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Strategy Appraisal Report

Authority scheme reference	SBC12
Defra/WAG LDW number	YOS351C/0001A /13SA
Promoting authority	Scarborough Borough Council
Strategy name	Whitby Coastal Strategy 2 (Sandsend to Abbey Cliff, Whitby)

Whitby Sands, Promenade and West Cliff (March 2011)

Date	June 2012
Version	3

StAR for *Whitby Coastal Strategy 2*

Version	Status	Signed off by:	Date signed	Date issued
1	Draft for Project Steering Group	N J Cooper	October 2011	October 2011
2	Draft for Public Consultation	S Rowe	December 2011	January 2012
3	Final following Project Steering Group sign-off	N J Cooper	May 2012	June 2012

Template version – April 2011

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TABLES

APPENDICES

For technical approval of the business case

Scarborough Borough Council:

Project name: **Whitby Coastal Strategy 2 (Sandsend to Abbey Cliff, Whitby)**

Approval Value: **£84,000,000**

Sponsoring Director: **David Archer** **Chief Executive**

Non-financial scheme of delegation

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

Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: Whitby Coastal Strategy 2 (Sandsend to Abbey Cliffs, Whitby)		**Project Code:**	
Project Manager: Stewart Rowe		**Date of Submission:**	
Lead Authority: Scarborough Borough Council		**Version No:**	
Consultant Project Manager: Nick Cooper		**Consultant: Royal Haskoning**	
The following confirm that the documentation is ready for submission to PAB or LPRG. The Project Executive has ensured that relevant parties have been consulted in the production of this submission.			
Position	**Name**	**Signature**	**Date**
Project Executive	David Archer		
	Job Title:		
2. Review by: Large Projects Review Group (LPRG)			
Date of Meeting(s):		**Chairman:**	
Recommended for approval: In the sum of £:		**Date:**	**Version No:**
3. Environment Agency NFSoD approval *Officers in accordance with the NFSoD.*			
Version No:		**Date:**	
Project Approval	**By:** In the sum of: £	**Date:**	
4. Defra or WAG approval *(Delete as appropriate)*			
Submitted to Defra / WAG or Not Applicable (as appropriate)		**Date:**	
Version No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		**Date:**	
Comments:			

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

1.

Project name	**Whitby Coastal Strategy 2 (Sandsend to Abbey Cliffs, Whitby)**			**Start date**	June 2012
				End date	June 2102
Business unit			**Programme**		
Project ref.		**Regional SoD ref.**		**Head Office SoD ref.**	-

2.

Role	**Name**	**Post Title**
Project Sponsor	Dean Hamblin	
Project Executive	David Archer	
Project Manager	Stewart Rowe	

3.

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

4.

NFSoD value	**£23,835k**
Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	£118,275k

5.

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

6.

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

1 Executive summary

1.1 Introduction and Background

Location and background

1.1.1 This Strategy Appraisal Report (StAR) presents the Flood and Coastal Erosion Risk Management (FCERM) 'business case' for investment in a strategic programme of future capital schemes between Sandsend and Whitby in North Yorkshire. The overall aim is to enable sustainable management of the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal slope instability over the next 100 years.

1.1.2 The StAR builds from the River Tyne to Flamborough Head Shoreline Management Plan 2 (formally approved by the Environment Agency in 2009), an earlier detailed Whitby Coastal Strategy (published in 2002) and a comprehensive suite of Further Investigations at Whitby Harbour (undertaken 2007 - 2009) Due to this extensive previous work, and in accordance with advice from the LPRG, a lite-touch approach has been adopted to the StAR, building upon the previous work in light of new guidance, data and environmental legislation that has emerged since the previous Whitby Coastal Strategy.

1.1.3 The Study Area covers five kilometres of North Yorkshire's coastline between Sandsend and Whitby's Abbey Cliff, and extends two kilometres into the River Esk estuary. For the purposes of developing the Whitby Coastal Strategy 2, the Study Area has been sub-divided into a number of coastal Management Units (Key Plan 1a) and river Management Units (Key Plan 1b).

1.1.4 The Study Area is highly renowned for its physical and cultural setting, with dramatic clifflines, sweeping sandy beaches, and a small but bustling harbour all within a short distance from the historic town centre of Whitby.

1.1.5 Considerable tourism and amenity value is associated with the seascape and landscape aesthetics of the Study Area's coastline, harbour and inner estuary as well as its unique cultural setting. Well over 1 million day visitors are attracted each year, with a total value to the UK economy from tourism at Whitby of £41.25M per annum.

1.1.6 There are also important heritage assets including three Scheduled Ancient Monuments (one of which is the iconic Whitby Abbey which sits dramatically on the cliff top and has inspired novelists and artists for centuries) and two Conservations Areas. In addition, there are 473 Listed Buildings and various maritime wrecks, military defences and archaeological sites located wholly or partially within, or immediately adjacent to, the Study Area.

1.1.7 There are no European or Internationally designated sites for nature conservation within the Study Area, but there is a recommended Marine Conservation Zone (rMCZ) located approximately 1km to the north west of the Strategy's frontage and Whitby to Saltwick Site of Special Scientific Interest (SSSI), designated for its features of geological interest, on the foreshore to the immediate east of Whitby Harbour. There are also a number of Sites of Importance to Nature Conservation (SINC). There are also parts of a Heritage Coast within the Study Area, reflecting its landscape importance.

1.1.8 We [Scarborough Borough Council] plan to implement the recommended capital works arising from the Whitby Coastal Strategy 2 in a prioritised manner using our permissive powers under the Coast Protection Act (1949).

History of Erosion, Instability and Sea Flooding

1.1.9 Coastal erosion and coastal slope instability has largely been arrested or slowed within the Study Area due to the construction of coastal defences over much of its length. Most notably, this involved shoreline structures, such as sea walls and rock revetments, but also includes the Whitby harbour structures which have trapped a significant proportion of the sand transported eastwards along the beach and, more significantly, in the nearshore zone since their construction.

1.1.10 However, there remain a number of undefended cliffs where erosion and landsliding continues, most notably at Upgang. Here the cliffs suffered an erosion episode in March 2011 which released soft material from the till that accumulated at the cliff toe in the form of talus. Two women had to be rescued after getting stuck on an incoming tide in the soft sand at the talus.

1.1.11 Historically, significant erosion and landsliding has occurred on several occasions, most notably at Whitby West Cliff and Sandsend Road, caused by a combination of breaches of the sea wall and instability in the backing slopes.

1.1.12 In 1936, two sections of sea wall collapsed at Whitby West Cliff soon after wall construction. This was triggered by a deep-seated landslide that breached through the sea wall from the landward side, enabling marine action to then excavate material through the breached area. In 1962 a further major breach of the sea wall occurred. Both events resulted in immediate repairs to the walls and stabilisation of the backing slopes. A major capital scheme followed in 1988 - 1990. Over the past decade shallow slides have opened in two areas along this section, with the risk remaining that they could develop into larger slides if left untreated.

1.1.13 There has also been a long history of erosion and instability along the cliffs at Sandsend Road, with the most recent major slump in the 1960s prompting a notable slope re-grading and stabilisation scheme which has been relatively effective to the present date. Other sections of the coastal slope in this area remain in an over-steepened condition and subject to episodic, presently shallow, slides. Smaller scale slumps and occasional rock falls also continue to occur along other sections of the frontage.

1.1.14 Local sea flooding due to wave overtopping occurs quite regularly within the Study Area, principally at Sandsend car park, Whitby West Cliff promenade and Whitby Harbour piers and extensions. Additionally, local flooding due to wave run-up along a boat slipway occurs at the root of West Pier.

1.1.15 Sea flooding due to extreme water levels in the harbour and lower estuary typically occurs around Endeavour Wharf on the west bank and upstream of the Swing Bridge on the east bank. The most recent event was in November 2011 when notable flooding occurred on the east bank in an area known as Church Street.

1.2 Problem

1.2.1 There are four principal problems in the Study Area associated with sea flooding, coastal erosion and coastal slope instability, namely:

- **Structural Condition of Existing Coastal Defences** – some of the Study Area is defended against coastal erosion or sea flooding by structures; in many areas these are in sub-optimal condition. If defences were to fail, then coastal erosion would re-commence or sea flooding would be more likely to occur, placing lives, properties and the environment at risk.
- **Wave Overtopping** – waves overtopping the crest of existing defences presents a risk to public safety and to the stability of defence structures.
- **Cliffs and Coastal Slopes** - much of the Study Area comprises sea cliffs and coastal slopes that are susceptible to erosion or instability, depending on their lithology. This places cliff top assets such as residential property, hotels and other businesses at risk. In Most places, there is critical interdependency between processes or coastal erosion at the toe and slope instability on the face of the cliffs or coastal slopes.
- **River Flooding** – low lying areas in and around Whitby Harbour and the lower River Esk estuary are at risk from sea flooding under particular return period tidal events.

1.2.2 Not all of these problems occur everywhere in the Study Area; instead they occur in various combinations depending on the specific characteristics of the particular Management Unit under consideration, with different consequences in each.

1.2.3 The most critical problem areas, where existing defences are in poorest condition and where failure would have notable consequences in terms of erosion and sea flooding, are located at Whitby Harbour (Management Units 17 and 18) and Sandsend Road (Management Units 4CD to 7).

1.2.4 Under a Do Nothing scenario, there would be 776 properties potentially at risk from erosion or instability over the next 100 years. There would also be the loss of 53 listed buildings, 68 cultural heritage sites, 21 archaeological sites, 17 Defence of Britain sites, and 2 scheduled monuments. Loss of the harbour piers would adversely affect the exposed geological features of a rock platform (which also happens to be designated as a geological SSSI) to the immediate east of the harbour, two Conservation Areas, a Heritage Coast and a Designed Landscape. There would also be a loss of tourism and amenity value, much of which is irreplaceable due to the unique tourist appeal of key cultural assets and the iconic location of the Abbey and harbour setting.

1.2.5 A further 159 properties are at risk from sea flooding during a 1 in 200 year event in the present day, rising to 194 properties when sea level rise is considered over the next 100 years.

1.2.6 Throughout much of the study area the probability of sea flooding, coastal erosion and slope instability occurring is currently reduced through the respective use of quayside/ riverside walls, coastal defence structures, and cliff stabilisation measures. However in some areas, especially at Sandsend Road and Whitby Harbour, the coastal defence structures are in poor condition.

1.2.7 If no further investment was made in managing the risks of erosion, instability and sea flooding within the Study Area, existing defences, where present, would deteriorate in condition over time and ultimately fail. The aim, therefore, of Whitby Coastal Strategy 2 is to manage the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal slope instability over the next 100 years.

1.2.8 In pursuance of this aim, the specific objectives are:

- To ensure that the risks from sea flooding, coastal erosion and coastal slope instability are identified and fully understood over the next 100 years.
- To ensure that a full range of management options has been considered, at appropriate levels of detail, to address these risks, taking on board latest guidance and advice on appraisal and selection of options.
- To ensure that the preferred management options are technically feasible, environmentally and socially acceptable, and economically viable and represent a robust and sustainable investment strategy for the Study Area.
- To ensure that there is appropriate organisational and public consultation on the findings and recommendations of the Strategy 2 and that feedback is appropriately considered.
- To ensure that, where possible, opportunities for environmental and economic enhancement have been considered.
- To ensure that a collaborative approach between the respective organisations is adopted throughout development of the Strategy 2, seeking to secure funding contributions and maximise 'win-win' outcomes.

1.3 Options Considered

1.3.1 From a longer list of options, the following were taken forward for further consideration

Option	Description
Do Nothing	Walk-away and undertake no further management other than for public safety
Do Minimum	Monitoring, inspection, maintain existing defences, repair breaches
Development control	Pro-actively reduce the consequences of the risks over the medium and long term through the statutory planning system
Warning systems	Flood, erosion and instability warnings to enable impact-reduction measures to be implemented in advance of a specific event
New (minor) works	Address issues of outflanking or tie-in between undefended and defended sections
Improvement works	Demolish and construct replacement coastal defences or undertake major defence improvements or refurbishments
Cliff and slope works	Major stabilisation works involving re-grading, drainage and vegetation
Re-alignment of coast road	Moving sections of the road landwards so it is not affected by coastal erosion
Re-routing of coast road	Upgrading alternative existing routes to replace an existing road
Tidal barrage	Construction of a moveable barrage across the estuary that could be closed when forecasts of large surges are received, thereby preventing the surge events from propagating up the estuary and causing flooding of harbour-side areas
Temporary / demountable flood defence measures	These could be erected when warnings are received of an impending surge event in the harbour
Property flood proofing and resilience	Measures at individual property level to reduce the consequences of a flood event
Manage public and/or vehicular access	Restrict access during periods of wave overtopping

1.4 Preferred Options

Description

1.4.1 Initially draft preferred options were developed based upon, technical, environmental and economic appraisals that were undertaken in accordance with Environment Agency Appraisal Guidance. Social aspects were incorporated based on comments received from previous consultation exercises associated with the Further Investigations at Whitby Harbour.

1.4.2 The draft preferred options were then subjected to a three month public consultation process running between January and March 2012. This involved a Media Day, a Public Open Event and web-based consultation.

1.4.3 Comments on the draft preferred options were received during the consultation period via feedback forms, questionnaires or verbal comments during the Public Open Event. These were reviewed before finalisation of the preferred options and completion of this StAR.

Environmental Considerations

1.4.4 Although not a statutory requirement, Defra and Environment Agency guidance strongly recommends that a Strategic Environmental Assessment (SEA) is undertaken for Flood and Coastal Erosion Risk Management Strategies, in accordance with European Directive 2001/42/EC. In recognition of this, environmental assessment and consultation has been integral to the identification, short-listing and appraisal of options as the StAR has been developed.

1.4.5 This has involved initial public consultation at the outset to raise awareness of the Strategy's development, further public consultation as part of a Contingent Valuation Study to gain views on perceived values of residents and visitors, and a three month public consultation on the draft Strategy (January 2012 – March 2012) to gain feedback on the draft preferred options.

1.4.6 Also, as part of the SEA process, a Scoping Consultation Document was issued in June 2011 to Scarborough Borough Council, Environment Agency, Natural England, English Heritage, Marine Management Organisation, North Yorkshire County Council, East Riding of Yorkshire Council, North Yorkshire and Cleveland Coastal Forum, North Eastern Inshore Sea Fisheries and Conservation Authority and North York Moors National Park Authority. Scoping responses from these organisations, where provided, were then incorporated into the development of the SEA Environmental Report issued in January 2012 for a three-month consultation to accompany the Strategy. An Indicative Landscape Plan has also been produced.

1.4.7 Key mitigation/enhancement measures recommended by the SEA include coordinating the works to avoid sensitive periods; protecting biodiversity by undertaking further studies, where necessary, and producing restoration and monitoring plans, in particular at Raithwaite Gill and Sandsend, and to adhere to best practice and pollution prevention guidance. A number of specific measures were also identified to avoid and / or mitigate any adverse effects to the historic environment, including a programme of recording any features that would affected by the Strategy and taking into consideration the settings of the Registered Parks and Gardens and Conservation Areas.

Benefits

1.4.8 The economic damages to people and the developed, natural and historic environments arising from coastal erosion, slope instability and sea flooding associated with an option of Do Nothing have been assessed across the Study Area. The economic benefits resulting from implementation of various options across the Study Area have then been derived as the damages avoided under that specific option.

1.4.9 In most cases it has been possible to quantify these damages, but in a small number of cases this has not been possible and the damage categories have instead been described qualitatively.

1.4.10 Particular care has been taken, given the multiple nature of the risks that exist across much of the Study Area, to avoid double-counting of damages. Also, whilst some damages are very specific to an individual Management Unit, others apply more widely, in a linked manner, across the whole or parts of the Study Area and have therefore been apportioned across several Management Units as appropriate.

1.4.11 Recognising the importance of the Study Area to the UK economy in terms of its tourism and recreational value, driven by its unique visitor product and tourist appeal, a Contingent Valuation Study was undertaken. This identified the annual economic revenue from tourism and recreation, the perceived 'equivalent value' enjoyed by visitors to the Study Area, and the reduction in visits should that value be adversely affected by deteriorating coastal, harbour and river defences under a Do Nothing option.

1.4.12 Another important aspect was the damage, due to traffic disruption, associated with loss of the A174 Sandsend Road under a Do Nothing option. This was assessed as being equivalent to the cost of permanent traffic diversion along existing alternative A roads in accordance with the methods set out in the 'Multi-Coloured Manual'.

1.4.13 In all cases, damages have been considered over a timeframe of 100 years, with a base date of 2011. Declining long term discounting rates have been applied in accordance with the recommendations of the 'Green Book'.

1.4.14 A summary of the Do Nothing damages across the Study Area is presented in Table 1.1.

Table 1.1 Present Value damages (PVd) across the Study Area

Damage Category		Do Nothing PVd (£k)
1	**Coastal Erosion**	
1.1	Property	49,343
1.2	Other assets (Services)	1,772
2	**Tidal Flooding**	
2.1	Property	21,057
2.2	Wave run-up	1,809
2.3	Wave Overtopping	3,973
3	**Tourism & Amenity**	
3.1	Tourism & Amenity	35,118
4	**Traffic Disruption**	
4.1	Coastal Erosion	158,542
4.2	Flooding	Damages not quantified
5	**Harbour Function**	
5.1	Loss of Refuge	6,679
5.2	Relocation of Life Boat Station	1,425
5.3	Damage to Vessels	417
5.4	Increased Dredging	4,771
6	**Loss of Business**	

Damage Category		Do Nothing PVd (£k)
6.1	Fisheries	2,349
6.2	Maritime	Damages not quantified
6.3	Tourism	Damages not quantified
6.4	Future Opportunities (e.g. offshore wind farms)	Damages not quantified
7	**Loss of Historic Environment**	
7.1	Piers – Listed Structures	58,255
7.2	Other Listed/Historic Structures	254
8	**Loss of Natural Environment**	
8.1	Smothering of Geological interest on foreshore rock platform *	233
	TOTAL	**345,998**

Costs

1.4.15 Cost estimates have been developed for each of the short-listed options within each Management Unit. These were built up as whole life cost estimates over the 100 year appraisal period of the Strategy to incorporate:

- capital scheme costs for the coastal defences, coastal slopes or river defences (which may occur on several occasions throughout the appraisal period)
- costs for subsequent structural modifications and adaptations (where necessary under a Managed Adaptive Approach)
- surveys, studies and investigations
- design
- environmental studies
- construction supervision
- inspection and monitoring
- preventative repairs
- damage repairs
- maintenance

1.4.16 After discounting the above elements to Present Value costs (PVc) an optimism bias of 60% has been applied.

Economic summary, outcome measures and priority

1.4.17 A summary of the preferred Strategy options for each Management Unit is provided in Table 1.2. This also shows the option whole life (100 year) cash costs, benefits and priorities (in terms of proposed year of construction for any required capital works). The coloured rows in the table refer to the legend below which indicates where funding will likely be required to implement the preferred options. For those schemes highlighted as 'FCERM eligible', the delivery of specific outcomes (as measured through Environment Agency Outcome Measures) will help determine the maximum level of FCERM Grant-in-Aid, and hence help determine the minimum level of third party contributory funding that will be required. Information on this for all capital schemes which achieve a Benefit:Cost ratio greater than unity is presented in the StAR.

Table Legend:

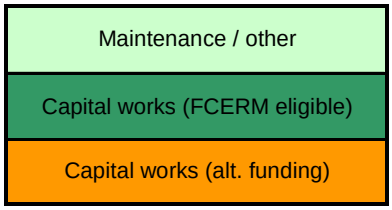


Table footnotes:

* No Active Intervention (while investigating outflanking at interface between defended and undefended frontages).

** Hold the Line (while investigating medium and long term options for road re-alignment).

^ originally part of MU7 but now sub-divided as a new Management Unit at the interface between defended and undefended sections to prevent outflanking.

*** Hold the Line (while investigating re-alignment at western end top prevent outflanking at transition between undefended and defended frontages).

Table 1.2 Preferred Strategy Options

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£k)		
						Total	Capital	Mainten-ance/Other			Total	Capital	Mainten-ance/Other
1	Sandsend Cliffs	NAI *	(2) Do Minimum - cliff erosion will continue - need to re-align Cleveland Way; undertake inspections; prevent outflanking at interface with MU2; ensure public safety.	Works to prevent outflanking incorporated as part of MU2. Works could affect SINC and BAP habitats. Loss of archaeological features through natural erosion.	-	117	0	117	0	0.00	406	0	406
2	Sandsend Car Park	HTL	(3) New Revetment - built in front of sea wall and slipway. Works to prevent outflanking at interface with undefended MU1. Replace road bridge over beck.	Revetment and outflanking works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Potential to affect landscape / seascape and Conservation Area character, and Heritage Coast. Works have potential to affect SAM.	Yr 20 (revetment); Yr 40 (road bridge)	1,034	796	237	7,240	7.00	2,587	1,972	614
3	Sandsend Frontage	HTL	(4) Warning signs, barriers on slipways, toe protection and future rock revetment, slipway and masonry wall	Maximised life of existing assets whilst managing overtopping risk, enabling future capital scheme to address structural condition and overtopping performance. Works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Potential to affect landscape / seascape and Conservation Area character.	Yr 10 (toe protection); Yr 40 (revetment)	1,501	1,031	469	27,978	18.64	4,667	3,601	1,067
4AB	Sandsend Valley	HTL	(3) Replace Walls	Revetment and outflanking works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works need to consider Conservation Area.	Yr 50	102	39	63	24,964	244.75	406	199	207
4CD	Sandsend Valley	HTL	(5) Protect A174 and Slope Stabilisation - capital works to sloping concrete revetment and stabilisation of backing slope.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought, particularly from North Yorkshire County Council). Works will affect SINC and BAP habitat. Potential to improve beach assess. Loss of a small area of agricultural land.	**HIGH PRIORITY** Yr 1	**3,602**	**3,408**	**193**	**17,687**	**4.91**	4,046	3,528	518
5	Sandsend Road A174 (Concrete Apron)	HTL **			**HIGH PRIORITY** Yr 1	**7,432**	**7,054**	**378**	**54,746**	**7.37**	8,605	7,301	1,304
6	Sandsend Road A174 (Embankment/Culvert)	HTL **			**HIGH PRIORITY** Yr 1	**1,333**	**1,251**	**83**	**8,841**	**6.63**	1,587	1,294	293
7A ^	Golf Course West	NAI	(5) Protect A174 and Slope Stabilisation - End detail to prevent outflanking in adjacent undefended frontage. Minor re-alignment of the road locally at a 'pinch point' *may* be required.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought, particularly from North Yorkshire County Council). Works will affect SINC and BAP habitat, landscape / seascape character and Heritage Coast.	**HIGH PRIORITY** Yr 1	**1,594**	**1,509**	**84**	**20,135**	**12.63**	2,355	2,064	291
7B	Golf Course West	NAI	(2) Do Minimum	Inspection to ensure public safety and provide information on erosion rates and mechanisms	-	80	0	80	0	0.00	278	0	278
8	Golf Course East	NAI			-	114	0	114	0	0.00	395	0	395
9	West Cliff (West)	HTL ***	(3) New Defences - maintain to end of design life, then refurbish or construct new defences as capital works	Maintain assets (defences and slopes) to end of residual life. Capital works likely to need alternative funding (depending on erosion rates and climate change) to prevent deterioration of amenity facilities (e.g. promenade) and environmental character of the frontage.	Yr 61	1,171	739	432	357	0.30	6,387	5,032	1,355
10	West Cliff (Seawall)	HTL			Yr 2 (slope) Yr 61 (defence)	1,318	858	460	94	0.07	2,806	1,449	1,357
11	West Cliff (East)	HTL			Yr 62	736	308	428	166	0.23	3,403	2,094	1,309
12	West Cliff Metropole	HTL			Yr 2 (slope) Yr 41 (defence)	2,208	1,652	556	592	0.27	7,296	5,868	1,428

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£)		
						Total	Capital	Mainten-ance/Other			Total	Capital	Mainten-ance/Other
13	West Cliff Spa	HTL	(3) New Defences and Slope Stabilisation	Maintain assets (defences and slopes) to end of residual life. Capital works to refurbish or construct new sea wall and rock armour toe. Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought.	Yr 20	1,176	845	331	4,387	3.73	2,574	1,677	897
14	West Cliff Blockwork Wall	HTL	(3) Replacement Blockwork Wall	Maintain assets (defences and slopes) to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. promenade) and environmental character of the frontage.	Yr 50	582	207	375	113	0.19	2,248	1,074	1,174
15	West Cliff Rock Outcrop	HTL	(2) Do Minimum	Inspection to ensure public safety and provide information on erosion rates and mechanisms.	-	114	0	114	0	0.00	395	0	395
16	Battery Wall	HTL	(3) Flood Gate and Wall Refurbishment	Maintain assets to end of residual life. Capital works to refurbish Battery Wall eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought. Asset is Grade II.	Yr 2 (flood gate) Yr 50 (wall refurbishment)	618	391	227	2,382	3.85	1,693	1,052	641
17	Harbour West Pier	HTL	(3b) Capital works to refurbish main piers and extensions. Overtopping performance managed by public access gates and a programme of maintenance and repairs.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have potential to affect SINC and BAP habitats, and SSSI. Main piers are listed structures.	**HIGH PRIORITY** Yr 3 and 4 Followed by Yrs 21 and 71	**8,195**	**7,824**	**371**	**64,626**	**7.89**	16,478	15,481	997
18	Harbour East Pier	HTL	(3b) Capital works to refurbish main piers and extensions. Rock armour to limit overtopping on extensions, with public access gates on main piers.		**HIGH PRIORITY** Yr 3 and 4 Followed by Yrs 21 and 71	**7,971**	**7,600**	**371**	**61,647**	**7.73**	15,275	14,278	997
19	Haggerlythe	HTL	(3) New Revetment & Slope Stabilisation - built to replace the present informal revetment comprised of loosely placed rocks	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have potential to affect SINC and BAP habitats.	**MEDIUM PRIORITY** Yr 2 (slope) Yr 5 (revetment)	**1,394**	**1,079**	**316**	**2,895**	**2.08**	2,614	1,246	1,368
20	Abbey Cliffs	HTL	(2) Do Minimum	Maintenance of rock revetment. Inspection of cliffs to ensure public safety and provide information on erosion rates and mechanisms.	-	414	0	414	967	2.34	1,803	0	1,803

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£)		
						Total	Capital	Maintenance/Other			Total	Capital	Maintenance/Other
FC1	Rowing Club, Museum	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have the potential to affect Listed Buildings, Conservation Area setting SINC and BAP habitats.	Yrs 5 (IPP), 20 and 31	1,054	783	271	2,000	1.90	2,960	2,016	944
FC2	The Dolphin, The Fleece, Church Street, Eskside Wharf	-	(3) Capital flood alleviation scheme (floodwalls) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought)	Yrs 3 (Flood Scheme), 31 and 70	3,194	2,442	751	28,265	8.85	7,541	5,521	2,019
FC3	Chelsea, Hackney	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. harbour side) and environmental character of the frontage. Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 5 (IPP) 31	627	377	250	313	0.50	1,955	1,062	893
FC4	NW Bank, Angel, New Quay, Endeavour Wharf, Marina, Chandlers	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (significant funding contributions will need to be sought as B-C ratio is only just over unity). Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 5 (IPP), 20, 21, 40, 51, 70 and 90	3,704	2,777	927	3,360	0.91	10,768	8,453	2,315
FC5	Fish Market, Marine Parade & St Anne's Staithe	-	(3) Capital scheme for harbour quay walls	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. harbour side) and environmental character of the frontage. Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 31 and 41	1,406	1,156	250	1,044	0.74	4,942	4,049	893
RE3-RW3	Swing Bridge	-	(3) Capital scheme for harbour quay walls at bridge abutments	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. bridge abutments) and environmental character of the frontage. Works have the potential to affect Conservation Area character, SINC and BAP habitats.	Yrs 50 and 51	480	58	422	1	0.00	1,805	302	1,503

1.4.18 Capital schemes with a benefit-cost ratio above unity from the preferred options of the Whitby Coastal Strategy 2 have been put through the Flood Defence Grant in Aid (FDGiA) calculator to determine the outcome measures and FDGiA contribution these schemes would attract. The outcome measures are presented in Table 1.3 for each of the first five years of the Strategy and the future years. The outcome measures for the capital schemes have been allocated to the year the construction of the scheme would be complete, the management units that contribute to each year are listed below the table.

Table 1.3 Medium term outcome measures contributions

		OM1 (Economic Benefit)	OM2 (Households better protected against flooding)			OM3 (Households better protected against coastal erosion)			OM4 (Statutory Environmental Obligations Met)	TOTAL FDGiA Contribution (£k)	Raw OM Score	Cost saving and/or external contribution required (£k)
			20% most deprived areas	21-40% most deprived areas	60% least deprived areas	20% most deprived areas	21-40% most deprived areas	60% least deprived areas				
2012/2013	Number									£0		£0
	Qualifying Benefits (£k)											
	FDGiA Contribution (£k)											
2013/2014	Number							10		£5,685	40.72%	£8,275
	Qualifying Benefits (£k)	£101,056						£353				
	FDGiA Contribution (£k)	£5,614						£71				
2014/2015	Number			54						£795	75.28%	£261
	Qualifying Benefits (£k)	£4,266		£1,859								
	FDGiA Contribution (£k)	£237		£558								
2015/2016	Number									£0		£0
	Qualifying Benefits (£k)											
	FDGiA Contribution (£k)											
2016/2017	Number			41		162	140	129		£5,971	60.15%	£3,984
	Qualifying Benefits (£k)	£49,659		£397		£2,917	£4,135	£2,518				
	FDGiA Contribution (£k)	£2,786		£127		£1,313	£1,241	£504				
Future Years	Number							62		£3,695	135.75%	£1,239
	Qualifying Benefits (£k)	£59,719						£1,887				
	FDGiA Contribution (£k)	£3,318						£377				
TOTAL	**Number**		**0**	**95**	**0**	**162**	**140**	**201**		**£16,146**	**58.36%**	**£13,759**
	Qualifying Benefits (£k)	**£214,700**	**£0**	**£2,256**	**£0**	**£2,917**	**£4,135**	**£4,758**	**£0**			
	FDGiA Contribution (£k)	**£11,955**	**£0**	**£685**	**£0**	**£1,313**	**£1,241**	**£952**	**£0**			

Note: Management Units w hich contribute to Outcome Measures:
2013/2014: MU4CD-7A
2014/2015: FC2
2016/2017: MU17&18, MU19, FC1, FC3, & FC4
Future Years: MU2, MU3, MU4AB, MU13, MU16

1.4.19 Over the 100 year life of the Strategy the capital schemes would benefit 95 households at risk of flooding and 503 households at risk of coastal erosion. These schemes would attract £16,146k of FDGiA funding towards the total present value cost of £27,665k, this gives a raw Outcome Measure score of 58%. External contributions (or cost savings) in the region of £13.8M would need to be secured over the lifetime of the Strategy to enable the schemes to go ahead.

Funding and contributions

1.4.20 Funding of the preferred options will come from three potential routes:

1) Use of revenue budgets to maintain existing coastal defences, harbour piers, quay walls, cliffs and coastal slopes (including cliff drainage and repairs to shallow slips) and manage risks to public safety from cliff erosion and wave overtopping. This will primarily be funded by revenue budgets of Scarborough Borough Council, North Yorkshire County Council, Whitby Town Council and Whitby Harbour Board.

2) Applications to central government for FCERM Grant-in-Aid of the capital costs of major refurbishments or construction of new or replacement defences where such works are necessarily for managing flood and erosion risks in accordance with existing Appraisal Guidance. This StAR is part of this process, seeking approval of the envisaged long term FCERM capital expenditure over the next 100 years and providing the overarching strategy that will enable individual Project Appraisal Reports (PARs) to be developed and submitted for consideration for FCERM Grant-in-Aid of the capital costs of schemes. Such applications will be supported by efforts to seek contributory funding from appropriate potential sources in line with outputs from the FCERM Grant in Aid (GiA) Calculator.

3) Applications to alternative (i.e. non-FCERM) funding sources for support in respect of the capital costs of major refurbishments or construction of new or replacement defences where driven by environmental (including amenity and heritage) aspects. A review of presently available potential alternative funding mechanisms is provided in the StAR.

Key delivery risks

1.4.21 The Whitby Coastal Strategy 2 has identified the following as key priorities over the next five financial years (2012/13 – 2017/18):

- A capital scheme is needed with high priority across Management Units 4(CD) to 7(A) (Sandsend Road) to address issues of coastal erosion and slope instability.
- A capital scheme is needed with high priority at Management Units 17 and 18 (Whitby Harbour piers and extensions) to address issues of poor structural condition and, for the pier extensions, poor overtopping performance.
- A capital scheme is needed with medium priority at Management Unit 19 (Haggerlythe) to address issues of coastal erosion and slope instability.
- A capital scheme is needed at Flood Cells 1, 2 and 4 to install individual property protection (IPP) to reduce the consequences of tidal flooding.
- A capital scheme is needed in Management Unit 16 (Battery Wall) to install a flood gate to address issues of local flooding due to wave run up along the boat slipway.
- Revenue budgets need to be used to clear blocked drains and repair shallow slips in Management Units 10 and 12.
- Revenue budgets need to be used to regularly undertake visual inspections of coastal defences, cliffs and coastal slopes, quay walls and other marine structures and rectify any defects that are noted, including clearing blocked drains and repairs to shallow slips in the coastal slopes.

1.4.22 The key delivery risks are listed in Table 1.4 along with risk management measures.

Table 1.4 Key delivery risks and their management

Delivery Risk		Risk Management
1	Non-approval or delayed approval of the business case and recommendations presented in this StAR by the Environment Agency's Large Projects Review Group (LPRG)	▪ Early discussion with LPRG regarding the 'lite-touch' approach to the StAR, leading to development of prioritised PARs in areas of highest priority. ▪ Involvement on the Project Steering Group (PSG) of Environment Agency representation throughout the development of *Whitby Coastal Strategy 2*. ▪ Completion of the StAR in accordance with latest Environment Agency procedures and guidance.
2	Non-approval or delayed approval of the business case and recommendations presented in subsequent Project Appraisal Reports by the Environment Agency's Regional Project Approvals Board (PAB)	▪ Involvement on the Project Steering Group of Environment Agency representation throughout the development of *Whitby Coastal Strategy 2* and subsequent PARs. ▪ Completion of the PARs in accordance with latest Environment Agency procedures and guidance.
3	Need for funding contributions in addition to FCERM Grant-in-Aid to deliver capital schemes	▪ Early discussions with potential contributory funders of the high priority schemes during development of *Whitby Coastal Strategy 2*. ▪ Further development of agreements and budgets during preparation of subsequent PARs.
4	Objection from statutory bodies to Strategy	▪ Engagement with statutory bodies throughout the development of the *Whitby Coastal Strategy 2*, both informally as members of the PSG and formally through the SEA process. ▪ Comfort Letter from Natural England to be provided.

Delivery Risk		Risk Management
5	Lack of public acceptance of the proposed solutions	▪ 3 month period of public consultation on the] preferred options, including a public 'open day' drop-in surgery
6	Deterioration or failure of defences before schemes are implemented	▪ Inspection and maintenance/repair of storm damage
7	Deterioration or failure of coastal slopes before schemes are implemented	▪ Inspection and maintenance/repair of shallow slips and blocked drains
8	Need for alternative funding sources to deliver some (medium and longer term) capital schemes and meet whole life non-capital commitments	▪ Investigate alternative funding sources through a review of potential alternative mechanisms and potential contributory funders ('beneficiary pays' principle) ▪ Long term budgetary planning for increased future capital budgets from alternative funding sources.
9	Need for revenue funding to repair shallow slips in MU10 and MU12 in the short term to ensure they do not develop into large slippages in the coastal slopes	▪ Internal budgetary provisions to repair shallow slips in MU10 and MU12.
10	Changes in erosion, overtopping or flooding risks are greater or quicker than projected	▪ Changes in risks, and the best options to manage them, to be considered in future reviews of the Whitby Coastal Strategy based on latest available climate change science and better informed estimates of coastal erosion rates due to longer term monitoring data.

1.5 Recommendation

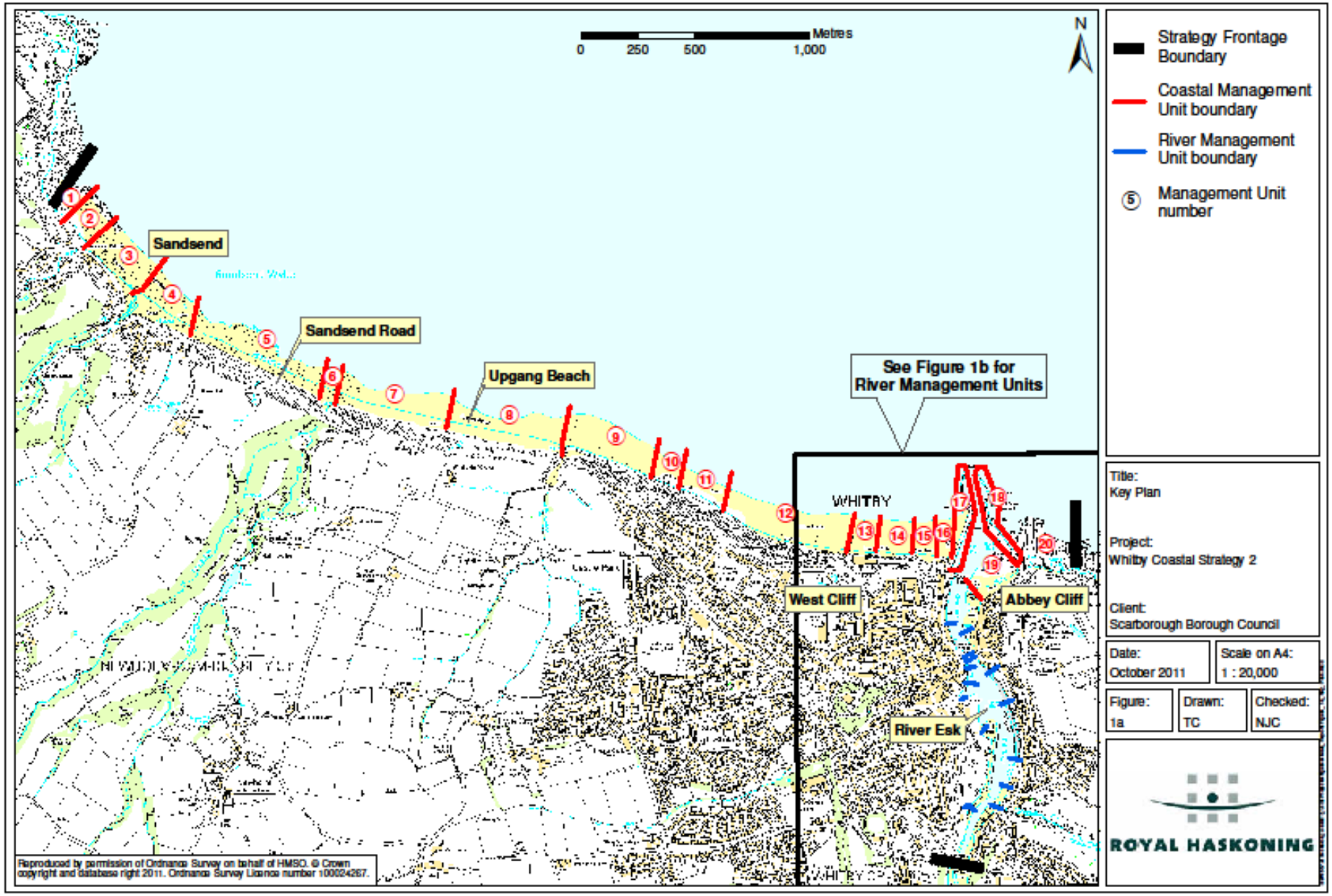
1.5.1 The recommended strategy for managing the risks to people and the developed, natural and historic environment from coastal erosion, slope instability and sea flooding is to deliver the series of actions identified as preferred options in this StAR.

1.5.2 The whole life cash cost of the capital investment, including optimism bias of 60%, is £84million, of which £64million is considered eligible for consideration of FCERM Grant-in-Aid under present funding regimes and £20million will require alternative funding sources.

1.5.3 The strategy is recommended for Approval in Principle for FCERM-eligible capital expenditure of £23.8 million, including optimism bias of 60%, over the first five years.

1.6 Key Plans

- Key Plan 1a – Coastal Management Units.
- Key Plan 1b – River Management Units.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Strategy Frontage Boundary
Coastal Management Unit boundary
River Management Unit boundary
Management Unit number
Sandsend
Sandsend Road
Upgang Beach
See Figure 1b for River Management Units
WHITBY
West Cliff
Abbey Cliff
River Esk
Title:
Key Plan
Project:
Whitby Coastal Strategy 2
Client:
Scarborough Borough Council
Date:
October 2011
Scale on A4:
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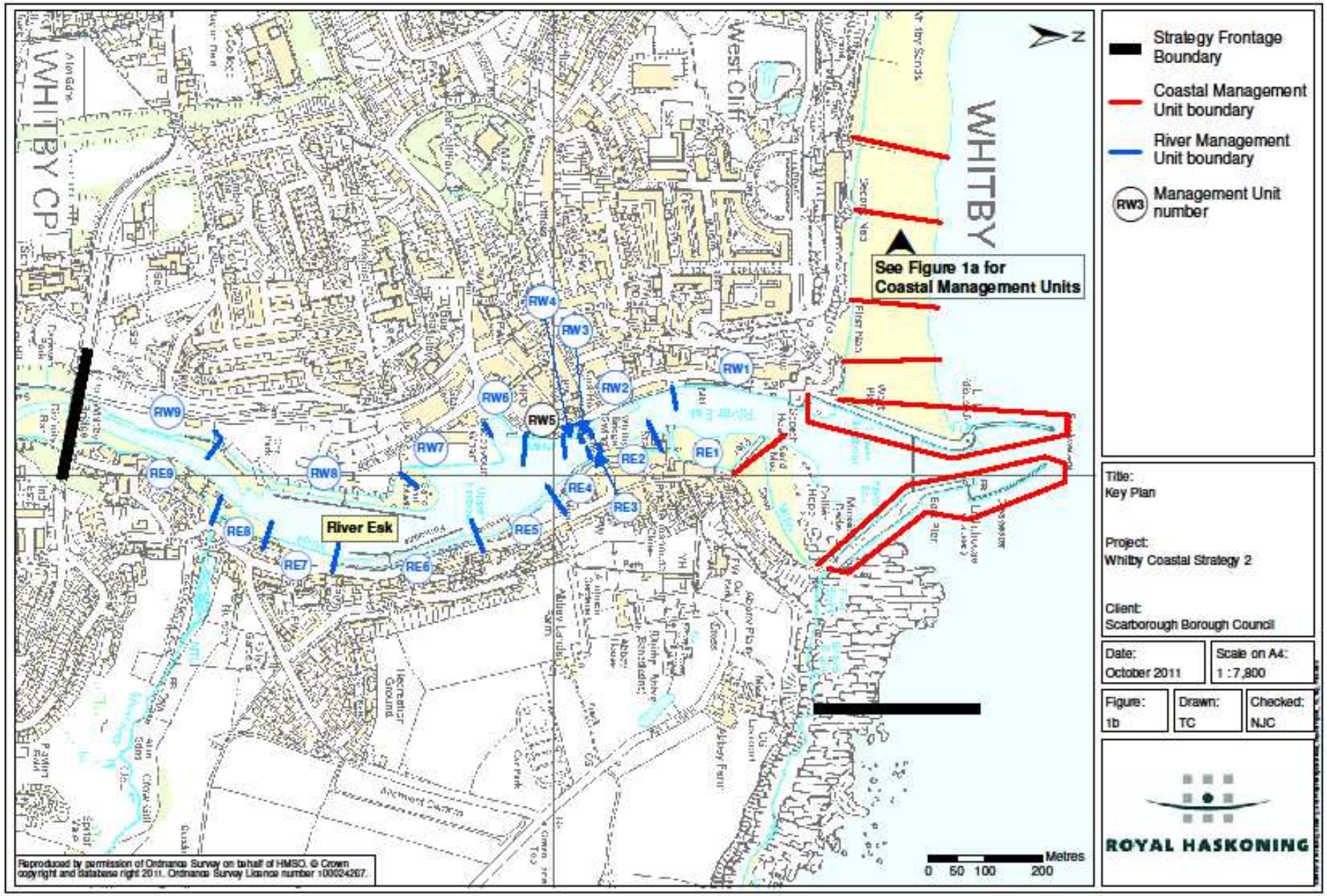
Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2011. Ordnance Survey Licence number 100024267.


Strategy Frontage Boundary
Coastal Management Unit boundary
River Management Unit boundary
RW3 Management Unit number
See Figure 1a for Coastal Management Units
River Esk
RW1
RW2
RW3
RW4
RW5
RW6
RW7
RW8
RW9
RE1
RE2
RE3
RE4
RE5
RE6
RE7
RE8
RE9
West Cliff
WHITBY
Title: Key Plan
Project: Whitby Coastal Strategy 2
Client: Scarborough Borough Council
Date: October 2011
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2 Introduction and background

2.1 Purpose of this report

2.1.1 This Strategy Appraisal Report (StAR) presents the Flood and Coastal Erosion Risk Management (FCERM) 'business case' for investment in a strategic programme of future capital schemes to manage the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal slope instability over the next 100 years. [In many parts of the Study Area the risks from coastal erosion at the toe of the cliffs or slopes and instability in the face of the cliffs or slopes are interdependent (see Appendix D, Figure 1) and therefore fully integrated coast protection and slope stability solutions are required.]

2.1.2 The StAR summarises the key risks in the Study Area from these sources and is seeking approval from the Environment Agency's Large Projects Review Group (LPRG) for our plans to manage them. Once approval of the StAR has been received, we shall begin to implement the recommendations.

2.1.3 The StAR has been undertaken in accordance with latest Environment Agency Flood and Coastal Erosion Risk Management Appraisal Guidance and associated Environment Agency policies and procedures.

2.1.4 We [Scarborough Borough Council] plan to implement the recommended capital works arising from the Whitby Coastal Strategy 2 in a prioritised manner using our permissive powers under the Coast Protection Act (1949).

2.2 Background

Strategic and legislative framework

2.2.1 The original Shoreline Management Plan (SMP) covering the Study Area was completed in 1997. This was followed in 2002 by publication of the original Whitby Coastal Strategy. Both documents were received and duly noted by MAFF.

2.2.2 The original Strategy document identified particularly urgent problems with the poor condition of defences at Whitby Harbour and proposed a capital scheme to address this issue. Although the full capital scheme was not taken forward at that time, some £3m was invested in Urgent Works on the East Pier Extension, which were undertaken between 2010 and 2011 to prevent a defective section from collapsing.

2.2.3 The River Tyne to Flamborough Head Shoreline Management Plan 2 was published in 2007, confirming the original Strategy's findings. The SMP2 was formally approved by the Environment Agency in July 2009.

2.2.4 As requested by the Environment Agency, the original Whitby Coastal Strategy is now being updated before any further capital investment is made in future flood and coastal risk management schemes because:

- Coastal Strategies are live documents that need to be kept up to date
- New national guidance has emerged since 2002 relating to funding and assessment procedures for coastal schemes

- National and regional pressures and priorities have changed to reflect economic circumstances
- Awareness of local community needs has increased as views and opinions have been expressed through the development of various studies over the past decade
- Understanding of coastal evolution has improved as we have continued to monitor the coast
- Scientific understanding of climate change and sea level rise has improved since 2002 and the latest scientific outputs and Environment Agency advice needs to be incorporated
- There are new legal processes that need to be considered as strategic options are developed, particularly those concerning environmental assessment (such as the Water Framework Directive 2000/60/EC and the Strategic Environmental Appraisal (SEA) Directive 2001/42/EC).

2.2.5 Our update of the original Strategy is called the Whitby Coastal Strategy 2. Its purpose is to:

- Provide an up to date assessment of the risks from coastal erosion, slope instability and sea flooding, especially those which directly affect people and the developed, natural and historic environments
- Identify and assess various options for managing these risks over the next hundred years
- Consult with the public and other interested bodies on those options, leading to identification of a preferred set of management options across the Study Area
- Develop a long term plan for future investment in sustainable coastal management activities across the Study Area

Previous studies

Strategy Area

2.2.6 The original Whitby Coastal Strategy (from 2002) provided a robust and thorough assessment of the key problems and appraisal of the management options within the Study Area. It was developed following a number of bespoke surveys and investigations:

- Modelling of the wave climate, coastal processes and flood risk
- Condition assessment of the river and coastal defences
- Condition assessment of the coastal cliffs and slopes, incorporating geomorphological mapping superimposed on oblique aerial photography
- Beach profile survey and beach sediment sampling
- Ground Investigation at Metropole Cliff

2.2.7 In addition, in 2008, English Heritage published a Rapid Coastal Zone Assessment of the North East which covered part of the present Study Area, extending west from Whitby West Pier. This was intended to provide a thorough baseline of archaeological and heritage features along the North East coast and presented a rapid assessment of the threats to them from sea level rise and coastal erosion.

2.2.8 Also, ongoing since 2008, beach profile surveys and beach topographic surveys have been collected along Sandsend Beach, Upgang Sands and Whitby Sands as part of the wider Cell 1 Regional Coastal Monitoring Programme. This programme has also obtained aerial photography and Lidar data in 2010 and used a wave rider buoy located directly offshore of Whitby Harbour to collect directional wave data (i.e. wave height,

wave period and wave direction) for a period of 1 year from May 2010. Walkover inspections of the condition of the coastal defences and natural assets (cliffs, slopes and beaches) have also been undertaken as part of previous surveys in 2008 and 2009.

Whitby Harbour

2.2.9 Following publication of the original Strategy in 2002 and the identification of tidal flooding as a potential risk to people, property and the natural environment, the Environment Agency undertook pre-feasibility work on a Whitby Flood Alleviation Scheme, commencing in 2003 and published in 2006. This included an assessment of the damages associated with tidal flooding in and around the harbour, identifying 120 properties as being at risk of flooding under a 1 in 200 year tidal return period event; a figure expected to increase with sea level rise.

2.2.10 Additionally, although the capital scheme proposed at Whitby Harbour by the original Whitby Coastal Strategy was not taken forward at that time (due to lack of available funding from central government), funding was made available for a comprehensive series of detailed investigations into the condition and performance of the structures at Whitby Harbour and a re-examination of the original Strategy's recommended management options, including public consultation on those options. The so-called Further Investigations at Whitby Harbour were undertaken in 2008/09 and included:

- Topographic, digital measured and photographic surveys
- Dive survey and visual inspections
- Ground probing radar and microgravity surveys
- Ground investigation
- Hydrographic, geophysical and seismic surveys
- Wave climate modelling and water level assessments
- Beach behaviour and sediment budget analysis
- Wave overtopping modelling assessments; and
- Assessment of flood levels along the River Esk estuary.

2.2.11 Some of the structures within Whitby Harbour and the inner estuary have also been subject to detailed investigations in 2011 to determine the extent of deterioration of steel sheet piling, using divers to survey below the water line. These surveys were undertaken at Endeavour Wharf, Eskside Wharf and Fish Pier.

Sandsend Road

2.2.12 In 2010 and 2011, visual inspections, drainage inspections, topographic surveys, environmental surveys and Ground Investigations were undertaken at Sandsend Road by North Yorkshire County Council to investigate issues associated with instability in the slope that backs the road and the poor condition of the sloping concrete revetment that protects the road against coastal erosion.

Location and designations

2.2.13 The Study Area covers five kilometres of North Yorkshire's coastline between Sandsend and Whitby's Abbey Cliff, and extends two kilometres into the River Esk estuary, up to the A171 road bridge. For the purposes of developing the Whitby Coastal Strategy 2, the Study Area has been sub-divided into a number of coastal (Key Plan 1a) and river Management Units (Key Plan 1b).

2.2.14 The Study Area is highly renowned for its physical and cultural setting, with dramatic clifflines, sweeping sandy beaches, and a small but bustling harbour all within a short distance from the historic town centre of Whitby.

2.2.15 Considerable tourism and amenity value is associated with the seascape and landscape aesthetics of the Study Area's coastline, harbour and inner estuary as well as its unique cultural setting. Well over 1 million day visitors are attracted each year, with a total value to the UK economy from tourism at Whitby of £41.25M per annum.

2.2.16 There are also important heritage assets including three Scheduled Ancient Monuments (one of which is the iconic Whitby Abbey which sits dramatically on the cliff top and has inspired novelists and artists for centuries) and two Conservations Areas. In addition, there are 473 Listed Buildings and various maritime wrecks, military defences and archaeological sites located wholly or partially within, or immediately adjacent to, the Study Area.

2.2.17 There are no European or Internationally designated sites for nature conservation within the Study Area, but there is a recommended Marine Conservation Zone (rMCZ) located approximately 1km to the north west of the Strategy's frontage and Whitby to Saltwick Site of Special Scientific Interest (SSSI), designated for its features of geological interest, on the foreshore to the immediate east of Whitby Harbour. There are also a number of Sites of Importance to Nature Conservation (SINC). There are also parts of a Heritage Coast within the Study Area, reflecting its landscape importance.

2.2.18 The western end of the Study Area, from Sandsend Ness to Sandsend Car Park, comprises undefended sea cliffs. Here alum mining was historically undertaken across the rocky foreshore. Sandsend car park is defended by a large sloping concrete apron, with a wave return wall and rock armour at the toe. The Sandsend village frontage mainly comprises an in-situ cast concrete seawall, although along one section the footpath adjacent to the road is cantilevered off the wall. The principal form of defence fronting the Sandsend Road is a sloping concrete apron. Steep coastal slopes are located landward of the road. Along Upgang Beach, there is a section of undefended till cliffs backing the beach. Further east, a large sea wall with fronting rock armour protects the promenade and backing coastal slopes at Whitby West Cliff. The harbour is characterised by the West Pier and East Pier, with extensions to both structures. The River Esk estuary is protected by block masonry quay walls in the outer estuary, and a series of masonry walls, sheet piled walls and sloping revetments in the inner estuary. East of the harbour, the high cliffline is protected by a rock armour revetment.

History of Erosion, Instability and Sea Flooding

2.2.19 Coastal erosion, cliff or slope instability, and sea flooding arises as a consequences of either no coastal defences being present or, where such defences are present, the structures failing to perform their intended function, or being affected by physical conditions that exceed their design thresholds. In response to coastal erosion, English Heritage has conducted a considerable amount of archaeological rescue work on the cliff-edge in advance of erosion. This has recovered considerable amounts of archaeological data, with evidence from the Bronze Age to the early medieval.

2.2.20 It is important to understand the structural condition of existing defences, where they are present, in order to fully identify the potential risks that exist across the Study Area. Whilst some of the frontages have benefited from relatively recent re-building or capital improvements to the structures (such as: (i) Management Unit 2 where the sea wall was rebuilt in 1997; (ii) Management Units 9 – 12 where a Coastal Defence and Slope Stabilisation scheme was undertaken between 1988 – 1990; and (iii) Management Units

19 and 20 where a Coastal Defence and Slope Stabilisation scheme was undertaken in 2001), many other structures are much older and more in need of urgent capital investment.

2.2.21 Walkover inspections of the defences within the Study Area were first undertaken in 2000 as part of the original Whitby Coastal Strategy and repeated in 2008 and 2009 as part of the Cell 1 Regional Coastal Monitoring Programme. This has provided a good overview of baseline condition and any further deterioration over the past decade.

2.2.22 In addition, more detailed inspections, including both intrusive and non-intrusive techniques, were also undertaken at Whitby Harbour piers and extensions as part of the Further Investigations at Whitby Harbour in 2007/08 and at Sandsend Road as part of local asset inspections in 2010 and 2011.

2.2.23 Due to the availability of this previous information, a Coastal Defence Walkover Survey was undertaken to bring the assessment of condition fully up to date to inform the present Strategy 2 (Appendix K2). Additionally, a diving survey of three sheet pile walls within the inner harbour was undertaken to provide more specific detail in noted areas of concern (Appendix K3).

2.2.24 Results identified that there are several structures in poor or very poor condition that are in need of urgent capital investment, most notably at Sandsend Road and Whitby Harbour. In the latter case, the successive inspections record notable deterioration over the past decade.

Erosion and Instability

2.2.25 Coastal erosion and coastal slope instability has largely been arrested or slowed within the Study Area due to the construction of coastal defences. Most notably, this involved shoreline structures, such as sea walls and rock revetments, but also includes the Whitby West Pier and its extension which have trapped a significant proportion of the sand transported eastwards along the beach and, more significantly, in the nearshore zone since their construction, leading to the slow, progressive development of a wide, protective beach immediately west of Whitby Harbour.

2.2.26 However, there remain a number of undefended cliffs where erosion and landsliding continues, most notably at Upgang. Here the cliffs suffered an erosion episode in March 2011 which released soft material from the till that accumulated at the cliff toe in the form of talus. Two women had to be rescued after getting stuck on an incoming tide in the soft sand at the talus.

2.2.27 Historically, more significant erosion and landsliding has occurred on several occasions, caused by a combination of breaches of the sea wall and instability in the backing slopes. In 1936, two sections of sea wall collapsed in Management Unit 12 soon after wall construction. This was triggered by a deep-seated slide that breached through the sea wall from the landward side, enabling marine action to then excavate material through the breached area. In 1962 a major breach of sea wall occurred in Management Unit 11 between White Point and Happy Valley. Both events resulted in immediate repairs to the walls and stabilisation of the backing slopes, with a major capital scheme undertaken in 1988 - 1990. Over the past decade shallow slides have opened in two areas along this section, with the risk remaining that they could develop into larger slides if left untreated.

2.2.28 The coastal slopes that back the Sandsend Road in Management Unit 5 have suffered a number of large and small-scale slumps over the past century, with the most recent major slump in the 1960s prompting a notable slope re-grading and stabilisation scheme which has been relatively effective to the present date. Other sections of the coastal slope remain in an over-steepened condition and subject to episodic, presently shallow, slides.

2.2.29 On a smaller scale, erosion of the undefended cliffs in Management Unit 1 is ongoing and will present a longer term risk of outflanking of the defences in the adjacent unit. Small slumps have also occurred in the cliff top along Management Unit 13 at the Whitby Pavilion car par necessitating a brick wall to be erected to keep people away from the affected area. Additionally, erosion has occurred over the past decade above the loosely constructed rock revetment in Management Unit 19 at the Haggerlythe. This is an area of historic larger-scale landslide activity extending back in recorded history to an event in 1787 that destroyed five houses. Occasional rock falls have also occurred behind the rock revetment in Management Unit 20 at Abbey Cliff.

2.2.30 Further information about the historic erosion and landsliding events, together with a classification of the cliff types within the Study Area and an assessment of their condition based on a walkover inspection, including any deterioration since the 2000, 2008 and 2009 inspections, is provided in Appendix K4.

Wave Overtopping

2.2.31 Local sea flooding due to wave overtopping occurs quite regularly within the Study Area, principally at Sandsend car park, Whitby West Cliff promenade and Whitby Harbour piers and extensions. Additionally, local flooding due to wave run-up along a boat slipway occurs at the root of West Pier.

2.2.32 Previous overtopping assessments from the original Whitby Coastal Strategy and the Further Investigations at Whitby Harbour are drawn together in a Wave Overtopping Overview (Appendix K5). Results show that in several areas overtopping discharge values exceed the target thresholds for serviceability, based on safe pedestrian and vehicle access, and in some areas they also exceed target thresholds for causing structural damage.

River Flooding

2.2.33 Sea flooding due to extreme water levels in the harbour and lower estuary typically occurs around Endeavour Wharf on the west bank and upstream of the Swing Bridge on the east bank. The most recent event was in November 2011 when notable flooding occurred on the east bank in an area known as Church Street. Also, sewer flooding incidents triggered by tide-locking have occurred, causing widespread damage around the harbour area, although this latter issue is currently being addressed by Yorkshire Water through a capital improvements campaign designed to overcome this problem.

2.2.34 Previous assessments of flood risk from the River Esk estuary produced for the original Whitby Coastal Strategy and the Further Investigations at Whitby Harbour are drawn together in a Flood Risk Overview (Appendix K5).

2.3 Current approach to flood risk management

Measures to manage the probability of flood and erosion risk

2.3.1 Throughout much of the study area the probability of sea flooding, coastal erosion and slope instability is reduced through the respective use of quayside/ riverside walls, coastal defence structures, and cliff stabilisation measures. Details of these structures are provided in Appendix K2.

2.3.2 In a small number of coastal Management Units, namely MU1, MU6, MU7, MU8 and MU15 there are no defences present and erosion occurs through occasional rock falls (MU1 and MU15) or small landslip episodes (MU6, MU7 and MU8).

Measures to manage the consequences of flood and erosion risk

2.3.3 The Study Area is served by the Environment Agency's North East Tidal Flood Forecasting Service and operational alerts are raised by the Environment Agency to Scarborough Borough Council when trigger thresholds that may lead to significant overtopping or sea flooding are exceeded. The wave buoy deployed off Whitby Harbour feeds real-time data into this operational system.

2.3.4 Some coastal slopes within the Study Area are comprised of glacial till and are highly susceptible to landslips, even in some cases where they are protected at the toe against marine action by coastal defences. In the most vulnerable areas, a network of instrumentation is installed, enabling any mass movements in the slopes to be identified and appropriate remedial or evacuation action to be undertaken. In the undefended section along Upgang, the owners of Whitby Golf Course have adopted an approach of adapting to ongoing coastal change and re-designing the layout of their course accordingly.

2.3.5 Some sea cliffs in the Study Area are composed of rock that is susceptible to occasional falls, even in some cases where they are protected at the toe against marine action by coastal defences. In areas of high public amenity, imminent rock falls are artificially collapsed in a pro-active and controlled manner.

2.3.6 As and when necessary, access along certain structures, such as the West Pier Extension, is controlled temporarily, or prohibited if risks to public safety are identified due to overtopping or poor structural condition.

Approach to developing Whitby Coastal Strategy 2

2.3.7 Robust and reliable information is available from the original Strategy plus a comprehensive suite of subsequent surveys and investigations that extend across the Study Area. In addition, a comprehensive re-appraisal of management options was also undertaken in 2008/09 at Whitby Harbour. Due to this, and in agreement with the Large Projects Review Group (LPRG), the Whitby Coastal Strategy 2 has adopted an approach of:

- Making best use of available data from previous surveys and investigations
- Extending previous analysis methods (e.g. economic appraisal) from Whitby Harbour to cover the whole Study Area
- Focusing new studies and investigations only on areas highlighted as key remaining uncertainties or potential constraints in need of further consideration

- Undertaking the necessary level of recommended environmental assessment through the Strategic Environmental Appraisal (SEA) process
- Adopting a 'lite-touch' approach by reporting the findings within the context of a StAR rather than additionally having a separate Strategy document

2.3.8 In line with the above philosophy, the Whitby Coastal Strategy 2 adopted a two-stage approach to its development.

2.3.9 Stage 1 involved Data Gathering and Analysis and incorporated the following:

- Coastal Processes Overview (Appendix K1) – to update previous Strategy's findings with results from new modelling undertaken as part of Further Investigations at Whitby Harbour and analysis of both new beach profile and beach topographic data since 2008 and historic beach profile data found from the 1980s.
- Coastal Defence Inspection (Appendix K2) – undertaken as a walk-over survey to identify signs of deterioration or repair since previous surveys in 2002, 2008 and 2009.
- Whitby Harbour Walls – Diving Survey (Appendix K3) – undertaken to specifically investigate above and below waterline condition of Endeavour Wharf, Eskside Wharf and Fish Pier at Whitby Harbour, focusing, in particular, on potential issues of Accelerated Low Water Corrosion of the steel sheet piling.
- Cliffs and Coastal Slopes Overview (Appendix K4) – undertaken as a walk-over survey to identify signs of deterioration or repair since previous surveys in 2002, 2008 and 2009.
- Wave Overtopping Overview (Appendix K5) – to update the previous Strategy's findings with results from new modelling undertaken as part of Further Investigations at Whitby Harbour.
- Flood Risk Overview (Appendix K6) – to collate the previous Strategy's findings with those from the Environment Agency's pre-feasibility work on a Whitby Flood Alleviation Scheme and those from the Further Investigations at Whitby Harbour.
- Geological Walkover Survey (Appendix K7) – undertaken to identify any specific geological interest features that might need to be taken into account when developing management options, considering, in particular, the SSSI geological foreshore located east of Whitby Harbour.
- Historic Environment Desk Based Assessment (Appendix K8) – undertaken to identify any specific heritage or archaeological features that might need to be taken into specific account when developing management options.
- Tourism and Leisure Report (Appendix K9) – undertaken to provide greater robustness to the benefits appraisal through use of a Contingent Valuation Survey.

2.3.10 Stage 2 involved Strategy Development and incorporated technical, economic and environmental assessments in accordance with latest Flood and Coastal Erosion Risk Management Appraisal Guidance and SEA Regulations (The Environmental Assessment of Plans and Programmes Regulations 2004 (SI 2004 No. 1633)).

2.3.11 A substantial way through development of the updated Strategy, the Environment Agency issued new advice on Adapting to Climate Change (in September 2011). Due to this, a review was undertaken of the implications of the new advice on the work undertaken to that point in developing the Strategy 2, with recommendations of whether and, if necessary, how to incorporate the advice. This review is presented in Appendix K10 and identifies that for sea level rise and storm surges the future extreme water level values used in the work to that point fell suitably within the ranges based on the new advice and therefore re-working of the Do Nothing damages was not warranted. It did

note, however, that new rainfall advice may have the effect of increasing landslip potential and hence potentially increasing the Do Nothing damages.

2.3.12 In November 2011, a sea flooding incident occurred along Church Street, prompting a more detailed investigation into issues and potential options than is possible at Strategy level. This involved a topographic survey of the levels and gradients along Church Street which revealed a better insight into flooding mechnaisms and pathways than was possible using the remotely-sensed Lidar data otherwise applied in developing the Strategy. As a consequence of this, the Startagey has benefitted from a more detailed Pre-feasibility Study for a Flood Alleviation Scheme at Church Street, which is presented in Appendix K11. This study was not available at the time of consultation on the draft Strategy but its findings have been incorporated when finalising the Strategy following the consultation activities.

3 Problem definition and objectives

3.1 Outline of the problem

3.1.1 There are four principal problems in the Study Area associated with sea flooding, coastal erosion and coastal slope instability, namely:

- **Structural Condition of Existing Coastal Defences (S)** – some of the Study Area is defended against coastal erosion or sea flooding by structures; in many areas these are in sub-optimal condition. If defences were to fail, then coastal erosion would re-commence or sea flooding would be more likely to occur, placing lives, properties and the environment at risk.
- **Wave Overtopping (O)** – waves overtopping the crest of existing defences presents a risk to public safety and to the stability of defence structures.
- **Cliffs and Coastal Slopes (C)** - much of the Study Area comprises sea cliffs and coastal slopes that are susceptible to erosion or instability, depending on their lithology. This places cliff top assets such as residential property, hotels and other businesses at risk. In Most places, there is critical interdependency between processes or coastal erosion at the toe and slope instability on the face of the cliffs or coastal slopes.
- **River Flooding (R)** – low lying areas in and around Whitby Harbour and the lower River Esk estuary are at risk from sea flooding under particular return period tidal events.

3.1.2 Not all of these problems occur everywhere in the Study Area; instead they occur in various combinations depending on the specific characteristics of the particular Management Unit under consideration, with different consequences in each.

3.1.3 The most critical problem areas, where existing defences are in poorest condition and where failure would have notable consequences in terms of erosion and sea flooding, are located at Whitby Harbour (Management Units 17 and 18) and Sandsend Road (Management Units 4CD to 7).

3.1.4 Our updated assessments for each Management Unit, assuming that the Whitby Harbour piers were to fail and ultimately be lost, have shown that there are 518 residential and 260 commercial properties at risk from coastal erosion/slope instability over the 100 year appraisal period. In addition, there are 76 residential and 87 commercial properties at risk of sea flooding during 1 in 200 year return period extreme tidal events under this scenario in the present day, rising to 91 and 116, respectively, due to sea level rise associated with climate change.

3.1.5 The problems associated with coastal erosion/slope instability and/or wave overtopping relate mainly to the coastal Management Units (see Key Plan 1a) and three river Management Units closest to the harbour mouth. A summary of the asset residual life, and the properties, infrastructure, services and heritage assets at risk from erosion/instability and, where applicable, wave overtopping over the 100 years are shown in Table 3.1.

Table 3.1 Problems Associated with Coastal Erosion, Slope Instability and Wave Overtopping

Management Unit		Asset Residual Life	Over-topping Issue	Property at risk of Coastal Erosion							Infrastructure at risk	Services at risk (m)	Heritage at Risk		
				Residential			Commercial			Total			Assets	Conser-vation Area	Heritage Coast
				Year 20	Year 50	Year 99	Year 20	Year 50	Year 99						
1	Sandsend Cliffs	Undefended		0	0	0	0	0	0	0		0	4		✓
2	Sandsend Car Park	20	✓	0	0	0	0	0	1	1	A174	75	11	✓	✓
3	Sandsend Frontage	30	✓	0	33	5	0	8	0	46	A174	2800	8	✓	✓
4AB	Sandsend Valley - west	49	✓	0	5	20	0	4	5	34	A174	928	12	✓	✓
4CD	Sandsend Valley - east	5	✓	0	0	10	0	1	5	16	A174	672	7		✓
5	Sandsend Road A174 (apron)	5	✓	0	0	0	0	0	0	0	A174	2605	7		✓
6	Sandsend Road A174 (embankment)	Undefended		0	0	0	0	0	0	0	A174	450	7		✓
7	Golf Course West	Undefended		0	0	0	0	0	0	0	A174	1284	6		✓
8	Golf Course East	Undefended		0	0	0	0	0	0	0		0	5		✓
9	West Cliff (West)	61	✓	0	0	0	0	0	0	0		70	5		✓
10	West Cliff (Seawall)	15	✓	0	0	0	0	0	0	0		240	1		
11	West Cliff (East)	61	✓	0	0	0	0	0	0	0		274	0		
12	West Cliff (Metropole)	40	✓	0	0	0	0	0	0	0		1530	8		
13	West Cliff (Spa)	40		0	0	0	0	2	0	2		40	3		
14	West Cliff (Blockwork Wall)	50		0	0	0	0	0	0	0		0	0		
15	West Cliff (Rock Outcrop)	Undefended		0	0	0	0	0	0	0		0	0	✓	
16	Battery Wall	50	✓	0	0	0	16	0	0	16		60	1	✓	
17	Whitby Harbour West Pier & Extension	10	✓	7	181	174	10	66	59	497	Harbour, Lifeboat Station	0	6	✓	
18	Whitby Harbour East Pier & Extension	10	✓									0	6	✓	
19	Haggerlythe	5	✓	0	27	5	0	21	3	56		0	22	✓	
20	Abbey Cliff	100		0	0	0	0	0	0	0		0	14	✓	✓
RW1	Fish Market	40		0	0	1	0	3	15	19		275		✓	
RW2	Marine Parade	50		0	13	0	0	10	0	23		170		✓	
RE1	Rowing Club	40		0	10	27	0	5	26	68		0		✓	

3.1.6 The problems associated with sea flooding relate solely to the river Management Units (see Key Plan 1b), which have been grouped into a series of Floodcells based on the flood outlines, a walkover visual inspection of the frontages, assessment of topography and a sense check on potential interconnectivities (Note: full hydraulic modelling to determine hydraulic connectivity has not been undertaken). A summary of the properties at risk from sea flooding under various return period tidal events, both present day and with 50 years of sea level rise, are shown in Table 3.2. This shows a total both with and without a failure of the Whitby Harbour piers.

Table 3.2 Problems Associated with Sea Flooding

Management Area		Current Conditions (2011) - without waves							SLR Conditions (2061) - without waves						
		1	3	10	50	100	200	1000	1	3	10	50	100	200	1000
Floodcell 1	Residential	0	0	0	10	10	10	13	0	9	10	11	12	13	13
	Comercial	0	0	0	11	13	13	14	0	10	13	13	13	14	14
	Total	0	0	0	21	23	23	27	0	19	23	24	25	27	27
Floodcell 2	Residential	20	40	41	52	53	54	60	41	48	53	55	59	61	69
	Comercial	5	10	12	13	13	14	16	11	13	13	14	16	16	17
	Total	25	50	53	65	66	68	76	52	61	66	69	75	77	86
Floodcell 3	Residential	6	6	7	7	7	7	7	7	7	7	7	7	7	9
	Comercial	2	2	2	3	3	3	3	2	3	3	3	3	3	5
	Total	8	8	9	10	10	10	10	9	10	10	10	10	10	14
Floodcell 5	Residential	0	0	0	0	0	0	2	0	0	0	0	2	2	2
	Comercial	0	0	0	0	0	0	9	0	0	0	0	9	9	10
	Total	0	0	0	0	0	0	11	0	0	0	0	11	11	12
Floodcell 4	Residential	0	8	10	11	11	12	13	10	10	11	12	13	14	14
	Comercial	0	18	25	31	33	35	43	25	25	31	38	43	46	50
	Total	0	26	35	42	44	47	56	35	35	42	50	56	60	64
TOTAL	Residential	26	54	58	80	81	83	95	58	74	81	85	93	97	107
	Comercial	7	30	39	58	62	65	85	38	51	60	68	84	88	96
	Total	33	84	97	138	143	148	180	96	125	141	153	177	185	203
Total if piers are lost (increased wave climate)	Residential	45	57	73	81	83	90	97	73	80	81	90	97	103	132
	Comercial	12	37	51	60	65	69	88	49	57	62	71	88	91	134
	Total	57	94	124	141	148	159	185	122	137	143	161	185	194	266

3.1.7 The location of the properties at risk from erosion, instability and sea flooding is shown in Appendix D, Figure 2. (Note: many properties are flats).

3.2 Consequences of doing nothing

3.2.1 If no further investment was made in managing the risks of erosion, instability and sea flooding within the Study Area, existing defences, where present, would deteriorate in condition over time and ultimately fail.

3.2.2 Along the coastal frontage, such failure of the defences would be due to a combination of marine process and instability in the backing slopes. Instability would increase if existing slope stabilisation measures, such as drainage, were not maintained.

3.2.3 At Whitby Harbour, failure would be likely to occur as a progressive process, with an initial breach most likely in the East Pier, where exposure is greatest and condition is presently poorest. Once occurred, the breach would unravel, exposing greater lengths of the West Pier to increased wave action, accelerating its deterioration.

3.2.4 Failure in the river defences and quay-side walls would accelerate after the protection provided by Whitby Harbour piers and extensions reduced, with greater wave penetration entering the inner harbour.

3.2.5 With failure of the coastal defences and harbour piers, processes of cliff erosion and instability would be re-activated, causing loss of cliff top property and other assets.

3.2.6 With failure of the river defences and harbour piers, sea flooding and wave overtopping of the quayside areas would increase in frequency, making continued use of the harbour untenable.

3.2.7 Critically, failure of the harbour piers would be a major contributor to increasing both the erosion and flooding risk within the Study Area, reflecting the strategic importance of maintaining these structures; an issue which was also identified in the SMP2. With loss of the harbour structures under a Do Nothing scenario, there would be an associated loss of the harbour function as a tenable refuge for vessels in the North Sea that experience difficulties during times of severe storms, together with the need for relocation of the lifeboat station, damage to vessels moored in the harbour and increased dredging requirements. Therefore an option of Do Nothing would increase the risk of loss of life and have other adverse consequences.

3.2.8 Erosion would also cause loss of Church Street, the only vehicular access route along the east bank of the River Esk estuary, and loss of the A174 Sandsend Road, connecting the village of Sandsend to the essential services and amenities of Whitby town, thereby affecting the sustainability of the coastal community at Sandsend.

3.2.9 In addition, coastal erosion will cause loss of telecommunications, gas, electricity and water supply services, a pumping station, telephone exchanges and car parks. Under this scenario, there would also be a loss of businesses directly associated with the harbour, such as fishing and maritime services, and a loss of future business opportunities that are associated with the needs of marine renewable energy developers for suitable bases from which to service the North Sea offshore wind farms.

3.2.10 Erosion resulting from a Do Nothing option would also cause the loss of 53 listed buildings, 68 cultural heritage sites, 21 archaeological sites, 17 Defence of Britain sites, and 2 scheduled monuments. It would also adversely affect the exposed geological features of a rock platform (which also happens to be designated as a geological SSSI), two Conservation Areas, a Heritage Coast and a Designed Landscape. There would also be a loss of tourism and amenity value, much of which is irreplaceable due to the unique tourist appeal of key assets and the iconic location of the Abbey and harbour setting.

3.3 Strategic issues

3.3.1 The River Tyne to Flamborough Head Shoreline Management Plan 2 (published in 2007) provides high level shoreline management policy for the coastal frontage within the Study Area, including the Whitby Harbour piers, although it does not set policy in the River Esk estuary beyond the boundary originally listed in Schedule IV of the Coast Protection Act (1949) and subsequently amended through statute in 1997 (Key Plan 2). In summary, the SMP2 generally recommends a policy of No Active Intervention in areas where there are presently no defences, and generally Hold the Line where defences currently are present.

3.3.2 There are two minor exceptions to this general policy where further investigations are recommended by the SMP2. At the Sandsend Road frontage it is recommended that a policy of Hold the Line is adopted in the first epoch and 'Retreat or Realignment' (subject to further investigations of options for the road) becomes adopted in the second and third epochs. These further investigations should include consideration of the option for road re-alignment. At the western end of the West Cliff promenade, there is likely to be the medium to longer term need to modify (through a policy of Managed Re-alignment) the transition between the defended section and the undefended section further west (fronting the Whitby Golf Course) as opposed to extending the defences across the presently undefended section.

3.3.3 Within the Study Area of Whitby Coastal Strategy 2, there is great inter-connectivity of physical processes and environmental setting across the coastal frontage, the Whitby Harbour piers, and the river frontage. At the centre of these interactions is Whitby Harbour itself, which has a strategic importance within the Study Area, not only socially, economically and environmentally (especially heritage value and earth science heritage value), but also in terms of technical issues related to the physical processes that operate across the Study Area. Management decisions at Whitby Harbour can positively or negatively influence the risks, and potentially can constrain the available management options, along the adjacent coasts and within the inner harbour. For this reason a strategic approach to management of risks within the Study Area is essential.

3.3.4 The frontage covered by the original Whitby Coastal Strategy extended between Sandsend and Abbey Cliff. This frontage is relatively self-contained in terms of physical processes and continuity of both habitats and assets. In developing Whitby Coastal Strategy 2, consideration was given to extending the boundaries to between the headlands of Sandsend Ness and Saltwick Nab simply for the sake of completeness, but the Project Steering Group (PSG) considered this to be unnecessary as the cliffs in these areas are of relatively resistant hard rock geology, there is little cliff top or foreshore access, and other than a short section of the Cleveland Way footpath – for which there is a policy of re-locating landwards in keeping with cliff recession – there are no cliff top assets at risk from erosion. Due to this the Study Area was kept as for the original Strategy, with a series of Management Units defined for the coastal frontage and both the west and east side of the river frontage.

3.3.5 Following discussion with the Environment Agency's Large Projects Review Group (LPRG), a decision was made to adopt a 'lite-touch' approach to development of the Whitby Coastal Strategy 2 that builds upon the extensive volume of high quality data that has been collected in previous studies, with new work focused on addressing remaining key uncertainties or known information gaps.

3.3.6 In keeping with latest Defra policy statements for appraisal of management options, the Whitby Coastal Strategy 2 will, where possible, tend towards a Managed Adaptive

Approach. This involves taking action when particular trigger points are observed and is most appropriate in cases where ongoing responsibility can be assigned to tracking the change in risk, and managing that risk through pre-determined interventions. This approach particularly provides flexibility to manage future uncertainties associated with climate change, for example in relation to future overtopping. This approach is different from the Precautionary Approach adopted in the original Whitby Coastal Strategy and the Further Investigation at Whitby Harbour, which both sought to build in allowances from the outset to cover any such risks that may arise during the 'whole life' of a scheme.

3.4 Key constraints and Opportunities

3.4.1 The main environmental constraints within the Study Area are:

- Whitby Harbour piers are Grade II Listed Buildings and there are numerous other Grade I, Grade II and Grade II* Listed Buildings within the Study Area. Although the Whitby Harbour pier extensions are not listed, they need to be treated as if they were due to the curtilage of the adjacent listed main piers. Parts of the Study Area are also within Conservation Area designations. Due to the number and importance of heritage features within the Study Area, a specialist Historic Environment Desk Study was undertaken (Appendix K8).
- The foreshore extending eastwards from Whitby Harbour East Pier is designated as Whitby to Saltwick SSSI for its geological interest. Due to the importance of geology within the Study Area, a specialist Geological Walkover Survey was undertaken (Appendix K6).
- The Study Area is of immensely high amenity and cultural value and attracts a large number of day-visiting and long-stay tourists. Any options must be sensitive to these amenity and cultural values placed on the harbour and beaches by residents and tourists. There are also other amenity and leisure features such as the Cleveland Way National Trail long distance public footpath, Whitby Golf Club and the many harbour-side amusements and businesses. Due to the importance of the amenity attributes within the Study Area, a specialist Tourism and Leisure Report was undertaken (Appendix K9).
- Whitby Harbour remains a functional harbour, with a duty of care to provide refuge to vessels that face navigational difficulties. It has a full time Harbour Master and its management is overseen by the Whitby Harbour Board. There is also an operational RNLI lifeboat station, as well as a RNLI lifeboat museum.
- The Study Area lies close to the boundary of the North York Moors National Park and there are a number of Sites of Importance to Nature Conservation (SINC) present.

3.4.2 In addition to these constraints, studies have previously been undertaken to identify the opportunities at Whitby Harbour for amenity enhancement or energy production schemes. These include:

- Whitby Pier Power (2009/10) – A study was undertaken aimed at investigating the technical feasibility, economic viability, and environmental and social acceptability of using 'oscillating water column' devices to harness wave power from the exposed seaward face of the harbour piers. The report concluded that although technically feasible, the environmental impact (visual and heritage) and economic return of the scheme would be showstoppers, even if the devices were incorporated into possible capital coastal defence works at the harbour.
- Whitby Harbour Impoundment Weir (2011) – A study aimed at investigating the technical feasibility, economic viability, and environmental and social acceptability of impounding the tidal reaches of the River Esk using a weir, with a view to developing new vessel berthing areas. The reported concluded that whilst it is

feasible to create berths, further detailed studies are required into berthing demand and environmental issues, especially in relation to the Water Framework Directive, before producing a business case.

3.4.3 In addition to these opportunities, there has been considerable interest expressed throughout development of the Strategy in re-instating a link bridge between the East Pier and its extension. However, this does not materially affect the management of flood and erosion risk and therefore this must be considered as an operational asset an amenity asset of the harbour and alternative funding sources would need to be identified.

3.4.4 Major opportunities for contributory funding from North Yorkshire County Council have arisen at Sandsend Road through the collaborative approach to development of the Whitby Coastal Strategy 2.

3.5 Objectives

3.5.1 The aim of Whitby Coastal Strategy 2 is to manage the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal slope instability over the next 100 years.

3.5.2 In pursuance of this aim, the specific objectives are:

- To ensure that the risks from sea flooding, coastal erosion and coastal slope instability are identified and fully understood over the next 100 years.
- To ensure that a full range of management options has been considered, at appropriate levels of detail, to address these risks, taking on board latest guidance and advice on appraisal and selection of options.
- To ensure that the preferred management options are technically feasible, environmentally and socially acceptable, and economically viable and represent a robust and sustainable investment strategy for the Study Area.
- To ensure that there is appropriate organisational and public consultation on the findings and recommendations of the Strategy 2 and that feedback is appropriately considered.
- To ensure that, where possible, opportunities for environmental and economic enhancement have been considered.
- To ensure that a collaborative approach between the respective organisations is adopted throughout development of the Strategy 2, seeking to secure funding contributions and maximise ‘win-win’ outcomes.

3.5.3 The above objectives have been set by a Project Steering Group (PSG) that comprised representatives from: Scarborough Borough Council; North Yorkshire County Council; Whitby Town Council; Whitby Harbour Board; Environment Agency; and Natural England. In setting the objectives, views from a wider range of organisations, such as English Heritage and members of the public, were also taken on board by the PSG.

4 Options for managing flood risk

4.1 Potential FCRM measures

4.1.1 The risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal slope instability can be managed by various approaches, or various combinations of approaches. These can be grouped generally as either measures to manage the probability of the risk or as measures to manage the consequence of the risk. Measures can be delivered as either a high level, strategic solution applied across all or much of the Study Area, or as a solution across a small sub-section of the Study Area, such as an individual Management Unit.

4.2 Long list of options

4.2.1 Having understood the particular characteristics, attributes, problems and opportunities within the Study Area, a long-list of management options was established (Table 4.1).

Table 4.1 Long List of Management Options

Option	Description
Do Nothing	Walk-away and undertake no further management other than for public safety
Do Minimum	Monitoring, inspection, maintain existing defences, repair breaches
Development control	Pro-actively reduce the consequences of the risks over the medium and long term through the statutory planning system
Warning systems	Flood, erosion and instability warnings to enable impact-reduction measures to be implemented in advance of a specific event
New (minor) works	Address issues of outflanking or tie-in between undefended and defended sections
New (shoreline barrier) works	Construct new defences such as sea walls or revetments where no defences are currently present
Improvement works	Demolish and construct replacement coastal defences or undertake major defence improvements or refurbishments
Headland control	Artificially defend the headlands at Sandsend Ness and Saltwick Nab in order that the embayment extending in between can be controlled in plan form
Offshore breakwaters	Construct rock or pre-cast concrete unit structures, placed parallel to the shore but within the nearshore zone, to reduce wave energy between them and the shore, thereby encouraging the build up of sand
Beach recharge	Artificially nourish the foreshore with sand imported from another area, such as a licensed sand extraction site, to provide a natural buffer until the sand, over time, is washed away by coastal processes
Groynes	Construct timber or rock structures constructed perpendicular to the shore in order to trap beach sediment that is drifting along the coast
Beach recharge and offshore breakwaters	Combination of two earlier options to increase the longevity of the beach recharge
Beach recharge and groynes	Combination of two earlier options to increase the longevity of the beach recharge
Cliff and slope works	Major stabilisation works involving re-grading, drainage and vegetation
Re-alignment of coast road	Moving sections of the road landwards so it is not affected by coastal erosion
Re-routing of coast road	Upgrading alternative existing routes to replace an existing road

Option	Description
Re-location of commercial and residential properties	Where these are identified as being at risk of flooding or erosion
Tidal barrage	Construction of a moveable barrage across the estuary that could be closed when forecasts of large surges are received, thereby preventing the surge events from propagating up the estuary and causing flooding of harbour-side areas
Temporary / demountable flood defence measures	These could be erected when warnings are received of an impending surge event in the harbour
Set-back flood walls	Permanent walls set back from the quay or river edge to limit the extent of flooding
Property flood proofing and resilience	Measures at individual property level to reduce the consequences of a flood event
Manage public and/or vehicular access	Restrict access during periods of wave overtopping

4.3 Options rejected at preliminary stage

4.3.1 During an Options Workshop in August 2011 (Appendix T), the Project Steering Group reviewed the long list of options and rejected a number at the preliminary stage (Table 4.2).

Table 4.2 Options Rejected at Preliminary Stage

Option	Discussion of Applicability	Reason
New (shoreline barrier) works	Construction of defences in presently undefended areas would be environmentally unacceptable since there are few 'fixed' assets at risk in these areas	Environmentally unacceptable
Headland control	The headlands within the Study Area are relatively resistant to erosion and therefore this measure was not considered to be technically effective.	Technically ineffective
Offshore breakwaters	There would unwanted adverse impacts, especially in terms of visual impact, in an area of such immense heritage and amenity value and therefore this measure was not considered to be environmentally acceptable.	Environmentally unacceptable
Beach recharge (without and with control structures)	Although beach levels in the Study Area can vary, they are not sufficiently denuded for beach recharge to presently be required and therefore this measure was not considered to be technically effective.	Technically ineffective
Groynes	The majority of sand transport is in the nearshore zone, rather than directly along the shore, so the success of this approach will be limited to stabilising upper beach levels only and therefore this measure was not considered to be sufficiently technically effective to warrant application as a strategic measure.	Technically ineffective
Re-location of commercial and residential properties	It would not be cost-effective to re-locate the vast number of properties presently at risk from flooding or erosion.	Economically unviable
Set-back flood walls	The bustling harbour environment does not present sufficient space to enable set-back walls to permanently be constructed.	Technically unfeasible and environmentally unacceptable

4.4 Options short-listed for appraisa

4.4.1 Not all of the options short-listed for appraisal are applicable to each Management Unit; for example some are applicable to problems of sea flooding and others to erosion or slope instability. The options short-listed for each Management Unit are presented in Table 4.3.

Table 4.3 Short-listed Options for each Management Unit

Coastal Management Unit		Option	
1	Sandsend Cliffs	1	Do Nothing
		2	Do Minimum
2	Sandsend Car Park	1	Do Nothing
		2	Do Minimum
		3	New Revetment
		4	Toe Protection, Warnings & Delayed New Revetment
3	Sandsend Frontage	1	Do Nothing
		2	Do Minimum
		3	New revetment
		4	Toe Protection, Warnings & Delayed New Revetment
4AB	Sandsend Valley	1	Do Nothing
		2	Do Minimum
		3	Replace Assets
4CD	Sandsend Valley	1	Do Nothing
		2	Do Minimum
		3	Re-align A174 & Slope Stabilisation
		4	Upgrade Minor Roads
		5	Protect A174 & Slope Stabilisation
5	Sandsend Road A174 (Concrete Apron)	1	Do Nothing
		2	Do Minimum
		3	Re-align A174 & Slope Stabilisation
		4	Upgrade Minor Roads
		5	Protect A174 & Slope Stabilisation
6	Sandsend Road A174 (Embankment/Culvert)	1	Do Nothing
		2	Do Minimum
		3	Re-align A174 & Slope Stabilisation
		4	Upgrade Minor Roads
		5	Protect A174 & Slope Stabilisation
7A	Golf Course West	1	Do Nothing
		2	Do Minimum
		3	Re-align A174 & Slope Stabilisation
		4	Upgrade Minor Roads
		5	Protect A174 & Slope Stabilisation
7B	Golf Course West	1	Do Nothing
		2	Do Minimum
8	Golf Course East	1	Do Nothing
		2	Do Minimum
9	West Cliff (West)	1	Do Nothing
		2	Do Minimum
		3	New Revetment
		4	New Revetment & Splash Wall
10	West Cliff (Seawall)	1	Do Nothing
		2	Do Minimum
		3	New Revetment
11	West Cliff (East)	1	Do Nothing
		2	Do Minimum
		3	New Revetment
		4	New Revetment & Splash Wall
12	West Cliff Metropole	1	Do Nothing
		2	Do Minimum
		3	New Wall

Coastal Management Unit		Option	
13	West Cliff Spa	1	Do Nothing
		2	Do Minimum
		3	New Revetment & Slope Stabilisation
14	West Cliff Blockwork Wall	1	Do Nothing
		2	Do Minimum
		3	Replacement Blockwork Wall
15	West Cliff Rock Outcrop	1	Do Nothing
		2	Do Minimum
16	Battery Wall	1	Do Nothing
		2	Do Minimum
		3	Flood Gate and Wall Refurbishment
17	Harbour West Pier	1	Do Nothing
		2	Do Minimum
		3a	(A) Main - Structural Only (B) Extension - Structural Only v1
		3b	(A) Main - Structural Only (B) Extension - Structural & Performance v1
		3c	(A) Main - Structural Only (B) Extension - Structural Only v2
		3d	(A) Main - Structural Only (B) Extension - Structural & Performance v2
18	Harbour East Pier	1	Do Nothing
		2	Do Minimum
		3a	(A) Main - Structural Only (B) Extension - Structural Only v1
		3b	(A) Main - Structural Only (B) Extension - Structural & Performance v1
		3c	(A) Main - Structural Only (B) Extension - Structural Only v2
		3d	(A) Main - Structural Only (B) Extension - Structural & Performance v2
		4a	(A) Main - Structural & Performance (B) Extension - Structural Only v1
		4b	(A) Main - Structural & Performance (B) Extension - Structural & Performance v1
		4c	(A) Main - Structural & Performance (B) Extension - Structural Only v2
		4d	(A) Main - Structural & Performance (B) Extension - Structural & Performance v2
19	Haggerlythe	1	Do Nothing
		2	Do Minimum
		3	New Revetment
20	Abbey Cliffs	1	Do Nothing
		2	Do Minimum

River Management Unit		Option	
FC1 (RE1 & RE2)	Rowing Club, Museum	1	Do Nothing
		2	Do Minimum
		3	Capital Flood Defence Scheme + Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls
		5	IPP Resilience (renewed every 20 years) + Capital Works to quay walls
FC2 (RE4 - RE7)	The Dolphin, The Fleece, Church Street, Eskside Wharf	1	Do Nothing
		2	Do Minimum
		3	Capital Flood Defence Scheme + Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls
		5	IPP Resilience (renewed every 20 years) + Capital Works to quay walls
FC3 (RE8 & RE9)	Chelsea, Hackney	1	Do Nothing
		2	Do Minimum
		3	Capital Flood Defence Scheme + Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls
		5	IPP Resilience (renewed every 20 years) + Capital Works to quay walls
FC4 (RW4 - RW9)	NW Bank, Angel, New Quay, Endeavour Wharf, Marina, Chandlers	1	Do Nothing
		2	Do Minimum
		3	Capital Flood Defence Scheme + Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls
		5	IPP Resilience (renewed every 20 years) + Capital Works to quay walls

FC5 (RW1 & RW2)	Fish Market, Marine Parade & St Anne's Staithe	1	Do Nothing
		2	Do Minimum
		3	Capital Flood Defence Scheme + Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls
RE3 & RW3	Swing Bridge	1	Do Nothing
		2	Do Minimum
		3	Capital Works to quay walls
		4	Tidal Barrier + Capital Works to quay walls

4.4.2 For all options within coastal Management Units other than Do Nothing, cliff maintenance works, including drainage clearance and repairs to shallow surface slips, will be necessary in order to realise the benefits of the coastal defence measures.

4.4.3 For all options involving capital intervention in new or upgraded defences, consideration should primarily be given to addressing wave and extreme sea level overtopping issues using an Adaptive Management Approach unless the risks warrant a Precautionary Approach.

5 Options appraisal and comparison

5.1 Technical issues

5.1.1 Consideration was initially given to whether there could be a solution delivered strategically across the entire Study Area, or across considerable frontage lengths, that would address the risks posed. Such solutions along the coastal frontage included headland controls, groynes, beach recharge and offshore breakwaters, and along the river frontage included a tidal barrage. However, for the coastal frontage, the screening of options from a long-list to a short-list resulted in these more 'strategic' options being rejected on technical grounds at that stage. Several of these options were rejected because they did not adequately technically address the problems being experienced.

5.1.2 The resulting short-list therefore focuses on individual coastal Management Units and generally considers the various ways of implementing improvement works, where and when these are needed over the 100 year time horizon of the appraisal, when compared against Do Nothing and Do Minimum options. The nature and timing of such works has been addressed given the detailed knowledge gained of the structural condition and performance of the existing defences, cliffs and slopes, and the nature of the problems being faced.

5.1.3 The main exception is within Management Units 5 and 6 (and parts of adjacent Management Units 4 and 7) where, in accordance with SMP2 recommendations, investigations have also been undertaken into re-routing the A174 Sandsend Road and upgrading existing minor roads in addition to considerations of improvement works to the exiting defences and the Do Nothing and Do Minimum options.

5.1.4 At Whitby Harbour, the Further Investigations at Whitby Harbour previously investigated in detail a large number of technical options, enabling the present Strategy to focus on Do Nothing, Do Minimum and various works to improve structural condition (only) or various works to improve structural condition and structural performance against wave overtopping (in combination). Since present day and anticipated future overtopping is not sufficient to cause structural damage to the main piers, the risk from overtopping relates to public safety, which can be managed through a gate system to restrict public access during overtopping events. Present day and anticipated future overtopping on the pier extensions, however, exceeds thresholds for causing structural damage and appropriate technical solutions are therefore required. It should be noted that both the main piers and the pier extensions contribute to the flood and coastal erosion risk management system. Previous wave modelling has demonstrated the reduced wave climate due to the presence of the structures and previous sediment transport modelling has demonstrated the importance of the pier extensions in reducing loss of beach sand from Whitby Sands since much transport occurs in the nearshore zone along a sand bar, rather than along the inter-tidal shoreline.

5.1.5 Along many of the coastal Management Units, there has been a need to consider both coastal defence works and slope stability works in combination, since the marine and slope processes, and hence resulting risks, are highly inter-linked.

5.1.6 Risks along the river Management Units are best managed through a combined approach across appropriate groupings of Management Units, called Floodcells. The technical approach has been to consider an approach that potentially could have strategic benefits (i.e. a tidal barrage) in addition to a suite of approaches applicable at

individual floodcell level, according to the existing condition of the defences and the nature of the problems being faced.

5.1.7 Throughout all technical issues, a Managed Adaptive Approach has been preferred where possible. This provides flexibility to manage future uncertainties associated with climate change, for example in relation to future overtopping. This will be achieved by adapting existing defences, if necessary, in the future, rather than adopting a Precautionary Approach from the outset which would build in conservative allowances for climate change over the whole life of the option. Where future adaptation is envisaged, the capital costs have been incorporated in the whole life cost estimates.

5.2 Environmental assessment

5.2.1 Although not a statutory requirement, Defra and Environment Agency guidance strongly recommends that a Strategic Environmental Assessment (SEA) is undertaken for Flood and Coastal Erosion Risk Management Strategies, in accordance with European Directive 2001/42/EC.

5.2.2 In recognition of this, environmental assessment and consultation has been integral to the identification, short-listing and appraisal of options as the Whitby Coastal Strategy 2 has been developed.

5.2.3 This has involved initial public consultation at the outset of the Study to raise awareness of the Strategy's development, further public consultation as part of the Contingent Valuation Study to gain views on perceived values of residents and visitors, and a three month public consultation on the draft Strategy (ongoing January 2012 – March 2012) to gain feedback on the draft preferred options.

5.2.4 Also, as part of the SEA process, a Scoping Consultation Document was issued in June 2011 to Scarborough Borough Council, Environment Agency, Natural England, English Heritage, Marine Management Organisation, North Yorkshire County Council, East Riding of Yorkshire Council, North Yorkshire and Cleveland Coastal Forum, North Eastern Inshore Sea Fisheries and Conservation Authority and North York Moors National Park Authority (Appendix N1). Scoping responses from these organisations, where provided, were then incorporated into the development of the SEA Environmental Report (Appendix N2) issued in January 2012 for a three-month consultation to accompany the Strategy.

5.2.5 The Environmental Assessment of Plans and Programmes Regulations identify environmental receptors that must be initially considered for all SEAs. These include:

- population and human health, including critical infrastructure and material assets
- biodiversity, flora and fauna
- air and climatic factors
- water
- landscape and seascape
- historic environment
- soil

5.2.6 It is also necessary to consider the interactions between the above receptors.

5.2.7 For each of the Management Units, the feasible coastal and river management options were appraised against a set of SEA assessment criteria. The magnitude of the impact and the sensitivity of the receptor were considered to determine the likely significance of the impact. The classifications ranged from major beneficial to major adverse.

5.2.8 This assessment identified an environmentally preferred option for each Management Unit within the Study Area (Table 5.1) to inform selection of an overall preferred option, and to assess the overall environmental impacts (positive and negative) of the preferred Strategy approaches.

Table 5.1 Environmentally Preferred Option for each Management Unit

MU	Environmentally preferred option	Comments
1	**Option 2** - Do Minimum	This area is currently not defended. The placement of rock fall material (Option 3) would affect the existing landscape / seascape character of the area. The placement of rock fall material could also result in health and safety issues to local users and also accumulate litter which can reduce the visual amenity value. Potential adverse impacts as a result of implementing the preferred option would be the additional loss of SINC and BAP habitat during the re-alignment of the Cleveland Way.
2	**Option 3** - New revetment, replacement of slipway and road bridge	The predicted effects of Options 3 and 4 are considered to be similar, as both options provide protection to the assets present whilst having lower effects on the local landscape / seascape character, Heritage Coast and Conservation Area; however, Option 3 would not involve the closure of the car park, when necessary, over the first 20 years reducing access to the coast.
3	**Option 3** - New revetment and replacement of slipway	The predicted effects of Options 3 and 4 are considered to be similar, as both options provide protection to the assets present whilst having lower effects on the local landscape / seascape character, Heritage Coast and Conservation Area; however, Option 3 would not involve the closure of the Cleveland Way, when necessary, over the first 20 years reducing access to the coast.
4AB	**Option 3** - Replacement Walls	Assets protected with no requirement to re-align the Cleveland Way. Potential issues to the visual amenity value of the area, should the wall obstruct sea views.
4CD - 7A	**Option 5** - Retain A174 in current location	Options to allow the retreat / realignment of the frontage over the medium to long term are considered to result in more significant impacts than this option. Potential adverse effects to the local landscape / seascape character and Heritage Coast through the crossing of Raithwaite Gill, by making the coast more linear; however, as the Gill has already been crossed the effects are anticipated to be minor. Stabilisation of slope prevents natural development of BAP habitat; however, as this area has already been artificially stabilised, this effect is considered to be neutral.
7B	**Option 2** - Do Minimum	This option would reduce health and safety risks to local users over the Do Nothing option.
8	**Option 2** - Do Minimum	This option would reduce health and safety risks to local users over the Do Nothing option.
9	**Option 3** - New revetment with realignment at Upgang Ravine & slope stabilisation	The slope stabilisation included within this option improves health and safety and access to the coast, thus enhancing the recreational and tourism potential of the area. The re-alignment of the frontage to tie in with the adjacent MU will result in the loss of a small area of SINC and BAP habitat; however, this option does not require the need to extend the revetment up Upgang Ravine, resulting in more extensive loss of

MU	Environmentally preferred option	Comments
		habitats and will result in a more natural landscape / seascape character.
10	**Option 3** - New revetment & slope stabilisation	This option does not involve the loss of foreshore or use rock. Stabilisation of slope prevents natural development of BAP habitat; however, as this area has already been artificially stabilised, this effect is considered to be neutral.. Furthermore, the seawall proposed for Option 5 would obstruct sea views along the promenade.
11	**Option 3** - New revetment & slope stabilisation	Whilst both options that protect the assets aim to reduce overtopping, this option also stabilises the coastal slope, which improves health and safety and access to the beach, thus improving the recreational and tourism potential of the area. Stabilisation of slope prevents natural development of BAP habitat; however, as this area has already been artificially stabilised, this effect is considered to be neutral.
12	**Option 3** - Replacement wall & slope stabilisation	This option avoids the loss of the foreshore that would occur with constructing a revetment in front of the existing defences (Option 4), which is considered to have a significant effect on the local landscape / seascape character, and maintaining the recreational and tourism potential of the area.
13	**Option 3** - Replacement wall rock armour toe below beach level - slope stabilisation and rock face works	This option avoids the loss of the foreshore that would occur with constructing a revetment in front of the existing defences (Option 4), which is considered to have a significant effect on the local landscape / seascape character, and maintaining the recreational and tourism potential of the area. Furthermore, this option stabilises the coastal slope, thereby improving health and safety and access to the beach and therefore the recreational and tourism value of the area, as well as providing the additional benefit to enhance the existing BAP habitat.
14	**Option 3** - Replacement wall & possible installation of scour protection and revetment to reduce wave energy	This option ensures that the assets are protected. The presence of the revetment has the potential to significantly affect the landscape / seascape character of the area and thus its recreational and tourism potential.
15	**Option 2** - Do Minimum	This option would reduce health and safety risks to local users over the Do Nothing option.
16	**Option 3** - Major refurbishment of existing wall	Whilst over topping remains an issue with this option, it avoids the loss of the foreshore that would occur with constructing a revetment in front of the existing defences (Option 4), which is considered to have a significant effect on the local landscape / seascape character, and maintaining the recreational and tourism potential of the area.
17 &	**Option 3** - Structural improvements only.	This option preserves the existing piers themselves, thus protecting the landscape / seascape character and Conservation Area's character, whilst avoiding the need for rock revetment material which would have

MU	Environmentally preferred option	Comments
18	Policy for closing the pier.	an adverse effect on these receptors. The need to close the piers is not considered to have a significant effect on the recreational and tourism potential of the area.
19	**Option 3** - New revetment and slope stabilisation	This option would improve the existing landscape / seascape character and maintain the Conservation Area's character; whilst the height of a new wall is considered to have an adverse effect on the character of the area.
20	**Option 2** - Do Minimum	This option would ensure that the assets remain protected.
FC1	**Option 3 / 5** - Incorporating IPP / flood resilience and capital works to quay walls	Whilst a tidal barrier would provide a better standard of protection, it would significantly affect river ecology, estuarine processes, WFD status, landscape / seascape character and Conservation Area's character. Flooding would still occur under this option.
FC2	**Option 3** - Incorporating refurbishment of quay walls and including flood walls and IPP/flood resilience flood defence measures	This option ensures that all assets are fully protected, unlike IPP (Option 5) without the potentially significant effects that could arise from the construction of a tidal barrage.
FC3	**Option 3 / 5** - Incorporating IPP / flood resilience and capital works to quay walls	Whilst a tidal barrier would provide a better standard of protection, it would significantly affect river ecology, estuarine processes, WFD status, landscape / seascape character and Conservation Area's character. Flooding would still occur under this option.
FC4	**Option 3** - Refurbishment of quay walls and including flood walls, flood gates, demountable defences and IPP/flood resilience flood defence measures	This option ensures that all assets are fully protected, unlike IPP (Option 5) without the potentially significant effects that could arise from the construction of a tidal barrage.
FC5	**Option 3** - Refurbishment of quay walls	This option ensures that all assets are protected from quay wall failure, without the potentially significant effects that could arise from the construction of a tidal barrage. Flooding would still occur under this option.
RE3 & RW3	**Option 3** - Replace or major refurbish of existing abutment	This option ensures that the bridge is maintained.

5.3 Social and community impacts

5.3.1 The Contingent Valuation Study incorporated an 'on site' questionnaire survey undertaken in May 2011. This was extremely useful in determining perceptions and observations from the local community as well as visitors to the study area, and identified that the aesthetics of the river, harbour and coastal environment in the Study Area were critical factors in determining their enjoyment from living and visiting the town. Furthermore, it was strongly observed that for a significant proportion of people, the value of river, harbour and coastal environment of Whitby was immeasurable and if these areas were to decline, then they would be likely to visit less often, or not at all, without necessarily visiting alternative destinations instead. This demonstrates a value to the UK economy, not only the regional or local economy, and is largely due to a generational lineage and strong childhood memories of the unique seascape aspect of the Whitby coast, which tended to dictate a large number of repeat visits.

5.3.2 Public consultation during the earlier Further Investigations at Whitby Harbour had raised significant opposition to the potential use of rock armour on the main piers at Whitby Harbour, particularly in relation to the main West Pier where visual appearance of the iconic harbour setting from the adjacent amenity beaches would be adversely affected. This issue, together with the current government guidance favouring an Adaptive Management Approach to managing risks from climate change, has influenced the appraisal process for options at Whitby Harbour (Management Units 17 and 18).

5.3.3 Additionally, there is a risk that the coastal community at Sandsend village will become significantly adversely affected should the A174 Sandsend Road, connecting the village to Whitby, be lost due to erosion. This potential impact has influenced the appraisal process for options along the Sandsend Road (Management Units 4 (part), 5, 6 and 7 (part)).

5.4 Option costs

5.4.1 Start writing here Cost estimates have been developed for each of the short-listed options within each Management Unit. These have been built up as whole life cost estimates over the 100 year appraisal period of the Strategy to incorporate:

- capital scheme costs for the coastal defences, coastal slopes or river defences (which may occur on several occasions throughout the appraisal period)
- costs for subsequent structural modifications and adaptations (where necessary under a Managed Adaptive Approach)
- surveys, studies and investigations
- design
- environmental studies
- construction supervision
- inspection and monitoring
- preventative repairs
- damage repairs
- maintenance

5.4.2 After discounting the above elements to Present Value costs (PVc) an optimism bias of 60% has been applied.

5.4.3 Although costs estimates for coastal strategies are typically undertaken as strategic level assessments, rather than site specific detailed estimates, the Whitby Coastal Strategy 2 has benefited from detailed information being available at Sandsend Road and Whitby Harbour, due to the availability of previous or ongoing assessments.

5.4.4 In addition, the lessons learned from out-turn cost overruns on the Whitby Harbour Urgent Works (completed in 2011) have been factored-in to the cost estimates for appropriate capital scheme cost estimates at Whitby Harbour.

5.4.5 Cost estimates have generally been based on an assessment of unit cost rates, derived from recent scheme experience and national unit cost databases. The cost estimates for the major capital scheme options have been reviewed by civil engineering contractors (Birse Coastal) and quantity surveyors (Royal Haskoning).

5.4.6 The costs for all of the options short-listed in each Management Unit are provided in Appendix H and are summarised in Table 5.3 alongside the benefits for ease of comparison.

5.5 Options benefits (Damages avoided)

5.5.1 The economic damages to people and the developed, natural and historic environments arising from coastal erosion, slope instability and sea flooding associated with an option of Do Nothing have been assessed across the Study Area. The economic benefits resulting from implementation of various options across the Study Area have then been derived as the damages avoided under that specific option.

5.5.2 In most cases it has been possible to quantify these damages, but in a small number of cases this has not been possible and the damage categories have instead been described qualitatively.

5.5.3 Particular care has been taken, given the multiple nature of the risks that exist across much of the Study Area, to avoid double-counting of damages. Also, whilst some damages are very specific to an individual Management Unit, others apply more widely, in a linked manner, across the whole or parts of the Study Area and have therefore been apportioned across several Management Units as appropriate.

5.5.4 For residential and commercial property damages due to coastal erosion or tidal flooding (including flooding due to wave run-up at the slipway adjacent to West Pier), approaches consistent with the Environment Agency's Appraisal Guidance have been adopted, using methods of the 'Multi-Coloured Manual' and market values from the National Property Database. The tidal flooding damages have also been supported by a Lidar-based Digital Ground Model, supplemented by a specific topographic survey undertaken in July 2011 as part of developing the Strategy.

5.5.5 Recognising the strategic importance of the Whitby Harbour piers and extensions, damages have been calculated for a scenario with the piers remaining intact, and another scenario with the piers failing (i.e. a true Do Nothing). Under the second scenario, there would be greater rates of erosion along parts of the coastline (west of the harbour) and increased flood risk within the harbour, in addition to other increased risks which have been treated separately. The difference in erosion and tidal flooding damages between these two scenarios has been apportioned as a direct benefit to Management Units 17 and 18, covering the West Pier and its extension and the East Pier and its extension, respectively.

5.5.6 Under a Do Nothing option, coastal erosion would also result in the loss of 161 heritage or archaeological features, including the Whitby Harbour piers, which are designated as a Grade II Listed Building. For these pier structures a re-build cost was defined as an analogue for the damages, although the antiquity of the structures would, of course, be irreplaceable. Quantitative evaluation of the damages to the other heritage or archaeological features was equated to the costs of surveying and recording these features before they became lost to erosion.

5.5.7 Additionally, loss of the Whitby Harbour piers and extensions would alter the existing coastal processes, which could result in the deposition (perhaps temporarily) of debris and marine sediments over the foreshore as well as changes to the natural erosion rates east of the harbour. The rock platform in this location is of interest to many fossil-hunters and provides an educational resource due to its exposed geological features (the site is also designated as part of a geological SSSI . The damage caused to the geological features (or 'geo-system services') was assessed in accordance with values per hectare quoted in the Economic Evaluation of Environmental Effects (although it is recognised that this guidance is based on eco-system services, which have been used as a proxy in the absence of any guidance on economic evaluation of geo-system services). Note that this is intended as a means of quantifying the economic damage that may be caused if the piers were to fail (and hence justify, if appropriate, the cost of investment in works) rather than implying a financial compensation for loss of or damage to the geological features (or indeed the SSSI).

5.5.8 For services damages due to coastal erosion across the Study Area, values have been taken as the cost, per linear metre, of relocating the services beyond the predicted 100 year erosion lines. For wave overtopping damages, values have been taken as an annual clean-up cost of sand and debris, per linear metre.

5.5.9 Recognising the importance of the Study Area to the UK economy in terms of its tourism and recreational value, driven by its unique visitor product and tourist appeal, a Contingent Valuation Study was undertaken. This identified the annual economic revenue from tourism and recreation, the perceived 'equivalent value' enjoyed by visitors to the Study Area, and the reduction in visits should that value be adversely affected by deteriorating coastal, harbour and river defences under a Do Nothing option.

5.5.10 Another important aspect was the damage, due to traffic disruption, associated with loss of the A174 Sandsend Road under a Do Nothing option. This was assessed as being equivalent to the cost of permanent traffic diversion along existing alternative A roads in accordance with the methods set out in the 'Multi-Coloured Manual'.

5.5.11 Further damages associated with failure of the Whitby Harbour structures under a Do Nothing option were calculated based on the importance of the ongoing functionality of the harbour to the UK economy, as defined by the loss of an important UK harbour refuge (leading to loss of life during North Sea storms), relocation of the RNLI Lifeboat Station, damage to vessels berthed in the harbour, and costs for increased dredging requirements in the harbour channel. Additional losses to harbour-related business of fishing and maritime services, as well as loss of opportunities for marine business associated with the North Sea offshore wind farm developments were considered either qualitatively or, where valid, quantitatively.

5.5.12 In all cases, damages have been considered over a timeframe of 100 years, with a base date of 4th Quarter 2011. The uplift to 1st Quarter 2012 using the Consumer Price Index (CPI) would be less than 1% and therefore insignificant, and has not been applied. Declining long term discounting rates have been applied in accordance with the recommendations of the 'Green Book'.

5.5.13 A summary of the Do Nothing damages across the Study Area is presented in Table 5.2, with further detail presented in Appendix G.

Table 5.2 Present Value damages (PVd)across the Study Area

Damage Category		Do Nothing PVd (£k)
1	**Coastal Erosion**	
1.1	Property	49,343
1.2	Other assets (Services)	1,772
2	**Tidal Flooding**	
2.1	Property	21,057
2.2	Wave run-up	1,809
2.3	Wave Overtopping	3,973
3	**Tourism & Amenity**	
3.1	Tourism & Amenity	35,118
4	**Traffic Disruption**	
4.1	Coastal Erosion	158,542
4.2	Flooding	Damages not quantified
5	**Harbour Function**	
5.1	Loss of Refuge	6,679
5.2	Relocation of Life Boat Station	1,425
5.3	Damage to Vessels	417
5.4	Increased Dredging	4,771
6	**Loss of Business**	
6.1	Fisheries	2,349
6.2	Maritime	Damages not quantified
6.3	Tourism	Damages not quantified
6.4	Future Opportunities (e.g. offshore wind farms)	Damages not quantified
7	**Loss of Historic Environment**	
7.1	Piers – Listed Structures	58,255
7.2	Other Listed/Historic Structures	254
8	**Loss of Natural Environment**	
8.1	Smothering of Geological interest on foreshore rock platform *	233
	TOTAL	**345,998**

* Note: In accordance with dialogue with Natural England (see Appendix M for details) a value of damages to the geological interest (or 'geo-system services') of the rock platform feature has been estimated. As there is no direct guidance available on the value of geo-system services, Eftec guidance on eco-system services has been applied as a proxy. It should be noted that this benefit category represents <0.1% of the total damages across the study area, but its inclusion is important to demonstrate the value from the geological service that this natural asset provides.

5.5.14 Since much of the total Do Nothing PVd arises from traffic disruption due to erosion of the Sandsend Road and loss of the Whitby Harbour piers and extensions, further comment on these topics is provided below.

Traffic Disruption Damages

5.5.15 Disruption to road traffic has been identified as a key problem in the western end of the Study Area, with the A174 Whitby to Sandsend road, covering Management Units 2 through to 7A, at risk of coastal erosion. If the road is breached at any point due to erosion then this will result in major disruptions to traffic through a 22km diversion, with increased journey lengths and costs. This diversion would be permanent for the rest of the appraisal period under a Do Nothing scenario and such a breach due to erosion would be expected to occur by year 20.

5.5.16 Following the Multi-Coloured Manual methodology for infrastructure at risk of coastal erosion, the least cost option needs to be considered from the following: abandoning the properties served by the affected infrastructure; diverting the infrastructure along a new

route out of erosion zone; or the increased costs where disruption can be accommodated within the existing network. Diverting the road out of the erosion zone has been considered as an option and, therefore, the damages have not been capped at the cost of a new road. The cost of permanent traffic diversion has been calculated following the methodology set out in the Multi-Coloured Manual, and has been based on traffic survey figures for the A174 provided by North Yorkshire County Council (Annual Average Daily Traffic figure of 5,209 vehicles). The total PVd value has been split proportionally between the MUs according to length of road present in each MU.

Whitby Harbour Piers

5.5.17 The damages attributable to the piers can be split into five categories:

- Increased risk from coastal erosion and tidal flooding to property, services and infrastructure should the piers and extensions fail (to avoid double counting only the additional damages over and above that predicted with the structures remaining in place are assigned to the pier Management Units);
- The loss of the role they play in creating the unique historic and cultural characteristics of Whitby that play such a vital role in the tourism 'product' of the town;
- Loss of functionality of the harbour for providing a base for commercial fishing, a safe harbour for launch of a lifeboat, and an emergency refuge for vessels caught in storms;
- Direct loss of the main piers as important historic, Grade II listed, structures; and
- Loss of the important role the structures play in maintaining the exposed geological features on the rock platform foreshore to the east of the harbour free from debris and marine sand.

5.5.18 A full description of each damage category and the assumptions made for calculation of the damages can be found in Appendix G.

5.5.19 The four components of the piers (East Main Pier, East Pier Extension, West Main Pier, and West Pier Extension) act as an integrated system, and as such it is difficult to split the damages between the components. For the purposes of the Whitby Coastal Strategy 2, the damages attributable to the piers and extensions have been split equally between MU17 and MU18.

5.5.20 The Present Value benefits (PVb) have been attributed to individual Management Units across the Study Area as appropriate and compared against the Present Value costs (PVc) of the various options considered within each Management Unit for managing the risks that exist. The PVc have been increased using an optimism bias of 60% to produced a 'benefit – cost ratio' for each option, which has led to identification an economically preferred option within each Management Unit (Table 5.3).

5.5.21 The economic 'decision rule' relating to indicative standards of defence is not suitable for coastal erosion or cliff stability projects (it was designed to optimise crest levels of defences that reduce the risk of flooding), but incremental benefit – cost ratios compared to the Do Minimum option were used to guide option choice.

Table 5.3 Economically Preferred Option for each Management Unit

Management Unit	Option		Proposed Year of Construction	PVd (£k)	PVb (£k)	PVc (£k)		Cash Cost (£k)		NPV (£k)	BCR
						No OB	With OB (60%)	No OB	With OB (60%)		
1	1	Do Nothing		£25	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£25	**£0**	£73	**£117**	£254	£406	-£117	**0.00**
2	1	Do Nothing		£7,394	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£7,380	**£14**	£115	**£184**	£190	£304	-£170	**0.07**
	3	New Revetment	20 & 40	£154	**£7,240**	£646	**£1,034**	£1,617	£2,587	£6,206	**7.00**
	4	Toe Protection & Warnings, with delayed new revetment	10 & 40	£233	**£7,161**	£697	**£1,115**	£2,021	£3,234	£6,046	**6.42**
3	1	Do Nothing		£28,344	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£27,896	**£449**	£178	**£285**	£293	£469	£164	**1.58**
	3	New Revetment	20 & 40	£243	**£28,101**	£1,158	**£1,853**	£2,808	£4,493	£26,249	**15.17**
	4	Toe Protection & Warnings, with delayed new revetment	10 & 40	£366	**£27,978**	£938	**£1,501**	£2,917	£4,667	£26,478	**18.64**
4AB	1	Do Nothing		£24,964	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£24,673	**£291**	£35	**£56**	£85	£136	£235	**5.19**
	3	Replace Assets	50	£0	**£24,964**	£64	**£102**	£254	£406	£24,862	**243.79**
4CD	1	Do Nothing		£17,697	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£17,586	**£111**	£447	**£715**	£763	£1,221	-£604	**0.16**
	3	Realign A174	19	£212	**£17,485**	£5,447	**£8,715**	£10,607	£16,971	£8,770	**2.01**
	4	Upgrade Minor Roads	19	£10,887	**£6,810**	£2,735	**£4,376**	£5,398	£8,637	£2,434	**1.56**
	5	Retain A174 on current alignment	1	£10	**£17,687**	£2,251	**£3,602**	£2,529	£4,046	£14,086	**4.91**
5	1	Do Nothing		£54,778	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£54,704	**£74**	£931	**£1,490**	£1,234	£1,974	-£1,416	**0.05**
	3	Realign A174	19	£884	**£53,894**	£12,593	**£20,149**	£24,336	£38,938	£33,745	**2.67**
	4	Upgrade Minor Roads	19	£34,132	**£20,646**	£6,235	**£9,976**	£12,124	£19,398	£10,670	**2.07**
	5	Retain A174 on current alignment	1	£32	**£54,746**	£4,645	**£7,432**	£5,378	£8,605	£47,314	**7.37**
6	1	Do Nothing		£8,846	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£8,846	**£0**	£94	**£150**	£331	£530	-£150	**0.00**
	3	Realign A174	19	£163	**£8,683**	£2,072	**£3,315**	£4,159	£6,654	£5,368	**2.62**
	4	Upgrade Minor Roads	19	£5,496	**£3,350**	£1,078	**£1,725**	£2,250	£3,600	£1,625	**1.94**
	5	Retain A174 on current alignment	1	£5	**£8,841**	£833	**£1,333**	£992	£1,587	£7,508	**6.63**
7A	1	Do Nothing		£20,352	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£20,352	**£0**	£78	**£125**	£290	£464	-£125	**0.00**
	3	Realign A174	19	£386	**£19,966**	£6,938	**£11,101**	£13,502	£21,603	£8,865	**1.80**
	4	Upgrade Minor Roads	19	£12,696	**£7,656**	£3,432	**£5,491**	£6,758	£10,813	£2,165	**1.39**
	5	Retain A174 on current alignment	1	£217	**£20,135**	£996	**£1,594**	£1,472	£2,355	£18,542	**12.64**
7B	1	Do Nothing		£0			**£0**		£0	£0	
	2	Do Minimum		£0	**£0**	£50	**£80**	£174	£278	-£80	**0.00**
8	1	Do Nothing		£1			**£0**		£0	£0	
	2	Do Minimum		£1	**£0**	£71	**£114**	£247	£395	-£114	**0.00**
9	1	Do Nothing		£1,017	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£947	**£70**	£255	**£408**	£659	£1,054	-£338	**0.17**
	3	New Revetment	61	£660	**£357**	£732	**£1,171**	£3,992	£6,387	-£814	**0.31**
	5	New Revetment & Splash Wall	61	£660	**£357**	£720	**£1,152**	£3,907	£6,251	-£795	**0.31**
10	1	Do Nothing		£259	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£245	**£14**	£231	**£370**	£445	£712	-£356	**0.04**
	3	New Revetment	16	£165	**£94**	£824	**£1,318**	£1,754	£2,806	-£1,224	**0.07**
11	1	Do Nothing		£463	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£426	**£36**	£255	**£408**	£659	£1,054	-£372	**0.09**
	3	New Revetment	61	£297	**£166**	£460	**£736**	£2,127	£3,403	-£570	**0.23**
	4	New Revetment & Splash Wall	61	£297	**£166**	£474	**£758**	£2,220	£3,552	-£593	**0.22**
12	1	Do Nothing		£1,265	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£1,150	**£115**	£360	**£576**	£760	£1,216	-£461	**0.20**
	3	New Wall	41	£673	**£592**	£1,380	**£2,208**	£4,560	£7,296	-£1,616	**0.27**
13	1	Do Nothing		£4,387	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£3,264	**£1,123**	£360	**£576**	£760	£1,216	£547	**1.95**
	3	New Revetment & Slope Stabilisation	20	£0	**£4,387**	£735	**£1,176**	£1,609	£2,574	£3,211	**3.73**
14	1	Do Nothing		£113	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£84	**£29**	£211	**£338**	£586	£938	-£309	**0.09**
	3	Replacement Blockwork Wall	51	£0	**£113**	£364	**£582**	£1,405	£2,248	-£469	**0.19**
15	1	Do Nothing		£291	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£291	**£0**	£71	**£114**	£247	£395	-£114	**0.00**
16	1	Do Nothing		£2,469	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£2,309	**£160**	£130	**£208**	£277	£443	-£48	**0.77**
	3	Replacement Wall + floodgate	51	£87	**£2,382**	£386	**£618**	£1,058	£1,693	£1,764	**3.86**
17	1	Do Nothing		£65,074	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£61,856	**£3,219**	£420	**£672**	£693	£1,109	£2,547	**4.79**
	3a	Main - Structural Only Extension - Structural Only v1	3, 4, 21, 51 & 61	£448	**£64,626**	£5,121	**£8,194**	£11,592	£18,547	£56,433	**7.89**
	3b	Main - Structural Only Extension - Structural & Performance v1	3, 4, 21, 51 & 61	£448	**£64,626**	£5,122	**£8,195**	£10,299	£16,478	£56,431	**7.89**
	3c	Main - Structural Only Extension - Structural Only v2	3, 4, 21, 51 & 61	£448	**£64,626**	£17,962	**£28,739**	£38,106	£60,970	£35,887	**2.25**
	3d	Main - Structural Only Extension - Structural & Performance v2	3, 4, 21, 51 & 61	£448	**£64,626**	£11,516	**£18,426**	£23,578	£37,725	£46,201	**3.51**

Management Unit		Option	Proposed Year of Construction	PVd (£k)	PVb (£k)	PVc (£k)		Cash Cost (£k)		NPV (£k)	BCR
						No OB	With OB (60%)	No OB	With OB (60%)		
18	1	Do Nothing		£62,095	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£58,876	**£3,219**	£419	**£670**	£692	£1,107	£2,548	**4.80**
	3a	Main - Structural Only Extension - Structural Only v1	3, 4, 21, & 61	£448	**£61,647**	£4,976	**£7,962**	£10,810	£17,296	£53,685	**7.74**
	3b	Main - Structural Only Extension - Structural & Performance v1	3, 4, 21, & 61	£448	**£61,647**	£4,982	**£7,971**	£9,547	£15,275	£53,676	**7.73**
	3c	Main - Structural Only Extension - Structural Only v2	3, 4, 21, & 61	£448	**£61,647**	£17,822	**£28,515**	£37,354	£59,766	£33,132	**2.16**
	3d	Main - Structural Only Extension - Structural & Performance v2	3, 4, 21, & 61	£448	**£61,647**	£11,376	**£18,202**	£22,826	£36,522	£43,445	**3.39**
	4a	Main - Structural & Performance Extension - Structural Only v1	3, 4, 21, & 61	£0	**£62,095**	£5,567	**£8,907**	£11,380	£18,208	£53,188	**6.97**
	4b	Main - Structural & Performance Extension - Structural & Performance v1	3, 4, 21, & 61	£0	**£62,095**	£5,573	**£8,917**	£10,117	£16,187	£53,178	**6.96**
	4c	Main - Structural & Performance Extension - Structural Only v2	3, 4, 21, & 61	£0	**£62,095**	£18,413	**£29,461**	£37,924	£60,678	£32,634	**2.11**
	4d	Main - Structural & Performance Extension - Structural & Performance v2	3, 4, 21, & 61	£0	**£62,095**	£11,967	**£19,147**	£23,396	£37,434	£42,948	**3.24**
19	1	Do Nothing		£2,895	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£2,599	**£296**	£153	**£245**	£477	£763	£51	**1.21**
	3	New Revetment	5	£0	**£2,895**	£871	**£1,394**	£1,634	£2,614	£1,501	**2.08**
20	1	Do Nothing		£979	**£0**	£0	**£0**	£0	£0	£0	
	2	Do Minimum		£11	**£967**	£259	**£414**	£1,127	£1,803	£553	**2.33**

Floodcells											
Management Unit		Option	Proposed Year of Construction	PVd (£k)	PVb (£k)	PVc (£k)		Cash Cost (£k)		NPV (£k)	BCR
						No OB	With OB (60%)	No OB	With OB (60%)		
FC1 (RE1 & RE2)	1	Do Nothing		£2,849						£0	
	2	Do Minimum		£2,843	**£7**	£117	**£187**	£257	£411	-£181	**0.04**
	4	Tidal Barrier	10 & 60 (20 & 31)	£781	**£2,068**	£980	**£1,568**	£2,504	£4,006	£500	**1.32**
	5	IPP Resilience (renewed every 20 years)	5 (25, 45, 65, 85) (20 & 31)	£849	**£2,000**	£659	**£1,054**	£1,850	£2,960	£946	**1.90**
FC2 (RE4 - RE7) (see floodcell sensitivity)	1	Do Nothing		£29,142			**£0**		£0	£0	
	2	Do Minimum		£22,862	**£6,280**	£342	**£547**	£598	£957	£5,732	**11.48**
	3	Capital Scheme	3 (20, 31, & 70)	£877	**£28,265**	£1,996	**£3,194**	£4,713	£7,541	£25,071	**8.85**
	4	Tidal Barrier	10 & 60 (20, 31, & 70)	£1,565	**£27,577**	£3,197	**£5,115**	£8,210	£13,136	£22,462	**5.39**
	5	IPP Resilience	5 (25, 45, 65, 85) (20, 31, & 70)	£3,486	**£25,656**	£1,799	**£2,878**	£5,269	£8,430	£22,777	**8.91**
FC3 (RE8 & RE9)	1	Do Nothing		£1,418			**£0**		£0	£0	
	2	Do Minimum		£1,392	**£26**	£128	**£205**	£362	£579	-£179	**0.13**
	3	Capital Scheme	5 (25, 45, 65, 85) (31)	£1,105	**£313**	£499	**£798**	£1,517	£2,427	-£485	**0.39**
	4	Tidal Barrier	10 & 60 (31)	£1,114	**£304**	£1,580	**£2,528**	£3,962	£6,339	-£2,224	**0.12**
	5	IPP Resilience (renewed every 20 years)	5 (25, 45, 65, 85) (31)	£1,105	**£313**	£392	**£627**	£1,222	£1,955	-£314	**0.50**
FC4 (RW4 - RW9) (see floodcell sensitivity)	1	Do Nothing		£7,666			**£0**		£0	£0	
	2	Do Minimum		£7,661	**£5**	£505	**£808**	£1,017	£1,627	-£803	**0.01**
	3	Capital Scheme	5 (25, 45, 65, 85) 20, 21, 40, 51, 70, 90)	£3,192	**£4,474**	£2,849	**£4,558**	£7,385	£11,816	-£84	**0.98**
	4	Tidal Barrier	10 & 60 (20, 21, 40, 51, 70, 90)	£4,550	**£3,116**	£4,988	**£7,981**	£12,877	£20,603	-£4,865	**0.39**
	5	IPP Resilience (renewed every 20 years)	5 (25, 45, 65, 85) (20, 21, 40, 51, 70, 90)	£4,306	**£3,360**	£2,315	**£3,704**	£6,730	£10,768	-£344	**0.91**
FC5 (RW1 & RW2)	1	Do Nothing		£1,209			**£0**		£0	£0	
	2	Do Minimum		£863	**£346**	£124	**£198**	£294	£470	£148	**1.74**
	3	Capital Scheme	(31 & 41)	£165	**£1,044**	£879	**£1,406**	£3,089	£4,942	-£362	**0.74**
	4	Tidal Barrier	10 & 60 (31 & 41)	£26	**£1,183**	£2,182	**£3,491**	£6,912	£11,059	-£2,308	**0.34**
RE3 & RW3	1	Do Nothing		£4			**£0**		£0	£0	
	2	Do Minimum		£3	**£1**	£222	**£355**	£528	£845	-£354	**0.00**
	3	Capital Scheme	(50)	£0	**£4**	£300	**£480**	£1,128	£1,805	-£476	**0.01**
	4	Tidal Barrier	10 & 60 (50)	£0	**£4**	£412	**£659**	£1,390	£2,224	-£655	**0.01**

Note: The benefit – cost ratio (BCR) is calculated as the ratio between the present value benefits (PVb) and the present value costs (PVc) including an optimism bias (OB) of 60%.

6 Selection and details of the preferred option

6.1 Selecting the preferred option

6.1.1 In developing the preferred options of the Whitby Coastal Strategy 2, technical, environmental and economic appraisals were undertaken in accordance with Environment Agency Appraisal Guidance, and social aspects were incorporated based on comments received from previous consultation exercises associated with the Further Investigations at Whitby Harbour.

6.1.2 The draft preferred options of the Whitby Coastal Strategy 2 were also subjected to a three month public consultation process running between November 2011 and January 2012 and comments on the draft preferred options were received and reviewed before finalisation of the preferred options and completion of this StAR. The consulted comments received and responses and/or changes made to the final StAR are documented in Appendix M.

6.1.3 A summary of the appraisal process for each Management Unit within the Study Area is provided in the Appraisal Summary Tables in Appendix U, with a description of the preferred approach and an overall summary of the preferred strategy presented later in this section.

6.1.4 In some Management Areas the preferred technical option was also the preferred environmental option and the preferred economic option, and was deemed to be socially acceptable based on previous consultation exercises. In such cases selection of the preferred option was a clear and obvious decision.

6.1.5 In some other Management Areas there was a difference in preferred option according to technical, economic or environmental criteria and in these cases the role of the StAR was to achieve a best overall outcome.

6.1.6 In some of these cases the preferred option choice was driven by lowest present value (PV) costs, providing that technical performance was still effective and environmental impacts were minimised to acceptable levels.

6.1.7 In some other cases environmental factors (such as amenity impacts or enhancements) dictated that an option other than the lowest PV cost (or most cost-beneficial) was selected. In many of these cases this StAR (a FCERM business case) has identified that FCERM Grant-in-Aid from central government would not be likely (due to low benefit – cost ratios) but in these cases it will be necessary to find additional funding from alternative sources to implement the preferred (environmental) option.

6.1.8 The preferred options for coastal Management Units generally comply with the recommendations of the original Whitby Coastal Strategy and the SMP2, which both generally involve Hold the Line of Defence, where defences are present, through improving the defences as they reach the end of their design lives. Where coastal frontages are currently undefended, there is a general tendency to favour continuation of approaches of allowing the erosion to continue (for environmental reasons) whilst undertaking monitoring and inspection to continually improve understanding of coastal processes operating across the Study Area. There is, therefore, relatively little contention other than, in some areas, identifying the optimum methods to achieve this

aim (e.g. Whitby Harbour piers and extensions) or in identifying how a preferred approach may be implemented due to economic and funding matters, particularly when driven by environmental factors.

6.2 Sensitivity testing

6.2.1 There is uncertainty associated with the process of selecting of the preferred options within some Management Units, related largely to estimates of future coastal erosion and projections of future climate change. In accordance with latest government guidance, we have preferred a Managed Adaptive Approach over a Precautionary Approach in instances where future sea level rise or coastal erosion may necessitate a different future approach. In such instances this provides a means of appropriately and sustainably managing risk in the short and medium term whilst scientific understanding of coastal erosion and climate change improves, enabling a future version of the Whitby Coastal Strategy 2 to re-assess approaches for the longer-term if the updated information demands.

6.2.2 This Managed Adaptive Approach is highly relevant in Management Units 17 and 18 (Whitby West Pier and Whitby East Pier, respectively) where sea level rise may affect estimates of future overtopping discharges.

6.2.3 In addition to the conventional economic appraisal using an optimism bias of 60% of costs, a sensitivity test was performed on the cost estimates at the Whitby Harbour piers and extensions, where the wave climate is known to be severe and could potentially cause cost-over-runs due to adverse marine conditions. For Management Units 17 and 18, the present value cost estimates were therefore also increased using an optimism bias of 135%. Even under this scenario, the benefit – cost ratio in both Management Units was in excess of 5.

6.2.4 It is particularly noticeable that at Whitby West Cliff (Management Units 9 – 12), there is presently no strong economic case for major capital investment from FCERM along most of the frontage. This is because the latest science on coastal erosion rates estimates that even over 100 years, relatively few properties would be lost to erosion. However, if these estimates are under-predicting the erosion that would occur under a Do Nothing scenario, then the economic case would swing in favour of a major capital investment, because if erosion lines were further landward then a large number of properties would become affected by erosion. Ongoing monitoring of this coastline as part of the Cell 1 Regional Coastal Monitoring Programme will help inform future coastal erosion rates and future versions of the Whitby Coastal Strategy 2 will benefit from longer term records that will exist.

6.3 Details of the preferred option

6.3.1 Throughout the Study Area the following approaches are recommended:

- Appropriate control of future development applications in line with current land use planning guidance on flood and erosion risk.
- Responding appropriately to flood warnings in accordance with Emergency Plans when alerted by the Environment Agency via the North East Tidal Flood Forecasting Service.
- Responding appropriately to early warnings in accordance with Emergency Plans when alerted by the instrumentation installed in the coastal slopes at Whitby West Cliff.

- Maintenance of existing coastal defences, quay walls and other maritime structures.
- Maintenance of existing cliff drainage and repair of small scale slips in the coastal slopes.
- Improve warning signage to the public regarding access to slipways, piers and promenades during storm conditions.
- Continue to operate public access gates to prohibit public access to key structures during severe storm conditions (e.g. West Pier extension).
- Analysis of data from the Cell 1 Regional Coastal Monitoring Programme to update understanding of coastal change and coastal processes.
- Maintain awareness of latest climate change science and guidance.
- Review the Whitby Coastal Strategy in line with appropriate timescales
- Where used, ensure that Individual Property Protection measures are renewed at 20 year intervals in order that they remain effective.

6.3.2 In addition, preferred management options have been established for each individual coastal and river Management Unit.

Coastal Frontage

Management Unit 1 – Sandsend Cliffs

6.3.3 The SMP2 policy for this undefended steep cliff frontage is No Active Intervention, but with necessary consideration of the need for works associated with Management Unit 2 to prevent outflanking of defences along that unit. The intent of this policy has been confirmed by the present Whitby Coastal Strategy 2 which recommends its implementation through a preferred option of Do Minimum (option 2).

6.3.4 This will involve no capital works along the frontage, meaning that erosion of the cliffs will continue and therefore measures will be needed to ensure public safety and prevent outflanking, with sections of the Cleveland Way footpath re-aligned as and when necessary. Works to prevent outflanking will then be undertaken in year 20 (assumed date) as part of the capital works in Management Unit 2 (subject to information from inspections and monitoring and future Strategy reviews).

6.3.5 Although Do Minimum does not have a positive benefit – cost ratio, this option is preferred technically and environmentally over Do Nothing so that information is available from monitoring and inspections to provide up to date information on recession rates and enable appropriate measures to be taken to ensure public safety, enable footpath re-alignment, and re-assess the timing of the necessary works to prevent outflanking.

6.3.6 This StAR (FCERM business case) identifies that delivery of this option will need to be funded from sources other than FCERM Grant-in-Aid from central government.

Management Unit 2 – Sandsend Car Park

6.3.7 The SMP2 policy for this defended frontage is Hold the Line. Due to the presently high levels of overtopping at this frontage, combined with concerns about undermining, the preferred option of the Whitby Coastal Strategy 2 is to implement this policy by undertaking a capital scheme in year 20 to construct a new revetment in front of the existing sea wall structure and slipway (option 3). This will necessarily extend marginally into Management Unit 1 in order to prevent outflanking at the western end of the defence. The road bridge across the beck will also need to be replaced, assumed in year 40.

6.3.8 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 3 – Sandsend Frontage

6.3.9 The SMP2 policy for this defended frontage is Hold the Line. The preferred option of the Whitby Coastal Strategy 2 is to achieve delivery of this policy through a combination of warning signs and public education to raise awareness of the risks from wave overtopping, barriers to restrict public access to slipways during overtopping events, and capital works in year 10 to provide initial protection to the toe of existing structures and further capital works in year 40 to provide a new revetment, slipway and partial masonry wall (option 4). This option maximises the life of the existing assets, has the highest benefit – cost ratio and, although not the environmentally preferred option, remains environmentally acceptable.

6.3.10 The strategic appraisal has demonstrated this to be the economically and technically preferred option and is environmentally acceptable. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 4A and 4B – Sandsend Valley

6.3.11 Management Unit 4 has been further sub-divided, with 4A and 4B covering the low-lying valley side slopes of East Row Beck, which are presently protected by masonry walls. The SMP2 policy for this frontage is Hold the Line. The preferred option of the Whitby Coastal Strategy 2 for implementing this policy is to construct new replacement walls, assumed in year 50 (option 3). This approach has a high benefit – cost ratio and is the technically and environmentally preferred option since an approach of Do Minimum would not be sufficient to prevent the walls from failing during the lifetime of the strategy.

6.3.12 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Units 4C, 4D, 5, 6 and 7A – Sandsend Road (A174)

6.3.13 The remaining sections of Management Unit 4, namely MU4C and MU4D, cover the sloping concrete revetment that extends between the beach and the A174 Sandsend Road. This concrete revetment also extends across Management Unit 5. The present condition of the revetment is poor in many places and therefore an option needs to be developed and delivered along this frontage with high urgency. This is compounded by the unstable nature of large sections of the coastal slopes that back the road.

6.3.14 These frontages which are presently defended by the concrete revetment have also been considered in conjunction with Management Unit 6 (the artificial 'fill embankment' that fronts the glacial till slopes and carries the road over the valley of Raithwaite Gill) and the western-most part of Management Unit 7 (now named MU7A; till slopes with now obsolete defences that once protected the former railway) due to issues of potential

outflanking of MU5 if this was not undertaken. The SMP2 policy for the defended frontage along MU4C and MU4D is Hold the Line over the short, medium and long term. For MU5 and MU6 the SMP2 policy is Hold the Line in the short term, with Retreat or Realignment in the medium and longer term, subject to the outcome of further investigations for the potential for re-aligning the A174 Sandsend Road. Along MU7 the SMP2 policy is for No Active Intervention.

6.3.15 During the present study, detailed investigations have been undertaken into various options for this frontage. This includes an option of realigning the A174 Sandsend Road between Dunsley Lane and Cliff Lane to beyond the 100 year erosion line along the top of the coastal slope, and upgrading minor roads (farm roads) between Lythe and the A171 to 'A' class standard to provide an alternative route (see Appendix D, Figure 3). Whilst re-alignment would technically be possible, it would require substantial slope stabilisation works before a new cutting could be made in the coastal slopes to accommodate a new road alignment. This would not be economically viable compared to the option of retaining the road on its present alignment. Similarly, whilst it would be possible to upgrade existing minor roads, there would be economic and social impacts of an unacceptable nature given that a more viable alternative exists. Both options were, therefore, ruled out on technical, economic and environmental grounds, resulting in the preferred option of the Whitby Coastal Strategy 2 being to undertake capital works to both the concrete revetment and the backing coastal slopes, enabling the A174 Sandsend Road to be retained in its present position (option 5). This results in a change in the adopted SMP2 policy for this frontage in epochs 2 and 3 from 'Retreat or Realignment (subject to further investigations of options for the road)' to 'Hold the Line'.

6.3.16 The capital works would need to be extended from MU4C, MU4D and MU5 (where the existing revetment is present) into the adjacent MU6 to provide additional protection to the existing 'fill embankment' that currently protects the road, thereby preventing outflanking of the revetment at its eastern end. Furthermore, to accommodate the juxtaposition between the defended section of coast and the undefended section along the adjacent Whitby Golf Course (Management Unit 7), end detailing would be needed at the western-most end of the undefended section, hence its separation as a new sub-unit MU7A. Also along MU7A, the road starts to divert back inland, away from the coastal margin. At this location there is currently a 'pinch-point' where a short section of road may need to re-aligned locally (as opposed to the larger scale re-alignment of the whole road) should further landslips occur.

6.3.17 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required, particularly from North Yorkshire County Council (highways) as a major beneficiary.

Management Units 7B and 8 – Whitby Golf Course

6.3.18 The SMP2 policy for this undefended frontage is No Active Intervention. The preferred option of the Whitby Coastal Strategy 2 for implementing this policy is Do Minimum (option 2). Although this option does not have a positive benefit – cost ratio, it is preferred over Do Nothing on both technical and environmental grounds so that information is available from monitoring and inspections to provide up to date information on recession rates and sediment yield from eroding cliffs that may ultimately contribute to beaches within Management Units 9-17 along Whitby Sands.

6.3.19 This StAR (FCERM business case) identifies that delivery of this option will need to be funded from sources other than FCERM Grant-in-Aid from central government.

Management Units 9, 10, 11 and 12 – Whitby West Cliff

6.3.20 The SMP2 policy for this defended frontage is Hold the Line, although with consideration given to medium to longer term realignment at the western end of MU9 to ensure outflanking does not occur at the transition between this defended frontage and the adjacent undefended frontage to the west of Upgang Ravine at Whitby Golf Club.

6.3.21 The preferred technical and environmental approach of the Whitby Coastal Strategy 2 along this frontage is for slope stabilisation works to repair small slips in MU10 and MU 12 in year 2, with new coastal defences to be constructed at the end of the residual life of the existing structures, assumed around year 41 for MU 12 and year 61 for MU9, Mu10 and MU11 (option 3).

6.3.22 However, this StAR (FCERM business case) has identified that the benefit – cost ratio for options involving new capital works is insufficient to justify such investment from central government FCERM Grant-in-Aid at the present time.

6.3.23 This is largely due to present estimates of cliff erosion over the 100 year lifespan of the strategy, which just stop short of a large number of cliff top properties. Therefore, if these cliff erosion rates are manifest, then those properties will not be lost to erosion during this time period (even under a Do Nothing option) and therefore it is not economically justifiable to invest, using Flood and Coastal Erosion Risk Management Grant-in-Aid, in new defences over the same time period on this basis.

6.3.24 It should, however, be noted that deterioration in amenity and environmental value that would otherwise arise under a Do Nothing option (or arise in a delayed timeframe under a Do Minimum option) is unacceptable within the context of the Strategic Environmental Appraisal and therefore investment will need to be made from alternative funding sources.

6.3.25 There is considerable uncertainty both in predicting cliff erosion over timescales of 100 years, and in projecting the climate changes, such as sea level rise and increase rainfall, over these timescales. Consequently, as the science of both cliff erosion estimates and climate change projections improves over future decades, so the understanding of the risk to these properties will increase. This will enable future versions of this StAR to be built upon more refined economic appraisals.

6.3.26 Between the present day and the expiry of defence life, maintenance of the coastal defences and slope stabilisation works should be undertaken to maximise the benefit from the capital scheme that was constructed along much of the frontage between 1988 and 1990. Indeed, it is particularly important to maximising the longevity of the coastal defences along this section that maintenance of the backing coastal slopes is undertaken on a regular basis, so that drains are cleared and shallow slips are treated. This will prevent larger scale slips from developing at subsequent dates that may otherwise compromise the coastal defences at their toe.

Management Unit 13 – Whitby Spa Pavilion

6.3.27 The SMP2 policy for this defended frontage is Hold the Line. The Whitby Coastal Strategy 2 has identified that due to the high economic value of the Spa Pavilion, it is justifiable to invest in a capital scheme to construct a new concrete sea wall, with a rock armour toe below beach level, and with some associated slope stabilisation and rock

face works (option 3). This investment is not required until the existing defence comes to the end of its design life, assumed to be year 20. As this is part of the amenity beach, this option is preferred on environmental grounds over alternative options, such as construction of a rock revetment at the toe of the existing defence to prolong its life expectancy.

6.3.28 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 14 – West Cliff Blockwork Wall

6.3.29 The SMP2 policy for this defended frontage is Hold the Line. The preferred technical and environmental option is to invest in a capital scheme to construct a new blockwork wall when the present defence comes to the end of its life, assumed year 50 (option 3). Although this is not the most economically advantageous option it is identified as the preferred option of the Whitby Coastal Strategy 2.

6.3.30 This StAR (FCERM business case) has identified that the benefit – cost ratio for new capital works is insufficient to justify such investment from central government FCERM Grant-in-Aid at the present time and therefore alternative funding sources will need to be sought.

Management Unit 15 – West Cliff Rock Outcrop

6.3.31 The SMP2 policy for this undefended frontage is Hold the Line. The preferred option of the Whitby Coastal Strategy 2 for implementing this policy is Do Minimum (option 2). Although this option does not have a positive benefit – cost ratio, it is preferred on technical and environmental grounds over Do Nothing so that information is available from monitoring and inspections to provide up to date information on recession rates and associated risks.

6.3.32 This StAR (FCERM business case) identifies that delivery of this option will need to be funded from sources other than FCERM Grant-in-Aid from central government.

Management Unit 16 – Battery Wall

6.3.33 The SMP2 policy for this defended frontage is Hold the Line. The preferred option of the Whitby Coastal Strategy 2 for implementing this policy is major refurbishment of the existing Grade II listed sandstone seawall as it comes to the end of its effective life in year 50 (option 3). As this is part of the amenity beach, this option is preferred on environmental grounds over alternative options, such as construction of a rock revetment at the toe of the existing defence to prolong its life expectancy or replacement of the wall with a modern structure. It is also economically viable due to the damages that would occur if a Do Nothing or Do Minimum option was otherwise selected. In addition, a flood gate should be constructed in Year 2 along the boat slipway to reduce the risk of flooding due to wave run-up.

6.3.34 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as

measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 17 – West Pier (A) and Extension (B)

6.3.35 The SMP2 policy for this defended frontage is Hold the Line. From technical, environmental, social and economic viewpoints, this policy is fully endorsed as part of the Whitby Coastal Strategy 2 since the structures have such a strategic role in managing erosion and flooding risks, as well as supporting many other significant benefits across the Study Area. There is also a strong case for the works to be undertaken as a high priority. For the main West Pier (MU17A), the preferred approach is to improve the condition of the structure using sheet piles, with grouting and re-pointing, and managing the public safety aspects of the overtopping risk through an access gate. This is preferred to an alternative option of using rock armour due to the amenity value of the Whitby Sands and the heritage value of the Grade II listed West Pier. This work needs to be undertaken with some urgency. For the extension (MU17B) the preferred approach is to improve the condition of the structure using sheet piles with backfill, and manage the overtopping performance using an existing access gate (at the landward end of the extension) and a new access gate (at the landward end of the main pier) to reduce risks to pedestrians and adopt an approach of maintenance and repairs through the whole life of the structure to address any overtopping damage to the structure. This has been included in the whole life costing of the option and is preferred over the use of rock armour due to the environmental impacts that would be associated with its visibility from an amenity beach to the west of the harbour at times of low water (see the option visualisation for the West Pier extension as shown in Appendix F) The initial capital works on the extension are not likely to be required until around Year 20 (subject to ongoing monitoring). The preferred option is, therefore, option 3b.

6.3.36 The strategic appraisal has demonstrated this to be the (joint) economically preferred option and is environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 18 – East Pier (A) and Extension (B)

6.3.37 The SMP2 policy for this defended frontage is Hold the Line. Similar to the West Pier, this policy is fully endorsed due to the strategic importance of the structures across the Study Area. There is also a strong case for the works to be undertaken as a very high priority. For the main East Pier (MU18A), the preferred approach of the Whitby Coastal Strategy 2 is to improve the condition of the structure using sheet piles, with grouting and re-pointing, and managing the public safety aspects of the overtopping risk through an access gate. This is presently preferred over a rock revetment because despite rock armour providing stability and protection to the highly exposed outer face of the structure and therefore increasing the longevity of the capital refurbishment, there would also be some undesirable impact on the heritage status of the East Pier and on the SSSI foreshore to its immediate east. This work needs to be undertaken with some urgency. For the extension (MU18B) the preferred approach is to improve the condition of the structure using sheet piles with backfill, and managing the risk of structural damage from overtopping using rock armour on the outer face. This is preferred on a technical basis because the East Pier extension is the most directly exposed to wave action of all the harbour structures and the rock armour will help extend the longevity of repairs. Environmentally, the rock armour is acceptable since it is not observable from the amenity beaches (located west of the harbour) at times of low tides (see the option visualisation for the East Pier extension as shown in Appendix F). The capital works on the extension are not likely to be required until around Year 20 (subject to ongoing

monitoring). At this time detailed design consideration would be given to the type of rock (granite is most likely as it is more durable and robust than alternative engineering materials, such as sandstone) and to the size of the rock so as to ensure it remains in place during storm conditions and does not move to other areas of the sea bed where it may present a hazard to navigation. The preferred option is, therefore, option 3b.

6.3.38 The strategic appraisal has demonstrated this to be the (joint) economically preferred option and is also technically preferred and environmentally acceptable. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 19 – Haggerlythe

6.3.39 The SMP2 policy for this defended frontage is Hold the Line. The preferred approach of the Whitby Coastal Strategy 2 is to deliver this policy through slope stabilisation works and a new capital scheme to install a formal rock revetment structure (option 3), with a strong case for the works to be undertaken as a medium priority due to the ongoing erosion above the loosely placed rock that presently exists. There is economic justification to deliver this option to prevent landslips from occurring and affecting the properties that back the frontage.

6.3.40 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Management Unit 20 – Abbey Cliff

6.3.41 The SMP2 policy for this defended frontage is Hold the Line. The preferred approach of the Whitby Coastal Strategy 2 to deliver this is through an option of Do Minimum (option 2). Ongoing maintenance of the rock revetment, involving replacement of any displaced armourstone, will ensure the structure has a life that extends across a 100 year time horizon.

6.3.42 This StAR (FCERM business case) identifies that delivery of this option will need to be funded from sources other than FCERM Grant-in-Aid from central government.

River Frontage

Flood Cell 1 (RE1 & RE2) – Rowing Club, Museum

6.3.43 The preferred approach of the Whitby Coastal Strategy 2 is to manage the risks in this flood cell through the use of individual property protection (IPP) with capital refurbishment or replacement of the quay walls (option 5). This is the most economically viable approach, however the technical efficacy of IPP, and hence its delivery of economic benefits, is critically dependent on the IPP being renewed every 20 years in order that it remains an effective means of protection. The costs of this renewal have been considered in the whole life costs of the options.

6.3.44 The strategic appraisal has demonstrated this to be the economically preferred option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in

support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. It is anticipated that contributory funding will be required.

Flood Cell 2 (RE4 - RE7) – The Dolphin, The Fleece, Church Street, Eskside Wharf

6.3.45 The preferred approach of the Whitby Coastal Strategy 2 is to manage the risks in this flood cell through the implementation of a capital flood alleviation scheme consisting of a combination of floodwalls and floodgates (option 3). The scheme would have a 100 year design life.

6.3.46 Although this option does not have the highest benefit – cost ratio (that is Do Minimum) it still has a B-C ratio over 8.8 and due to its incremental benefit-cost ratio being greater than 5 it is the preferred approach. This option also provides for quay wall replacement at the end of the effective life of the structures, rather than allowing failure which would be environmentally unacceptable.

6.3.47 The strategic appraisal has demonstrated this to be economically viable option and is technically and environmentally preferred also. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications, but funding may be needed to cover the difference between the economically preferred option costs and the overall (environmentally-driven) preferred option costs, with contributions also likely needing to be sought.

Flood Cell 3 (RE8 & RE9) – Chelsea, Hackney

6.3.48 The preferred approach of the Whitby Coastal Strategy 2 is to maintain the existing quay walls through to the end of their effective life and then undertake a capital scheme to refurbish or replace them, along with IPP to individual properties (option 5).

6.3.49 This StAR (FCERM business case) has identified that capital investment in the quay walls is not sufficiently economically viable to warrant FCERM Grant-in-Aid from central government, and therefore alternative funding sources must be sought to deliver this option.

Flood Cell 4 (RW4 - RW9) – NW Bank, Angel, New Quay, Endeavour Wharf, Marina, Chandlers

6.3.50 The preferred approach of the Whitby Coastal Strategy 2 is to manage the risks in this flood cell through the use of individual property protection (IPP) with capital refurbishment or replacement of the quay walls (option 5). The technical efficacy of IPP, and hence its delivery of economic benefits, is critically dependent on the IPP being renewed every 20 years. The costs of this renewal have been considered in the whole life costs of the options.

6.3.51 The strategic appraisal has demonstrated this option has the highest benefit – cost ratio, but this is just over unity. This StAR (FCERM business case) identifies that eligibility for FCERM Grant-in-Aid from central government in support of the capital costs will be determined through delivery of outcomes (as measured through Environment Agency Outcome Measures) that are current at the time of funding applications. Given the marginal economic benefit, contributory funding would significantly assist with delivery of this option.

Flood Cell 5 (RW1 & RW2) – Fish Market, Marine Parade & St Anne's Staithe

6.3.52 The preferred approach of the Whitby Coastal Strategy 2 is to maintain the existing quay walls through to the end of their effective life and then undertake a capital scheme to refurbish or replace them (option 3). No flood defence measures are required.

6.3.53 This StAR (FCERM business case) has identified that capital investment in the quay walls is not sufficiently economically viable to warrant FECRM Grant-in-Aid from central government, and therefore alternative funding sources must be sought to deliver this option.

Management Units RE3 & RW3 – Swing Bridge

6.3.54 There is a strong environmental case for ensuring that other structures at the abutments to the Swing Bridge are maintained and refurbished or replaced when they reach the end of their design life. No flood defence measures are required.

6.3.55 Whilst this is the preferred option (option 3), this StAR (FCERM business case) has identified that capital investment in the quay walls is not sufficiently economically viable (in FCERM terms) to warrant FCERM Grant-in-Aid from central government, and therefore alternative funding sources must be sought to deliver this option.

Strategic Environmental Appraisal of Preferred Options

6.3.56 The main potential environmental effects of the Strategy, as identified through the SEA process are summarised below. Receptors where no significant effects have been identified have been omitted.

Population and Human Health

6.3.57 Strategy will continue to manage coastal erosion and sea flooding risk to populations and human health by ensuring a strategic approach is taken to protect centres of population and businesses from increased coastal erosion and flood risk, in the face of a changing climate. Furthermore, the Strategy aims to prevent and reduce current overtopping and slope instability issues. Over 820 properties (both residential and commercial) will benefit from coastal erosion and flood risk management over the lifetime of the Strategy. Whist the flood resilience measures proposed for Whitby Harbour will improve protection of the properties, flooding of the town will still occur, resulting in damage.

6.3.58 The Strategy will have a major beneficial effect on tourism and recreational resources, through the improved protection of Sandsend car park, Whitby promenade and Whitby town centre, and through the slope stabilisation works proposed from Upgang to Whitby. The Strategy will also ensure the protection of the Cleveland Way National Trail and improve / increase access to the coast wherever possible. The predicted flooding of Whitby will negatively affect the tourism and recreational potential of the town.

Biodiversity, fauna and flora

6.3.59 In general, the Strategy will maintain the current extents of the terrestrial SINCs and BAP habitats present along the coastal frontage, in addition to providing protection to River Esk SINC and the mudflat and saltmarsh BAP habitats present within the harbour.

6.3.60 SINC and BAP habitat will be lost as a result of the realignment of the Cleveland Way, to the immediate west of Sandsend, by continuing the defence across Raithwaite Gill and from the managed realignment of the frontage at Upgang. Stabilisation of the coastal slope will prevent the natural development of Maritime Cliff and Slope BAP habitat;

however, as the slope has been artificially stabilised in the past, this effect is considered to be neutral. Continued consultation should be undertaken with Natural England, the Environment Agency and the County Ecologist to ensure that the coastal slopes are suitably restored and enhanced, where possible. It is recommended that a monitoring programme is established to ensure that the slope restoration works have been successful.

Landscape and seascape

6.3.61 Overall the Strategy is considered to have a positive effect on the landscape and seascape character and North Yorkshire and Cleveland Heritage Coast designation of the Sandsend to Whitby frontage and Whitby townscape, due to the slope stabilisation and restoration works. The preferred options to manage overtopping will improve the tourism and recreational potential of the frontage, which is an important element of the landscape / seascape; however, the predicted flooding of Whitby will have an adverse effect on the townscape character.

6.3.62 The preferred option to continue the defences across Raithwaite Gill and part of the golf course is considered to have a minor adverse effect on the local landscape / seascape character by reducing its complexity; whilst the managed realignment of the frontage at Upgang is considered to benefit the local character by providing a more natural form to the coastal frontage.

Historic Environment

6.3.63 Hold the Line options will either maintain or improve the standard of protection of the Listed Buildings, Conservation Areas and Registered Parks and Gardens along the Strategy's coastal frontage. The draft preferred options for the harbour will, in general, improve the protection to the historic assets present; however, the predicted flooding could still cause damage to, in particular, Listed Buildings and the Conservation Area as a whole.

6.3.64 The proposed options to prevent coastal erosion at Sandsend will consider the potential to physically impinge upon the Scheduled Monuments of Sandsend Alum House and Quarry, and the potential to affect the settings of all other designated Historic Assets on a temporary or permanent basis. Due consideration will also be awarded to all other undesignated Historic Assets and appropriate mitigation measures to effect their preservation in situ, or by record, proposed as a routine element of any option design scheme.

6.4 Summary of preferred strategy

6.4.1 A summary of the preferred Strategy options for each Management Unit is provided in Table 6.1. This also shows the proposed year of construction for any required capital works, together with the whole life (100 year) cash costs required to deliver the option. The coloured rows in the table refer to the legend below which indicates where funding will likely be required to implement the preferred options. For those schemes highlighted as 'FCERM eligible', the delivery of specific outcomes (as measured through Environment Agency Outcome Measures) will help determine the maximum level of FCERM Grant-in-Aid, and hence help determine the minimum level of third party contributory funding that will be required. Information on this for all capital schemes which achieve a Benefit:Cost ratio greater than unity is presented in Appendix I.

Table legend:

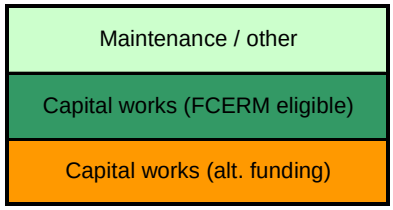

Table footnotes:

* No Active Intervention (while investigating outflanking at interface between defended and undefended frontages).

** Hold the Line (while investigating medium and long term options for road re-alignment).

^ originally part of MU7 but now sub-divided as a new Management Unit at the interface between defended and undefended sections to prevent outflanking.

*** Hold the Line (while investigating re-alignment at western end top prevent outflanking at transition between undefended and defended frontages).

Table 6.1 Preferred Strategy Options

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£k)		
						Total	Capital	Mainten-ance/Other			Total	Capital	Mainten-ance/Other
1	Sandsend Cliffs	NAI *	(2) Do Minimum - cliff erosion will continue - need to re-align Cleveland Way; undertake inspections; prevent outflanking at interface with MU2; ensure public safety.	Works to prevent outflanking incorporated as part of MU2. Works could affect SINC and BAP habitats. Loss of archaeological features through natural erosion.	-	117	0	117	0	0.00	406	0	406
2	Sandsend Car Park	HTL	(3) New Revetment - built in front of sea wall and slipway. Works to prevent outflanking at interface with undefended MU1. Replace road bridge over beck.	Revetment and outflanking works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Potential to affect landscape / seascape and Conservation Area character, and Heritage Coast. Works have potential to affect SAM.	Yr 20 (revetment); Yr 40 (road bridge)	1,034	796	237	7,240	7.00	2,587	1,972	614
3	Sandsend Frontage	HTL	(4) Warning signs, barriers on slipways, toe protection and future rock revetment, slipway and masonry wall	Maximised life of existing assets whilst managing overtopping risk, enabling future capital scheme to address structural condition and overtopping performance. Works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Potential to affect landscape / seascape and Conservation Area character.	Yr 10 (toe protection); Yr 40 (revetment)	1,501	1,031	469	27,978	18.64	4,667	3,601	1,067
4AB	Sandsend Valley	HTL	(3) Replace Walls	Revetment and outflanking works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works need to consider Conservation Area.	Yr 50	102	39	63	24,964	244.75	406	199	207
4CD	Sandsend Valley	HTL	(5) Protect A174 and Slope Stabilisation - capital works to sloping concrete revetment and stabilisation of backing slope.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought, particularly from North Yorkshire County Council). Works will affect SINC and BAP habitat. Potential to improve beach assess. Loss of a small area of agricultural land.	**HIGH PRIORITY** Yr 1	**3,602**	**3,408**	**193**	**17,687**	**4.91**	4,046	3,528	518
5	Sandsend Road A174 (Concrete Apron)	HTL **			**HIGH PRIORITY** Yr 1	**7,432**	**7,054**	**378**	**54,746**	**7.37**	8,605	7,301	1,304
6	Sandsend Road A174 (Embankment/Culvert)	HTL **			**HIGH PRIORITY** Yr 1	**1,333**	**1,251**	**83**	**8,841**	**6.63**	1,587	1,294	293
7A ^	Golf Course West	NAI	(5) Protect A174 and Slope Stabilisation - End detail to prevent outflanking in adjacent undefended frontage. Minor re-alignment of the road locally at a 'pinch point' *may* be required.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought, particularly from North Yorkshire County Council). Works will affect SINC and BAP habitat, landscape / seascape character and Heritage Coast.	**HIGH PRIORITY** Yr 1	**1,594**	**1,509**	**84**	**20,135**	**12.63**	2,355	2,064	291
7B	Golf Course West	NAI	(2) Do Minimum	Inspection to ensure public safety and provide information on erosion rates and mechanisms	-	80	0	80	0	0.00	278	0	278
8	Golf Course East	NAI			-	114	0	114	0	0.00	395	0	395
9	West Cliff (West)	HTL ***	(3) New Defences - maintain to end of design life, then refurbish or construct new defences as capital works	Maintain assets (defences and slopes) to end of residual life. Capital works likely to need alternative funding (depending on erosion rates and climate change) to prevent deterioration of amenity facilities (e.g. promenade) and environmental character of the frontage.	Yr 61	1,171	739	432	357	0.30	6,387	5,032	1,355
10	West Cliff (Seawall)	HTL			Yr 2 (slope) Yr 61 (defence)	1,318	858	460	94	0.07	2,806	1,449	1,357
11	West Cliff (East)	HTL			Yr 62	736	308	428	166	0.23	3,403	2,094	1,309
12	West Cliff Metropole	HTL			Yr 2 (slope) Yr 41 (defence)	2,208	1,652	556	592	0.27	7,296	5,868	1,428

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£)		
						Total	Capital	Mainten-ance/Other			Total	Capital	Mainten-ance/Other
13	West Cliff Spa	HTL	(3) New Defences and Slope Stabilisation	Maintain assets (defences and slopes) to end of residual life. Capital works to refurbish or construct new sea wall and rock armour toe. Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought.	Yr 20	1,176	845	331	4,387	3.73	2,574	1,677	897
14	West Cliff Blockwork Wall	HTL	(3) Replacement Blockwork Wall	Maintain assets (defences and slopes) to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. promenade) and environmental character of the frontage.	Yr 50	582	207	375	113	0.19	2,248	1,074	1,174
15	West Cliff Rock Outcrop	HTL	(2) Do Minimum	Inspection to ensure public safety and provide information on erosion rates and mechanisms.	-	114	0	114	0	0.00	395	0	395
16	Battery Wall	HTL	(3) Flood Gate and Wall Refurbishment	Maintain assets to end of residual life. Capital works to refurbish Battery Wall eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought. Asset is Grade II.	Yr 2 (flood gate) Yr 50 (wall refurbishment)	618	391	227	2,382	3.85	1,693	1,052	641
17	Harbour West Pier	HTL	(3b) Capital works to refurbish main piers and extensions. Overtopping performance managed by public access gates and a programme of maintenance and repairs.	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have potential to affect SINC and BAP habitats, and SSSI. Main piers are listed structures.	**HIGH PRIORITY** Yr 3 and 4 Followed by Yrs 21 and 71	**8,195**	**7,824**	**371**	**64,626**	**7.89**	16,478	15,481	997
18	Harbour East Pier	HTL	(3b) Capital works to refurbish main piers and extensions. Rock armour to limit overtopping on extensions, with public access gates on main piers.		**HIGH PRIORITY** Yr 3 and 4 Followed by Yrs 21 and 71	**7,971**	**7,600**	**371**	**61,647**	**7.73**	15,275	14,278	997
19	Haggerlythe	HTL	(3) New Revetment & Slope Stabilisation - built to replace the present informal revetment comprised of loosely placed rocks	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have potential to affect SINC and BAP habitats.	**MEDIUM PRIORITY** Yr 2 (slope) Yr 5 (revetment)	**1,394**	**1,079**	**316**	**2,895**	**2.08**	2,614	1,246	1,368
20	Abbey Cliffs	HTL	(2) Do Minimum	Maintenance of rock revetment. Inspection of cliffs to ensure public safety and provide information on erosion rates and mechanisms.	-	414	0	414	967	2.34	1,803	0	1,803

Management Unit or Flood Cell		SMP Policy	Preferred Strategy Option	Comments	Proposed Year(s) of Capital Works	Whole Life (100 yrs) Present Value Costs (£k)			Present Value Benefits (£k)	Average Benefit/Cost Ratio	Whole Life (100 yrs) Cash Costs (£)		
						Total	Capital	Maintenance/Other			Total	Capital	Maintenance/Other
FC1	Rowing Club, Museum	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought). Works have the potential to affect Listed Buildings, Conservation Area setting SINC and BAP habitats.	Yrs 5 (IPP), 20 and 31	1,054	783	271	2,000	1.90	2,960	2,016	944
FC2	The Dolphin, The Fleece, Church Street, Eskside Wharf	-	(3) Capital flood alleviation scheme (floodwalls) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (funding contributions will need to be sought)	Yrs 3 (Flood Scheme), 31 and 70	3,194	2,442	751	28,265	8.85	7,541	5,521	2,019
FC3	Chelsea, Hackney	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. harbour side) and environmental character of the frontage. Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 5 (IPP) 31	627	377	250	313	0.50	1,955	1,062	893
FC4	NW Bank, Angel, New Quay, Endeavour Wharf, Marina, Chandlers	-	(5) IPP (renewed every 20 yrs) + capital works to quay walls	Capital works eligible for consideration of FCERM Grant-in-Aid (significant funding contributions will need to be sought as B-C ratio is only just over unity). Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 5 (IPP), 20, 21, 40, 51, 70 and 90	3,704	2,777	927	3,360	0.91	10,768	8,453	2,315
FC5	Fish Market, Marine Parade & St Anne's Staithe	-	(3) Capital scheme for harbour quay walls	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. harbour side) and environmental character of the frontage. Works have the potential to affect Listed Buildings, Conservation Area character, SINC and BAP habitats.	Yrs 31 and 41	1,406	1,156	250	1,044	0.74	4,942	4,049	893
RE3-RW3	Swing Bridge	-	(3) Capital scheme for harbour quay walls at bridge abutments	Maintain quay walls to end of residual life. Capital works likely to need alternative funding to prevent deterioration of amenity facilities (e.g. bridge abutments) and environmental character of the frontage. Works have the potential to affect Conservation Area character, SINC and BAP habitats.	Yrs 50 and 51	480	58	422	1	0.00	1,805	302	1,503

7 Implementation

7.1 Project planning

Phasing and approach

7.1.1 Start writing here The preferred options presented in the Whitby Coastal Strategy 2 to manage risks to people and the developed, natural and historic environments from coastal erosion, slope instability and sea flooding fall into one of three categories:

(1) Use of revenue budgets to maintain existing coastal defences, harbour piers, quay walls, cliffs and coastal slopes (including cliff drainage and repairs to shallow slips) and manage risks to public safety from cliff erosion and wave overtopping. This will primarily be funded by revenue budgets of Scarborough Borough Council, North Yorkshire County Council, Whitby Town Council and Whitby Harbour Board.

(2) Applications to central government for FCERM Grant-in-Aid of the capital costs of major refurbishments or construction of new or replacement defences where such works are necessarily for managing flood and erosion risks in accordance with existing Appraisal Guidance. This StAR is part of this process, seeking approval of the envisaged long term FCERM capital expenditure over the next 100 years and providing the overarching strategy that will enable individual Project Appraisal Reports (PARs) to be developed and submitted for consideration for FCERM Grant-in-Aid of the capital costs of schemes. Such applications will be supported by efforts to seek contributory funding from appropriate potential sources in line with outputs from the FCERM Grant in Aid (GiA) Calculator (see Appendix I).

(3) Applications to alternative (i.e. non-FCERM) funding sources for support in respect of the capital costs of major refurbishments or construction of new or replacement defences where driven by environmental (including amenity and heritage) aspects. A review of presently available potential alternative funding mechanisms is provided in Appendix V.

7.1.2 The Whitby Coastal Strategy 2 has identified the following as key priorities over the next five financial years (2012/13 – 2017/18):

- A capital scheme is needed with high priority across Management Units 4(CD) to 7(A) (Sandsend Road) to address issues of coastal erosion and slope instability.
- A capital scheme is needed with high priority at Management Units 17 and 18 (Whitby Harbour piers and extensions) to address issues of poor structural condition and, for the East Pier pier extension, poor overtopping performance.
- A capital scheme is needed with high priority at Flood Cell 2 to implement a flood alleviation scheme consisting of floodwalls and floodgates to reduce the consequences of tidal flooding.
- A capital scheme is needed with medium priority at Management Unit 19 (Haggerlythe) to address issues of coastal erosion and slope instability.
- A capital scheme is needed at Flood Cells 1and 4 to install individual property protection (IPP) to reduce the consequences of tidal flooding.
- A capital scheme is needed in Management Unit 16 (Battery Wall) to install a flood gate to address issues of local flooding due to wave run up along the boat slipway.
- Revenue budgets need to be used to clear blocked drains and repair shallow slips in Management Units 10 and 12.

- Revenue budgets need to be used to regularly undertake visual inspections of coastal defences, cliffs and coastal slopes, quay walls and other marine structures and rectify any defects that are noted, including clearing blocked drains and repairs to shallow slips in the coastal slopes.

7.1.3 The StAR has demonstrated that the above capital schemes are all eligible for consideration of FCERM Grant-in-Aid, although in all cases funding contributions will need to be sought in line with present Environment Agency procedures (see Appendix I). As individual Project Appraisal Reports are prepared for each capital scheme, consideration should be given to potential contributory funding from the main beneficiaries of the works, who are Scarborough Borough Council, North Yorkshire County Council, Whitby Town Council, Whitby Harbour Board, Environment Agency (non-FCERM budgets), English Heritage and Yorkshire Water.

7.1.4 The capital schemes that will require alternative (i.e. non-FCERM) funding sources are planned to be implemented in the medium or longer term, providing sufficient time for alternative funding to be sought if the process is commenced sufficiently early. The earliest such works will be required to sections of the quay walls within the harbour (starting in around Year 30), but many of the major investments will be needed in future decades, such as Years 40 and beyond. Potential alternative funding mechanisms that are current are reviewed in Appendix V, but many of these will change over time and therefore we will keep this review up to date at appropriate intervals.

7.1.5 The projected cash expenditure profile for capital costs (FCERM-eligible) and non-capital costs over the next 5 years are provided in Table 7.1 to inform Medium Term Planning. This has been based on the categorisation of schemes arising from Section 6 of this StAR.

Table 7.1 Projected cash expenditure profile on capital projects

Cash* Expenditure Profile (£k)	Year						Total	First 5 Years
	2012/13	2013/14	2014/15	2015/16	2016/17	Future		
Eligible FCERM Capital Costs**	£420	£12,331	£1,243	£4,418	£5,423	£43,429	£67,263	£23,835
Non-eligible FCERM Capital Costs***	£348	£70	£1,124		£86	£19,282	£20,911	£1,629
TOTAL	**£768**	**£12,401**	**£2,367**	**£4,418**	**£5,509**	**£62,711**	**£88,174**	**£25,463**

Notes:
* Cash costs including Optimism Bias
** Capital works incl. design, surveys (e.g. SI) and construction
*** Non-capital works incl. emergency works, preventative repairs, and 10 yearly Strategy reviews

7.1.6 The prioritisation and expenditure profile for FCERM capital schemes arising from the Whitby Coastal Strategy 2 over the next 100 years is provided in Appendix I. The programme for delivery is provided in Appendix J.

Outcome measures contributions

7.1.7 Capital schemes with a benefit-cost ratio above unity from the preferred options of the Whitby Coastal Strategy 2 have been put through the Flood Defence Grant in Aid (FDGiA) calculator to determine the outcome measures and FDGiA contribution these schemes would attract. The outcome measures are presented in Table 7.2 for each of the first five years of the Strategy and the future years. The outcome measures for the capital schemes have been allocated to the year the construction of the scheme would be complete, the management units that contribute to each year are listed below the table. A full breakdown of the FDGiA calculation for each management unit that has a preferred option of a capital scheme with a benefit-cost ratio of greater than 1 can be found in Appendix I.

Table 7.2 Medium term outcome measures contributions

		OM1 (Economic Benefit)	OM2 (Households better protected against flooding)			OM3 (Households better protected against coastal erosion)			OM4 (Statutory Environmental Obligations Met)	TOTAL FDGiA Contribution (£k)	Raw OM Score	Cost saving and/or external contribution required (£k)
			20% most deprived areas	21-40% most deprived areas	60% least deprived areas	20% most deprived areas	21-40% most deprived areas	60% least deprived areas				
2012/2013	Number									£0		£0
	Qualifying Benefits (£k)											
	FDGiA Contribution (£k)											
2013/2014	Number							10		£5,685	40.72%	£8,275
	Qualifying Benefits (£k)	£101,056						£353				
	FDGiA Contribution (£k)	£5,614						£71				
2014/2015	Number			54						£795	75.28%	£261
	Qualifying Benefits (£k)	£4,266		£1,859								
	FDGiA Contribution (£k)	£237		£558								
2015/2016	Number									£0		£0
	Qualifying Benefits (£k)											
	FDGiA Contribution (£k)											
2016/2017	Number			41		162	140	129		£5,971	60.15%	£3,984
	Qualifying Benefits (£k)	£49,659		£397		£2,917	£4,135	£2,518				
	FDGiA Contribution (£k)	£2,786		£127		£1,313	£1,241	£504				
Future Years	Number							62		£3,695	135.75%	£1,239
	Qualifying Benefits (£k)	£59,719						£1,887				
	FDGiA Contribution (£k)	£3,318						£377				
TOTAL	**Number**		**0**	**95**	**0**	**162**	**140**	**201**		**£16,146**	**58.36%**	**£13,759**
	Qualifying Benefits (£k)	**£214,700**	**£0**	**£2,256**	**£0**	**£2,917**	**£4,135**	**£4,758**	**£0**			
	FDGiA Contribution (£k)	**£11,955**	**£0**	**£685**	**£0**	**£1,313**	**£1,241**	**£952**	**£0**			

Note: Management Units w hich contribute to Outcome Measures:
2013/2014: MU4CD-7A
2014/2015: FC2
2016/2017: MU17&18, MU19, FC1, FC3, & FC4
Future Years: MU2, MU3, MU4AB, MU13, MU16

7.1.8 Over the 100 year life of the Strategy the capital schemes would benefit 95 households at risk of flooding and 503 households at risk of coastal erosion. These schemes would attract £16,146k of FDGiA funding towards the total present value cost of £27,665k, this gives a raw Outcome Measure score of 58%. External contributions (or cost savings) in the region of £13.8M would need to be secured over the lifetime of the Strategy to enable the schemes to go ahead.

7.2 Procurement strategy

7.2.1 The procurement of Consultant services to develop Project Appraisal Reports for schemes arising from the Whitby Coastal Strategy 2 will be through the YorConsult Framework, which covers the Yorkshire and Humber region and includes specialist services under a 'Coastal Lot'.

7.2.2 The procurement of Contractors to design and construct schemes arising from the Project Appraisal Reports will be through the YorCivils Framework, which covers the Yorkshire and Humber region.

7.2.3 Our [Scarborough Borough Council] procurement philosophy and approach is described in more detail in Appendix R. This entails a partnership approach based upon the principles of Latham's Constructing the Team and Egan's Rethinking Construction reports, as enshrined in the philosophy of the New Engineering Contract. Consultants will be procured via the YorConsult Framework and Contractors from the YorCivils Framework, both of which are open to all Local Authorities operating across the Yorkshire and Humber Regions. Where appropriate, we will adopt Early Contractor Involvement (ECI) and tend to favour Design and Build contracts so that lines of liability are clearly defined between the Client and Designer/Contractor.

7.3 Delivery risks

7.3.1 The risks to delivery of the preferred options recommended in the Whitby Coastal Strategy 2 together with proposed risk management activities, are shown in Table 7.3.

Table 7.3 Principal delivery risks and risk management

Delivery Risk		Risk Management
1	Non-approval or delayed approval of the business case and recommendations presented in this StAR by the Environment Agency's Large Projects Review Group (LPRG)	▪ Early discussion with LPRG regarding the 'lite-touch' approach to the StAR, leading to development of prioritised PARs in areas of highest priority. ▪ Involvement on the Project Steering Group (PSG) of Environment Agency representation throughout the development of *Whitby Coastal Strategy 2*. ▪ Completion of the StAR in accordance with latest Environment Agency procedures and guidance.
2	Non-approval or delayed approval of the business case and recommendations presented in subsequent Project Appraisal Reports by the Environment Agency's Regional Project Approvals Board (PAB)	▪ Involvement on the Project Steering Group of Environment Agency representation throughout the development of *Whitby Coastal Strategy 2* and subsequent PARs. ▪ Completion of the PARs in accordance with latest Environment Agency procedures and guidance.
3	Need for funding contributions in addition to FCERM Grant-in-Aid to deliver capital schemes	▪ Early discussions with potential contributory funders of the high priority schemes during development of *Whitby Coastal Strategy 2*. ▪ Further development of agreements and budgets during preparation of subsequent PARs.
4	Objection from statutory bodies to Strategy	▪ Engagement with statutory bodies throughout the development of the *Whitby Coastal Strategy 2*, both informally as members of the PSG and formally through the SEA process. ▪ Comfort Letter from Natural England to be provided.
5	Lack of public acceptance of the proposed solutions	▪ 3 month period of public consultation on the] preferred options, including a public 'open day' drop-in surgery
6	Deterioration or failure of defences before schemes are implemented	▪ Inspection and maintenance/repair of storm damage
7	Deterioration or failure of coastal slopes before schemes are implemented	▪ Inspection and maintenance/repair of shallow slips and blocked drains
8	Need for alternative funding sources to deliver some (medium and longer term) capital schemes and meet whole life non-capital commitments	▪ Investigate alternative funding sources through a review of potential alternative mechanisms and potential contributory funders ('beneficiary pays' principle) ▪ Long term budgetary planning for increased future capital budgets from alternative funding sources.
9	Need for revenue funding to repair shallow slips in MU10 and MU12 in the short term to ensure they do not develop into large slippages in the coastal slopes	▪ Internal budgetary provisions to repair shallow slips in MU10 and MU12.
10	Changes in erosion, overtopping or flooding risks are greater or quicker than projected	▪ Changes in risks, and the best options to manage them, to be considered in future reviews of the Whitby Coastal Strategy based on latest available climate change science and better informed estimates of coastal erosion rates due to longer term monitoring data.

7.4 Recommendation

7.4.1 The recommended strategy for managing the risks to people and the developed, natural and historic environment from coastal erosion, slope instability and sea flooding is to deliver the series of actions identified as preferred options in Table 8 of this StAR.

7.4.2 The whole life cash cost of the capital investment, including optimism bias of 60%, is £84million, of which £64million is considered eligible for consideration of FCERM Grant-in-Aid under present funding regimes and £20million will require alternative funding sources.

7.4.3 The strategy is recommended for Approval in Principle for FCERM-eligible capital expenditure of £23.8million, including optimism bias of 60%, over the first five years.