local level with the overlapping regional policies of the SMP2 and TE2100.
- To enable an effective long-term approach to the management of designated habitat, aligned with the Environment Agency's regional habitat creation programme.
- Due to the importance of the coastal frontage to the economy of Southend-on-Sea, a strategic approach will ensure that development policy and coastal management practice are aligned. As tourism is a major component of the economy in Southend-on-Sea, it will be important that coastal management works complement the aspirations for developing the tourism offering in the borough.
- To provide greater alignment with local and regional partners, including the identification of opportunities for contributions towards schemes and potential efficiencies

3.3.2 The highest level of planning for flood and coastal erosion at Southend-on-Sea is covered by the SMP2 and TE2100, which are described in Section 2.2. The most relevant actions to the Strategy from the SMP2 Action Plan and TE2100 Plan have informed the option appraisal process. Details of the relevant actions for SBC can be found in Technical Appendix J.

3.3.3 Habitat Regulations Assessments undertaken by both TE2100 and within the SMP2 have identified compensatory habitat requirements for the loss of habitat from the Natura 2000 sites at Southend-on-Sea as a result of the policy of Hold the Line. This Southend-on-Sea Shoreline Strategy Plan is a component part of the TE2100 and SMP2 overarching plans. The coastal squeeze and thus loss of intertidal habitat which may occur as a result of the Southend-on-Sea Shoreline Strategy Plan is thus not additional, but a component part of the higher plans (see HRA in Technical Appendix O).

## 3.4 Key Constraints

3.4.1 As Southend-on-Sea is a regional centre for tourism, any option to manage flood and coastal risk needs to take into consideration both future amenity and business needs in order to maintain the local and regional economy. The highly developed nature of the coastline throughout the Strategy area and the presence of key assets

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immediately behind the coastal defences (such as the railway line and buried utilities) limits the potential for set-back defences.

3.4.2 The potential contamination risks from historic landfill and waste management sites at Two Tree Island (see Table 2-2) limit the opportunities for managed realignment along this undeveloped section of the frontage. Given the extensive challenges associated with managing historic coastal landfill and the need for a collaborative approach to this issue (see Section 3.5.1) maintaining existing defences for the first epoch of the Strategy is recommended. A long-term approach is not currently identified and it is a recommendation of this Strategy that a regional working group be formed to identify an appropriate long-term solution for this site.

3.4.3 The existence of Natura 2000 sites will limit the nature of any works on the frontage. The nature of the defences and construction methodology will need to avoid, minimise or compensate for impacts to the intertidal habitat. As part of the Strategy the following have been produced:

- A Habitat Regulations Assessment (see Technical Appendix O)
- A WFD compliance assessment (see Technical Appendix P)
- A Strategic Environmental Assessment (SEA) (see Technical Appendix N)

### 3.5 Objectives

3.5.1 The Strategy has assessed and considered a variety of economic, environmental, and technical approaches to manage the coastal flood and erosion risk, to balance the wide range of features and interests within the area.

3.5.2 A series of primary and secondary objectives have been developed for the Strategy (Table 3-4). These ensure that the Strategy remains focused and provide an objective basis from which to assess strategic options.

**Table 3-4: The Strategy Objectives**

Primary Objectives	Secondary Objectives
Objective 1: Maximise the reduction of coastal flood and erosion risk to properties and infrastructure at significant or very significant risk of flooding in light of coastal change over the next 100 years.	Objective 3: Support regeneration of Southend-on-Sea and the viability and sustainable development of the tourist industry in accordance with local development policy.
Objective 2: Contribute to a functional, healthy estuary while maintaining and improving the integrity of designated habitats. Aim to offset the impact of coastal squeeze and achieve a net environmental gain in support of the delivery of the Thames River Basin Management Plan.	Objective 4: Align with the objectives of TE2100 and Essex SMP2 to ensure a coherent approach to coastal flood and erosion risk in the region where appropriate.
	Objective 5: Develop a realistic implementation plan that favours options that reduce the whole-life costs and liabilities to the tax payer and utilise partnership funding sources, subject to the consideration of wider community benefits.

# 4 Options for Managing Coastal Erosion and Flood Risk

## 4.1 Potential FCRM Measures

- 4.1.1 To develop a coherent Shoreline Strategy, a wide-ranging assessment of management options should be considered. Development of the management options involved identifying as wide a range of options as possible. These were then developed through the appraisal process, with options; screened out, refined, combined and optimised (Environment Agency, 2010b). Each option needs to address the problem, meet the objectives and demonstrate potential for delivering opportunities to Southend-on-Sea.

## 4.2 Long List of Options

- 4.2.1 For each Benefit Area a long list of management options was generated in consultation with stakeholders including representatives from Southend-on-Sea Borough Council, the Environment Agency and Natural England. Potential options were derived using a combination of best practise guideline documents, professional expertise, existing findings from the 2012 Strategy and the SMP2.

- 4.2.2 The Source-Pathway-Receptor model was applied to ensure an inclusive and systematic approach to the definition of potential management options. Further information regarding the option selection process can be found in Technical Appendix J. The following long list of options were considered:

- 4.2.3 No Active Intervention:

- No Flood or coastal erosion risk management activity.
- Defences are allowed to deteriorate, with no action taken to prevent or slow down the process. This option includes the safe removal of structures from a Health and Safety perspective.
- The result is failure of the existing defences, leading to coastal erosion and the flooding of some low-lying areas.
- Not in line with the preferred SMP2 (2010) and TE2100 (2012) policies, but considered for comparison of options promoting investment. FCERM-AG guidance (Environment Agency, 2010b) states “the do-nothing baseline is critical to the analysis as it forms the baseline against which all other do-something options are appraised”.

- 4.2.4 Hold the Line – Maintain (Do Minimum – Patch and Repair):

- Involves continued routine maintenance of flood defences for the remainder of their useful life. This option is only suitable for defences with a high enough residual life that patch and repair will maintain the defences for the project lifespan.
- Routine asset surveys will inform an on-going programme of patch and repair works.

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- With this option, the existing defence alignment is maintained however the SoP deteriorates over time because of rising sea levels and changes to wave climates.
- This option is partially in line with SMP2 (2010) and TE2100 (2012) policies, as it holds the line but does not maintain the standard of protection.

#### 4.2.5 Hold the Line – Maintain:

- The existing defences are to be replaced and improved as required to their existing crest level. This will see the existing defence line maintained, however the SoP will deteriorate throughout the lifetime of the Strategy due to sea level rise and increased storminess associated with the effects of climate change.
- As with the “Hold the Line – Maintain (Do Minimum – Patch and Repair)” option, routine asset surveys will inform an on-going programme of planned works. This will be a combination of regular patch and repair works to counteract localised damage and more extensive capital maintenance works to avoid structural failure.
- Small quantities of beach recharge and repairs to the existing shoreline control structures will also be undertaken as part of an on-going planned programme of works.
- However, in the future sea levels are expected to rise, putting increasing pressure on the existing defences. Even with investment to replace the defences (on a like for like basis, to their existing crest level), flooding will increase in frequency and severity for the low-lying areas.
- This option is partially in line with SMP2 (2010) and TE2100 (2012) policies, as it holds the line but the SoP reduces.

#### 4.2.6 Hold the Line – Sustain:

- The existing defences are to be replaced and improved as required to continue to provide their current level of protection for the next 100 years. As with the “Hold the Line – Maintain” option, routine asset surveys will inform an on-going programme of planned works. In addition, under this option, defences will be raised in the future with a higher crest level to offset sea level rise and increased storminess associated with the effects of climate change.
- Beach recharge will be required in increasing quantities and many of the existing shoreline control structures will need to be lengthened to contain the higher beach volumes.
- This option is in line with the preferred SMP2 (2010) and TE2100 (2012) policies as the existing defence alignment is maintained and defences are raised to counteract rising sea levels and increased storminess associated with climate change.
- The choice of SoP that is sustained will be linked to economic viability and the potential to realise the objectives of the Shoreline Strategy.

#### 4.2.7 Hold the Line - Upgrade:

- In this option, the existing defences would be replaced and improved as required to provide a higher standard of protection than they do at present for the next 100 years.
- This option is in line with the preferred SMP2 (2010) and TE2100 (2012) policies policy as the existing defence alignment is maintained and defences are raised to counteract rising sea levels and increased storminess associated with climate change.

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- The choice of SoP that is defined will be linked to economic viability and the potential to realise the objectives of the Shoreline Strategy.
- Beach recharge will be required in increasing quantities and many of the existing shoreline control structures will need to be lengthened to contain the higher beach volumes.

#### 4.2.8 Managed Realignment (retreat or advance the line):

- This option involves the creation of a new line of defence landward or seaward (dependant on the type of realignment) from the existing alignment.
- This option is not in line with the preferred SMP2 (2010) and TE2100 (2012) policies as the existing defence line would be changed, not held in its current location.

#### 4.2.9 Adaptation Measures:

- This option involves not developing the front-line defence and instead improving the flood resilience and resistance through demountable defences or at an individual property level (e.g. flood doors). It also includes measure such as development control to minimise the impacts of a flood event. Although flooding may occur over the frontline defence on a more regular basis properties/business located behind the defence line would be more resilient.
- Not in line with the preferred SMP2 (2010) and TE2100 (2012) policies as the defence alignment and SoP are not sustained.
- May compliment other strategic options.
- Difficult to implement in areas of high density housing.

### 4.3 Options Rejected at Preliminary stage

- 4.3.1 Options for **managed realignment** of defences have been rejected due to the highly developed nature of the existing coastline and existing (or in some cases historic) land uses. At Two Tree Island where the land behind the defence is largely undeveloped, realignment has not been considered to be a viable option due to the contamination risk (see Section 2).
- 4.3.2 **Advancement** of the line of defence is also not considered to be an option as this would accelerate coastal squeeze of the Natura 2000 site seaward of the existing defences.
- 4.3.3 A **patch and repair** approach has only been considered in Benefit Area A. This Benefit Area only considers management until the end of epoch one (2034). For all other sections, a patch and repair approach has not been considered as all defences would require replacement prior to the end of the Strategy. Although a proactive maintenance regime is included within all hold the line options, it is not deemed suitable as a standalone option.

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## 4.4 Options Short Listed for Appraisal

4.4.1 A workshop was held with engineering, planning and environmental specialists from Mott MacDonald (MM), the EA, SBC and Natural England to screen the long list of options and agree on the shortlist.

Each long list management option was screened against the five project objectives (Section 3.5). A summary of how each of the long listed options aligns to the project objectives is provided in

4.4.2 Table 4-1.

Table 4-1: Fulfilment of Project Objectives by Long Listed Options

		Benefit Area A					Benefit Area B					Benefit Area C					Benefit Area D					Benefit Area E									
		Objective																													
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5					
Management Option	No Active Intervention																														
	HTL Maintain (Patch and Repair)	✓	✓			✓																									
	HTL Maintain							✓		✓	✓		✓		✓	✓		✓		✓	✓		✓		✓	✓		✓		✓	✓
	HTL Sustain						✓		✓	✓	✓	✓			✓		✓			✓		✓			✓		✓		✓	✓	✓
	HTL Upgrade						✓			✓		✓			✓		✓			✓											
	Managed Realignment - Retreat the Line							✓					✓					✓					✓					✓			
	Managed Realignment - Advance the Line								✓					✓					✓					✓					✓		
	Adaptation Measures						✓				✓	✓				✓	✓				✓	✓				✓	✓				✓

4.4.3 Where the option met neither of the primary objectives for the Strategy, it was rejected. Where at least one of the primary objectives were met, the option was then assessed against technical, environmental, social and cost criteria:

- **Technical feasibility:** based on engineering judgement, previous schemes and an understanding of the local region would the option be technically feasible to deliver. Consideration included: the nature of existing assets, design and construction complexities, access limitations and opportunities, health and safety considerations.

- **Environmental impact:** What implications does the option have on the existing environment. Based within the context of local, regional, national and international designations and policy.
- **Social impact:** What implications does the option have on local communities. Based within the context of local, regional, national and international development policy.
- **Cost:** Are any options cost prohibitive for their intended purpose.

4.4.4 Each option was assigned a score between one (very poor) and five (very good) for these criteria. Where an option scored a total of eight or lower it was rejected. All remaining options were taken forward as part of the shortlist. A summary of the shortlisted options is provided in Table 4-2. More detail on the option assessment process can be found in Technical Appendix J.

4.4.5 The No Active Intervention management option reflects the baseline option for each section, demonstrating what would happen if no management activity were to occur. Therefore, this was included in the provisional shortlisted options, despite the option not meeting the project objectives. Adaptation Measures were identified as a complementary component of the Hold the Line policy and are not seen as a standalone strategic option.

**Table 4-2: Summary of Shortlist of Options for each defence section**

Benefit Area	Defence Section	No Active intervention	HTL (Do Minimum – Patch & Repair)	HTL Maintain	HTL Sustain	HTL Upgrade	Managed Realignment	Adaptation Measures
A	1		✓					
B	2	✓		✓	✓	✓		✓
C	3	✓		✓	✓	✓		✓
	4	✓		✓	✓	✓		✓
	5	✓		✓	✓	✓		✓
D	6	✓		✓	✓	✓		✓
	7	✓		✓	✓	✓		✓
	8	✓		✓	✓	✓		✓
E	9	✓		✓	✓			✓



# 5 Options Appraisal and Comparison

## 5.1 Technical Issues

5.1.1 The SoP provided by each management option in 2116 is summarised in Table 5-1.

**Table 5-1: SoP Provided by Each Strategic Management Option in 2116**

Benefit Area	HTL Maintain SoP (% AEP)	HTL Sustain SoP (% AEP)	HTL Upgrade SoP (% AEP)	Erosion Risk SoP (% AEP)
Benefit Area A	-			
Benefit Area B	100%	10%	2%	All HTL options would negate the risk posed by coastal erosion.
Benefit Area C	100%	1%	0.5%	
Benefit Area D	100%	1%	0.5%	
Benefit Area E	100%	10%	-	

5.1.1 Specific technical issues are apparent for each of the Benefit Areas:

5.1.2 **Benefit Area A:** Management of the legacy landfill at Two Tree Island is of paramount importance due to the risk it poses to human health and the natural environment. In-situ management of the contaminated material is currently deemed to be the only feasible option. The existing defences have been assessed as having a residual life of more than 20 years (Table 2-3).

5.1.3 **Benefit Area B:** Any option would need to be cognisant of the unique challenges posed by this section of coastline. Old Leigh has developed with a strong connection to the water and maintaining this connectivity is important. Therefore, the HTL Upgrade option has only been considered to a 2% AEP level. To avoid damage to the mudflats which are present at the toe of the existing defences, improvements to the SoP can only occur on the existing defence alignment or as a secondary setback defence. By raising defences, it will impact on the existing townscape and line of sight to the estuary.

5.1.4 **Benefit Area C:** The defences currently in place at Cinder Path and Westcliff predominantly protect against toe erosion of the stabilised cliff. These defence sections provide essential transport links to and from Southend-on-Sea and within the borough and regular flooding would see disruption of these services.

5.1.5 Chalkwell currently benefits from a setback secondary defence offering a 0.5% AEP SoP. A HTL Sustain policy would see this SoP fall to 1% AEP, with other defences in the benefit area being raised to offer a consistent SoP. A HTL Upgrade option would see this defence section remain at 0.5% AEP and all other defences in this Benefit Area raised to 0.5% AEP SoP.

5.1.6 **Benefit Area D:** The defences currently in place between the Three Shells and Thorpe Bay benefit from a recharge scheme undertaken at Jubilee Beach in 2001/02. The defences currently in place between Thorpe Bay and Shoebury Common vary in their SoP (see Table 3-1). A scheme is currently under investigation to the east of Thorpe Bay Yacht Club to bring the defences to a level consistent with those throughout the rest of the Benefit Area.

- 5.1.7 **Benefit Area E:** HTL Upgrade has not been considered in this Benefit Area due to the limited number of assets that would benefit from an increase in the SoP and the impact this may have on the natural environment at this location.

## 5.2 Environmental Assessment

- 5.2.1 The assessment of the environmental constraints and impacts has been integral to the optioneering process. A high-level SEA (Technical Appendix N) has been undertaken to better understand the impact of the short listed options on key receptors within the study area (Table 5-2).
- 5.2.2 An SEA is a systematic process for evaluating and anticipating the consequences of decision-making, such as policies, plans, strategies, and programmes prior to the implementation stage, and to identify measures to prevent, reduce, and as fully as possible offset any significant adverse effects. A SEA was produced in 2011 for the Southend-on-Sea Shoreline Strategy Plan (Black & Vetch, 2011). A review of the Shoreline Strategy Plan was undertaken in 2013, after this, an addendum to the SEA was produced (Black & Vetch, 2013). These documents are found in Technical Appendix N alongside an SEA Environmental Review Report.
- 5.2.3 Alongside the SEA, a HRA (Technical Appendix O) and WFD Assessment (Technical Appendix P) were undertaken to support the evaluation of the short list of options and selection of the preferred option (Table 5-2). The HRA identified coastal squeeze as a key consideration along the frontage, although it was identified that the impacts would be the same for all short listed options.

**Table 5-2: Environmental Assessment Criteria on the Shortlist of Options**

Environmental Assessment	Criteria	Explanation
SEA (Strategic Environmental Assessment)	Human Beings	Assesses the potential risks to community, amenities and livelihoods. This section includes the importance of the shoreline as an amenity area for residents and visitors alike.
	Geomorphology and hydrodynamics	Assesses the implications to the coastal processes operating along the shoreline of implementing the Shoreline Strategy. The foreshore provides an important component of the coastal protection at Southend-on-Sea.
	Water	Assess the quality of the water bodies and implications of the Strategy options on the water body in place, including the three beaches with Blue Flag awards and seven beaches with Seaside awards along the Southend frontage.
	Flora and Fauna	Due to its coastal location, Southend-on-Sea supports an extensive series of intertidal habitat including saltmarshes, mudflats and sandflats as well as scrub and grassland. This section assesses the potential impacts of the Shoreline Strategy options on the flora and fauna present.
	Traffic and Transport	Southend-on-Sea attracts millions of visitors each year, with 2015 attracting more than 6.8 million tourists (Jarques, 2015). The majority of these visitors arrive by car via the A127, A13 and A1160, or by rail. This section assesses the impact that the Shoreline Strategy options will have on traffic and transport links.
	Land Use	This section assesses the impact of the Shoreline Strategy options on present and future land use within the borough, including consideration of the legacy landfill site at Two Tree Island.
	Landscape and visual amenity	Assesses the balance of change to the landscape character area. This includes the impact to the 14 Conservations Areas (CA) within the study area.
	Cultural Heritage and Archaeology	Southend-on-Sea's location and importance as a strategic military location in the past is evident in the variety of war-time monuments along its frontage. The pier is also a Grade II listed structure. This section assesses the impacts of the shortlisted options on these cultural and historic assets.
	Climate	Assesses the implications of current climate and the challenges posed by future climate change on the short listed options.

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Environmental Assessment	Criteria	Explanation
	Use of Natural Resources	Assesses the potential impact the shortlisted options may have on the use of natural resources within the study area.
WFD (Water Framework Directive)	Compliance assessment outcome	Presents the preliminary results of the Water Framework Directive (WFD) assessment. This WFD assessment has been conducted with reference to Environment Agency guidance.  The only waterbody considered to be potentially affected by the Shoreline Strategy is the Thames Lower transitional waterbody (ID: GB530603911401).
HRA (Habitats Regulation Assessment)	HR01 Assessment	Due to the presence of these European Conservation Sites, there is a requirement for a Habitats Regulations Assessment (HRA) under the provisions of the EC Habitats Directive (92/43/EEC) and its implementation in the UK under The Conservation of Habitats and Species Regulations 2017 (as amended).

## 5.3 Option Costs

- 5.3.1 To enable the economic assessment of the short list, and to select the preferred options, each short listed option within each BA was costed over the 100-year appraisal period. This cost includes costs for capital works, costs for maintaining the structure, and 'other' costs including costs to create the Outline Business Case (OBC), post-OBC to construction costs and costs incurred during the construction phase. The costs have been estimated and optimised using contractor information and recent costs of construction of similar works.
- 5.3.2 To determine timings of capital interventions, the condition of existing defences has been taken from an Asset Condition Survey (Technical Appendix G). Timings of interventions following replacement of assets is based on the Environment Agency's 'Technical report – FCRM assets: deterioration modelling and WLC analysis' (2013). Adjustments have been made to timings where efficiencies have been identified in coinciding works. Further detail can be found in Technical Appendix J.
- 5.3.3 Costs have been estimated as realistically as possible considering the Strategy high level nature, with an Optimism Bias of 60% added to reflect the assumptions and risks at this stage. As designs are subsequently refined and specific contractor methods, materials and working practices are gained through early contractor involvement during the project level business case development, the optimism bias can be reduced. A Monte Carlo risk assessment has been undertaken on the known risks. This has identified requirement for an 18% financial allocation to these risks. Therefore, 42% of the Optimism Bias allocation is for risks unknown at the present time. Further information on the risk assessment is available in Technical Appendix R.
- 5.3.4 All capital costs have been uplifted to December 2016 using the Consumer Price Index as an inflation factor. Costs have been estimated over the 100-year appraisal period and discounted to present value (PV) using the Treasury variable discount rate.
- 5.3.5 A detailed description of the approach taken to derive the costs for each option and the sourcing of cost information can be found in the Economic Appraisal Report in Technical Appendix K. However, Table 5-3 provides a summary of the costs considered.

**Table 5-3: Summary of Costs included in Economic Appraisal**

Cost Element	Costing Assumption / Information Source
<b>CAPITAL COST:</b>	
Construction Cost	Used unit rates from the EA long term costing tool for flood and coastal risk management (2015) and the 2012 Strategy. Costs validated against Spon's (2014), outturn costs from recent projects of a similar nature and available contractor pricing schedules.  Cost rates allow for: materials, plant and labour, general and preliminaries, access and mobilisation, contractor's overhead and contractor's profit.
Capital Maintenance	Capital maintenance costs include the costs that will be needed for major maintenance works to improve the condition of an ageing defence. These costs have been estimated at 50% of the construction costs for the asset and as such include the same elements as detailed in the construction costs.
<b>MAINTENANCE COSTS:</b>	
Routine Maintenance Activities	Maintenance rates include the annual patch and repair works to be undertaken on defences. These costs do not include for major repair work and are envisaged to be undertaken by SBC's Term Service Contractor.  Costs have been taken from the 2012 Strategy, the EA long term costing tool for flood and coastal risk management (2015) and the SBC Maintenance Schedule for their Term Service Contractor.
<b>OTHER COSTS:</b>	
Professional Services Costs	Professional services costs include for: technical studies, business case development, detailed design, tender document preparation and activities on site during construction including Project Management, Site Supervision and Construction Design and Management (CDM) duties.  Combined with the Operating Authority costs, calculated as 5% of the construction cost, with a minimum value of £100k associated with any capital intervention.
Operating Authority Costs	Allowance for SBC staff costs associated with project management.  Combined with the professional services costs, calculated as 5% of the construction cost, with a minimum value of £100k associated with any capital intervention.
Compensatory Habitat Costs	Where a Hold the Line approach is adopted, it will lead to the loss of Natura 2000 habitat through coastal squeeze. Therefore, habitat replacement costs have been included based upon the net loss of intertidal habitat area over the appraisal period and a replacement cost of £51k/ha, based on estimates from the Anglian Regional Habitat Creation Team.

## 5.4 Options Benefits (Damages Avoided)

- 5.4.1 The economic damages associated with each option have been estimated in accordance with the Flood Hazard Research Centre's "Multicoloured Manual" (MCM, 2016) and the Defra / Environment Agency FCERM-AG (Environment Agency, 2010b) and Supporting Guidance. A detailed description of the approach taken to derive the economic damages for each option can be found in the Economic Appraisal Report in Technical Appendix K. Table 5-4 provides a summary of how the economic damages have been estimated.

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**Table 5-4: Summary of Damages included in Economic Appraisal**

Source of Economic Damage	Assessment Methodology
Residential and non-residential property	Annual Average Damages (AAD) have been calculated for flooding of commercial and residential properties for five flood events (100% AEP, 10% AEP, 2% AEP, 1% AEP and 0.5% AEP). This has allowed calculation of the AAD curve and the range of return periods assessed gives greater confidence in the economic assessment undertaken.  Data tables from the MCM (Penning-Rowse et al., 2016) have been used as flood damage values.
Emergency services	In accordance with MCM (2016), 10.7% has been added to property damages for emergency services.
Road	Assessed the additional cost of diversion (MCM methodology used) in BA D from the A1160/Western Esplanade to Maplin Way/Thorpe Esplanade via the A13. The additional traffic made the A13 over the free flow limit, resulting in an annual additional cost for travel of £1,124,531, which is associated with every year the road is considered eroded.
Rail	Passenger and freight train information was obtained for the London, Tilbury and Southend Railway (LTSR).  The impacts of coastal flooding on the LTSR was assessed. MCM guidance (Penning-Rowse, et. al, 2016) was followed to estimate the number of services that would be cancelled or delayed under a flood event.
Utilities	Included sewer, water and gas mains and pumping stations, as identified from plans. The erosion of the assets of these utilities were included within the Strategy and yearly discounting applied.
Human intangible impacts	Intangible health impacts caused by flooding within the economic appraisal (health, stress, loss of memorabilia etc.) have been valued at £200 per household per year using The Appraisal of Human-Related Intangible Impacts of Flooding (Defra, 2004).
Tourism / recreation	The total tourism damage cost per year has been estimated by assessing the spend per visitor loss following the partial and total loss of frontage amenities. The total tourism damage was then shared between the benefit areas based on their percentage of the overall frontage. Benefit Area C and D are the longest frontages in the Study and also the where the concentration of tourist activities are greatest.
Agricultural land	Not included – No agricultural land within the Strategy.

5.4.2 As with the costs, the economic damage for each option has also been assessed over the 100-year appraisal period and discounted to present value. Where appropriate the damages have been capped, at the write off value or some equivalent “maximum attributable damage cost”. The benefit of a “do something” option is the difference between the “do something damages” and the “do nothing damages”, i.e. the damage avoided by implementing the option. The PV damages and benefits associated with each option are set out in Table 6-2 to Table 6-5. No damages have been calculated for Benefit Area A (Two Tree Island) as the Strategy does not identify a long-term strategic option for this Benefit Area.

5.4.3 Some benefits are easier to place a monetary value on than others. The benefit analysis cannot fully account for the significance of internationally designated habitat, and cultural and historical assets in relation to other monetised benefits. The Strategy Area benefits from a rich social and cultural history and as such there are a number of areas of historical importance that would be at risk under a No Active Intervention scenario, including the conservation areas at Old Leigh and The

Old Ranges and the Grade II listed pier. Loss of these sites would see the loss of part of Southend-on-Sea's heritage.

- 5.4.4 For much of the length of the frontage, the coastline is a Public Right of Way and National Cycle Path. This provides popular leisure and recreation facilities for residents and tourists alike. The opportunity for outdoor pursuits and recreation has benefits for health, wellbeing and general quality of life, which would be lost or severely affected under a No Active Intervention scenario.
- 5.4.5 The impact to the environment under a No Active Intervention scenario would be substantial, in particular at Two Tree Island where contaminated material is stored in-situ. Release of this material could prove disastrous for the local environment. Additionally, pollution from the erosion and flooding of a highly urbanised area would likely lead to further contamination and degradation of water bodies.
- 5.4.6 There would also be a much wider implication to the regional economy than those quantified in this Strategy if a No Active Intervention Scenario were realised. Increased flooding and erosion would likely curtail inward investment to the area as confidence is lost from the local economy. This will impact on job opportunities and people are likely to move away from the borough in search of work. Development of the area is reliant on effective coastal management as outlined in the SBC DPD (2015).
- 5.4.7 These elements that have not been quantified have been identified as key issues and constraints in the SEA (Technical Appendix N). Information on these elements was presented as part of the preferred option workshop to ensure non-quantifiable elements were also considered in selecting the preferred option.

## 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 Benefit Area, and the subsequent results of the Strategy wide assessment.
- 6.1.2 Selection of the preferred options has been an ongoing and iterative process taking into account the potential socio-environmental impacts, stakeholder opinions and the technical feasibility of the options. The short listed options for each of the Benefit Areas were compared against the strategic objectives, environmental issues, stakeholder feedback and the economic results to determine the preferred option. Further details on the method used to assess the preferred option, and the results are provided in Technical Appendix J and K.

### 6.2 Economic Assessment of the Short List of Options

- 6.2.1 An economic assessment of the short list of options was undertaken in line with FCERM-AG (Environment Agency, 2010b) to determine the benefit cost ratios for each of the short listed options for each of the Benefit Areas. The benefit cost ratio compares the cost of each option over the next 100 years (including design, build and ongoing maintenance), against the benefits over the same period.

#### Benefit Area A: Two Tree Island

- 6.2.1 Management of the legacy landfill at Two Tree Island is of paramount importance due to the risk it poses to human health and the natural environment. In-situ management of the contaminated material is currently deemed to be the only technical, environmental and economically feasible option. The existing defences have been assessed as having a residual life of more than 20 years (Table 2 3).
- 6.2.2 Therefore, a programme of patch and repair works will be undertaken during the first epoch of the Strategy. An annual assessment and inspection of defences in this Benefit Area will be undertaken to ensure maintenance works are carried out in a proactive manner. A summary of the costs associated with this management approach is included in Table 6-1. Compensatory habitat costs have also been included for this section for the 100-year lifetime of the Strategy and these costs are also shown in Table 6-1.
- 6.2.3 During the first epoch of the Strategy, it is proposed that a working group is formed with key stakeholders and interested parties to identify a long-term approach to managing this issue. Therefore, a detailed economic assessment of this Benefit Area has not been undertaken.

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**Table 6-1: Benefit Area A: Two Tree Island Management Costs**

Activity	Cash Costs	PV Costs
	(£k)	(£k)
Operation and Maintenance (to 2034)	1,554	1,223
Compensatory Habitat Costs (to 2116)	9,412	1,333
Optimism Bias Adjustment (60%)	6,579	1,534
<b>Total</b>	<b>17,545</b>	<b>4,090</b>

**Benefit Area B: Old Leigh Port**

6.2.1 The defences currently in place are predominantly comprised of steel sheet piling with short sections of concrete wall. Details of the SoP provided by each short listed option in 2116 are presented in Table 5-1. A summary of the economic appraisal for Benefit Area B is provided in Table 6-2.

**Table 6-2: Summary of Economic Appraisal for Benefit Area B – Old Leigh**

Option	PVc	PVd	PVb	Net PV	Av. BCR	iBCR
	(£k)	(£k)	(£k)	(£k)		
<b>Option 1: No Active Intervention</b>	£0	£77,867	£0	£0	N/A	N/A
<b>Option 2: Hold the Line - Maintain</b>	£8,186	£11,043	£66,824	£58,638	8.16	N/A
<b>Option 3: Hold the Line - Sustain</b>	£8,633	£8,189	£69,678	£61,045	8.07	6
<b>Option 4: Hold the Line - Upgrade</b>	£8,726	£7,070	£70,797	£62,070	8.11	12

**Benefit Area C: Cinder Path to Three Shells**

6.2.1 The defences currently in place are predominantly comprised of sea walls, revetments and timber groynes to control the longshore movement of sediment. Details of the SoP provided by each short listed option in 2116 are presented in Table 5-1.

6.2.2 SBC intend to deliver a surface water flood management scheme at Chalkwell as a result of recent flood events (see Section 2.2). An assessment was undertaken of the properties affected by both surface water and coastal flooding at this location. 50% of the total properties affected by coastal flooding were also found to be affected by surface water flooding. As a result, 50% of the damages to residential and commercial properties affected by coastal flooding in this Benefit Area and associated vehicle and health and emergency services damages) have been removed to support grant in aid funding for surface water flooding.

6.2.3 A summary of the economic appraisal for Benefit Area C is provided in Table 6-3.



**Table 6-3: Summary of Economic Appraisal for Benefit Area C – Cinder Path to Three Shells**

Option	PVc	PVd	PVb	Net PV	Av. BCR	iBCR
	(£k)	(£k)	(£k)	(£k)		
<b>Option 1: No Active Intervention</b>	£0	£179,466	£0	N/A	N/A	N/A
<b>Option 2: Hold the Line - Maintain</b>	£33,179	£7,962	£171,503	£138,325	5.17	N/A
<b>Option 3: Hold the Line - Sustain</b>	£51,601	£4,389	£175,076	£123,475	3.39	0.19
<b>Option 4: Hold the Line - Upgrade</b>	£55,121	£3,761	£175,704	£120,584	3.19	0.19

**Benefit Area D: Three Shells to Old Ranges**

- 6.2.1 The defences currently in place are predominantly comprised of sea walls, revetments and timber groynes to control the longshore movement of sediment. Details of the SoP provided by each short listed option in 2116 are presented in Table 5-1.
- 6.2.2 SBC intend to deliver a surface water flood management scheme at Eastern Esplanade and Marine Parade as a result of recent flood events (see Section 2.2). An assessment was undertaken of the properties affected by both surface water and coastal flooding at this location. 10% of the total properties affected by coastal flooding were also found to be affected by surface water flooding. As a result, 10% of the damages to residential and commercial properties affected by coastal flooding in this Benefit Area (and associated vehicle and health and emergency services damages) have been removed to support grant in aid funding for surface water flooding.
- 6.2.3 A summary of the economic appraisal for Benefit Area D is provided in Table 6-4.

**Table 6-4: Summary of Economic Appraisal for Benefit Area D - Three Shells to Old Ranges**

Option	PVc	PVd	PVb	Net PV	Av. BCR
	(£k)	(£k)	(£k)	(£k)	
<b>Option 1: No Active Intervention</b>	£0	£366,118	£0	N/A	N/A
<b>Option 2: Hold the Line - Maintain</b>	£52,465	£70,451	£295,667	£243,202	5.64
<b>Option 3: Hold the Line - Sustain</b>	£56,810	£23,804	£342,314	£285,503	6.03
<b>Option 4: Hold the Line - Upgrade</b>	£58,100	£11,042	£355,076	£296,976	6.11

## Benefit Area E: Old Ranges to East Beach

- 6.2.1 Defences at East Beach have developed in an ad-hoc fashion due to the historical use of this land by the Ministry of Defence. Coastal Defences are a mixture of built defences including sea walls, rock revetments gabion baskets and timber groynes and a sand dune system. Details of the SoP provided by each short listed option in 2116 are presented in Table 5-1.
- 6.2.2 A summary of the economic appraisal for Benefit Area E is provided in Table 6-5.

**Table 6-5: Summary of Economic Appraisal for Benefit Area E - East Beach**

Option	PVc	PVd	PVb	Net PV	Av. BCR	iBCR
	(£k)	(£k)	(£k)	(£k)		
<b>Option 1: No Active Intervention</b>	£0	£17,611	£0	N/A	N/A	N/A
<b>Option 2: Hold the Line - Maintain</b>	£4,944	£56	£17,556	£12,612	3.55	N/A
<b>Option 3: Hold the Line - Sustain</b>	£8,270	£12	£17,599	£9,328	2.13	0.01

## 6.3 Details of the Preferred Option

- 6.3.1 The following section provides details of the preferred option selected for each Benefit Area. The options were mapped to the project objectives when deciding upon the shortlist (see Section 4). The project objectives were reviewed again as part of the selection process for the preferred option to ensure the most suitable solution was chosen. Further details on the selection of the preferred option can be found in Technical Appendix K. A summary of the economic appraisal for the preferred option for each Benefit Area is provided in Table 6-6. The preferred options for each Benefit Area are:
- 6.3.2 **Benefit Area A: Two Tree Island.** A programme of patch and repair works will be undertaken during the first epoch of the Strategy. An annual assessment and inspection of defences in this Benefit Area will be undertaken to ensure maintenance works are carried out in a proactive manner. During the first epoch of the Strategy, it is proposed that a working group is formed with key stakeholders and interested parties to identify a long-term approach to managing this issue.
- 6.3.3 **Benefit Area B: Old Leigh Port – HTL Sustain.** Defences will be raised to provide a consistent SoP against coastal flooding in light of climate change. A 10% AEP SoP will be provided in 2116. The risk of coastal erosion will be negated. This will ensure flood risk remains consistent with the present day, enabling the status quo of the area to remain, retaining the connectivity the area has with the estuary and minimising the impact on the townscape. Although the iBCR was higher for HTL Upgrade, minimising impact in a Conservation Area was a deciding factor in the selection of a HTL Sustain approach. Adaptation measures should be applied including temporary and demountable defences to achieve a consistent 10% AEP SoP. Wherever possible development should be compatible with potential flooding, thereby limiting the consequence of these events.
- 6.3.4 **Benefit Area C: Cinder Path to Three Shells – HTL Upgrade.** Defences will be upgraded to provide a 0.5% AEP against coastal flooding in 2116 in light of climate

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change. The risk of coastal erosion will be negated. This will ensure the coastal flood risk at Chalkwell remains consistent with the present day and Cinder Path and Westcliff are upgraded to an improved SoP. This will provide better protection against coastal flood risk to vital assets including the mainline railway between Shoeburyness and Fenchurch Street. The iBCR is identical for HTL Upgrade and Sustain. Therefore, the Upgrade option has been selected as the preferred option as it will ensure more assets are better protected and still returns a strong BCR. Adaptation measures should be applied including development and planning control. Temporary and demountable defences are only deemed suitable to provide property level protection at Chalkwell. At Cinder Path and Westcliff, the presence of long expanses of key infrastructure adjacent to the coastal defences make temporary and demountable defences unsuitable.

6.3.5 **Benefit Area D: Three Shells to the Old Ranges – HTL Upgrade.** Defences will be upgraded to provide a 0.5% AEP against coastal flooding in 2116 in light of climate change. The risk of coastal erosion will be negated. This will ensure the coastal flood risk reduces throughout this Benefit Area. The Benefit Area has been identified as a key geographical area for the future development of Southend-on-Sea and improvement to the SoP will ensure coastal flood protection complements SBC's wider aspirations. This area is also at the greatest flood coastal flood risk, due to the low-lying hinterland. The BCR is best for the HTL Upgrade Option. Adaptation measures should be applied including development and planning control. Temporary and demountable defences will be considered in localised areas to achieve a consistent 0.5% AEP SoP.

6.3.6 **Benefit Area E: East Beach – HTL Sustain.** Defences will be raised to provide a consistent SoP against coastal flooding in light of climate change. A 10% AEP SoP will be provided in 2116. The risk of coastal erosion will be negated. This will ensure flood risk remains consistent with the present day. Adaptation measures should be applied including development and planning control. Temporary and demountable defences to be considered in localised area to achieve a consistent 10% AEP SoP.

**Table 6-6: Summary of the Economic Assessment for the Preferred Option**

Benefit Area	Option	PVc	PVd	PVb	Net PV	Av. BCR
		(£k)	(£k)	(£k)	(£k)	
Benefit Area A	HTL Maintain (Patch and Repair)	£4,090	-	-	-	-
Benefit Area B	HTL Sustain	£8,633	£8,189	£69,678	£61,045	8.07
Benefit Area C	HTL Upgrade	£55,121	£3,761	£175,704	£120,584	3.19
Benefit Area D	HTL Upgrade	£58,100	£11,042	£355,076	£296,976	6.11
Benefit Area E	HTL Sustain	£8,270	£12	£17,599	£9,328	2.13

## Technical Aspects

- 6.3.7 By implementing the preferred strategic option, SBC intend to continue to retain defences in their current alignment, replacing assets at the end of their residual / design life, therefore preventing coastal erosion.
- 6.3.8 The crest level of existing flood defences will be raised in order to mitigate for the effects of climate change and in Benefit Area C and D, the SoP will be increased. The mechanism to achieve the targeted SoP will be defined at scheme appraisal stage through detailed technical, economic and environmental assessment. The specific capital interventions for each Benefit Area are detailed in Table 6-7. The timings outlined are indicative only and the actual timings of works will depend on the observed rate of deterioration, sea level rise and funding availability, with works typically being undertaken in a staged manner. The form of construction, defence alignment and other specific details will all be determined through a more detailed defence specific study (Project Appraisal) and will include local consultation. A summary of the technical considerations associated with the delivery of the preferred option for each Benefit Area are summarised in Table 6-8 as well as Strategy wide technical considerations. Further information can be found in Technical Appendix J.

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**Table 6-7: Interventions for Preferred Option and Forecast Year (Y) Capital Interventions to Occur**

	<b>Benefit Area A</b>	<b>Benefit Area B</b>	<b>Benefit Area C</b>	<b>Benefit Area D</b>	<b>Benefit Area E</b>
<b>Epoch One (2017 – 2034)</b>	<ul style="list-style-type: none"> <li>• Programme of patch and repair works</li> <li>• Working group to define long-term management approach to managing the area and historic landfill issue</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of concrete seawall at Bell Wharf in Y4 to provide protection against 10% AEP coastal flood event in 2116</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of defences at Cinder Path in Y9 to provide protection against 1% AEP coastal flood event in 2116</li> <li>• Replacement of defences to the west of the Genting Club in Y9 to provide protection against 1% AEP coastal flood event in 2116. Replacement of timber groynes for the entirety of defence section 5.</li> </ul>	<ul style="list-style-type: none"> <li>• Capital works at Shoebury Common in Y1</li> <li>• New groynes in Section 6 in Y4</li> <li>• Replacement of defences at the base of the pier in Y14 to provide protection against a 1% AEP coastal flood event in 2116</li> <li>• Capital maintenance to defences in Section 7 west of Thorpe Bay Yacht Club in Y14 including replacement of groynes</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of defences in Y4 to provide protection against a 10% AEP coastal flood event in 2116</li> </ul>
<b>Epoch Two (2035 – 2049)</b>		<ul style="list-style-type: none"> <li>• Replacement of defences (excluding Bell Wharf) in Y19 to provide protection against 10% AEP coastal flood event in 2116</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of defences at Chalkwell in Y24 to provide protection against 1% AEP coastal flood event in 2116.</li> <li>• Replacement of defences to the east of the Genting Club in Y30 to provide protection against 1% AEP coastal flood event in 2116.</li> </ul>	<ul style="list-style-type: none"> <li>• New defence in Section 7 and Section 8 in Y30 to provide protection against a 1% AEP coastal flood event in 2116</li> </ul>	

<p><b>Epoch Three (2050 – 2116)</b></p>		<ul style="list-style-type: none"> <li>• Replacement of defences (excluding Bell Wharf) in Y59 to provide protection against 10% AEP coastal flood event in 2116</li> <li>• Replacement of defences (excluding Bell Wharf) in Y99 to provide protection against 10% AEP coastal flood event in 2116</li> </ul>	<ul style="list-style-type: none"> <li>• Capital works in Y50 to re-raise all Benefit Area C defences to provide protection against a 0.5% AEP event in 2116.</li> <li>• Capital maintenance works on all Benefit Area C defences in Y80.</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of defences in Section 6 (excluding Section 6.1) in Y34 to provide protection against a 1% AEP coastal flood event in 2116</li> <li>• Capital works in Y50 to re-raise all Benefit Area D defences to provide protection against a 0.5% AEP event in 2116.</li> <li>• Capital maintenance and new groynes in Section 6 and to setback embankment in Section 8 in Y 72</li> <li>• Replacement of timber groynes in Section 8 in Y78</li> <li>• Capital maintenance to defences in Section 7 and Section 8 in Y90</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of timber groynes in Y52</li> <li>• Capital maintenance including new gabions in Y75</li> </ul>
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**Table 6-8: Technical Aspects of the Preferred Option**

Strategy Wide	Benefit Area A	Benefit Area B	Benefit Area C	Benefit Area D	Benefit Area E
<ul style="list-style-type: none"> <li>•Unexploded ordnance a risk throughout the borough</li> <li>•Material delivery a challenge in an urban area. Limited access from the sea due to extensive mudflat system</li> <li>•Annual inspection of coastal defences required to ensure defects identified early and proactive maintenance regime</li> <li>•Annual review of beach levels to monitor sediment transport patterns and identify beach recycling activities</li> <li>•During construction works an acceptable level of coastal defence must be provided</li> <li>•Schemes should align with wider aspirations for the coastal frontage, including the development of the tourism offering</li> </ul>	<ul style="list-style-type: none"> <li>•Patch and repair works only until the end of the first epoch (2034)</li> <li>•Working group to be formed to identify long-term approach to the management of this site</li> </ul>	<ul style="list-style-type: none"> <li>•Accelerated low-water corrosion an issue on steel sheet piling</li> <li>•Foreshore is predominantly mudflat. Therefore, improvements to the SoP cannot be achieved through beach recharge</li> <li>•Constrained site with potential access issues</li> <li>•Quayside infrastructure including working areas for marine industries can be designed to allow for some flooding</li> <li>•Property level protection may be suitable in certain locations to achieve consistent SoP</li> </ul>	<ul style="list-style-type: none"> <li>•Interfacing with Network Rail necessary for Cinder Path site</li> <li>•Close proximity to railway line will make access difficult at Cinder Path</li> <li>•Demountable barriers may be suitable as part of a defence at Chalkwell. However, in other areas the existence of large extents of key infrastructure do not make this approach appropriate.</li> <li>•Alignment with surface water flood schemes necessary</li> </ul>	<ul style="list-style-type: none"> <li>•Interfacing with the Ministry of Defence necessary at the Old Ranges who retain ownership of the foreshore</li> <li>•Old Ranges foreshore more exposed to North Sea waves which may lead to more rapid degradation of defences</li> <li>•Alignment with surface water flood schemes necessary</li> <li>•Property level protection may be suitable in certain locations to achieve consistent SoP</li> <li>•Unexploded ordnance a particular risk due to history of area as Ministry of Defence site</li> </ul>	<ul style="list-style-type: none"> <li>•Foreshore more exposed to North Sea waves which may lead to more rapid degradation of defences</li> <li>•Interfacing with the Ministry of Defence necessary as SBC currently lease this land</li> <li>•Property level protection may be suitable in certain locations to achieve consistent SoP</li> <li>•Unexploded ordnance a particular risk due to history of area as Ministry of Defence site</li> </ul>

## Environmental Aspects

6.3.9 Table 12 in the SEA Environmental Review Report (Technical Appendix N) sets out the significant environmental effects of the preferred strategy and outlines the mitigation required. A summary is provided in Table 6-9 below.

**Table 6-9: Key Significant Effects Associated With the Preferred Option of the Shoreline Strategy**

Key Significant Effects	Proposed Mitigation Actions
Intermittent disturbance (inc. noise, dust, reduced access etc) from maintenance and construction activities to residents, businesses and visitors.	<p>Planning liaison with Public Rights of Way (PRoW) Officer (PRoW / cycle route diversions), Environment Agency (contaminated land); MoD, English Heritage (preservation in situ and / or by record).</p> <p>Provide alternative facilities along the frontage.</p> <p>Sensitive timing and phasing of works to take account of tourist season and environmental sensitivities.</p> <p>Comply with construction best practice in undertaking any works, including maintenance and use construction techniques that minimise ground disturbance.</p> <p>Consult with local residents and businesses in advance of any works.</p> <p>Liaison with the fishing community with regards to sea delivery, such as, importation of rock and beach recharge, to ensure that their operations are not impeded.</p>
Increase in crest levels of defences may result in obstruction to access and sea views which may affect fishing, tourism and recreational activities and visual amenity and landscape character.	<p>Liaise with local societies / associations and provide alternative facilities along the frontage, where feasible.</p> <p>Take setting of Conservation Areas into consideration during detailed design.</p> <p>Liaise with local fisheries community. Provide temporary moorings elsewhere along the frontage. Allow for access in detailed design, through use of a removable defence or alignment of defence landward of processing units.</p>
Beach recharge / recycling activities could damage internationally and nationally designated intertidal habitats as a result of smothering of habitat or via release of fine material into the marine environment.	<p>Liaison with Natural England in matters of nature conservation.</p> <p>Comply with construction best practice and implement effective sediment control measures.</p> <p>Sensitive timing and phasing of works.</p> <p>Ensure that material used for beach recharge is similar to the existing material and free from contaminants.</p>
Coastal squeeze will affect internationally and nationally designated intertidal habitats.	<p>Provide compensatory habitat.</p> <p>Comply with construction best practice.</p> <p>Consult with Natural England.</p>

6.3.10 Both the SEA (Technical Appendix N) and HRA (Technical Appendix O) have identified coastal squeeze as a threat to the long-term integrity of the natural environment as a result of the HTL policy being adopted within the study area. The HRA proposes appropriate compensatory mechanisms to offset the effect of coastal squeeze, as summarised in Table 6-10.

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**Table 6-10: Habitat Loss Compensation Mechanisms**

Epoch	Foulness SPA (Essex Estuaries SAC losses are a component part of the SPA)	SMP2 Environment Agency Anglian Regional Habitat Creation Programme	Benfleet and Southend Marshes SPA and Ramsar	TE2100 Habitat Creation Programme
2017 – 2034	5ha (5ha)	Wallasea	6ha	Wallasea - Will form component part of 42 ha of habitat creation committed to under EA Regional Habitat Creation Programme for Epoch 1 of TE2100.
2035 – 2049	7ha (6.5ha)	To be confirmed once ongoing EA monitoring has confirmed actual habitat losses during Epoch 1.	17ha	To be confirmed once ongoing EA monitoring has confirmed actual habitat losses during Epoch 1.
2050 – 2116	137ha (130.5ha)	To be confirmed once ongoing EA monitoring has confirmed actual habitat losses during Epoch 1.	571ha	To be confirmed once ongoing EA monitoring has confirmed actual habitat losses during Epoch 1.

6.3.11 The SEA Environmental Review Report (Technical Appendix N) proposes a Monitoring Plan to be implemented as the works associated with the preferred option are brought forward. The implementation and findings of the Monitoring Plan will be reviewed and reported (by SBC) as a component of the regular review and update process of the Shoreline Strategy, which is approximately every ten years (but can be more or less frequent depending on the need to address new challenges or a significant change in policy, guidance, or other factors that may influence the management approach).

### Costs of the Preferred Option

6.3.12 The Strategy wide expenditure profile is outlined in Table 6-11. The full expenditure profile for all the BA's can be found in Technical Appendix L and a summary is provided in Table 7-1. It should be noted that operation and maintenance costs have been aggregated every five years for costing purposes. These costs will be allocated on an annual basis, with patch and repair works identified in annual defence inspection. Epoch Two shows a high expenditure profile relative to the length of this epoch due to the requirements for major interventions in Benefit Area D.

**Table 6-11: Strategy Wide Expenditure Profile (£k). Values Shown are Cash Costs**

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5-17 (Epoch One)	Year 18-32 (Epoch Two)	Year 33 – 100 (Epoch Three)	Total
Professional Service Fees and SBC Staff Costs	203	87		284	122	1,563	2,915	4,083	<b>9,257</b>
Operation and Maintenance Costs	267	267	267	267	382	4,155	3,238	21,626	<b>30,469</b>
Capital Costs	0	5,795			7,045	31,257	58,294	76,089	<b>178,480</b>
Habitat Compensation						561	1,224	36,108	<b>37,893</b>
Contingency (60% Optimism Bias)	282	3,689	160	331	4,529	22,522	39,403	82,745	<b>153,660</b>
<b>Whole Life Cash Cost</b>	<b>752</b>	<b>9,838</b>	<b>427</b>	<b>882</b>	<b>12,078</b>	<b>60,058</b>	<b>105,074</b>	<b>220,650</b>	<b>409,759</b>

## 6.4 Sensitivity Testing

6.4.1 To ensure the preferred option is economically robust, a series of sensitivity tests have been undertaken. During the course of the economic appraisal, many assumptions are made. Some of these assumptions will be more critical than others. Changing such variables may lead to the selection of a different option as the economically preferred option or substantially affect the robustness of the economic business case. By undertaking sensitivity testing, it is possible to explore how sensitive the economic case and option selection is to key assumptions. The sensitivity tests undertaken are summarised in Table 6-12. Further details can be found in Technical Appendix K.

**Table 6-12: Sensitivity Test Scenarios**

Sensitivity Test	Potential Scenarios for Change
<b>Costs increase by 20%, benefits remain consistent</b>	<ul style="list-style-type: none"> <li>• Increase in construction and professional services costs</li> <li>• Major cost implications realised through known or unknown risks</li> <li>• Unforeseen works required</li> <li>• Greater compensatory habitat costs</li> </ul>
<b>Costs remain consistent, benefits reduce by 20%</b>	<ul style="list-style-type: none"> <li>• Uncertainties associated with the long-term predictions for climate change may result in fewer flood damages</li> <li>• Reduction in the predicted extent of erosion</li> <li>• Requirements to allocate further grant in aid contributions to surface water flooding at the cost of coastal schemes</li> </ul>
<b>Costs increase by 10%, benefits reduce by 10%</b>	<ul style="list-style-type: none"> <li>• A combination of the scenarios identified above</li> </ul>
<b>Costs remain consistent, benefits increase by 10%</b>	<ul style="list-style-type: none"> <li>• Value of residential and commercial property increases faster than expected</li> <li>• Other benefits identified during appraisal at scheme stage which have not been considered in the Strategy</li> </ul>

6.4.2 A summary of the Benefit Cost Ratios (BCRs) associated with each of the sensitivity tests undertaken is provided in Table 6-13. Further detail can be found in Technical Appendix K. All sensitivity tests return a BCR above unity, suggesting a positive return on investment. Benefit Area E appears closest to unity; however, it should be noted that these are calculated including optimism bias at 60%, which would be expected to reduce at scheme appraisal stage.

6.4.3 The BCR is found to be most sensitive to a reduction in benefits. However, at scheme appraisal stage, benefits are often seen to increase following a more site-specific assessment of the associated benefits of delivering a flood and erosion risk management scheme. Additionally, future revisions of climate change guidance (UKCP18) are likely to see SLR estimates increase, leading to greater flood damages (Met Office, 2016).

**Table 6-13: Sensitivity Test BCR Results**

Scenario	Benefit Area B	Benefit Area C	Benefit Area D	Benefit Area E	Strategy Wide
Base Scenario	8.07	3.19	6.11	2.13	4.61
Costs increase by 20%, benefits remain consistent	6.73	2.66	5.09	1.77	3.84
Costs remain consistent, benefits reduce by 20%	6.46	2.55	4.89	1.70	3.68
Costs increase by 10%, benefits reduce by 10%	6.60	2.61	5.00	1.74	3.77
Costs remain consistent, benefits increase by 10%	8.88	3.51	6.72	2.34	5.07

## Outcome Measures

6.4.4 “Outcome Measures” (OMs) have been developed by Defra to ensure the Environment Agency use the limited funds available for the maximum benefit to the nation as a whole. The Outcome Measures describe the overall benefits of flood and coastal erosion risk management. OMs 1 to 4 (presented in Table 6-14) are to be delivered via flood and coastal risk management schemes that may result from this Strategy.

**Table 6-14: National Flood and Coastal Erosion Risk Management Outcome Measures**

Outcome Measure	Description of Outcome Measure
OM1	The whole life present value benefits (Pvb) of the scheme
OM2	Number of households moved out of any flood probability category to a lower probability category.
OM2b	The number of households moved from the very significant or significant probability category to the moderate or low probability category.
OM2c	The number of households in the 20 per cent most deprived areas moved out of the significant or very significant probability categories to the moderate or low probability category.
OM3	The number of households better protected from coastal erosion.
OM3b	The number of households protected against loss from coastal erosion in a 20-year period
OM3c	The number of households in the 20 per cent most deprived areas protected against loss from coastal erosion in a 20-year period
OM4a	Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive, Section 28 of the Wildlife and Countryside Act, 1981 and the England Biodiversity Strategy
OM4b	Hectares of intertidal habitat created to help meet the objectives of the Water Framework Directive for areas protected under the EU Habitats/Birds Directive, Section 28 of the Wildlife and Countryside Act, 1981 and the England Biodiversity Strategy
OM4c	Length (in kilometres) of rivers protected under the EU Habitat Directive, EU Birds Directive or Section 28 of the Wildlife and Countryside Act 1981 improved to meet the objectives of the Water Framework Directive.

6.4.5 The OM scores for each Benefit Area are presented in Table 6-15. As no OM4s are being achieved through the Strategy, these are omitted from the table. Where

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flood benefits have been allocated to surface water flood events, these OMs have been removed from Table 6-15.

**Table 6-15: Preferred Option Outcome Measure**

Outcome Measure	Benefit Areas*			
	B	C	D	E
OM1 (£k, PV Benefits)	69,678	175,704	355,076	17,599
OM2	0	7	1,521	0
OM2b	0	7	266	0
OM2c	0	0	32	0
OM3	240	593	16	0
OM3b	175	303	0	0
OM3c	2	173	0	0

\*Note – Benefit Area A has not been assessed in terms of OMs.

## 6.5 Partnership Funding

- 6.5.1 In 2013, Defra implemented the new Flood and Coastal Resilience Partnership Funding system, which changes the way in which funding is allocated to projects. The new approach, referred to as “Partnership Funding” aims to allow more schemes to go ahead and to give each community greater say in what is done to protect them from flooding and coastal erosion. Instead of meeting the full costs of just a limited number of projects, “Partnership Funding” aims to make funding available for any worthwhile (i.e. economic) scheme, with the amount of FDGiA funding being related to the achievement of OMs. The funding gap will then need to be met locally, either through the local levy (limited funds) or via external contributions.
- 6.5.2 The potential Partnership Funding (PF) available for each of the short listed and preferred options was calculated using the EA GiA Calculator. This tool identified the maximum amount of funding available based on the economics, properties better protected from the risk of flooding and erosion and the hectares of intertidal habitat created over the next 100 years. The results of the assessment are included in Technical Appendix K. Table 6-16 provides a summary of the PF scores for the preferred options for each Benefit Area.

**Table 6-16: Preferred Option Partnership Funding Scores**

Benefit Area	Raw PF Score	Adjusted PF Score	External Contribution (£k) or saving required to achieve an Adjusted Score of 100%	Benefit Period
A – Two Tree Island*	0%	0%	2,133	2017-2034
B – Old Leigh Port	77%	77%	1,936	2017-2117
C - Cinder Path to Three Shells	39%	39%	30,788	2017-2117
D - Three Shells to Old Ranges	38%	38%	31,610	2017-2117
E – Old Ranges to East Beach	12%	12%	5,980	2017-2117
<b>Overall Strategy Area</b>	<b>38%</b>	<b>38%</b>	<b>73,494**</b>	<b>2017-2117</b>

\*Two Tree Island has only been considered for operation and maintenance activities for the first epoch of the Strategy

\*\*Note: This figure has been taken from the Strategy wide PF Calculator. This does not equal the sum of the individual PF calculations due to internal calculation and rounding within the PF Calculator

- 6.5.3 The additional financial contributions that need to be secured to achieve a PF score of 100%, for each benefit area are presented in Table 6-16. Note that: a score in excess of 100% is required before the scheme can proceed. Optimism bias has been included within the PF calculations. It is likely this will reduce at a particular scheme appraisal stage, which will contribute to the positive adjustment of the PF score.
- 6.5.4 At this strategic stage contributions from other sources have not been included. However, some contributions (i.e. other than FDGiA) will be needed to fully implement the Strategy. Possible sources for contributions (capital and maintenance) are identified in Table 6-17, along with the applicable funding mechanism and the section(s) of defence that this funding source is suitable for. SBC are currently discussing future funding with Network Rail, the MoD, Anglian Water and private developers. Following approval of the Strategy, SBC will begin to approach the other organisations identified and discuss future funding more formally and further explore opportunities for joint working and funding contributions. A more detailed funding plan will be developed.

**Table 6-17: Potential Sources for Partnership Funding**

Possible Funding Source	Applicable Defence Sections	Funding Mechanism
Network Rail	2, 3 & 4 (Leigh-on-Sea to Chalkwell).	Riparian owner, with existing responsibility for maintaining defence.
MoD	8 & 9 (foreshore)	MoD own foreshore and have responsibility for its upkeep and maintenance.
Private Developers	All sections - capital works with commuted sum to SBC for maintenance.	Section 106 agreements (similar to that for the Old Ranges Garrison development) and other partnership working.

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Utility providers	All sections where utility asset is protected by defence) – capital works.	Financial contribution to be made for continued protection.
Essex County Council (ECC)	Defence Section 1 where ECC had involvement in legacy landfill activities.	Financial contribution to be made for continued protection.
SBC	All sections, but most likely those where SBC is the lead authority – capital and maintenance works.	Financial contribution and on-going maintenance budget.
Local businesses	All sections, but most likely those in the higher amenity areas (around the pier) - capital and maintenance works.	Innovative mechanism such as Infrastructure levy. SBC is a CIL (Community Infrastructure Levy) charging authority.
Local residents	All sections - capital and maintenance works.	Innovative mechanism such as council tax levy.
Environment Agency (EA)	Two Tree Island.	Part of a collaborative approach for works on contaminated land in the area including Two Tree Island and Hadleigh Marsh.
North Thames FLAG	2 (Old Leigh)	Alignment of coastal works with delivery of works to upgrade working port facilities. Providing opportunities to tie into wider national and international funding sources.

## 6.6 Summary of Preferred Strategy

6.6.1 The economic case for the preferred Strategy is presented in Table 6-18.



**Table 6-18: Summary of the Preferred Strategy (£k)**

Benefit Area (BA)	BA A	BA B	BA C	BA D	BA E	Total
Standard of Protection in 2116	N/A	10% AEP	0.5% AEP	0.5% AEP	10% AEP	
<b>PV Costs, inc. risk (60% OB) (£k)</b>						
<b>Other Costs (£k)</b>	£0	£463	£2,532	£2,379	£323	<b>£5,697</b>
<b>Capital Costs (£k)</b>	£0	£7,571	£45,923	£45,567	£6,059	<b>£105,120</b>
<b>Maintenance Costs (£k)</b>	£1,957	£161	£4,630	£6,741	£1,489	<b>£14,978</b>
<b>Compensatory Habitat Costs (£k)</b>	£2,133	£437	£2,036	£3,413	£400	<b>£8,419</b>
<b>Total PV Costs (£k)</b>	£4,090	£8,633	£55,121	£58,100	£8,270	<b>£134,214</b>
<b>PV Benefits (£k)</b>	£0	£69,678	£175,704	£355,076	£17,598	<b>£618,056</b>
<b>Average Benefit/Cost Ratio (BCR)</b>	N/A	8.07	3.19	6.11	2.13	<b>4.61</b>
<b>Cash Costs (£k) – not including risk</b>						
<b>Other Costs</b>	£0	£911	£3,729	£4,401	£358	<b>£9,399</b>
<b>Capital Costs</b>	£0	£17,168	£70,256	£84,707	£6,349	<b>£178,480</b>
<b>Maintenance Costs</b>	£1,554	£627	£9,033	£16,285	£2,972	<b>£30,471</b>
<b>Compensatory Habitat Costs</b>	£9,411	£1,929	£9,585	£15,058	£1,765	<b>£37,748</b>
<b>Total Cash Costs (£k)</b>	£10,966	£20,635	£92,603	£120,452	£11,443	<b>£256,098</b>
<b>Initial Benefit Period</b>						
Benefit Period	0 - 17	0 – 100 years	0 – 100 years	0 – 100 years	0 – 100 years	<b>0 – 100 years</b>
PV Costs (£k)	£4,090	£8,633	£55,121	£58,100	£8,270	<b>£134,214</b>
PV Benefits (£k)	£0	£69,678	£175,704	£355,076	£17,598	<b>£618,056</b>
Raw Score (%)	0%	77%	39%	38%	12%	<b>38%</b>
Contributions Required (£k)	£2,133	£1,936	£30,788	£31,610	£5,980	<b>£73,494*</b>
Contributions Achieved (£k)	£0	£0	£0	£0	£0	<b>£0</b>
<b>Adjusted PF Score (%)</b>	<b>0%</b>	<b>77%</b>	<b>39%</b>	<b>38%</b>	<b>12%</b>	<b>38%</b>

\*Note: This figure has been taken from the Strategy wide PF Calculator. This does not equal the sum of the individual PF calculations due to internal calculation and rounding within the PF Calculator

\*\*Note: Taken from the PF Calculator rather than a raw score percentage of PV Costs

# 7 Implementation

## 7.1 Project Planning

### Phasing and Approach

- 7.1.1 An Outline Business Case (OBC) is currently being prepared for works at Shoebury Common (eastern end of defence Section 7) to improve the SoP provided against coastal flooding. This OBC document is currently being prepared with capital works intended for year one of the Strategy.
- 7.1.2 Further works have been identified in to occur within the first five years of the Strategy:
- Benefit Area B: Replacement of a length of degraded sea wall at Bell Wharf in year four of the Strategy
  - Benefit Area D: Replacement of the timber groynes in Defence Section 6 in year four of the Strategy. These have been identified as either being in a poor condition or buried following the beach recharge event at Jubilee Beach. Installation of a new groyne field will ensure beach material from the recharge event remains in position for as long a duration as possible.
  - Benefit Area E: Replacement of existing defences in year four of the Strategy. These defences have been identified as being in a poor condition. SBC are currently investigating short-term repair works on these defences. However, a full replacement is recommended in year four of the Strategy following full appraisal and agreement on funding.
- 7.1.3 SBC currently have an ageing stock of coastal defence assets, The Hold the Line policy to be implemented along the coastline will require all defences to be replaced in the 100-year time horizon of this Strategy. Details of the timing of capital works are provided in Section 6.3. and an Implementation Plan is included in Technical Appendix L. In developing this Implementation Plan, a series of efficiencies have been identified to coincide works to reduce capital costs and ongoing disruption along the foreshore. This approach will also enable a wider range of external funding contributors to be identified to maximise benefit to the taxpayer. Implementation efficiencies include:
- Alignment of works at two sites in year nine of the Strategy within Benefit Area C. Works to be undertaken at Cinder Path and west of the Genting Club
  - Alignment of works at two sites in year 14 of the Strategy within Benefit Area D. Works to be undertaken at the base of the pier and in Defence Section 7, west of the Thorpe Bay Yacht Club
  - Capital Maintenance works will be undertaken in Defence Section 7 in the first epoch of the Strategy. This will extend the residual life of the defences to year 30 of the Strategy. In year 30 of the Strategy major works will then be required throughout Benefit Area D and also the east of the Genting Club in Benefit Area C.
  - To achieve the 0.5% AEP SoP in 2116 in Benefit Area C and D, a re-raising intervention has been scheduled for year 50 of the Strategy. This is intended to

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minimise the present-day impact on the townscape as well as enabling adaptation to future changes that may be seen relating to climate change effects.

- 7.1.4 The timing of these interventions is based on present understanding of the defence conditions. Variations to the changing rates of deterioration of these defences is to be mapped as part of the annual defence condition inspection process. Where variation to the current understanding is found to occur, these efficiencies should be reviewed to ensure an effective implementation plan remains in place.
- 7.1.5 Undertaking works on an emergency basis due to lack of funding is seen as the last resort. By having a Strategy in place, it is SBC's intention to develop partnerships and secure the necessary funding in advance of defence failure.

### **Programme and Spend Profile**

- 7.1.6 An annualised spend profile, is presented in Table 7-1. Further information on the derivation of these numbers can be found in Technical Appendix K. Due to the long time-horizon of the Strategy, inflation has not been included with these figures. However, it is required that this be included at scheme appraisal stage.

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**Table 7-1: Annualised Spend Profile (Cash Costs) and PF Score (£k)**

Costs (£k)	2017/18	2018/19	2019/20	2020/21	2021/22	Future Years	Total
<b>Benefit Area A – Two Tree Island</b>							
PF Score = N/A (patch and repair maintenance for first epoch of Strategy only)							
Capital	0	0	0	0	0	0	0
Non-capital	78	78	78	78	78	10,576	10,966
Risk	47	47	47	47	47	6,346	6,581
<b>Total</b>	<b>125</b>	<b>125</b>	<b>125</b>	<b>125</b>	<b>125</b>	<b>16,992</b>	<b>17,547</b>
<b>Benefit Area B – Old Leigh Port</b>							
PF Score = 8.07; Potential Funding Source = Environment Agency, SBC (own funding and via FDGiA) FLAG, Network Rail, Private Developers, Utility Providers, ECC, Local residents/businesses							
Capital	0	0	0	0	940	16,228	17,168
Non-capital	0.5	0.5	0.5	70.5	30.5	3,364	3,467
Risk	0.3	0.3	0.3	42	582	11,755	12,380
<b>Total</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>112.5</b>	<b>1,552.5</b>	<b>31,347</b>	<b>33,015</b>
<b>Benefit Area C – Cinder Path to Three Shells</b>							
PF Score = 3.19; Potential Funding Source = SBC (own funding and via FDGiA), Network Rail, Private Developers, Utility Providers, ECC, Local residents/businesses							
Capital	0	0	0	0	0	70,256	70,256
Non-capital	79	79	79	79	651	21,380	22,347
Risk	47	47	47	47	391	54,982	55,562
<b>Total</b>	<b>126</b>	<b>126</b>	<b>126</b>	<b>126</b>	<b>1,042</b>	<b>146,618</b>	<b>148,165</b>
<b>Benefit Area D – Three Shells to the Old Ranges</b>							
PF Score = 6.11; Potential Funding Source = SBC (own funding and via FDGiA), Ministry of Defence Network Rail, Private Developers, Utility Providers, ECC, Local residents/businesses							
Capital	0	5,795	0	0	2,024	76,888	84,707
Non-capital	259	143	56	127	87	35,073	35,745
Risk	155	3,563	34	76	1,267	67,177	72,271
<b>Total</b>	<b>414</b>	<b>9,501</b>	<b>90</b>	<b>203</b>	<b>3,378</b>	<b>179,138</b>	<b>192,723</b>
<b>Benefit Area E – Old Ranges to East Beach</b>							
PF Score = 2.13; Potential Funding Source = SBC (own funding and via FDGiA), Ministry of Defence, Private Developers, Utility Providers, ECC, Local residents/businesses							
Capital	0	0	0	0	4,081	2,268	6,349
Non-capital	54	54	54	196	114	4,622	5,094
Risk	32	32	32	118	2,517	4,134	6,865
<b>Total</b>	<b>86</b>	<b>86</b>	<b>86</b>	<b>314</b>	<b>6,712</b>	<b>11,024</b>	<b>18,308</b>
<b>Combined Total</b>							
Capital	0	5,795	0	0	7,045	165,640	178,480
Non-capital	470.5	354.5	267.5	550.5	960.5	75,015	77,619
Risk	282	3,690	161	330	4,804	144,394	153,660
<b>Total</b>	<b>752</b>	<b>9,839</b>	<b>428</b>	<b>881</b>	<b>12,809</b>	<b>385,049</b>	<b>409,759</b>

## 7.2 Procurement Strategy

- 7.2.1 Following approval of the Strategy, individual projects will be taken forward in accordance with the timings detailed in Table 6-7 and the Implementation Plan in Technical Appendix L.
- 7.2.2 SBC will adhere to their contract procurement rules and ensure that the Procurement Code of Conduct is complied with. This document sets out the procedure which must be followed for every contract made between the Council and a third party for the supply of goods, services and works. For procurement of professional services, the NEC3 Professional Services Contract for Consultancy Support for Coastal Defences shall be used. Procurement of construction services shall be achieved through The Official Journal of European Union (OJEU) whilst this remains available. If the OJEU is not available for use a suitable alternative procurement mechanism or framework shall be identified by SBC. Parties required to undertake survey shall be appointed by SBC following procurement rules (SBC, 2016) and under standard terms and conditions.
- 7.2.3 SBC have appointed Mott Macdonald as a multi discipline engineering consultant in a 5-year framework agreement to commence the implementation of the approved Strategy. SBC have also appointed Marlborough Surfacing on a ten-year Term Service Contract to undertake maintenance repairs on coastal defence assets.

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## 7.3 Delivery Risks

### High Level Risk Register

7.3.1 The project team has developed a risk register for the implementation of the Strategy (see Technical Appendix R). The top five risks based on a combination of their probability of occurring or impact once they do occur are presented in Table 7-2

**Table 7-2: High Level Risk Schedule and Mitigation**

Key Project Risk	Adopted Mitigation Measure
Scheme costs increase	<ul style="list-style-type: none"> <li>Run sensitivity tests on costings to ensure robust economic case</li> <li>Early Contractor Involvement at scheme design stage</li> </ul>
Lack of funding contributions by other parties whose assets are at risk from coastal flooding and erosion (Network Rail, MoD) and other third parties.	<ul style="list-style-type: none"> <li>Early engagement with third parties at Strategy stage to understand their long-term plans for management of assets.</li> <li>Following adoption of the Strategy SBC will seek to develop relationships and partnerships with potential funders.</li> <li>At scheme stage, early engagement with third party contributors to get buy-in to proposed works.</li> </ul>
Lack of suitable habitat for compensation in close proximity to Southend-on-Sea or habitat not available at the required time.	<ul style="list-style-type: none"> <li>Work with Regional Habitat Creation Programme to ensure wherever possible suitable habitat can be identified.</li> <li>Align with TE2100 to improve possibility of identifying suitable habitat in close proximity to the borough.</li> <li>Work with Ministry of Defence to identify opportunities for creating habitat at Foulness.</li> </ul>
Lack of public support for schemes.	<ul style="list-style-type: none"> <li>Ensure early stakeholder engagement and consultation</li> <li>Use non-technical summaries when presenting schemes to public to help clear understanding.</li> <li>Show clear options development process and detailed reasoning for the scheme.</li> <li>Review lessons learnt on other schemes.</li> <li>Setup a Stakeholder Engagement Group to represent their local community/ organisation.</li> </ul>
Solution to managing contamination issue at Two Tree Island is not identified.	<ul style="list-style-type: none"> <li>Create working group with key partners to identify solutions</li> <li>Link in to regional, national and international initiatives regarding the management of historic landfill sites.</li> </ul>

### Safety Plan

7.3.2 Any projects arising from the Strategy will need to meet the requirements of the Construction (Design and Management) Regulations 2015. In designing any future works, the principles of prevention will be followed and public safety post construction will be a key consideration.