Project Appraisal Report

Authority scheme reference	
Defra/WAG LDW number	
Promoting authority	North Yorkshire County Council
Scheme name	Sandsend Road Coast Protection & Slope Stabilisation Scheme

Existing revetment at Sandsend, September 2011

Date	May 2012
Version	1

PAR for Sandsend Road Coast Protection and Slope Stabilisation Scheme

Version	Status	Signed off by:	Date signed	Date issued
1	Final to NYCC	N Cooper	May 2011	June 2011

Template version – April 2011

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APPENDICES

Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Review (to be completed by promoting Authority)			
Project Title: Sandsend Road Coast Protection and Slope Stabilisation Scheme			
Authority Project Code:		**Date of PAR: May 2012**	
Lead Authority: North Yorkshire County Council			
Consultant: Royal Haskoning		**Version No: 1**	
Position	**Name**	**Signature**	**Date**
"I have reviewed this document and confirm that this project meets our quality assurance requirements, satisfies all the required environmental obligations and meets Defra investment appraisal criteria. I confirm that all internal approvals including member approval have been completed for this project and recommend submission to the Environment Agency for eligible capital grant approval in the sum of £ "			
Authority Project Executive	David Bowe		
"I have reviewed this document and confirm that it complies with the current PAR guidelines for Local Authority and IDB submissions"			
PAR Reviewer			
"I confirm that I have consulted with the Head of FCRM & Business Finance and that the project is ready for submission to PAB/NRG"			
Area Flood Risk Manager			
PAB – Project Assessment Board ☐ **(Projects less than £2 million)** (Check box to indicate which is appropriate)		NRG – National Review Group ☐ (Projects greater than £2 million)	
Date of Meeting(s):		**Chairman:**	
Recommended for approval: In the capital grant eligible sum of £:		**Date:**	**Version No:**
3. Project approval Officers in accordance with the FSoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Agency Board			
Version No:		**Date:**	
Capital Grant sum Approval	**By:** In the sum of: £ *(if different from above)*	**Date:**	
Breakdown of approved costs			
4. Defra approval			
Submitted to Defra or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra Approval: or Not applicable (as appropriate)		Date:	
Comments:			

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1.0 Executive summary

1.1 Introduction and background

Location and background

1.1.1 Sandsend is a small village on the North Yorkshire coast, 4km to the west of the town of Whitby. These settlements are linked by the A174 coast road. As there are limited facilities within the village itself the residents of Sandsend depend on access to Whitby. A section of the A174 is at risk from coastal erosion and slope instability. It is situated on a bench in the coastal slope with the upper slope unprotected on the landward side and the lower slope protected on the seaward side by a deteriorating concrete revetment. The loss of the A174 direct connection between Sandsend and Whitby would isolate the community and have major social implications.

1.1.2 The aim of this PAR is to appraise options to manage risks from coastal erosion and coastal slope instability, leading to identification of a preferred option. The aim of the scheme is to manage the risk of isolation of the community of Sandsend by maintaining some form of safe road link with Whitby, along an alignment to be determined.

1.1.3 This project is being promoted ahead of the approval of the Whitby Coastal Strategy 2 as a Framework for Action project due to the urgency of the works required for the rapidly deteriorating condition of the existing assets and the time-limited potential major financial contribution to the costs of the scheme by North Yorkshire County Council (NYCC).

1.1.4 The review of the Whitby Coastal Strategy has taken on board the recommendations from the Shoreline Management Plan 2 (2007) to consider options for relocating the highway, and the draft preferred strategic option is in line with the previous 2002 strategy. This project builds upon the (ongoing) review of the strategy and will not therefore compromise any future strategic decisions.

1.1.5 The project will be carried out under the powers of the Coast Protection Act 1949 and the Highways Act 1980, section 41, 'duty to maintain highways maintainable at public expense'.

History of Coastal Erosion

1.1.6 The coastline in the study area for this PAR is composed of soft glacial material which is easily susceptible to coastal erosion. It has been shaped over the last 130 years by transport, with coastal defence assets constructed to protect first the Whitby to Loftus railway line which ran through Sandsend and then, following the demolition of the railway, the A174 coastal road.

1.2 Problem

1.2.1 There are several issues which contribute to the coastal erosion problem along this stretch of the coastline. The factors are all interconnected and will require an integrated solution to deal with all of the issues together.

1.2.2 Although there are existing coastal defence assets along most of the study area, they are in a very poor condition and continuing to deteriorate at a rapid rate. There are ongoing problems with sections of the revetment failing, with the most recent collapses (at time of writing) occurring in October 2011, and there are a large variety of failure mechanisms at work affecting all aspects of the structure. NYCC have to spend increasing amounts on emergency repairs of the revetment every year to repair failures. The instability of the structure is also a public safety risk for beach users.

1.2.3 The historic defences that were associated with the old railway line in the eastern end of the study area have deteriorated to such an extent that they are now virtually obsolete. Erosion of the base of the cliff has continued and resulted in an outflanking problem, placing the A174 at risk.

1.2.4 The upper coastal slope is composed of glacial till and is over-steep with poor drainage. There are ongoing issues with continuous shallow surface failures, and the development of large slip failures which could compromise the stability of both the highway and the lower revetment. This could occur before the highway is lost to coastal erosion. The poorly drained upper coastal slope also exacerbates the problem of washing out of material in the revetment, through flow routes under the highway and into the revetment.

1.2.5 Under the Do Nothing scenario the coastal slope would erode back to the A174 within 20 years. As well as the road, the services within the road would be lost. One property would be lost by year 50 (the doctor's surgery), with a further 12 properties at risk within 100 years. Loss of the A174 would have a significant impact on the way of life for residents of Sandsend, with the village becoming more isolated and services harder to access via a 22km diversion. The Do Nothing scenario would result in the loss of a large section of Upgang Beck to Sandsend Cliffs SINC and Maritime Cliff and Slope BAP habitat as the coastline retreats. Water quality in the coastal waters would likely be reduced due to breakage of the services within the road, including sewers.

1.3 Options considered

1.3.1 Following the recommendations in the SMP2 a range of strategic level options have been considered to determine whether to keep to the A174 along its current alignment or to realign it, either through upgrading existing roads or constructing a new section of road. Retaining the A174 along its current alignment is the most cost efficient strategic option, with a significantly higher benefit-cost ratio of 7.3 than the realignment options of 2.3. This option was also preferred on technical and environmental grounds.

1.3.2 A range of options were considered at PAR stage for implementing the preferred strategic option of retaining the A174 along its current alignment, both to deal with the upper coastal slope issues and the replacement of the existing coastal revetment. From a longer list of options, two options for management of the coastal slope and two options for management of revetment were taken forward for further consideration.

- **Coastal Slope Option 1**: Upper coastal slope would be re-graded, with trench drains installed along the slope face and interceptor drains at the toe and crest of the slope. This option would also include replacement vegetation planting/seeding.
- **Coastal Slope Option 3**: Installation of 4m high king post barrier wall at toe of upper coastal slope to catch any material falling off the slope, with filter drains at intervals up the slope.
- **Revetment Option B**: Rock armour revetment constructed over the existing revetment and extending across the mouth of Raithwaite Ravine.
- **Revetment Option C**: Concrete stepped revetment constructed over the existing revetment with a rock revetment extending across the mouth of Raithwaite Ravine.

1.3.3 Due to the critical inter-dependencies between processes of erosion and landslip, the coastal slope and revetment options were combined to produce four integrated options which were assessed along with the Do Nothing and Do Minimum.

- **Do Nothing**: No active intervention would be taken, with no further maintenance or capital works carried out on existing revetment or cliffs, failure would occur and erosion commence.
- **Do Minimum**: Maintenance of the existing revetment would continue until the end of its residual life, estimated to be approximately 5 years. No new capital works would be carried out. The undefended sections would continue to erode as currently, and the road would still be lost within same timescales as Do Nothing.
- **Option 1B**: Coastal slope re-grading, installation of drainage, with a rock armour revetment.
- **Option 1C**: Coastal slope re-grading, installation of drainage, with a concrete stepped revetment.
- **Option 3B**: King post barrier wall, with a rock armour revetment.
- **Option 3C**: King post barrier wall, with a concrete stepped revetment.

1.4 Preferred option

Description

1.4.1 The preferred option is Option 1C: Coastal slope re-grading and trench drain installation, with concrete stepped revetment.

1.4.2 The preferred option includes the stabilisation of the upper coastal slope through re-grading to a stable angle and the installation of drainage in addition to the replacement of the existing concrete revetment with a concrete stepped revetment. The defence would be continued across Raithwaite Ravine, at the eastern end, with a rock revetment protecting the toe of the highway embankment.

1.4.3 The replacement concrete stepped revetment will be designed to ensure that the rate of beach level reduction and bedrock erosion is considered over the asset life and that toe depth and design are appropriate. It will also be designed such that the height of the revetment is sufficient to prevent erosion of the grassed slope above the revetment, based on current 1 in 200 year still water and wave levels, with the ability to raise the height of the rear wall to accommodate sea level rise and potential increased wave overtopping in the future – delivering a managed adaptive approach to climate change issues.

1.4.4 The preferred PAR option has the highest benefit-cost ratio (6.84) of the short listed options. The concrete stepped revetment offers greater amenity and access benefits than the rock revetment, and is visually less of a deviation from the existing defences both within the study area and the adjacent frontage within the village itself. Option 1C best fulfils the scheme objectives, including being sympathetic to the tourism potential of Sandsend.

1.4.5 The preferred option concurs with the strategic option being proposed in the draft Whitby Coastal Strategy 2, due for submission to LPRG in summer 2012.

Environmental considerations

1.4.6 An Environmental Screening Opinion has been received and an Environmental Impact Assessment is not required. An Environmental Report building up on the Strategic Environmental Assessment carried out for the draft Whitby Coastal Strategy 2 has been produced and can be found in Appendix N.

1.4.7 The project requires several approvals and consents; these include Planning Permission, Marine Licence, and Discharge Consent.

1.4.8 An Indicative Landscape Plan identifying constraints and opportunities has been produced (Appendix F). Key constraints include the potential to affect the local landscape/seascape, the Upgang Beck to Sandsend Cliffs SINC and Maritime Cliff and Slope BAP habitat, and the known and unknown heritage assets. The opportunity to improve the biodiversity value of the area has been identified, enhancing the SINC and BAP habitats.

1.4.9 During and after construction, risks and impacts will be managed though implementation of the Environmental Action Plan, and Site Waste Management Plan.

1.4.10 Consultation has been carried out with Scarborough Borough Council, North Yorkshire County Council, Environment Agency, Marine Management Organisation and Natural England.

Benefits

1.4.11 The key benefits of the preferred option are:

- Protection to 16 properties (10 residential and 6 commercial) from coastal erosion for 100 years, including the doctor's surgery in the village;

- The A174 Sandsend to Whitby coast road will continue to be protected, ensuring that the community of Sandsend retain their vital link with Whitby for access to major facilities and emergency services;
- Protection of services within the A174 which serve the whole of the village;
- Removal of public safety risk to beach and road users from sudden collapses of the existing revetment or upper coastal slope;
- Increased biodiversity on the upper coastal slope and in Raithwaite Ravine;
- Present Value Benefits of £84,810k and benefit-cost ratio of 9.09.

Costs

1.4.12 The costs have been derived through a combination of Royal Haskoning's in-house Cost Consultants (Quantity Surveyors) and from estimates provided by Birse Coatsal. The quantities and cost estimates were based on the outline design drawings, initial intrusive site investigation and information provided by North Yorkshire County Council's (NYCC) Highways employees (who are responsible for the maintenance and repairs of the both the upper coastal slope and the coastal revetment). General costs were derived using SPONS price database, discussions with local Land Fill operators and discussions with NYCC staff. Costs for the preferred option were obtained from estimates provided by Birse Coastal, based on actual costs for a similar scheme currently being constructed in Redcar. A full breakdown of costs can be found in Appendix H.

Table 1.1 Project Costs (£k)

	Economic appraisal	Whole Life Cash Cost	EA FSoD Approval
Costs to PAR	N/A – sunk costs	£59	£35
Costs post PAR			
Environment Agency staff	£53	£57	£57
Consultant fees	£116	£120	£120
Early Contractor Involvement (ECI)	£8	£8	£8
Cost consultant fees	£67	£71	£71
Site investigation & survey	£0	£0	£0
Construction	£6,635	£7,106	£7,106
Environmental mitigation	£33	£36	£36
Environmental enhancement	£20	£21	£21
Site supervision	£196	£210	£210
Compensation	£100	£107	£107
Risk contingency			
95%ile (represents x% of project FSoD approval)	N/A	N/A	£2,038
50%ile	£1,332	£1,332	N/A
Inflation	N/A	N/A	£523
Future costs (const. + maintenance)	£774	£2,110	N/A
Other	£0	£0	£0
Contributions - Scheme			£3,797
Contributions – Inflation & Risk			£1,736
TOTAL	£9,334	£11,064	£4,763

Economic summary, outcome measures and priority

1.4.13 An economic assessment of the Do Nothing damages has been carried out for the key receptors; namely property, traffic disruption, services and heritage assets. The appraisal has been carried out over 100 years following the methodologies and guidance set out in the Multi-Coloured Manual and the Green Book, in combination with the Defra FCERM-AG series and supplementary Guidance Notes. Discounted over 100 years the Present Value Damages for the Do Nothing are £101,673k, capped to £85,108k using the cost of constructing a new replacement road inland. The outcome measures for the scheme are shown in table below. The scheme will attract 51% FDGiA funding of £4,763k and with the £3,797k contribution from NYCC this results in an adjusted OM score of 100%.

Table 1.2 Benefit-cost ratios and outcome measures

Outcome Measures		Number	Qualifying Benefits	FDGiA Contribution
OM1 (Economic Benefit)			£84,457	£4,692
OM2 (Households better protected against flooding)	20% most deprived areas	0	£0	£0
	21-40% most deprived areas	0	£0	£0
	60% least deprived areas	0	£0	£0
OM3 (Households better protected against coastal erosion)	20% most deprived areas	0	£0	£0
	21-40% most deprived areas	0	£0	£0
	60% least deprived areas	10	£353	£71
OM4 (Statutory Environmental Obligations Met)			£0	£0
TOTAL FDGiA Contribution				**£4,673**
Raw OM Score				51.03%
Cost saving and/or external contribution required				£3,797
Scheme Contributions Secured				£3,797
Adjusted OM Score				100%

Funding and contributions

1.4.14 North Yorkshire County Council has so far contributed £24k to the production of the PAR for this scheme and will contribute £3,797k towards the detailed design and construction of the scheme. This contribution has been allocated in NYCC's budgets for 2013/14 and 2014/15, if the project does not go ahead within these timescales the contribution cannot be guaranteed to still be available at a later date. NYCC will be responsible for on-going maintenance of scheme and will therefore contribute the £774k required over the 100 year life of scheme.

Key delivery risks

1.4.15 A description of the five key delivery risks together with their mitigation is shown in Table 1.3.

Table 1.3 Risks and mitigation

Key delivery risk	Mitigation
Weather and tide delays	Detailed design and ECI stage to consider the balance between working in more favourable seasons against the impact on tourism and also environmental considerations.
Volume of excavated material exceeds the usable capacity at Raithwaite Gill – requiring landfill disposal	Detailed topographic surveys have been carried out of the upper and lower coastal slopes and of Raithwaite Gill itself, therefore this risk is low. Detailed design to consider steepest allowable upper slope angle to reduce total excavation quantities.
Further instability of upper slope occurs prior to or during construction resulting in additional disposal quantities and potential alternative design solution(s).	Works to be carried out as soon as possible to minimise the risk of a major upper slope failure.
Tidal erosion of temporary haul road on beach results in additional imported sand costs and potential need for rock armour placement of seaward side	Timing of construction works to minimise risk of storm damage. Consideration of the use of rock for Raithwaite Ravine to line the seaward face of the access track should be considered.
Material beneath existing revetment is unsuitable for reuse as fill material	Risk Register includes an allowance for extra disposal and importing material.

1.5 Recommendation

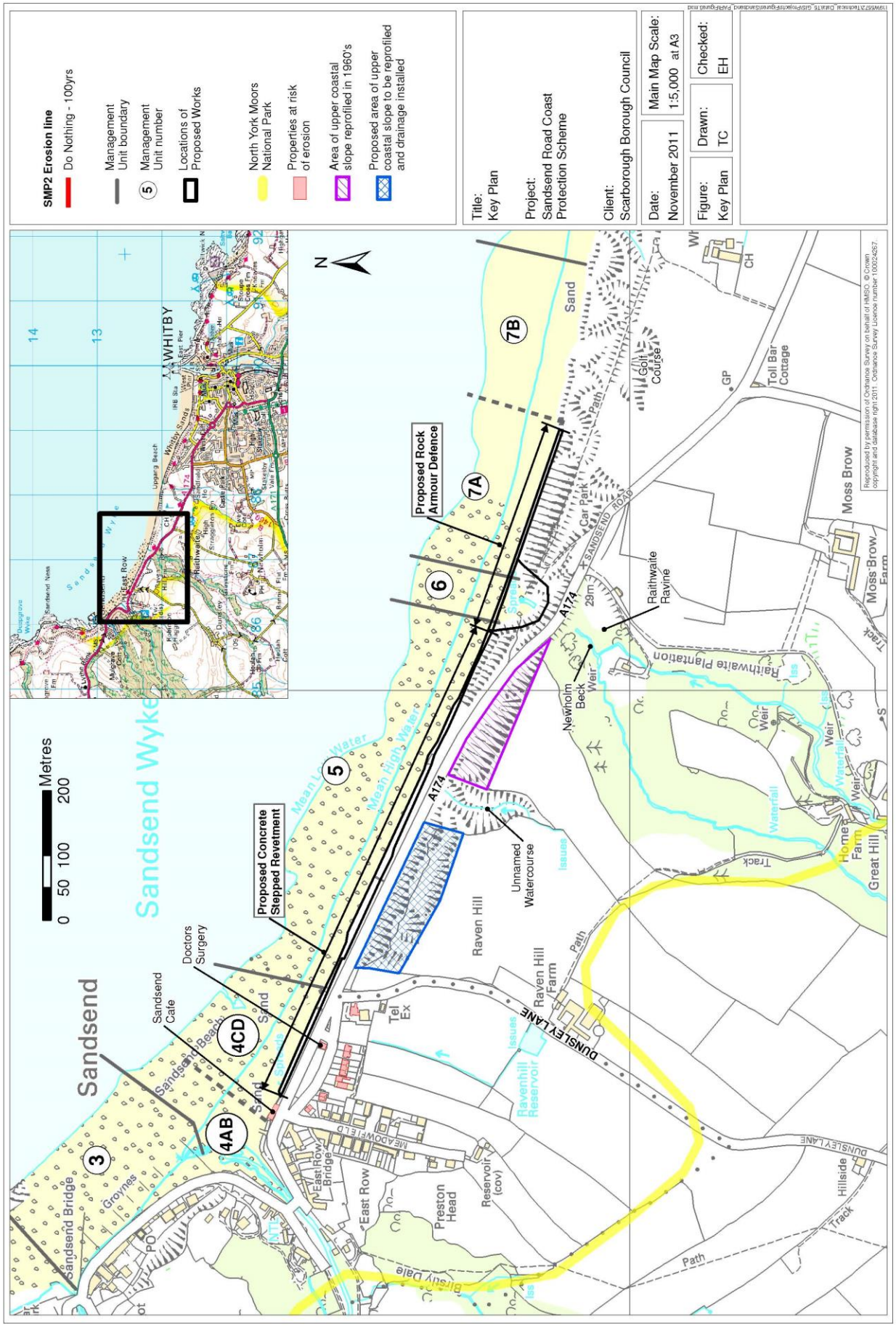
1.5.1 We recommend that the Environment Agency give technical and scheme approval to the Sandsend Road Coast Protection and Slope Stabilisation Scheme in the sum of £4,763k for the design and construction of the preferred option of upper coastal slope re-grading and installation of trench drains with a concrete stepped revetment.

1.5.2 The total cost of the scheme is £10,296k, which includes £2,038k risk contingency at the 95%ile level and £523k inflation allowance at 2.5%. This will be funded by a combination of £4,763k FDGiA funding and £3,797k contribution from NYCC. In addition NYCC will provide £1,736k allowance to cover inflation and risk contingencies above the 50%ile level.

1.6 Directors' briefing paper

Authority:	North Yorkshire County Council	**Project Executive:**	David Bowe		
Project Title:	Sandsend Road Coast Protection and Slope Stabilisation Scheme	**Code:**			
Consultant:	Royal Haskoning	**Contractor:**	n/a	**Cost Consultant:**	n/a
The Problem:	The existing coastal defences date back to 1880s and are in very poor condition with frequent local failures, and they require increasing amounts of maintenance every year. Failure poses a public safety and highway safety risk. In addition the upper coastal slope is unstable and could compromise the stability of botht he highway and the coastal defence assets.				
Assets at risk from coastal erosion:	There are 10 residential and 6 commercial properties at risk of erosion over the 100 year appraisal period. The A174 Sandsend to Whitby road is at risk, this is the main community link road, in addition to being a strategic Teeside to Whitby route (one of two).				
Existing standard of protection:	Asset residual life is 5 years	**Proposed standard of protection:**	Design life of scheme is 100 years		
Description of proposed scheme:	Stabilisation of upper coastal slope through re-grading and installation of drainage, replacement of existing concrete revetment with a new concrete stepped revetment, and partial infill of Raithwaite Ravine protected by a new rock revetment.				
Costs (PVc): (100 year life inc. maintenance)	£9,334k	**Benefits: (PVb)**	£84,810k	**Ave. B: C ratio: (PVb/PVc)**	6.84
NPV:	£75,476k	**Incremental B: C ratio:**	n/a	**Whole life cost (cash value):**	£11,064k
Choice of Preferred Option:	Option 1C was selected as it has best BCR, and was judged to be the best option for better achieving the objectives of the project, in particular to ensure the scheme is sympathetic to the tourism potential of the village.				
Total eligible cost for which capital grant approval is sought:	£ **4,763k (incl. £0 inflation & £680 contingency)**				
Delivery programme:	Planning Approval: October 2013 Award Construction Contract: April 2013 (Design & Build) Construction Start: October 2013 Construction end: March 2015 End of Project: March 2015				
Are funds available for the delivery of this project?	Yes				
External approvals:	Planning permission, Marine Licence and Discharge Consent will be required – to be obtained by October 2013.				
Outcome measures	10 residential properties protected (60% least deprived). Raw OM Score = 51.03% (£4,763k) Adjusted OM Score = 100% (£9,334k)				

1.7 Key plan(s)


SMP2 Erosion line
Do Nothing - 100yrs
Management Unit boundary
Management Unit number
Locations of Proposed Works
North York Moors National Park
Properties at risk of erosion
Area of upper coastal slope reprofiled in 1960's
Proposed area of upper coastal slope to be reprofiled and drainage installed
Title: Key Plan
Project: Sandsend Road Coast Protection Scheme
Client: Scarborough Borough Council
Date: November 2011
Main Map Scale: 1:5,000 at A3
Figure: Key Plan
Drawn: TC
Checked: EH
Metres
0 50 100 200
Sandsend Wyke
Sandsend
WHITBY
Proposed Rock Armour Defence
Proposed Concrete Stepped Revetment
7B
7A
6
5
4CD
4AB
3
A174
Mean Low Water
Mean High Water
Sandsend Bridge
Groynes
Sandsend Beach
Sandsend Cafe
Doctors Surgery
Sand
East Row Bridge
East Row
Preston Head
Reservoir (cov)
Meadowfield
Tel Ex
Raven Hill
Raven Hill Farm
Unnamed Watercourse
Ravenhill Reservoir
Dunsley Lane
Bivouac
Newholm Beck
Weir
Raithwaite Ravine
Raithwaite Plantation
Waterfall
Track
Path
Hillside
Moss Brow
Moss Brow Farm
Toll Bar Cottage
GP
Golf Course
Car Park
Sandsend Road
29m
Great Hill
Homer Farm
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2.0 Introduction and background

2.1 Purpose of this report

2.1.1 The purpose of this report is to support an application for Flood Defence Grant in Aid (FDGiA) funding for the Sandsend Road Coast Protection and Slope Stabilisation Scheme and seek approval to undertake the works. The aim of the scheme is to manage the risk of isolation of the community of Sandsend by maintaining some form of safe road link with Whitby, along an alignment to be determined.

2.1.2 The aim of this PAR is to appraise options to manage risks from coastal erosion and coastal slope instability, leading to identification of a preferred option. The appraisal has been carried out in accordance with the Defra Flood and Coastal Erosion Risk Management Appraisal Guidance and associated Environment Agency policies and procedures.

2.2 Background

Strategic and legislative framework

2.2.1 This area is covered by the River Tyne to Flamborough Head Shoreline Management Plan 2 produced in 2007. This plan recommended that in the short term the policy should be Hold the Line, and that consideration should be given to options for realigning the highway out of the erosion zone in the medium to long term.

2.2.2 The Whitby Coastal Strategy: Sandsend to Abbey Cliff was originally approved in 2002. A review of the strategy has recently been carried out to update the appraisal with additional information that has been gathered since the original strategy, including incorporating the information gathered during the Whitby Harbour Further Investigations (2007-9). The Whitby Coastal Strategy 2 is due to be issued for public consultation in January 2012 and submission to LPRG is expected in spring 2012.

2.2.3 This project is being promoted ahead of the approval of the Whitby Coastal Strategy 2 as a Framework for Action project due to the urgency of the works required due to rapid deterioration of condition of existing assets and the time-limited potential major contribution to the costs of the scheme by North Yorkshire County Council (NYCC).

2.2.4 The review of the Whitby Coastal Strategy has taken on board the recommendations from the SMP to consider options for relocating the highway, and the draft preferred strategic option is in line with the previous 2002 strategy. This project builds upon the review of the strategy and will not therefore compromise any future strategic decisions.

2.2.5 The project will be carried out under the powers of the Coast Protection Act 1949 and the Highways Act 1980, section 41, duty to maintain highways maintainable at public expense.

Social and political background

2.2.6 The A174 is the main road between Sandsend and Whitby, which provides the majority of services for the Sandsend community. Currently it takes around 5 minutes to drive to the centre of Whitby (4km); the loss of the direct A174 road link would increase this to around 25 minutes (26km) and sever direct connection to Whitby, thereby isolating the community and causing major adverse social implications.

2.2.7 Sandsend is a small coastal village with limited facilities within the village itself. There is a small independent grocery store and a doctor's surgery; however the surgery is at risk of coastal erosion if the scheme does not go ahead. In addition there is a primary school in the village of Lythe to the west of Sandsend. However, for all other facilities and services including emergency services (ambulance, fire and police), secondary schools, supermarkets, train station, petrol

station, medical services and hospital (A&E provided by Scarborough or Middlesbrough), and recreational facilities, the residents of Sandsend depend on access to Whitby. Whitby is also likely to be the major centre of employment for residents of the village.

2.2.8 Tourism is an important industry for Sandsend. There are several hotels, cafes, shops and galleries that cater for tourists. However Sandsend is not a principal destination in itself, it is situated on the popular coast road from Redcar to Whitby, and depends on tourists stopping off along this route and due to its proximity to Whitby it also benefits from visitors to the town. The loss of the A174 would remove this through route and turn the village into a dead-end destination, having a large impact on its tourism potential.

Location and designations

2.2.9 Sandsend village is located on the North Yorkshire coast, 4km west of Whitby. The coastline is north facing between the two communities and consists of a wide sandy beach backed by steep boulder clay cliffs. The beach and cliffs continue along the coast to Whitby. To the north of the village the foreshore becomes rock outcrops and Sandsend Ness, a rocky promontory, defines the end of the bay.

2.2.10 The A174 road runs for approximately 4km between Sandsend and Whitby following the edge of the coastline along the frontage covered by this scheme before turning inland and out of the predicted 100 year erosion zone. The section of the A174 that is at risk is situated on a bench in the coastal slope with the upper slope unprotected on the landward side and the lower slope protected on the seaward side by a deteriorating concrete revetment.

2.2.11 At the top of the coastal slope landward of the A174 are agricultural fields. Where the highway turns inland the land between the road and the cliff top is occupied by Whitby Golf Club.

2.2.12 There are several watercourses which outfall onto the foreshore in the Sandsend vicinity. East Row Beck and Sandsend Beck outfall within the village itself which is outside the study area, and Newholm Beck which outfalls through Raithwaite Ravine at the eastern end of the study area for the Sandsend Road Coast Protection and Slope Stabilisation Scheme.

2.2.13 The North York Moors National Park is close to the village of Sandsend; however the study area is outside the boundary of the park. The coastal frontage is within the North Yorkshire and Cleveland Heritage Coast, and the coastal slopes are locally designated as a Site of Importance to Nature Conservation and classified as Maritime Cliff and Slope Biodiversity Action Plan (BAP) priority habitat under the UK BAP.

History of Coast Erosion

2.2.14 The coastline in the study area for this PAR has been shaped over the last 130 years by transport infrastructure. In 1883 the Whitby to Loftus railway line opened, running along the coastline through Sandsend. In order to protect the railway from coastal erosion, defences in the form of a revetment were constructed at the toe of the slope, and have been maintained and modified and repaired ever since.

2.2.15 In 1922 construction began on the improvement scheme of the Whitby to Sandsend toll road, this became the A174. This scheme included building a 75 foot high embankment across Raithwaite Ravine, parallel with the railway viaduct (MU6). The road ran parallel to the railway on the landward side.

2.2.16 The railway line was closed in 1958 and the track and viaducts were demolished in the early 1960s. Following closure of the railway the coast protection assets primary beneficiary changed to the A174 road, and the revetment was maintained to continue to provide protection to the highway. However the section of revetment to the east of Raithwaite Ravine (in Management Unit 7A) became abandoned following closure of the railway and only fragments remain. The defences for the railway have been updated over the years and the concrete revetment that exists today is based on the original revetment (MU4CD-5).

2.3 Current approach to Coastal Erosion Risk Management

Measures to manage the probability of coastal erosion risk

2.3.1 The study area covers Management Units (MU) 4CD to 7A of the Whitby Coastal Strategy. MU4CD and 5 have existing coast protection assets; however the assets in MU7 have deteriorated to such an extent that they are now virtually obsolete.

2.3.2 MU4CD is located at the western end of the study area, running from the café opposite the Meadowfield residential road to the concrete outfall opposite Dunsley Lane; the existing defences within this MU are a short section of gabion baskets (25m) adjacent to the café building and then the start of the deteriorating concrete revetment (205m). The revetment covers approximately two-thirds of the lower slope. The concrete revetment is in a poor condition and requires frequent major repair and emergency work, which is undertaken by NYCC. The road is backed through this MU by properties.

2.3.3 MU5 runs from MU4CD to the western edge of Raithwaite Ravine. Within this MU the existing defences consist of a continuation of the deteriorating concrete sloping revetment present in MU4CD, this runs for 600m and is in a worse condition than that in MU4 and also requires frequent major repair and emergency work. At the end of the concrete revetment there is a 35m section of failed timber piles at the approach to Raithwaite Ravine. The road is backed through this MU by the steep upper coastal slope.

2.3.4 Works have been carried out previously to the upper coastal slope in MU5 to improve its stability and reduce the likelihood of collapses onto the A174. A 200m section of cliff adjacent to Raithwaite Ravine was re-profiled in 1968 to a less steep angle, since then this section has appeared to be stable. Another short 75m section adjacent to Dunsley Road was re-profiled in 2004. In addition improvements to the drainage of the slope have been attempted. The works carried out to the upper coastal slope were not part of an integrated solution with the lower concrete revetment.

2.3.5 MU6 is Raithwaite Ravine, this is a short MU of 85m and it contains the culverted outfall of Newholm Beck through the embankment constructed in the 1920s to support the A174 across the ravine. The embankment is set back from the adjacent sections of coastline forming a small inlet. The toe of the embankment is currently unprotected from coastal erosion.

2.3.6 MU7A runs from Raithwaite Ravine into the Golf Course to the point where the A174 turns inland. There are currently no formal coast protection assets; however there are remnants of a concrete sloping revetment that was historically constructed to protect the railway, that have deteriorated to such an extent that they are now virtually obsolete. The road is up on top of the coastal slope by this point.

Measures to manage the consequences of coastal erosion risk

2.3.7 NYCC carry out maintenance works annually to both the revetment and the coastal slope. This work is reactionary, repairing damage to the surface of the revetment and clearing debris from the A174 road following slumps and falls from the upper coastal slope. SBC carries out regular inspections and monitoring of the area as part of the Cell 1 Regional Coastal Monitoring Programme, this includes beach level surveys, and asset and slope inspections. NYCC also carry out routine asset inspections of the concrete revetment and the upper slope.

3.0 Problem definition and objectives

3.1 Outline of the problem

3.1.1 There are several issues which contribute to the coastal erosion problem along this stretch of the coastline. The factors are all interconnected and will require an integrated solution to deal with all of the issues in a suitably comprehensive manner.

3.1.2 The existing concrete revetment in MUs 4CD and 5 is in a very poor condition, it has reached the end of its serviceable asset life. There are on-going problems with sections of the revetment failing, with the most recent collapses occurring in October 2011, and there are several failure mechanisms at work. NYCC are having to spend increasing amounts on maintenance of the revetment every year to repair failures, in 2010-11 approximately £66k was spent on maintenance, £60k was spent in 2011-12, and a further £60k has been allocated for maintenance during 2012-13. The residual life of the asset is estimated at 5 years with large scale maintenance and repairs of failures.

3.1.3 The failure mechanisms of the revetment are; toe failure due to undercutting, lamination of the unreinforced concrete surface layer in large sheets, abrasion of concrete surface exposing fill material beneath, and washing out of fill material (sand and blast furnace waste) resulting in the concrete surface layer collapsing in on itself. Washing out is caused by three main sources; ground water flow from the upper coastal slope beneath the highway, tidal influx through failures in the revetment, and surface water pipes draining the highway which discharge above the revetment washing out material behind the revetment and at the toe.

3.1.4 The instability of the structure is a public safety risk; sections of the revetment could collapse inwards or slabs of the concrete surface layer could slide down the revetment at any time. In addition a large scale sudden collapse of the revetment could potentially endanger the stability of the highway above.

3.1.5 The beach level in the study area is extremely variable; it is thought that during storms the sand is moved to an offshore sand bar before moving back onshore. When the beach levels drop the bed rock at the toe of the revetment is sometimes exposed; this is relatively soft and easily eroded. Erosion of the bedrock removes support from beneath the toe of the revetment and contributes to toe failure. In addition low beach levels present a public safety risk, as the two sets of wooden access steps from the road to the beach are left ‘hanging’ above the level of the beach.

3.1.6 The upper coastal slope in MU5 is composed of glacial till and is over-steep with poor drainage. In particular there is a lack of drainage at the top of the slope resulting in surface water issues from the overland flow from the farmland. There are on-going issues with the development of large slip failures and continuous surface failures as a result of excessive surface and ground water. The continuous surface failures result in material falling onto the highway, causing a public safety risk. Further development of a large slip failure may result in a deep seated rotational failure plane beneath the level of the highway and revetment, which would compromise the stability of both of these assets. This could occur before the highway is lost to coastal erosion within 20 years.

3.1.7 The upper coastal slope in MU5 exacerbates the problem of washing out of material in the revetment, through flow routes under the highway and into the revetment. This has been observed occurring by NYCC staff whilst carrying out emergency repairs to the revetment following failures.

3.1.8 The historic defences in MU7 that were associated with the old railway line were no longer maintained following the closure of the line, and are now almost entirely gone. Erosion of the base of the cliff has continued and resulted in an outflanking problem at the eastern end of the study area, placing the A174 at risk within 20 years.

3.2 Consequences of doing nothing

3.2.1 Under the Do Nothing scenario the concrete revetment would continue to deteriorate and collapse in large sections, leaving the toe of the coastal slope unprotected against coastal erosion. Erosion in the eastern section of the study area where the defences are virtually obsolete will continue as currently. Within 20 years the coastal slope would erode back to the A174 and sections of the road would collapse onto the foreshore. The loss of the road will result in vehicles having to use the 22km diversion on the existing alternative A-roads to reach Whitby, increasing journey times by five times.

3.2.2 The upper coastal slope above the A174 will continue to be unstable with frequent collapses of material onto the highway. There will be an increased risk of a major deep seated slope failure which could result in a section of the road being destroyed prior to it being compromised through coastal erosion. Ground and surface water will continue to cause issues on the upper coastal slope and washout material from beneath the concrete revetment on the lower coastal slope.

3.2.3 There are several services within the A174 road that supply Sandsend with electricity, gas, water, sewerage and telecoms. The sewer within the road is the principal pumping main to the sewage works at Whitby. Sandsend currently achieves the excellent standard of bathing water quality, and is amongst the best beaches in Europe. The back-up sewer should the pumping main be lost through erosion is a short sea outfall at Sandsend. This would result in a significant reduction in the bathing water quality.

3.2.4 Under the Do Nothing scenario one property would be lost by year 50, with a further 15 properties at risk within 100 years. The property at risk within 50 years is the doctor's surgery for the village and therefore is a key property. The nearest alternative surgery is in Whitby, which after the road is lost will require a 22km diversion. The properties are located at the western end of the study area for this scheme (MU4CD).

3.2.5 Sandsend is a small village, with the majority of its services based in Whitby, including schools, hospital, supermarkets, employment, emergency services etc. Loss of the A174 would have a significant impact on the way of life for residents of Sandsend, with the village becoming more isolated and services harder to access. Affected residents may feel isolated and abandoned, and suffer stress from blight on property values and concerns regarding on-going viability of properties/community. Longer journey times would impact on travel to Whitby for jobs, leisure, health and social reasons. In addition the nature of the village as a tourist destination would be affected. Loss of A174 would isolate the village, making it a dead-end destination rather than a through route. This could result in loss of trade for businesses reliant on tourist/recreation trade, which could result in the loss of businesses affecting the job market and range of services available locally for residents.

3.2.6 The A174 is not only a local route connecting Sandsend with Whitby; it is also one of the two main routes which connect Teesside with Whitby, the other being the A171. The two routes act as strategic diversion routes to one another, in the event of closure of one route due to accidents or bad (winter) weather. The loss of the A174 would therefore have wider implications for the regional transport network.

3.2.7 There are a variety of heritage assets along this section of coastline which would be lost through coastal erosion under the Do Nothing scenario; these include seven Cultural Heritage and three Defence of Britain sites which are present within Raithwaite Ravine, six Cultural Heritage and two Defence of Britain sites adjacent to the existing revetment, as well as two Cultural Heritage sites and an Archaeological Event Site along the A174, and a Cultural Heritage site at the top of the upper coastal slope.

3.2.8 The Do Nothing scenario would result in the loss of a large section of Upgang Beck to Sandsend Cliffs SINC and Maritime Cliff and Slope BAP habitat as the coastline retreats. Water quality in the coastal waters would likely be reduced, which could potentially affect the chemical and physico chemical quality elements of the waterbody depending on the potential presence of contaminates.

3.2.9 The erosion of the frontage would have a significant adverse impact on the local landscape / seascape character, through the degradation of the defences and loss of natural assets. Erosion of the coastline and further slippages of the coastal slope would give a threatening aspect to the existing pleasurable coastal setting and reduce the area's visual amenity value. The erosion of the frontage would both support and conflict with the Heritage Coast's objectives.

3.2.10 The present value of the Do Nothing damages (PVd) for the Sandsend Road Coast Protection and Slope Stabilisation Scheme are £101,673k. This is made up of £100,731k PVd from traffic disruption due to loss of the A174, £828k PVd from damage to services contained within the A174, £111k PVd from loss of property and £3k from the loss of heritage assets.

3.3 Strategic issues

3.3.1 The Sandsend Road Coast Protection and Slope Stabilisation Scheme study area is covered by the Whitby Coastal Strategy: Sandsend to Abbey Cliff, which was originally approved in 2002. A review of the strategy has recently been carried out to update the appraisal with additional information that has been gathered since the original strategy. The Whitby Coastal Strategy 2 is due to be issued for public consultation in January 2012 and submission to LPRG is expected in spring 2012.

3.3.2 The Whitby Coastal Strategy covers a 5km section of coastline in North Yorkshire, stretching from the village of Sandsend in the west to Abbey Cliff at the eastern edge of the town of Whitby. The main communities within the Strategy area are the town of Whitby and the village of Sandsend. As well as the coastal frontage Whitby has fluvial frontages with the River Esk flowing through the centre of the town and discharging into the harbour.

3.3.3 Within the full Strategy area under the Do Nothing scenario there are 778 properties at risk of coastal erosion over the next 100 years, and 163 properties at risk of tidal flooding in the 0.5% annual probability event, increasing to 207 with sea level rise.

3.3.4 This project covers several management units, MU 4CD to 7A, of the Whitby Coastal Strategy. The extent of the frontage covered by this project has been selected based on the similarity of the problems experienced by the adjacent management units and the associated consequences.

3.3.5 The preferred strategic option from the original 2002 Whitby Coastal Strategy was to carry out capital works to progressively upgrade and refurbish the revetment structure on a priority basis (through repairing concrete surface, filling voids and improving the toe with rock apron) and carrying out slope stabilisation of slopes inland of A174. The 2007 Shoreline Management Plan 2 (North East Coast – River Tyne to Flamborough Head) recommended that in the short term the policy should be Hold the Line, and that consideration should be given to options for realigning the highway out of the erosion zone in the medium to long term.

3.3.6 The recent review of the Whitby Coastal Strategy has considered different options for abandoning the existing A174 alignment and allowing coastal erosion to recommence as recommended in the SMP2; options included realigning the highway, upgrading existing minor roads and relaying on existing alternative A-roads. These options were assessed against the option for retaining the A174 along its existing alignment through construction of coast protection assets.

3.3.7 The draft preferred strategic option for this frontage on technical, environmental and economic grounds is to retain the A174 Sandsend to Whitby road along its current alignment through a capital scheme to replace the existing concrete revetment and carry out stabilisation works to the coastal slope. This is in line with the original 2002 Whitby Coastal Strategy and it is not anticipated that there will be any objections to the preferred strategic option during the public consultation period.

3.4 Key constraints

3.4.1 The project is not subject to a large number of constraints, and the majority of the constraints affect the programme of works and not the type of option.

3.4.2 North Yorkshire County Council as the highway authority for the A174 is a significant funder for the scheme. The funding for the scheme from NYCC is however time limited, funds have been set aside in their budgets for 2013/14 and 2014/15 for the scheme and in the event that the scheme does not proceed in this timescale then NYCC cannot guarantee that the funding will be available for the scheme at a later date.

3.4.3 The major constraint on the option selection and design of the scheme is the safety of the public whilst using the highway and the beach.

3.4.4 During construction there will be several constraints; access, weather and tides will affect when different parts of the scheme can be constructed, Sandsend is popular with tourists which will affect when the scheme can be constructed.

3.4.5 The environmental constraints that could affect the implementation of the scheme are presented in Section 3 of Report N1 in Appendix N and illustrated on the Indicative Landscape Plan in Appendix F. These include the proximity of the North York Moors National Park, the Upgang Beck to Sandsend Cliffs SINC and Maritime Cliff and Slope BAP habitat, the Yorkshire and Cleveland Heritage Coast, known Cultural Heritage and Defence of Britain sites, and four WFD waterbodies.

3.5 Objectives

3.5.1 The objectives for the scheme were identified by the key stakeholders in the project; Scarborough Borough Council, North Yorkshire County Council, and the Environment Agency.

- To ensure continued safe vehicular access between Sandsend & Whitby (road link);
- To protect properties from coastal erosion;
- To maintain the close connection between communities of Sandsend and Whitby;
- To ensure public safety during use of beach and highway;
- To provide an integrated solution for both upper and lower coastal slope issues;
- To ensure scheme is sympathetic to the tourism potential of the village;
- To minimise waste and carbon footprint of the scheme;
- To protect and enhance biodiversity;
- To preserve the historic and cultural importance of the coastal frontage;
- To preserve and enhance the landscape and seascape character;
- To comply with all statutory obligations arising from national and international nature conservation designations and related legislation.

4.0 Options for managing flood risk

4.1 Potential FCRM measures

4.1.1 The recent review of the Whitby Coastal Strategy has considered different options for ensuring the continued provision of some form of road link between Sandsend and Whitby along an alignment to be determined. This included abandoning the existing A174 alignment and allowing coastal erosion to recommence as recommended in the SMP2, and an option for retaining the A174 along its existing alignment through construction of coast protection assets. These options were assessed against the Do Nothing and Do Minimum scenario to determine a strategic level draft preferred option.

4.1.2 The strategic options considered were:

- Do Nothing: no active intervention, no capital or maintenance works carried out;
- Do Minimum: maintenance of existing assets until end of residual life, but no new capital works (residual life of asset is approximately 5 years);
- Realign A174: 1.2km section of new road to be constructed between Dunsley Lane and Cliff Lane on top of coastal slope out of the 100 year erosion zone (MU5 to MU7). 200m section of revetment in MU4CD to be replaced, west of Dunsley Lane;
- Upgrade Minor Roads: 6.2km of the existing minor roads (mainly single track farm access) to be upgraded to A-road status between Lythe and the existing A171 Guisborough to Whitby road;
- Retain A174 on current alignment: works to be carried out to the revetment and the upper coastal slope in order to retain the road on its current alignment through MU4CD to MU6, with short section of road realignment in MU7A in the future.

4.1.3 The strategic options were assessed on technical, environmental and economic grounds and the draft preferred strategic option is to retain the A174 along its existing alignment through a capital scheme to replace the existing concrete revetment and carry out stabilisation works to the upper coastal slope. This option had the significantly highest benefit-cost ratio, lowest costs of the Do Something options, was technically the simplest and most robust, had least risks associated, and had least impacts on the environment and community of Sandsend. Table 4.1 presents a summary of the economic appraisal of the strategic options. More details of the appraisal of the strategic options can be found in the Strategic Appraisal Summary Table in Appendix K.

Table 4.1 Economic assessment summary of strategic options

Option	PV Damage (k)	PV Benefits (k)	PV Costs (k)	Cash Cost (k)	Net Present Value (k)	BCR
Do Nothing	£101,673	£0	£0	£0	£0	-
Do Minimum	£101,489	£184	£2,480	£4,189	-£2,296	0.07
Realign A174	£2,114	£99,559	£43,280	£84,166	£56,279	2.30
Upgrade Minor Roads	£63,248	£38,425	£21,568	£42,448	£16,857	1.78
Retain A174	£298	£101,376	£13,960	£16,594	£87,416	7.26

4.2 Long list of options

4.2.1 In order to achieve the preferred strategic option of retaining the A174 on its current alignment a variety of different options were considered for the upper coastal slope and for the revetment. The long list of options was developed through a workshop with the key stakeholders and on-site discussions with the technical team. The long list of options were assessed on technical merit, and only options which were technically able of delivering the objectives of the scheme with a good level of confidence in their long term performance were progressed to the short list.

4.2.2 Upper coastal slope options have been given a numerical prefix and revetment options have been given an alphabetical prefix.

4.2.3 A variety of slope stabilisation techniques have been considered for the upper coastal slope including both hard and soft engineering options as follows:

- Slope Re-grading & Installation of Trench Drains: existing upper coastal slope would be re-graded to 22° with geotextile erosion control mats installed, trench drains of ~2.5m deep installed with filter drains at the top of the upper coastal slope to intercept surface run-off, vegetation should be incorporated into surface protection design;
- Slope Re-grading & Installation of Horizontal Drains: existing upper coastal slope would be re-graded to 22° with geotextile erosion control mats installed, horizontal drains bored into the slope with filter drains installed at the top of the upper coastal slope to intercept surface run-off, vegetation should be incorporated into surface protection design;
- Installation of king post barrier wall: construction of barrier wall using steel H section piles with pre-cast concrete panels between. Wall would have 4m up-stand and 4-8m below ground, ground anchors into bedrock required for lateral support. Filter drains to be provided at the top of the upper coastal slope to collect surface water; in addition filter drains would be required at intervals up the slope. Slope re-grading not required;
- Soil nailing and horizontal drainage: horizontal drains to be installed prior to soil nails, along with filter drain at top of upper coastal slope to intercept surface water flows. Soil nails to be

installed into competent material or bedrock, at a depth greater than identified slip planes. A flexible facing will be provided for slope surface protection in areas of soil nailing. Slope re-grading not required.

4.2.4 Planting for stabilisation will be used in combination with other upper coastal slope options. Planting of the slope would be carried out with species picked for their properties that would assist in binding the slope together to aid slope stabilisation. This could provide enhancement opportunity to provide new habitats.

4.2.5 The different options considered for the revetment works were:

- A. Major upgrading and refurbishment of existing structures with rock armour at eastern end of scheme (as proposed in the original 2002 Whitby Coastal Strategy): phased approach, progressively refurbishing the revetment and addressing priority areas first. Works would include measures to protect toe from undercutting, measures to protect top of slope to prevent wash out, and install measures to minimise force of wave attack and run-up;
- B. Rock armour revetment in front of existing concrete revetment: rock armour revetment overlain on existing revetment (concrete surface broken out first to allow rocks to bed in);
- C. New concrete revetment: existing revetment removed and new concrete revetment built in its place.

4.2.6 In addition to these options the Do Nothing and Do Minimum scenarios were carried forward from the Whitby Coastal Strategy 2 review.

4.3 Options rejected at preliminary stage

4.3.1 Only the options for the upper coastal slope stabilisation which were assessed as being technically viable with a good level of confidence in their long term performance were taken forward for detailed appraisal. These were Option 1 and Option 3.

- Option 2 is very similar to Option1, with the difference being the type of drainage installed, both options would perform to same standard however the horizontal drains in Option 2 would be more expensive and technically more difficult to construct than the trench drains in Option 1.
- Option 4 was rejected because soil nailing would not work on the deep seated slip plane and additionally in order for the solution to work on the shallow slips, details of the location of all slip planes would be required. Therefore this option does not provide certainty that it would perform as required and was rejected on technical grounds.
- Option A from the revetment options was discounted as a progressive refurbishment of the revetment was assessed as not being technically robust or cost efficient due to the nature and rate of deterioration of the revetment. The residual life of the existing revetment has been assessed as being approximately 5 years, therefore the progressive refurbishment would have to be carried out over this relatively short timescale and with multiple mobilisation costs would not be costs efficient. Additionally the interfaces between the different stages of refurbishment would provide weak points in the defence, and there would be no consistent continuity to the defence. It has been observed that areas immediately adjacent to the most recent repairs on the existing revetment are often the next locations to sustain damage.

4.4 Options short-listed for appraisal

Option 1: Do Nothing

4.4.1 No active intervention would be taken, with no further maintenance or capital works carried out on existing revetment or upper coastal slopes. The revetment will fail in large sections and quickly unravel laterally, and erosion of lower coastal slope will commence. Erosion in the eastern section of the study area will continue as currently where the defences are virtually obsolete. The A174 will be compromised and become unusable by year 20. This is the baseline against which the options are assessed

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Option 2: Do Minimum

4.4.2 Maintenance of the existing revetment would continue until the end of its residual life, estimated to be approximately 5 years. At this point the failures of the surface of the existing revetment would be on too large a scale to patch repair. No new capital works would be carried out and Do Nothing would then commence with the revetment failing in large sections, and erosion of lower coastal slope starting. The eastern sections (MUs 6 and 7) would continue to erode as currently, the A174 would therefore be lost as under the Do Nothing scenario by year 20.

Option 3: Coastal Slope Option 1

4.4.3 Upper coastal slope would be trimmed back to 22°, with excavated material placed in Raithwaite Ravine to provide erosion protection to the 1920's road embankment; this will require the outfall culvert to be extended by approximately 40m. Installation of drainage (vertical drains at 10m centres, toe drain, and French drain at top of slope to collect surface water), and planting of reprofiled slope.

4.4.4 Maintenance of this option would be limited to vegetation management and routine maintenance of the drainage system.

Option 4: Coastal Slope Option 3

4.4.5 Installation of 12m 'H' section steel piles at 2 m centres with precast concrete panels to a height of 4m between the piles. The 'H' piles would be anchored into bed rock to a distance of 5m. Initial trimming of the slope will be required to remove the most unstable sections and drainage at the toe, mid slope and upper slope will be required. The option would work by allowing the upper coastal slope to continue to fail and 'catching' the material behind the wall preventing it reaching the road. The drainage would collect surface and ground water and discharge it safely through the revetment preventing damage to the revetment.

4.4.6 This slope option would require relatively high levels of maintenance, including clearance of fallen material from behind the catch wall, and maintenance of the wall itself and the slope drainage. The design life of the catch wall would be limited to 50 years and would require replacement at that point.

4.4.7 Maintenance of this option would be limited to vegetation management and routine maintenance of the drainage system.

Option 5: Revetment Option B

4.4.8 A rock armour revetment would be constructed on top of the existing revetment, after the concrete surface had been broken out. The revetment would be constructed to approximately the same height as the existing revetment and would continue across the front of Raithwaite Ravine (either in-filled with new fill material or excavated material from slope Option AC), and into MU7 to provide a transition from the scheme into the area of No Active Intervention and prevent outflanking.

4.4.9 The bedrock would be excavated to a depth of approximately 2m and the toe of the rock armour revetment tied in to prevent undercutting.

4.4.10 Improvements to drainage outfalls from the road gullies would be made, and new outfalls incorporated for Newholme Beck at Raithwaite Ravine and the unnamed watercourse close to Raven Hill Farm.

4.4.11 Maintenance for this option would include replacement of rocks and maintenance of the profile of the revetment following storms, and maintenance of the drainage systems.

Option 6: Revetment Option C

4.4.12 A reinforced concrete stepped revetment would be constructed on top of the existing revetment, after the concrete surface had been broken out and the fill material reprofiled to a suitable profile. The revetment would be constructed to approximately the same height as the existing revetment.

4.4.13 The concrete revetment would end at the edge of Raithwaite Ravine and tie into a new rock armour revetment across the front of the fill material placed in Raithwaite Ravine (either in-filled with new fill material or excavated material from slope Option AC).

4.4.14 The bedrock would be excavated to a depth of approximately 2m and the toe of the concrete revetment tied in to prevent undercutting.

4.4.15 Improvements to drainage outfalls from the road gullies would be made, and new outfalls incorporated for Newholme Beck at Raithwaite Ravine and the unnamed watercourse close to Raven Hill Farm. Additional drainage through the concrete revetment would be installed to allow discharge of ground water and ingressed seawater without damaging the revetment.

4.4.16 Maintenance for this option would include concrete repairs following storms, maintenance of the drainage systems and joints. Additionally for the rock armour section maintenance would be required including replacement of rocks and maintenance of the profile of the revetment following storms. In addition, future non-capital works may be required to prevent outflanking to the east of the rock armour; these may be in the form of a timber groyne type structures, such as have been used at the end of the existing defences at Raithwaite Gill.

5.0 Options appraisal and comparison

5.1 Technical issues

Interconnection between Upper Coastal Slope and Revetment

5.1.1 The options considered have been assessed on the basis of upper coastal slope stabilisation options and coastal revetment replacement options. The two aspects are however intrinsically linked in that the inadequate drainage of the upper coastal slopes is resulting in destabilisation and washing out of material in the revetment. A greater combined risk is that of a deep rooted slip failure, as a result of poor drainage and progression of existing shallow and medium slips. This would result in the potential loss of the road and also the coastal revetment. Therefore, although the two areas have been assessed separately, they are linked in terms of the overall stabilisation of the coastal revetment and protection of the highway.

Coastal Slope Option 1

5.1.2 The slope trimming and drainage option ensures that; material is prevented from falling onto the highway, that the slope is stabilised and that surface water and ground water discharge is managed such that it reduces the amount of flows received at the rear of the coastal revetment, thereby reduces the risk of material being washed out and the revetment failing.

5.1.3 The slope trimming and installation of drainage option has proven to be successful on the adjacent slopes where these works have previously been carried out. This option includes an upper interceptor drain and lower toe drain to improve the drainage performance and reduce the risk of shallow surface failures occurring due to surface water flows down the slope face. The drainage system will be separate from the highway drainage (gulley collection) system and therefore the discharged water will be entirely surface water from the slope face. Appropriate techniques and plant will be required for the trimming of the upper slope due to the unstable surface. The trimmed slope material will be placed at Raithwaite Ravine to provide additional protection for this undefended coastal unit and reduce the need to landfill useful material.

5.1.4 This is a low risk, technically proven option that is visually unobtrusive and will provide a low maintenance solution to the upper slope instability problem.

Coastal Slope Option 3

5.1.5 The king-post option ensures that material is prevented from falling onto the highway and that surface water and ground water discharge is managed such that it reduces the amount of flows received at the rear of the coastal revetment and thereby reduces the risk of material being washed out and the revetment failing. The short term and long terms costs for achieving these objectives are however considerably more than the slope trimming option.

5.1.6 The king-post option for the upper coastal slopes minimises the amount of slope material that would need to be removed and reduces the need for slope drainage. However, there are a number of complex technical aspects, such as the rock anchors and the piles themselves, which increase the cost of the option and result in a lower residual life. In addition the concrete wall panels between the king-posts would be between 3 and 4m in height and would not be aesthetically pleasing. This option is expensive, not visually attractive, has a relatively low residual life, high maintenance costs and is technically complex.

Revetment Option B

5.1.7 The rock armour revetment option provides continued erosion protection to the toe of the highway and allows discharge of surface, ground and tidally ingressed water.

5.1.8 The rock armour option for replacing the existing concrete revetment would limit the extent of public access to the beach along the 1km length frontage, with access restricted to full height timber or concrete steps through the armour profile.

5.1.9 In addition, it would require considerably more excavation of the beach / bed rock / sea bed to allow the toe stones to be installed (compared to the stepped revetment toe detail). This has a negative environmental impact and also results in considerable landfill disposal of the excavated material.

5.1.10 As the existing structure is a concrete revetment that has been in place for many decades, a rock armour revetment would present a considerable visual change to the existing character of the beach frontage.

5.1.11 The rock armour revetment would provide a simple method of ensuring drainage and discharge of ground water, surface water and tidally ingressed water, without the need for formalised drainage outlets which have the maintenance requirement for ensuring the non-return valves are functioning.

5.1.12 The height of the rock armour and the depth of the embedded toe stones can be designed to take into account changes in still water levels and overtopping levels, in addition to the rate of erosion (loss) of beach material and/or bed rock. Therefore climate change issues can be incorporated into the design. It is very difficult to implement a managed adaptive approach with rock armour, as this may require complete reprofiling of the revetment to incorporate additional depth or height of rock.

Revetment Option C

5.1.13 The stepped revetment option provides continued erosion protection to the toe of the highway, allows discharge of surface, ground and tidally ingressed water and improves public access to the beach.

5.1.14 The replacement revetment is stepped rather than having a smooth face. This allows the opportunity to enhance access to the beach, as parking is available along the road along the whole 1km frontage where the revetment will be installed. Short lengths of timber steps can be installed to provide more safe access points for beach users. The stepped revetment will also be a safety improvement on the existing concrete revetment, which is slippery and unstable.

5.1.15 It has been recognised that the revetment will require regular jetting and cleaning to ensure that the risk of slipping on algal growth (or similar) is reduced. This maintenance cost has been included within the whole life costs.

5.1.16 The stepped revetment toe is just at Mean High Water Springs, and therefore the revetment will not be subject to continuous wave action. In addition the beach material is fine sand, with very little stone and the risk of debris damage from wave carried particles is reduced. Therefore this is an appropriate environment for a stepped revetment.

5.1.17 The height of the stepped revetment and the depth of the toe have been assessed taking into account current predictions of increases in still water level and wave overtopping resulting from climate change. A managed adaptive approach can be incorporated by allowing the vertical wall section at the rear of the 1.5m walkway to be raised in the future, to manage increased overtopping and slope erosion issues.

Other Technical Issues

5.1.18 The lack of cover (sand) material on the foreshore presents an issue in terms of construction plant causing damage and potential long term instability to the mudstone and clay bed rock areas where tracking and working is required. The construction cost estimate allows for a 1km length temporary haul road to be constructed to a width of 5m and a depth of approximately 1m. This haul road may require rock armour (or similar) protection on the seaward face to prevent excessive washing out during tides/storms. This risk has been identified in the risk register and further consideration will be required during the development of the construction method statement to minimise plant movements on the beach and the overall construction duration.

5.1.19 The rock armour tie-in across Raithwaite Ravine terminates on the east side of the ravine, abutting the remnants of the concrete toe revetment in front of the golf club. There may be a need for future (non capital) works to be carried out to manage outflanking at this location. This could be in the form of timber groyne type structures, which have been successfully control erosion at the current defence termination point on the west side of Raithwaite Ravine.

5.2 Environmental assessment

Table 5.1 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 2 – Do Minimum		
Assets would remain protected for an additional five years compared to the Do Nothing option.	Over the first five years, the coastal slope will continue to undergo minor failures requiring clear up and temporary piecemeal stabilisation works and resulting in periodic temporary road closures and further deterioration to the SINC and BAP habitat.	Construction works should follow industry best practice guidance (i.e. CIRIA).
	Repairs would be undertaken on an emergency basis, which could coincide with peak tourism period.	Production of a construction method statement will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc).
	Following the first five years the key negative impacts would be the same as for the Do Nothing option.	A Site Waste Management Plan (SWMP) will be implemented prior to the commencement of works, if required.
Slope Option 1 – Stabilise the coastal slope and new outfall beneath the road.		
Reduced disturbance and improved health and safety to human receptors through the prevention of slippages onto the A174.	Loss of small area of agricultural land due to re-grading.	Construction works should follow industry best practice guidance (i.e. CIRIA).
Stabilisation of slope will allow for colonisation by floral species, thus enhancing the SINC and BAP habitat.	Re-grading of the slope could affect unknown features of archaeological interest.	Works should be undertaken outside of peak tourism period.
Stabilisation and subsequent colonisation will enhance the visual amenity value and local landscape / seascape character.	The re-use of the material in Raithwaite Ravine will result in the loss of SINC and BAP habitat.	Production of a construction method statement will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc).

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
The re-use of the material in Raithwaite Ravine will improve protection of the A174.	Requirement to extend the existing culvert through the deposited material at Raithwaite Ravine. Potential impacts on water quality resulting from deposition of potentially contaminated material at Raithwaite Ravine.	A Site Waste Management Plan (SWMP) will be implemented prior to the commencement of works. Site Investigation undertaken during October 2011 will determine the presence of contaminants within the coastal slope and potential to re-use.
A number of archaeological sites are present within Raithwaite Ravine. The deposition of material from the coastal slope onto these features would allow for the *in-situ* preservation of such features and sites.		An archaeological watching brief is likely to be required to identify any as yet un-recorded features during the excavations required for the slope stabilisation works. More detailed archaeological recording of the identified sites is likely to be required around the Raithwaite Ravine deposition area, prior to in-filling works.
		A reseeding strategy will need to be put in place to mitigate for the damage to the SINC and BAP habitat and which aims to enhance biodiversity.
Slope Option 3 - Construction of a catch wall and new outfall beneath the road.		
Reduced disturbance and improved health and safety to human receptors through the prevention of slippages onto the A174.	Significant adverse impact to the visual amenity value of the area and local landscape / seascape character due to the presence of the wall.	Construction works should follow industry best practice guidance (i.e. CIRIA).
No disturbance to unknown features of archaeological interest potential located in coastal slope.	Unstable slope material to be sent to landfill.	Works should be undertaken outside of peak tourism period.
	A174 and underlying services at Raithwaite Ravine remains at risk.	Production of a construction method statement will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc).
	The option does not provide a permanent solution to the slope stability issue, and future landfalls are likely to result in further loss of habitat present within the SINC and further loss of BAP habitat.	A Site Waste Management Plan (SWMP) will be implemented prior to the commencement of works.
	Removal of fallen material behind the wall will result in disturbance to human receptors.	A precautionary archaeological watching brief required to identify any as yet un-recorded features during the excavations required for the slope stabilisation works.
	Archaeological features in Raithwaite Ravine remain at risk from erosion.	A reseeding strategy will need to be put in place to reduce the damage to the SINC and BAP habitat and which aims to enhance biodiversity.
Revetment Option B - Construction of a rock armour revetment		
Both revetment options provide the greatest protection over a 100 year period.	Increased sustainability issues in comparison with option C due to the requirement for increased volumes of quarry run rock.	Recycled rock material should be sourced, where possible.
Lower carbon footprint than revetment Option C.	Both options (4a and 4b) will result in the loss of SINC and BAP habitat resulting from the increased height of the defence to take into account sea level rise.	Construction works should follow industry best practice guidance (i.e. CIRIA).
.	Increased use of signage required and increased accumulation of debris in comparison with option 4a.	Works should be undertaken outside of peak tourism period.
	Larger footprint when compared to option 4a.	Production of a construction method statement will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc).
	Increased health and safety risks in comparison with option C due to the increased use of rock armour.	A Site Waste Management Plan (SWMP) will be implemented prior to the commencement of works.
		A reseeding strategy will need to be put in place to reduce the damage to the SINC and BAP habitat and which aims to enhance biodiversity.
Revetment Option C - Construction of a reinforced concrete stepped revetment with rock armour extension.		
Both revetment options provide the greatest protection over a 100 year period.	The use of concrete has the greatest carbon footprint.	Consideration should be given to the used of materials will a lower carbon footprint, such as carbon capturing concrete.

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Improved access to beach from A174.	Both revetment options will result in the loss of SINC and BAP habitat resulting from the increased height of the defence to take into account sea level rise.	Construction works should follow industry best practice guidance (i.e. CIRIA).
	Requirement for signage to deter people from climbing on rock armour. Furthermore, rock revetments accumulate litter.	Works should be undertaken outside of peak tourism period.
		Production of a construction method statement will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc).
		A Site Waste Management Plan (SWMP) will be implemented prior to the commencement of works.
		A reseeding strategy will need to be put in place to reduce the damage to the SINC and BAP habitat and which aims to enhance biodiversity.
		Potential to increase formal access to the beach from the A174 via the revetment. This will have the added benefit of reducing trampling of the SINC and BAP habitat.

5.3 Option costs

5.3.1 The costs have been derived through a combination of Royal Haskoning's in-house Cost Consultants (Quantity Surveyors) and from estimates provided by Birse Coastal. The quantities and cost estimates were based on the outline design drawings, initial intrusive site investigation and information provided by North Yorkshire County Council's (NYCC) Highways employees (who are responsible for the maintenance and repairs of the both the upper coastal slope and the coastal revetment). General costs were derived using SPONS price database, discussions with local Land Fill operators and discussions with NYCC staff.

5.3.2 Costs for the preferred option were obtained from estimates provided by Birse Coastal, based on actual costs for a similar scheme currently being constructed at Redcar.

5.3.3 All options were initially assessed with a 45% overall contingency allowance to reflect the level of uncertainty associated with the risks and costs of certain key activities at the option scoping stage.

5.3.4 A full breakdown of the Option Costs is provided in Appendix H.

Table 5.2 Summary of options present value costs (£k)

	Do Minimum	Option 1B	Option 1C	Option 3B	Option 3C
Local Authority Staff		£27	£22	£41	£36
Consultant Fees		£222	£183	£334	£295
Early Contractor Involvement (ECI)		£14	£11	£20	£18
Cost consultant fees		£8	£7	£12	£11
Site investigation & survey		£0	£0	£0	£0
Construction		£8,130	£6,659	£12,399	£10,928
Environmental mitigation		£168	£137	£256	£225
Environmental enhancement		£84	£69	£128	£113
Site supervision		£671	£549	£1,023	£901
Compensation		£168	£137	£256	£225
Risk contingency (45%)		£4,270	£3,500	£6,510	£5,740
Sub Total	**£0**	**£13,762**	**£11,274**	**£20,979**	**£18,492**
Other (Strategic Monitoring & Review)	£147	£226	£226	£226	£226
Future costs (const. + maintenance)	£2,329	£855	£896	£2,701	£2,741
Total PV cost	**£2,476**	**£14,843**	**£12,396**	**£23,906**	**£21,459**

5.4 Options benefits (Damages avoided)

5.4.1 Damages have been calculated using the Multi Coloured Manual (MCM) and the Green Book (HM Treasury, 2003). These documents have been used in combination with the Defra FCERM-AG series and Supplementary Guidance Notes. Figures in the Multi Coloured Manual have been updated to 2nd Quarter 2011 using the Consumer Price Index.

5.4.2 Damages have been calculated for the 100 year appraisal period and discount rates starting at 3.5% and reducing to 2.5% have been applied.

5.4.3 The damages that have been quantified fall into four categories, road traffic disruption, property, services and historic assets. Damages which have not been quantified include social, amenity and tourism. These damages have not been quantified as it would not be proportional to do so. Compared to the value of the damages derived from the road traffic disruption, the damages derived from social, amenity and tourism impacts would be relatively minor and would not change the magnitude of the total damages or the overall economic viability of a scheme.

Do Nothing

5.4.4 Based on the 2007 SMP erosion lines the A174 would be unusable by year 20 under the Do Nothing scenario, resulting in a permanent 22km diversion on alternative existing A-roads. The cost of the permanent traffic diversion has been calculated following the methodology set out in the MCM. Survey figures provided by NYCC give an Annual Average Daily Traffic figure of 5,209 vehicles between Sandsend and Whitby on the A174; resulting in an annual cost for the additional 22km journey length of £9,681k. This is applied over the remaining appraisal period and discounted.

5.4.5 In addition for the first 20 years, up to the point that the road becomes unusable, damages have been allowed to account for road closure and clearance on health and safety grounds to clear cliff falls onto the road, to prevent road accidents, with a cost per incident of £88k applied every other year over the first 20 years.

5.4.6 The total discounted value of the road traffic disruption damages has been factored for the length of the A174 that is within the study area of this project, to avoid double counting of benefits in the future for any potential schemes for Sandsend Village. The PVd from damages due to road traffic disruption for the Do Nothing scenario is £100,731k. This is the value used to appraise the strategic options.

5.4.7 Following the MCM methodology for infrastructure at risk of coastal erosion the least cost option needs to be considered from; 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. At strategy stage diverting the road out of the erosion zone was being considered as an option and therefore the damages were taken as the costs of traffic using the 22km diversion. However at PAR stage the Do Nothing damages for the road traffic disruption have been capped at the cash cost of the road diversion (Option 3 from Whitby Coastal Strategy 2) which is £84,166k.

5.4.8 There are 16 properties at risk of erosion within the 100 year appraisal period. The year of loss of the properties has been based on the 2007 SMP erosion lines. Damages have been calculated following the MCM methodologies and values for the properties have been taken at market value discounted for the year of loss. The PVd from damages due to loss of property due to coastal erosion for the Do Nothing scenario is £111k.

5.4.9 There are a variety of services within the A174 road. The services will start to be compromised by coastal erosion along with the road by year 20. The damages for the services have been calculated following the MCM methodology for infrastructure at risk of coastal erosion. The least cost option would be to divert the services to a new route out of the erosion zone, and this is therefore the damage taken. The cost for diverting the services has been taken as £375/m and the year of diversion is based on the SMP erosion lines. The PVd from damage to services contained within the A174 for the Do Nothing scenario is £828k.

5.4.10 In order to assign damage values for the loss of historic assets at risk of coastal erosion specialists in archaeology have been consulted (Northern Archaeological Associates Ltd). The damages have been derived as the cost of surveying and recording the historic assets before they are lost to coastal erosion, as recommended in Environment Agency guidance (Flood and Coastal Erosion Risk Management Appraisal Guidance – Supporting Document for the Appraisal Summary Table, March 2010). The costs for each management unit have been applied 5 years before the Do Nothing erosion of the frontage in that management unit is due to commence (taking into account existing coastal defence assets with no maintenance). The 5 years is to allow time for the surveying and recording to be carried out before the historic asset becomes directly at risk. The PVd from loss of historic assets for the Do Nothing scenario is £3.1k.

Do Minimum

5.4.11 Although under the Do Minimum scenario the coastal defence assets in MU4CD and 5 would have a slightly longer residual life (5 years more than Do Nothing), the artificial embankment in MU6 and the historic defences in MU7A that have deteriorated to such an extent that they are now virtually obsolete would erode at the same rate as under Do Nothing and the road would still become unusable by year 20. Therefore the Do Minimum damages for road traffic disruption are the same as for Do Nothing.

5.4.12 The property damages are reduced as the residual life in the assets in MU4CD is extended by 5 years under Do Minimum, resulting in PVd of £13k.

5.4.13 The damages relating to services and historic assets are slightly reduced under Do Minimum in MU4CD and MU5 due to the extended residual life of the existing assets, however the damages remain the same as under Do Nothing for MU6 and MU7A. Therefore the Do Minimum PVd for services is £742k and for historic assets is £2.9k.

Do Something

5.4.14 All of the short listed Do Something options being considered provide the same outcome; a scheme to maintain the A174 along its existing alignment with a design life of 100 years, and would be implemented at same time regardless of option. Therefore the options will have the same residual damages, and therefore benefits.

5.4.15 The properties, which are in MU4CD at risk under the Do Nothing would be protected, as would the services and historic assets in MU4CD to MU6, therefore all of these damages would be avoided. However the services and historic asset damages in MU7A would still occur where the short section of road is re-aligned, the residual damages will be £205k and £0.5k respectively. The majority of the road traffic disruption damages would also be avoided, with residual damages of £92k due to temporary road closure and clearance following surface slips on the upper coastal slope during the period prior to scheme construction (Year 1).

Table 5.3 Summary of present value (PV) damages and benefits (£k)

Option	Damage (PVd)	Damage avoided	Benefits (PVb)
Do Nothing	£85,108k	-	-
Do Minimum	£84,924k	£184k	£184k
Option 1B	£298k	£84,810k	£84,810k
Option 1C	£298k	£84,810k	£84,810k
Option 3B	£298k	£84,810k	£84,810k

6.0 Selection and details of the preferred option

6.1 Selecting the preferred option

6.1.1 Following the FCERM decision process the economically preferred option identified in Stage 2 as having the highest average benefit-cost ratio is Option 1C, coastal slope re-grading and drainage installation with a concrete stepped revetment. All of the Do Something options provide the same benefits and therefore there are no incremental benefit-cost ratios.

Table 6.1 Benefit-cost assessment

Option	PV Costs (£k)	PV Benefits (£k)	Av. Benefit/cost ratio
Do Minimum	£2,476k	£184k	0.07
Option 1B	£14,843k	£84,810k	5.71
Option 1C	£12,396k	£84,810k	6.84
Option 3B	£23,906k	£84,810k	3.55
Option 3C	£21,459k	£84,810k	3.95

6.1.2 The preferred option was selected at an options workshop with SBC and NYCC. Option 1C was selected for visual and tourism reasons as well as being the most economic.

6.1.3 A concrete stepped revetment will provide more amenity potential than a rock armour revetment, allowing residents and visitors to use the revetment for seating, access and an alternative solid surface to the sandy beach for walking on for members of the public with mobility problems. In terms of access, the rock armour revetment would limit access from the foreshore to the footpath alongside the A174 to designated access points (e.g. steps), however the concrete stepped revetment would allow access along its entire length to a safe level above the MHWS, and this will improve the public safety for beach users.

6.1.4 The concrete stepped revetment would be more visually acceptable than a rock revetment in this location, particularly as the existing revetment is concrete; there is also no precedent for rock armour in the immediate vicinity of Sandsend, the coastal defence assets are predominantly vertical masonry walls.

6.1.5 Option 1C was judged to be the best option for better achieving the objectives of the project, in particular to ensure the scheme is sympathetic to the tourism potential of the village.

6.2 Sensitivity testing

6.2.1 If the erosion rate is slower than anticipated then the loss of the highway could be delayed beyond year 20 under the Do Nothing and Do Minimum scenario. A delay of 10 years (road lost in year 30) would result in a decrease of 14% for the road traffic disruption present value damages; a further delay to year 40 would reduce the road traffic disruption damages by 39%. Although this would reduce the BCR of preferred option 1C from 6.84 to 5.87 and 4.15 respectively the scheme is still economically viable with a good BCR.

6.2.2 Conversely if the erosion rate is more rapid than expected and the road is lost by year 10 instead of 20, the road traffic disruption damages will increase by 127% and if they are not capped at the cost of relocating the highway inland, then the BCR would increase to 15.43.

6.2.3 As well as the costs associated with the permanent 22km diversion of traffic, there will be additional road traffic disruption damages associated with increased congestion on the diversion route. The 22km diversion is on existing busy A-roads, and the additional approximately 5,000 vehicle movements a day on these roads would cause increased congestion, reducing the average speed and increasing the cost to the vehicles already using the roads that make up the diversion route. These additional road traffic damages calculated following the methodology in the MCM amount to £91,203k, and if capping of the Do Nothing damages was not applied this would strengthen the BCR of the preferred option to 20.15.

6.2.4 The costs of preferred option 1C (including the 45% optimism bias included in the option appraisal costs) would have to increase by an additional 37% (£4,566k), or the benefits reduce by 27% (£23,128k) before the BCR would drop below 5.

6.2.5 Options 1B and 1C are closest in cost, with 1B £2,447k (20%) more expensive. Although typically rock is a cheaper construction technique than concrete for coastal revetments, in this instance the rock revetment requires more excavation at the toe to tie into the bedrock than for the concrete revetment, and this increases the construction cost above that for Option 1C. The material costs for concrete would have to double before the total cost of Option 1C would increase to above that for Option 1B.

6.2.6 One of the key cost risks is that the material excavated during the slope re-grading and the breaking out of the existing revetment cannot be reused in the construction of the in-filled section of Raithwaite Ravine, and therefore has to be disposed of in landfill. This would result in an additional cost of £1,734k to the project, reducing the benefit-cost ratio of the preferred option to 6.00. This additional cost would not change the preferred option, as both revetment options would be affected in the same way, and the king post slope option (Slope Option 3) was significantly more expensive than the additional cost of landfilling the material trimmed from the slopes in Slope Option 1 if necessary.

6.3 Details of the preferred option

Technical aspects

6.3.1 The preferred option includes the stabilisation of the upper coastal slope and the replacement of the existing concrete revetment. The replacement concrete stepped revetment will be designed to ensure that the rate of beach level reduction and bed rock erosion is considered over the asset life and that toe depth and design are appropriate. It will also be designed such that the height of the revetment is sufficient to prevent erosion of the grassed slope above the revetment, based on current 1 in 200 year still water and wave levels, with the ability to raise the height of the rear wall to accommodate sea level rise and potential increased wave overtopping in the future – delivering a managed adaptive approach to climate change issues.

6.3.2 The upper slope will need to be regraded with mechanical excavators and the material relocated to Raithwaite Ravine. Slope drainage will be installed with upper and lower interceptor drains constructed. An inspection chamber will be constructed and associated pipe connections laid beneath the highway to a new outfall structure through the proposed replacement revetment in order to discharge the collected drainage.

6.3.3 The existing concrete revetment will need to be broken out, and fill material imported to form the new revetment slope profile. A drainage layer will be installed and the new revetment placed or formed on top of this. Drainage outfalls will need to be accommodated through the revetment and special step units placed where formalised access is required to the beach.

6.3.4 A short length of rock armour revetment will be formed across the material placed at Raithwaite Ravine, to provide protection to the toe of the road embankment. This rock armour section will terminate on the east side of Raithwaite Ravine. Future non-capital works may be required to control outflanking at the junction for the defences and the undefended cliffs that front the golf course.

6.3.5 Rock armour infill will be placed between the end of the revetment at Sandsend Café and the adjacent concrete slipway, to provide a tie-in detail to this existing feature at the western end of the study area.

6.3.6 On completion of the works the inspection and maintenance responsibilities for the new assets will be taken on by NYCC's highways team, as is the current management arrangement for these coastal assets. Maintenance will include jetting and cleaning of the stepped revetment, repairs to the revetment units, inspection and cleaning of the drainage assets on the upper slopes and repairs and maintenance to the non-return valves on outfalls through the revetment.

6.3.7 Public safety has been considered within the development of the preferred option. As there is a 1km frontage with parking along this whole length, it is considered that a stepped revetment provides the best opportunity for safe access and egress. It is accepted that jetting of the step surface will be required and that repairs to the steps over time will be inevitable. These costs have been identified in the whole life cost estimate. The existing timber access steps are the responsibility of SBC and it is anticipated that they will continue to maintain any replacement timber steps.

6.3.8 The stability of the upper coastal slope is a major contribution to public safety, as it removes the risk of falling materials onto the highway. This is of particular concern as the road is very popular with motorcycles that are especially vulnerable to debris and/or mud on the road.

6.3.9 The preferred option incorporates the reuse of 19,000 cubic metres of trimmed slope material to provide a formalised defence to the toe of the artificially constructed highway embankment at Raithwaite Ravine, where the historic defences are now so dilapidated as to be virtually obsolete. This sustainable reuse of material that would otherwise have been land filled, provides costs savings in excess of £1M and substantially reduces vehicle movements and hence pollutant emissions.

6.3.10 A key residual risk is the unknown formation of the slope material beneath the existing concrete revetment. If this is not formed from a trimmed sand slope in some locations, then additional costs may be incurred for trimming, disposal and importing fill material. This risk has been identified in the Risk Register.

6.3.11 Several investigations have been carried out to support the development of the preferred option. These include intrusive ground investigation, contaminated land testing of the upper coastal slope material to be reused, drainage investigation of the existing highway drainage system, topographic survey, and a Phase 1 habitat survey. In addition to these surveys carried out specifically for this PAR, information has been drawn from surveys carried out for the Whitby Coastal Strategy Review, including archaeological desk study, geological walkover survey, cliff survey, and asset condition inspections. The results from all of these surveys and studies have informed the outline design, and reduce the uncertainties associated with the preferred option.

Environmental aspects

6.3.12 The proposed scheme has the potential to affect the existing coastal processes, in particular through the continuation of the revetment across Raithwaite Ravine. This has the potential to reduce sediment input into the system, which could affect beach levels and rate of erosion elsewhere along the coast; however, considering the small extent of coastal frontage affected, any effects are considered to be negligible.

6.3.13 A Phase 1 Habitat Survey undertaken in September 2011 identified that the preferred options would affect semi-improved neutral grassland and coastal grassland habitats, as well as a small area of open yellow dune, present above the existing defences near Sandsend Café, and another small area of open fore dune, present in Raithwaite Ravine (Report N2 in Appendix N). The survey did not record any floral species of note; however, it is known that, in particular, orchids are present and that the lack of any recordings may be a result of the timing of the survey. As such a re-survey at the appropriate time (between June and July) in 2012 has been recommended.

6.3.14 The Phase 1 Survey identified the following recommendations:

- If possible, the works should be undertaken outside the breeding bird season (typically beginning of March to end of August). Where this is unavoidable the areas of vegetation likely to be directly disturbed or damaged should be cleared outside of the breeding bird season to deter birds from nesting. A suitably qualified ecologist should survey the works areas for the presence of nesting birds immediately prior to work commencing;
- The works areas, including vehicle access routes, should be delimited with tape or temporary fencing to avoid any accidental damage to adjacent habitats;
- Although the extent of the proposed works has not been confirmed, the coastal slopes offer suitable reptile habitat; however, as noted, no reptiles have been identified within 2km of the study area. As such consultation with NYCC's Ecologist is recommended to inform any further work that may be required to mitigate for the presence of reptiles. Should it be required, it is suggested that a supervised vegetation clearance exercise be undertaken during the active season (April to September, inclusive);
- The re-graded slope and defence works to Raithwaite Ravine should be appropriately re-seeded, with the species mix used discussed and agreed with NYCC and Natural England.

6.3.15 The stabilisation and subsequent re-seeding of the upper coastal slope is considered to be beneficial to the SINC and BAP habitat. The placement of material and subsequent re-seeding of Raithwaite Ravine is considered to have no significant effect on the SINC and BAP habitat. The removal of any scrub and re-seeding with suitable grassland species could be seen as being of benefit to the biodiversity value of Raithwaite Ravine.

6.3.16 The status of the WFD waterbodies will be maintained by adhering to best practice and Environment Agency guidelines during the construction phase.

6.3.17 In order to minimise the potential effects to beach users, tourists, road users and local community, the proposed works are to take place outside of the peak tourism period. Should it be required, it is also suggested that delivery times could be organised to not coincide with peak traffic periods, such as commuting periods. Furthermore, information signs will be placed around the site compound providing contact details for any complaints to be sent to and addressed. Furthermore, all local residents within 500m will be informed of the proposed works by letter drop, providing them with a contact details to address complaints to, so that they can be addressed.

6.3.18 In order to mitigate any adverse effects to the features of archaeological interest present, the following measures are proposed and which have been agreed with NYCC's Archaeologist:

- a written statement of investigation and recording which will be approved by the County Archaeologist (a detailed account of mitigation requirements and how they are to be met including working methods, anticipated outputs, the dissemination and archiving of information, monitoring and quality assurance arrangements and a timetable);
- watching brief for the slope re-grading works;

- detailed investigation and recording of the features known to be present within Raithwaite Ravine; and,
- The recording of the features known to be present along the existing revetment.

6.3.19 The replacement of the existing defences is considered to improve the local landscape / seascape character and amenity value through the replacement of defences that are in a state if disrepair and by increasing access to the beach from the A174. Additional benefits will arise through the stabilisation and subsequent re-seeding of the upper coastal slope, which will allow for the establishment of grassland species and the prevention of slippages onto the A174.

6.3.20 The continuation of the revetment across Raithwaite Ravine is considered to affect the local landscape / seascape character through the presence of the rock revetment and by making the frontage more linear. As Raithwaite Ravine has already been partially infilled by the embankment to carry the road in the 1920s it is considered that there are fewer potential impacts from continuing the revetment across the ravine, than if it was a natural valley.

6.3.21 The rock revetment will prevent the erosion of the cliffs seaward of the A174. Whilst this will affect the natural evolution of the frontage, the actual extent of this change is considered to be small and therefore not significantly affect the local landscape / seascape character of the frontage, in terms of the revetment's effect on the cliffs. In order to minimise the potential effects of the rock revetment, the following measures are being proposed:

- minimising the extent and overall footprint of the revetment through modelling the predicted effect the revetment will have on the frontage to ensure that the road remains protected, whilst minimising the volume of rock required;
- using rock that is similar in colour, as much as possible, to the new revetment in order to reduce the transition from the stepped to rock revetment.

Costs for the preferred option

6.3.22 The costs for the preferred option have been developed further from the costs presented in Table 5.2 in Section 5.3. The construction costs are based on the price estimate provided by Birse Coastal. The PAR to construction and construction stage staff costs (Local Authority, Consultant, Cost Consultant, Site Supervision) have been refined based on the likely level of input required throughout the programme.

6.3.23 Inflation has been calculated at a rate of 2.5% following the standard Environment Agency methodology. Inflation for 18months has been included.

6.3.24 Details of the cost estimate can be found in Appendix H.

Table 6.2 Project costs for preferred option (£k)

	Cost for economic appraisal (PV)	Whole life cash cost	EA FSoD approval project cost
Costs to PAR:			
Local Authority staff		£5	
Site investigation & survey		£23	
Consultant fees		£31	
Early Contractor Involvement (ECI)		£0	
Cost consultant fees		£0	
Sub-total		**£59**	**£35**
PAR to Construction:			
Local Authority staff	£14	£15	£15
Site investigation & survey	£0	£0	£0
Consultant fees	£116	£120	£120
Early Contractor Involvement (ECI)	£8	£8	£8
Cost consultant fees	£28	£29	£29
Other costs	£0	£0	£0
Sub-total	**£166**	**£172**	**£172**
Construction:			
Construction costs	£6,635	£7,106	£7,106
Inflation allowance for 18 months @ 2.5%			£523
Environmental enhancement	£20	£21	£21
Environmental mitigation	£33	£36	£36
Local Authority staff (ECC PM)	£39	£42	£42
Consultant fees	£0	£0	£0
Site supervision	£196	£210	£210
Cost consultation fees	£39	£42	£42
Compensation	£100	£107	£107
Other costs	£0	£0	£0
Sub-total	**£7,062**	**£7,563**	**£8,086**
Future costs:			
Maintenance	£408	£1,435	
Future construction	£366	£675	
Risk contingency:			
Monte Carlo 95% or similar			£2,038
Monte Carlo 50% or similar	£1,332	£1,332	
Contributions - Scheme			-£3,797
Contributions – Inflation & Risk			-£1,736
TOTAL	**£9,334**	**£11,064**	**£4,763**

*Note: these costs have been developed further during the outline design of the preferred option and therefore differ from the costs presented in Table 5.2 for the option appraisal comparison.

Contributions and funding

6.3.25 North Yorkshire County Council (NYCC) have so far contributed £24k to the production of the PAR and will contribute £3,797k to the design and construction of the scheme (including 50%ile risk contingency). In addition they will make a provision for a £1,736k allowance to cover inflation and risk contingencies at the 95%ile level. This contribution has been allocated in NYCC's budgets for 2013/14 and 2014/15, if the project does not go ahead within these timescales the contribution cannot be guaranteed to still be available at a later date.

6.3.26 NYCC will be the responsible authority for on-going of maintenance of the scheme following its construction. NYCC will contribute the £774k costs for the future maintenance and works.

6.3.27 NYCC have allocated £60k for 2012/13 for maintenance to prevent failure of the existing revetment and upper coastal slope prior to the scheme being implemented.

Outcome measures and funding priority

6.3.28 The Sandsend Road Coast Protection and Slope Stabilisation Scheme would provide benefits for 10 households at risk of coastal erosion. The scheme has an overall benefit-cost ratio of 9.09, and will attract Flood Defence Grant in Aid (FDGiA) funding of £4,763k. The scheme has a raw outcome measure score of 51%. With the contribution of £4,571k from NYCC (£3,797k for design & construction, and £774k for on-going maintenance), the adjusted outcome measure score is 100%, as shown in Table 6.3

Table 6.3 Outcome measure contributions and prioritisation score

Outcome measure		Number	Qualifying Benefits	FDGiA Contribution
OM1 Economic Benefit			£84,457	£4,692
OM2 (Households better protected against flooding)	**20% most deprived areas**	0	£0	
	21-40% most deprived areas	0	£0	
	60% least deprived areas	0	£0	
OM3 (Households better protected against coastal erosion)	**20% most deprived areas**	0	£0	
	21-40% most deprived areas	0	£0	
	60% least deprived areas	10	£353	£71
OM4 (Statutory Environmental Obligations Met)			£0	£0
TOTAL FDGiA Contribution				**£4,763**
Raw OM Score				51.03%
Cost saving and/or external contribution required				£4,571
Scheme Contributions Secured				£4,571
Adjusted OM Score				100%

7.0 Implementation

7.1 Project planning

Phasing and approach

7.1.1 The construction of the different components of the scheme are interlinked; the material removed from the upper slope will be re-used to construct the defence at the base of the road embankment at Raithwaite Ravine. Therefore it is difficult to split the construction programme into discrete phases, and a single construction phase is proposed.

7.1.2 Careful consideration of the phasing of the works within the programme will be required to ensure that the useful material relocated from the upper slopes is not washed out before it can be protected by the proposed rock armour.

Programme and spend profile

7.1.3 North Yorkshire County Council have funds available as part of their contribution to the design and construction of the scheme to begin the procurement process in 2012/13. Procurement of all the necessary roles and the Design & Build Contractor is programmed to be complete by April 2013. This early procurement will allow the project to progress efficiently to construction as soon as possible, in order to reduce the likelihood of a major failure of the existing revetment given its current very poor condition or the upper coastal slope occurring before the new scheme is in place.

7.1.4 Design of the scheme is programmed to take 6 months between April and September 2013. During this period all the necessary consents, licences and permissions will be sought, in order to get them all approved by October 2013.

7.1.5 The construction period is 18 months. Within that period works will be carefully programmed to minimise potential impacts on the tourism industry. Activities that would cause the greatest disruption such as closure or partial closure of the A174 would be programmed outside of peak tourism season. Construction is programmed to commence in October 2013, and would therefore only impact on one summer season.

7.1.6 The necessary consents and permissions will be obtained prior to works commencing on site. The consents and permissions identified are;

- Marine Management Organisation Licence
- Planning Permission
- Discharge Consent

7.1.7 The detailed programme can be found in Appendix J.

7.1.8 The expenditure profile is presented in Table 7.2. This is compatible with the Medium Term Plan.

Table 7.1 Key dates

Activity	Date
MMO Licence and Planning permission received	October 2013
Works start on site on	October 2013
Works substantially complete by	March 2015

Table 7.2 Annualised spend profile (£k)

	2012/13	2013/14	2014/15	2015/16	2016/17	Future Years	Total
Local Authority staff		29	28			15	72
Fees	29	212	168			90	499
Construction		2,429	5,200			350	7,456
Environmental mitigation		12	24			7	43
Environmental enhancement		7	14			5	26
Compensation		75	32			15	122
Other							
Risk contingency (50% risk)		444	888			193	1,525
Less non grant eligible costs						675	
Grant Rate	0%	51%	51%			0%	
Total grant eligible sum*		**1,652**	**3,021**				***4,673**

Notes: Fees includes site investigation, surveys and site supervision.
Figures include inflation at 2.5% for 18months

7.2 Procurement strategy

7.2.1 The scheme will be promoted by North Yorkshire County Council and will be project managed by the Highway's Area Team based in Whitby.

7.2.2 The consultant and contractor services for the next stages of the project will be procured using the recently appointed YorCosult and YorCivils frameworks.

7.2.3 The scheme will be procured under a Design & Build contract using the YorCivils framework. This will ensure that full contractor involvement and integration will be embedded into the project going forwards into the design and construction phases. The early involvement of a contractor with experience of constructing this type of coastal project will assist in reducing cost uncertainty through maximising the buildability of the scheme and from having realistic cost assessments based on recent similar projects and an understanding of the nature and extent of the residual risks.

7.2.4 The following roles will be procured through YorConsult:

- Employer's Agent – to assist in producing tender documents and assessing tenders and subsequently to assist the Project Manager to oversee the contract(s) awarded;
- Cost Consultant – to assist in evaluating tenders prior to award and to assess payments and provide contract advice during the construction phase ;
- Site Supervisor – to supervise the Contractor during the construction phase;
- CDM-Coordinator – to advise the Client and ensure that CDM Regulation requirements guidance are being implemented and integrated into the project;

7.3 Delivery risks

High level risk register

7.3.1 A Monte Carlo risk analysis has been carried out on the preferred option and can be found in Appendix L. The key delivery risks identified are outlined in Table 7.3.

7.3.2 The 95%ile risk allowance included within the scheme costs is £2,038k.

Table 7.3 High level risk schedule and mitigation

Key project risk	Adopted mitigation measure
Weather and tide delays	Detailed design and ECI stage to consider the balance between working in more favourable seasons against the impact on tourism and also environmental considerations.
Volume of excavated material exceeds the usable capacity at Raithwaite Gill – requiring landfill disposal	Detailed topographic surveys have been carried out of the upper and lower coastal slopes and of Raithwaite Gill itself, therefore this risk is low. Detailed design to consider steepest allowable upper slope angle to reduce total excavation quantities.
Further instability of upper slope occurs prior to or during construction resulting in additional disposal quantities and potential alternative design solution(s).	Works to be carried out as soon as possible to minimise the risk of a major upper slope failure.
Tidal erosion of temporary haul road on beach results in additional imported sand costs and potential need for rock armour placement of seaward side	Timing of construction works to minimise risk of storm damage. Consideration of the use of rock for Raithwaite Ravine to line the seaward face of the access track should be considered.
Material beneath existing revetment is unsuitable for reuse as fill material	Risk Register includes an allowance for extra disposal and importing material.

Safety plan

7.3.3 The CDM-Coordinator will be appointed using the YorConsult framework prior to the detailed design of the scheme commencing.

7.3.4 The key roles under CDM are as follows:

- CDM-Co-ordinator To be appointed using YorConsult framework
- Client North Yorkshire County Council
- Principal Contractor To be appointed using YorCivils framework

7.3.5 Public safety will be assessed in line with North Yorkshire County Council's procedures prior to the start of construction of the works.

Appendix A Project report data sheet

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):	
Project Name (60 characters max.):	Sandsend Road Coast Protection & Slope Stabilisation Scheme
Promoting Authority: Defra ref (if known)	
Name	North Yorkshire County Council
Emergency Works:	No (Yes/No)
Strategy Plan Reference:	Whitby Coastal Strategy
River Basin Management Plan	n/a
System Asset Management Plan	n/a
Shoreline Management Plan:	River Tyne to Flamborough Head
Project Type:	Coast Protection

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

CONTRACT DETAILS

Estimated start date of works/study:	Oct 2012
Estimated duration in months:	Mar 2015
Contract type*	Design/Construct

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

COSTS

	APPLICATION (£000's)
Appraisal:	59
Costs for Environment Agency approval:	4,763
Total Whole Life Costs (cash):	11,064

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:	
Deductible Contributions:	
ERDF Grant:	
Other Ineligible Items:	

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	North-East Region
Name of watercourse (fluvial projects only):	n/a
District Council Area of project (all projects):	Scarborough Borough Council
EA Asset Management System Reference:	
Grid Reference (all projects):	NZ866486

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

DESCRIPTION

Specific town/district to benefit:	Sandsend

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

The preferred option includes the stabilisation of the upper coastal slope through re-grading to a stable angle and the installation of drainage in addition to the replacement of the existing concrete revetment with a concrete stepped revetment. The defence would be continued across Raithwaite Ravine, at the eastern end, with a rock revetment protecting the toe of the highway embankment.

DETAILS

Design standard (chance per year):	n/a	yrs
Existing standard of protection (chance per year)	n/a	yrs
Design life of project:	100	yrs
Fluvial design flow (fluvial projects only):	n/a	m^3/s
Tidal design level (coastal/tidal projects only):	4.38	m
Length of river bank or shoreline improved:	1,100	m
Number of groynes (coastal projects only):	1	
Total length of groynes* (coastal projects only):		m
Beach Management Project?	No	Yes/No
Water Level Management (Env) Project?	No	Yes/No
Defence type (embankment, walls, storage etc)	Revetment	

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

ADDITIONAL AGREEMENTS:

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

ENVIRONMENTAL CONSIDERATIONS

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

SITES OF INTERNATIONAL IMPORTANCE

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

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

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

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

OTHER ENVIRONMENTAL CONSIDERATIONS

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

COMPATIBILITY WITH OTHER PLANS

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

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

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

Other agreements

Detail	Result

(Not Applicable/Received/Awaited for each)

Costs, benefits & scoring data

(Apportion to this phase if part of a strategy)

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

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

LAND AREA

Total area of land to benefit:	1		Ha
of which present use is:	FRM	CERM	
Agricultural:		0.2	Ha
Developed:		0.8	Ha
Environmental/Amenity:			Ha
Scheduled for development			Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
[1]Residential		10		90
Commercial/industrial		6		21
Critical Infrastructure		1		84,697
Key Civic Sites		0		
Other (description below):				
Description:				

Costs and Benefits

[1]Present value of total project whole life costs (£'000s):	9,334
Project to meet statutory requirement?	N

	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:		90
Present value of commercial/industrial		21
Present value of public infrastructure benefits:		84,697
Present value of agricultural benefits:		0
Present value of environmental/amenity		2.6
[1]Present value of total benefits (FRM &	84,810	
Net present value:	75,476	
Benefit/cost ratio:	9.09	

Base date for estimate:	Q4 2011	
PAG Decision Rule stage 3 applied	No	Yes/No
PAG Decision Rule stage 4 applied	No	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*: **42.86%** Indicate if deprived: No Yes/No

(*as ranked by Indices of Multiple Deprivation)

Risk: VH, H or N/A

	Wetland	Saltmarsh/ Mudflat	
Net gain of BAP habitat:	0	0	ha
SSSI protected:	0		ha
Other Habitat:			ha
Heritage Sites:			"I or II" , "II or other" or "N/A"

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: Yes/No

Reason (max 100 chars):

Appendix B List of reports produced

Reports produced specifically for Sandsend Road Coast Protection & Slope Stabilisation Scheme PAR:

- Sandsend Road PAR Geotechnical Desk Study – Royal Haskoning (July 2011)
- Addendum to Sandsend Road PAR Geotechnical Desk Study (Land Quality) – Royal Haskoning (September 2011)
- Sandsend Sloep Stabilistion: Factual Report on Ground Investigation. Report No A1077-11 – Soil Mechanics (December 2011)
- Assessment of suitability of re-use of soil memo – Royal Haskoning (November 2011)
- Drainage Survey Report - Lanes for Drains
- Topographic Survey
- Sandsend PAR Extended Phase 1 Habitat Survey – Royal Haskoning (October 2011)
- Sandsend Road Coast Protection Scheme Environmental Screening Report – Royal Haskoning (December 2011)
- Sandsend Road PAR Environmental Report – Royal Haskoning (November, 2011)

Other reports used during development of the PAR:

- River Tyne to Flamborough Head Shoreline Management Plan 2 (2007)
- Whitby Coastal Strategy: Sandsend to Abbey Cliff – High Point Rendell (2002)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategy Appraisal Report (draft) – Royal Haskoning (2011)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategy Appraisal Report Appendices (draft) – Royal Haskoning (2011):
    - Historic Environment Desk Based Assessment
    - Geological Walkover Survey
    - Coastal Cliffs and Slopes Inspections
    - Coastal Defence Inspection
    - Wave Overtopping Overview
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategic Environmental Assessment Scoping Consultation Document (draft) – Royal Haskoning (2011)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategic Environmental Assessment Environmental Report (draft) – Royal Haskoning (2011)
- Cell 1 Monitoring: Scarborough Asset Inspection 2010 – Royal Haskoning (2010)