

Project Appraisal Report

Authority Scheme Reference	HP11
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LDW/CPW Number	CPW1926
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Promoting Authority	Hartlepool Borough Council
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Scheme Name	Town Wall Model Study & Construction C6-3
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Historical damage at the Hartlepool Town Wall and recent overtopping and undermining of the wall foundations

Date	September 2011
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Version	1
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Form CPA 1

This form is to accompany the Project Appraisal Report for a works scheme submitted for grant. Form and PAR are to be sent to the appropriate Area Flood & Coastal Risk Manager of the Environment Agency.



Customer services line: 08708 506 506

Email: laidbfinance@environment-agency.gov.uk

Coast Protection Act 1949 Sections 5(1) to 5(6)

For Official Use Only

Grant
Allocation no:

Authority Ref:

Local Authority Coast Protection Project

Certificate of Statutory Consultations and Responses to them

NOTE • This certificate should be completed and signed by an officer of the Council authorised to sign the Project Appraisal Report – Approval History Sheet.

I hereby certify that **Hartlepool Borough** Council has complied with the provisions of the Coast Protection Act 1949 ('the Act'), the Coast Protection (Notices) (England) Regulations 2002 SI 2002/1278 ('the Regulations') and the Memorandum Relating to Scheme Approvals and Grants under the Coast Protection Act 1949 ('the Memorandum'), in respect of the project the Council wishes to undertake at:

Town Wall, Hartlepool

Project name: **Town Wall Model Study & Construction C6-3**

In particular, the Council has:

1. Published Notice of the project in the form laid down in the Regulations in the following local newspaper(s):

Name of newspaper	Date Notice published	Response(s) (Nos)	Objection(s) (Nos*)

* If consent to withdraw an objection was conditional please provide details below

--

If required please continue on a separate sheet,
(manual users) please use a separate sheet of paper and tick this box to indicate you have done so,
(electronic users) please tick this box and a continuation page will be automatically generated.....

☐

2. Served Notice of the scheme on those bodies specified under regulation 3 of the Regulations, namely:

Name of Body	Date Notice Served	Number of objections*
English Heritage	13/05/11	0

in the form required by regulation 2 of, and the Schedule to, the Regulations.

* If consent to withdraw an objection was conditional please provide details below

If required please continue on a separate sheet,
(manual users) please use a separate sheet of paper and tick this box to indicate you have done so,
(electronic users) please tick this box and a continuation page will be automatically generated.....

☐

When is the latest expiry date of any of the above mentioned Notices?

3. Consulted the following bodies as required by the Memorandum with the identified responses

Name of Body	Date of service	Date of response or consent	Consent given (With/without condition*)
Crown Estate Commissioners		01/07/2011	With condition
Natural England (see 5 below)		20/04/2011	With condition*
Duchy of Cornwall**			
Duchy of Lancaster***			
Ministry of Defence Land Agent			

Councils in **Cornwall, ***Lancashire & Merseyside North of R. Mersey and others where the Duchy is known to have an interest.

* If consent was conditional please provide details below

CEC – Review of detailed design
 NE - Review of Environmental Statement

4. Obtained necessary permissions and consents

Please tick appropriate boxes

(a) Planning permission for the works was granted.....

☐

By

Date

Reference

Conditions applied

Due to Scheduled Monument Status, planning permission can only be considered upon submission of the detailed design. An EIA has been prepared following a scoping exercise agreed with HBC Planning Department to support the planning application once the detailed design is complete.

If required please continue on a separate sheet,

(manual users) please use a separate sheet of paper and tick this box to indicate you have done so, (electronic users) please tick this box and a continuation page will be automatically generated.

☐

or

Planning permission is not required for any of the proposed works.....

☐

Reason

If required please continue on a separate sheet,

(manual users) please use a separate sheet of paper and tick this box to indicate you have done so, (electronic users) please tick this box and a continuation page will be automatically generated.

☐

(b) All other necessary consents e.g. building consent, listed building consent etc. have been obtained.

☐

Type of consent

By

Date

or

No other consents were required.....

☐

(c) All necessary licences under Part II of the Food and Environment Protection Act 1985 will have been obtained before the commencement of works.

☒

or

No licences under Part II of the Food and Environment Protection Act 1985 are necessary.

☐

Reason

If required please continue on a separate sheet,

(manual users) please use a separate sheet of paper and tick this box to indicate you have done so, (electronic users) please tick this box and a continuation page will be automatically generated.

☐

(d) A resolution was passed by the Council or a Sub-Committee with delegated powers authorising application to the Secretary of State for approval of the proposed works.....

☐

Date of resolution

5. Further to 3 above and where necessary, Natural England has confirmed that either;

Please tick appropriate box

the works do not require an appropriate assessment, under
The Conservation (Natural Habitats, &c.) Regulations 1994.....

☒

or

its agreement to the conclusions of the appropriate assessment,
under The Conservation(Natural Habitats, &c.) Regulations 1994.....

☐

Natural England letter dated

20/04/2011

attached (Appendix L).

6. Established ownership of the land required for the site

Please tick appropriate box

The Council owns the entire site of the proposed works.....

☐

or

The following persons or bodies own some or the entire site of the works and have
consented to the carrying out of the works and their subsequent maintenance.....

☒

Name of person/body	Date of Agreement
Crown Estates	01/07/2011

Please tick appropriate box

- I certify that no part of the permanent or temporary works relating to this scheme
has been started (other than work relating to the design of the scheme).

☒

or

- I certify that the works comprising this scheme were carried out under the provisions of section
5(6) of the Act as they appeared to the Council to be urgently necessary for the protection of land
in its area.

☐

I am authorised by the
to sign on its behalf.

HARTLEPOOL BOROUGH

Council

Signature



Date

20/09/11

Name in
BLOCK letters

ALASTAIR SMITH


Position

ASSISTANT DIRECTOR – TRANSPORTATION
AND ENGINEERING

Contact details

HARTLEPOOL BOROUGH COUNCIL
CIVIC CENTRE
VICTORIA ROAD
HARTLEPOOL
TS24 8AY

PAR for Hartlepool Town Wall Construction C6-3

Version	Status	Signed off by:	Date signed	Date issued
1	PAB submission		20/09/11	

PAR Template Version – August 2010

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Approval History Sheet

APPROVAL HISTORY SHEET (AHS)			
1. Review (to be completed by promoting Authority)			
Project Title: Town Wall Model Study & Construction C6-3			
Authority Project Code: HP11		Date of PAR: September 2011	
Lead Authority: Hartlepool Borough Council			
Consultant: URS Scott Wilson Ltd		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 £1,307k			
Authority Project Executive	Alastair Smith		20/09/11
"I have reviewed this document and confirm that it complies with the current PAR guidelines for Local Authority and IDB submissions"			
PAR Reviewer	Dennis Hancock		20/09/11
"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 <input checked="" type="checkbox"/> (Projects less than £10 million) NRG – National Review Group <input type="checkbox"/> (Projects greater than £10 million) (Check box to indicate which is appropriate)			
Date of Meeting(s): 13 October 2011		Chairman:	
Recommended for approval: In the capital grant eligible sum of £1,307k		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:			

Coast Protection Scheme COVERSHEET to Signify Technical Approval

1.	Project name	Town Wall Model Study & Construction C6-3			Start date	June 2011	
					End date	December 2012	
	Business unit	North East Area		Programme			
	Project ref.	HP11			FSoD ref. & date		

2.	Role	Name	Post Title
	Project Sponsor	Ian Hodge	Area FCRM Manager
	Project Executive	Alastair Smith	Assistant Director-Transportation and Engineering
	Project Manager	Dennis Hancock	Principal Engineer (Environmental Issues)

3.	FSoD schedule		Description	Delegation	
				Regional – up to	Environment Agency – up to
	A1	<input type="checkbox"/>	Projects (includes FCRM revenue)	£5m	£5m
	A2	<input checked="" type="checkbox"/>	FCRM capital project within approved strategy	£10m capital	£100m WLC Defra/£5m capital NAW
	A3	<input type="checkbox"/>	FCRM capital project outside of approved strategy	£5m capital	£100m WLC Defra/£5m capital NAW
	A5	<input type="checkbox"/>	Consultancy project	£300k	£500k
	T2	<input type="checkbox"/>	Purchase or lease of land and buildings	£1m purchase/£50k pa lease	£5m

4.	FSoD value	
	Preparation costs for FRM2/Business Case/PAR	£400k
	Project costs	£1,307k

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

6.	FSoD approver name	Post title			Signature	Date
	David Dangerfield	North East Regional Director				
	FSoD consultee name	Post title			Signature	Date
	Graeme Warren	PAB/LPRG Chair	RED <input type="checkbox"/>	AMBER <input type="checkbox"/>	GREEN <input type="checkbox"/>	
	Ian Hodge	Area FCRM Manager				
	Phil Welton	Area Coastal Engineer				
	Dennis Hancock	Local Authority Project Manager			<i>D. Hancock</i>	22/09/2011

1 Executive Summary

1.1 Introduction and Background

Location and Background

- 1.1.1 This report presents a robust business case to implement the preferred coastal defence strategy for the Hartlepool Town Wall situated within Management Area MA12 of the 2009 River Tyne to Flamborough Head SMP2. Approval to carry out this Project Appraisal Report was given by the Environment Agency Project Assessment Board (PAB) in Spring 2008.
- 1.1.2 Hartlepool Town Wall is located on the North East Coast of England (Figure 1). Hartlepool Borough Council (HBC) has coastal management and maintenance responsibilities for this frontage under the Coastal Protection Act 1949. The frontage is adjacent to the navigation channel to the port of Hartlepool (Victoria Harbour) which is owned and operated by PD Teesport, who have maintenance responsibilities for the port structures including part of the Town Wall.
- 1.1.3 The appraisal area is covered by the 2006 Hartlepool Coastal Strategy North Sands to Newburn Bridge referred to herein as the Hartlepool Coastal Strategy. The strategy area is defined as the coastline between North Sands and Newburn Bridge and comprises Management Area's MA11.1 to MA11.3 and MA12.1.
- 1.1.4 The Town Wall is a Grade I listed Scheduled Monument located within the Headland Conservation Area and dates back to the 14th Century. The wall is considered of national heritage importance, and is therefore afforded protection against unauthorised change under the Ancient Monuments and Archaeological Areas Act 1979.

History of Flooding and Coastal Erosion

- 1.1.5 Coastal flooding of the Headland at this location is due to wave overtopping of the Town Wall, which is directly exposed to waves from the North Sea heading in from a southerly direction. Overtopping occurs most frequently in the central section of the wall, which receives less shelter from the surrounding Pilot and Middleton piers (Figure 2) and is fronted by very low beach levels. This causes waves to break directly on to the wall, leading to significant overtopping several times a year.
- 1.1.6 Protection against coastal erosion along this frontage is currently provided by one functioning groyne, a fluctuating beach of varying make up, and the Town Wall itself. At the wall toe recent site inspections show that undermining is a particular issue to the west of Sandwell Gate. Previous attempts to stabilise the wall toe have been successful but due to a further reduction in beach levels are themselves at risk of being undermined. Beach levels are not predicted to recover.
- 1.1.7 Significant historical repairs have been carried out to the Town Wall by both PD Teesport and HBC in 1953 and 1987 respectively as a result of catastrophic collapse of the wall as shown in Figure 2 and on the PAR front cover.

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1.2 Problem

- 1.2.1 The current overtopping rates for a 1:1 year event pose a threat to public safety, with the ongoing residual risk that an event greater than 1:20 years would cause significant flood damage. A total of 230 properties are at risk of flooding from overtopping. By Year 10 the parapet wall is anticipated to have deteriorated further thereby reducing the standard of protection to less than 1:10 years. Further predicted rises in sea level and climate change will exacerbate these risks.
- 1.2.2 In relation to coastal erosion, under average annual conditions, there is no imminent threat to the stability of the wall, but under less frequent conditions a breach in the wall can be expected within the next 10 years due to failure and undermining of the wall toe as experienced in the past. This would put the 12 residential properties directly behind the wall at significantly increased risk from erosion.
- 1.2.3 Fundamentally in its present condition, when measured against today's defence standards, the Town Wall does not provide a robust standard of protection against flooding and coastal erosion. Any significant improvement works to the Town Wall would compromise the Scheduled Monument statutory designation and adversely impact upon this sensitive Conservation Area. Therefore the preferred option must carefully balance these constraints and put forward a suitable option to address these complex circumstances.

1.3 Options Considered

- 1.3.1 A long list of options was developed in a preceding technical and environmental report, based on a condition and performance assessment study, to address the concerns. To develop an option short list, each option was evaluated against a series of strategic objectives and considered consultation responses from statutory consultees and local residents. Given the conflicting technical, environmental and economic constraints of each of the short listed options, hybrid solutions which would address the undermining risk and reduce flood risk were developed and considered.

1.4 Preferred Option

- 1.4.1 The preferred hybrid approach (Configuration 2) includes construction of setback secondary flood defence walls, enhanced toe protection to the Town Wall to prevent erosion, and a future tidal inundation wall to prevent outflanking of the Town Wall. The condition of the Town Wall would be maintained through a proactive approach to monitoring and maintenance funded by PD Teesport and HBC to replace damaged blocks and re-point the wall, in order to offset the residual risk of wall failure through ongoing deterioration. Configuration 2 will provide a 1:100 year standard of protection over the 100 year appraisal period.
- 1.4.2 The first section of setback wall 100m long will be constructed in Year 0 (2012, Phase 1) using pile driven steel posts and infill panels to provide a setback wall 0.7m high. As part of the works the existing drainage through the wall will be cleaned, inspected and improved where required. A further setback wall (Phase 2) is to be constructed in Year 30 (2042) and located further to the west.

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- 1.4.3 The concrete toe protection will be constructed in Year 0 along the most critical section of the Town Wall (140m) using mass concrete to prevent further undermining of the wall and subsequent breaching. The existing beach terminal groyne will be maintained in its current configuration. Future repairs will be completed to maintain the toe protection and condition of the terminal groyne and a 0.5m high tidal inundation wall will be constructed in Year 70 (2082) around the Fish Quay and Victoria Harbour.

Environmental Considerations

- 1.4.4 The scheme requires a statutory Environmental Impact Assessment (EIA) which has been developed in conjunction with the PAR to aid option development and selection. The EIA has considered in detail the environmental effects associated with the preferred and alternative options on the Scheduled Monument status, and any ecological impacts on the neighbouring SPA and SSSI sites. This advice has formed an integral part of the optioneering and appraisal process. Letters of support have been provided by Natural England and English Heritage and are included in Appendix L.

Costs

- 1.4.5 The Whole life cost and Grant Approval Project costs are shown in Table 1-1 below. The project is seeking approval for £1,307k Grant-in-Aid funding. A risk contingency at 30% of the construction costs equating to £255.5k has been allocated and this is recommended for budgeting purposes. Upon receipt of competitive tenders this can be reviewed and potentially reduced.

Table 1-1 Project Costs (£k)

	Economic appraisal	Whole Life Cash Cost	Approval
Costs to PAR (outline design)	N/A – sunk costs	400	
Costs post PAR			
Local authority management	20.0	20.0	20.0
Consultant design fees	100.0	100.0	100.0
Site investigation & survey	80.0	80.0	80.0
Construction	657.1	657.1	657.1
Environmental mitigation	88.0	88.0	88.0
Site supervision	90.0	90.0	90.0
Risk contingency			
95%ile (represents 30% of project FSoD approval)			255.5
50%ile	147.1	147.1	
Inflation	N/A	N/A	16.4
Future costs (const. + maintenance)	950.8	3432.3	N/A
Contributions			
TOTAL	2133	5014	1307.0

Benefits

- 1.4.6 The option benefits have been derived using the latest guidance provided in EA FCERM-AG, and flood damages from the Multi-Coloured-Manual, 2003. These are based on detailed physical and numerical modelling of overtopping carried out during the PAR study. The total 'Do Nothing' PV damages including residential, commercial, infrastructure, fatality and heritage loss is £11,069k.

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- 1.4.7 Following discussions with English Heritage a nominal conservative allowance of £1,000k cash (£808k PV) was included to represent the national heritage loss should a section of the historic Town Wall fail. Due to the rate of overtopping significantly exceeding safe and acceptable levels for pedestrians, particularly after failure of the parapet, an allowance for a single fatality loss has also been included, at a cash sum of £1,508k (£449k PV).
- 1.4.8 The benefits are considered conservative as no allowance has been made for erosion damages (12 properties, cash value £1,810k) to avoid double counting or for flood damages associated with the inundation from Victoria Harbour from Year 70.

Economic Summary Flood and Coastal Resilience Partnership Funding

- 1.4.9 The scheme has been appraised in accordance with the May 2011 Defra policy statement on Flood and Coastal Resilience Partnership funding as summarised in Table 1-2 below. The scheme achieves an Outcome Measure score of 174.8% and a scheme benefit to cost ratio of 4.92 and reduces the flood risk to 230 households (120 of which are in the most deprived category) from significant or very significant to moderate or less for a period of 70 years. Under the previous system the scheme achieved an OM score of 6.12.

Table 1-2 Benefit-Cost Ratios and Outcome Measures

Outcome Measure	Value	FDGiA Contribution
OM1- Economic Benefit		£22,107
PV Benefits (£k)	£9.10M	
PV Costs (£k)	£1.85M	
Benefit/Cost Ratio	4.92	
OM2 Households at risk from Flooding		£2,886,102
20% Most Deprived	120	
21-40% Deprived	110	
60% Least Deprived	0	
OM3 Households at risk from Erosion		£324,078
20% Most Deprived	0	
21-40% Deprived	12	
60% Least Deprived	0	
Total FDGiA Contribution		£3,232,464
'Raw' Outcome Measure Score		174.83%

Funding and Contributions

- 1.4.10 The total sum for Flood Defence Grant in Aid (FDGiA) approval is £1,307k. The preferred option includes continuation of the existing proactive joint approach to monitoring, maintenance and repair of the Town Wall by PD Teesport and HBC. As part of this scheme the existing maintenance programme will be formalised

and a new maintenance regime implemented to identify key areas for repair as part of a 10 year rolling programme at a cost of £150k every 10 years.

- 1.4.11 Further discussions are currently ongoing between HBC and English Heritage, to determine if a heritage grant can be made available. Other sources of external contribution, including PD Ports, have been thoroughly investigated. However the only benefit the Port will receive from the scheme is enhancement of the toe works that they installed and subsequently transferred to HBC. Maintenance of the fabric of the wall will remain the joint responsibility of HBC and PD Ports.

Key Delivery Risks

- 1.4.12 Table 1-3 below highlights the most significant high level risks and corresponding mitigation measures. Of most concern are the poor ground conditions identified by the recent site investigation to be technically challenging and presenting a risk to the piling works. This risk is mitigated by utilising the detailed site investigation (which includes both passive and invasive surveys) supplemented with further information, which will be applied when developing the detailed design of the piling works. However, the contingency sum may need to compensate for having to locally change the foundation designs of the wall at critical locations.

Table 1-3 Risk schedule and Mitigation

Key Project Risk	Adopted Mitigation Measure
Storm damage prior to or during the works.	HBC routinely monitor site for damage. Works programmed to start in the summer months.
Difficult ground conditions.	Stage A studies included ground and structure investigations. These will be applied in the design and further site investigation studies are planned.
Difficult site access for setback wall construction.	Detailed design to be developed in conjunction with specialist piling contractor.
Objections from Local or Statutory consultees to the planning application.	Extensive consultation has been completed at each stage of the project to mitigate this risk. The preferred option is sensitive to the location and statutory designations.
Construction damage to residential properties or the Town Wall.	This risk will be managed by the contractor using risk assessments, method statements and conditions surveys in accordance with industry best practice.

- 1.4.13 Design and construction risks could be further mitigated through HBC adopting an Early Contractor Involvement (ECI) approach to the contract. The risk of objections from Local or Statutory consultees will be mitigated through further consultation. An appropriate risk contingency has been included in the 'Sum for Approval' and is considered reasonable at this stage.

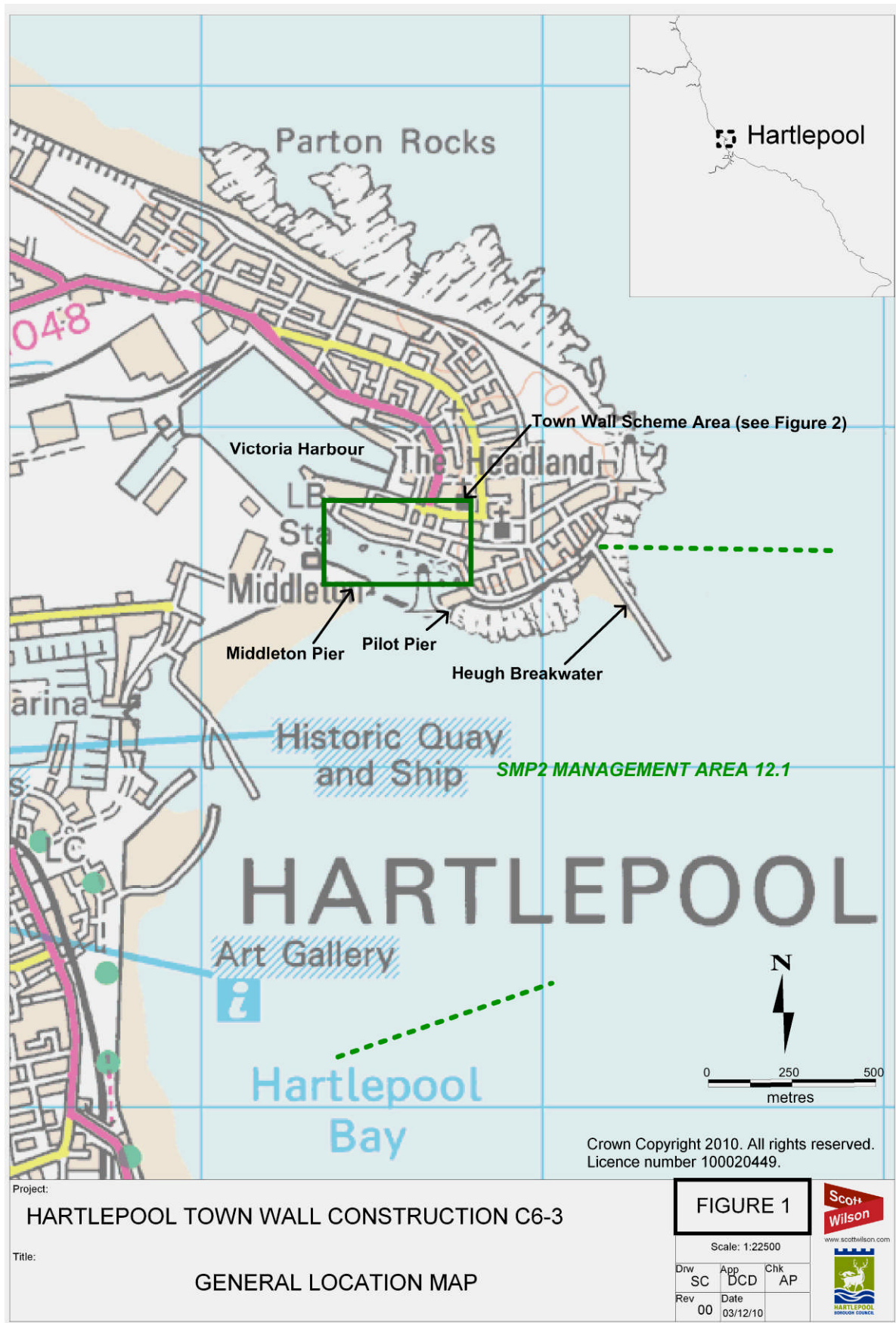
1.5 Summary

- 1.5.1 The implementation of the preferred appraisal option: Configuration 2 Setback wall and toe protection supported by proactive monitoring and maintenance of the condition of the Town Wall, will significantly reduce the flood risk to properties on the Hartlepool Headland, reduce health and safety risks to the public from overtopping and prevent further undermining of the wall toe leading to wall failure. This option strikes a careful balance considering the fundamental conflict between the condition of the Town Wall, its Scheduled Monument designation and its flood and erosion standard of protection. The scheme benefit cost ratio is 4.9 with an OM score of 174.8%.

1.6 Briefing Paper

Authority:	Hartlepool Borough Council	Project Executive:	Alastair Smith		
Project Title:	Town Wall Model Study & Construction C6-3		Code:		
Consultant:	URS Scott Wilson Ltd	Contractor:	-	Cost Consultant:	-
The Problem:	The Town Wall, a Scheduled Monument of national heritage importance, is prone to ongoing deterioration and damage, particularly at the undermined wall toe. A sudden failure would pose a health and safety risk to the general public, and would lead to coastal erosion and flooding of residential properties. The Town Wall provides flood protection to households on the Headland, from wave overtopping. The standard of protection is currently 1:20 years but decreases significantly as the condition of the wall parapet deteriorates and sea levels rise.				
Assets at risk:	Residential and commercial property, highway, infrastructure, heritage, public health and safety.				
Existing standard of flood protection:	1:20 years	Proposed standard of flood protection:	1:100 years		
Description of proposed scheme:	Toe protection works to provide a more robust structure to prevent undermining. Setback flood wall to reduce overtopping flood risk to property.				
Costs (PVc, £k): (100 year life inc. maintenance)	£2,133k	Benefits: (PVb) £k	£10,897k	Ave. B: C ratio: (PVb/PVc)	5.11
NPV £k:	£8,764k	Incremental B: C ratio:	17.64	Whole life cost (cash value) £k:	£5,015k
Choice of Preferred Option:	Toe protection works, to provide a more robust structure to prevent undermining. Setback flood wall to reduce overtopping flood risk.				
Total eligible cost for which capital grant approval is sought:	£ 1,307k (incl. £16.4k inflation & £255.5k contingency)				
Delivery programme:	Planning Approval: May 2012 Award Construction Contract: April 2012 Construction Start: June 2012 Construction end: December 2012 End of Project: March 2013				
Are funds available for the delivery of this project?					
External approvals:	Marine licence, CPA consent, Planning Permission, Scheduled Monument Consent.				
Outcome measures	Scheme benefit cost ratio is 4.92 OM score of 174.8%				

1.7 Key Plan(s)



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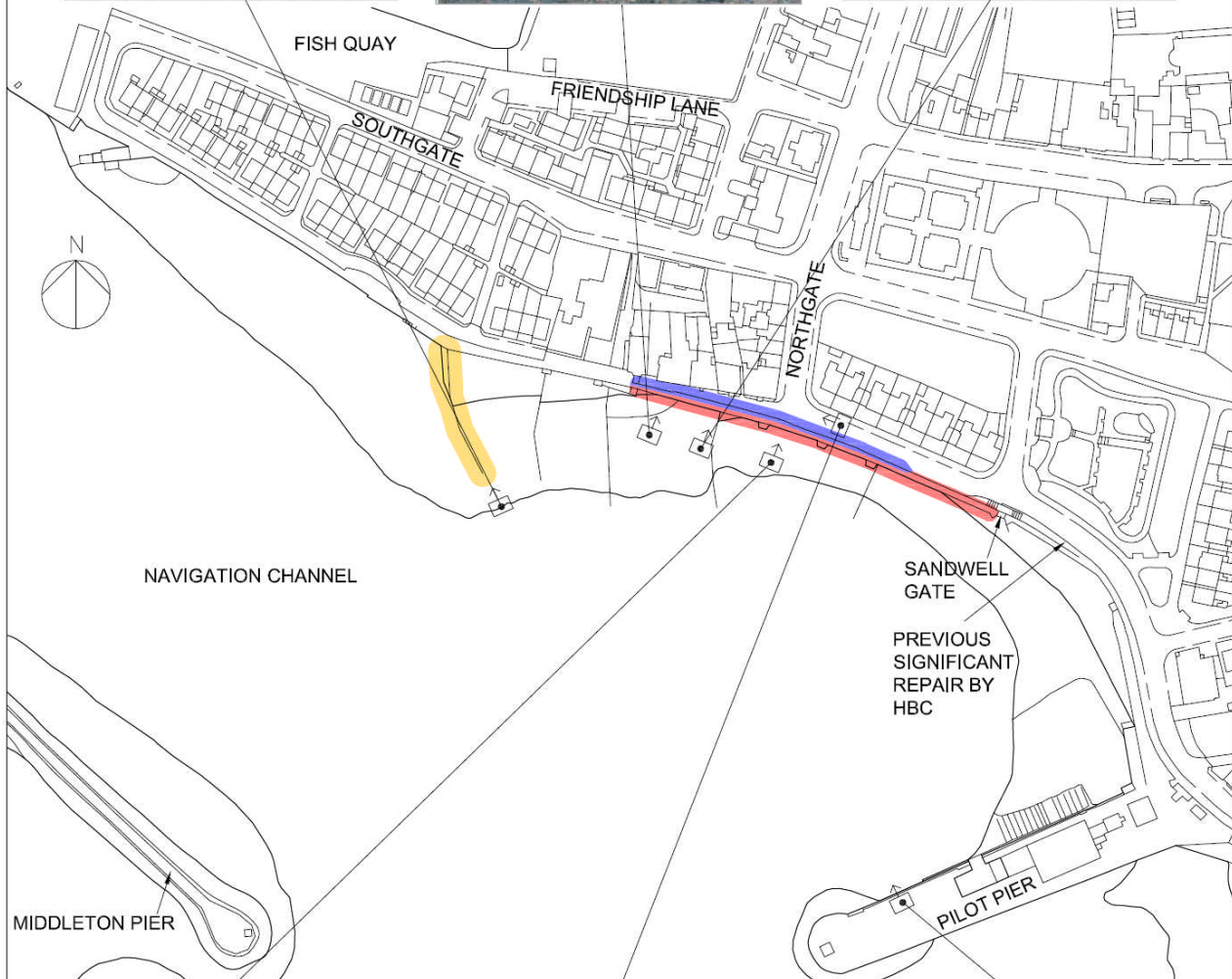
TERMINAL GROYNES SUPPORTS A LARGE AMOUNT OF MATERIAL



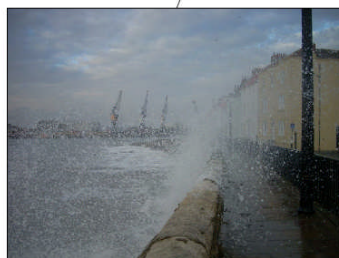
PAST BREACH REPAIR WORKS BY PD TEES PORT



EXISTING TOE IN POOR CONDITION



BEACH LOWERING IS UNDERMINING PREVIOUS TOE REPAIRS



OVERTOPPING EVENT VIEWED FROM THE BOTTOM OF NORTHGATE ROAD



OVERTOPPING EVENT VIEWED FROM THE PILOT PIER

Project Title

HARTLEPOOL TOWN WALL CONSTRUCTION C6-3

Drawing Title

SCHEME AREA LOCATION MAP

FIGURE 2

Scale at A4 : 1:1250

Drw MRM

App DCD

Rev

Chk SC

Date 12/01/11

Date

Scott
Wilson

www.scottwilson.com



Title	Hartlepool Town Wall Model Study and Construction C6-3				
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2 Introduction and Background

2.1 Purpose of this Report

- 2.1.1 This Project Appraisal Report (PAR) is to support an application for Flood Defence Grant in Aid (FDGiA) funding and to seek approval to undertake coastal protection works. The report presents a robust business case to implement the preferred coastal defence works for the Hartlepool Town Wall.
- 2.1.2 The appraisal has been carried out in accordance with the EA's Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG), March 2010.
- 2.1.3 In developing this PAR, detailed supporting studies have been completed including a Condition and Performance Assessment, a Technical and Environment Assessment, numerical and physical modelling and an Environmental Statement. This PAR builds upon these preceding studies.

2.2 Background

Strategic and Legislative Framework

- 2.2.1 The Headland Structures and breakwaters form an essential part of the navigation approaches into the Port of Hartlepool. The Town Wall borders the northern edge of the main navigation channel into Victoria Harbour. Any options to address coastal erosion and flooding risk must also not adversely impact the function of the navigation channel, which requires regular maintenance dredging to maintain the required depth. The options must also be compatible with wider coastal policy and strategy objectives.
- 2.2.2 The appraisal area is covered by the 2006 Hartlepool Coastal Strategy North Sands to Newburn Bridge, referred to herein as the Hartlepool Coastal Strategy. The strategy area is defined as the coastline between North Sands and Newburn Bridge and comprises Management Area's MA11.1 to MA11.3 and MA12.1 as defined in the River Tyne to Flamborough Head SMP2 (2007) (Figure 1). The appraisal area is situated at the northern extent of MA12.1, from the Pilot Pier in the east, to the Victoria Harbour and Fish Quay in the west, with the Hartlepool Town Wall forming the defence line between these two points.
- 2.2.3 The 2006 Coastal Strategy recommended a 'Hold the Line Policy', consistent with the 1999 Shoreline Management plan (SMP1) policy for this area. The SMP1 was superseded by the North East Coastal Authorities Group Shoreline Management Plan 2 (NECAG SMP2). The Strategy considered a series of 'Do Something' options for the frontage. The preferred strategy option was to construct a detached rock breakwater at the edge of the existing navigation channel, nourish the beach and refurbish the terminal groyne. This current PAR determines a different preferred scheme option in light of more detailed studies than the previous coastal strategy.

- 2.2.4 The NECAG SMP2 is a second generation Shoreline Management Plan which reviewed both the SMP1 and Coastal Strategy policies. The SMP2 recommended a 'Hold the Line' policy for the frontage between the Heugh Breakwater and Newburn Bridge (including the appraisal area) for the entire duration of the Shoreline Management Plan (up to 2105). The SMP2 confirmed the recommendations of the Hartlepool Coastal Strategy; to provide improved protection for the Town Wall. The NECAG SMP2 was fully approved in 2009.
- 2.2.5 Hartlepool Borough Council (HBC) has coastal management responsibilities within the appraisal area. HBC has powers under the Coast Protection Act 1949 to undertake recommended coastal works along the frontage. PD Teesport owns and operates the Port of Hartlepool and is also jointly responsible with HBC for maintenance of the Hartlepool Town Wall.
- 2.2.6 The Town Wall is a Grade I listed Scheduled Monument located within the Headland Conservation Area and dates back to the 14th Century. The wall is considered of national heritage importance, and is therefore afforded protection against unauthorised change under the Ancient Monuments and Archaeological Areas Act 1979. There are no environmentally designated sites within the boundaries of the appraisal area. However, the foreshore directly east of the Pilot Pier is designated as a Special Protection Area (SPA) and a Site of Special Scientific Interest (SSSI) and is therefore protected by environmental legislation.
- 2.2.7 Under the Town and Country Planning (EIA) Regulations 1999, the potential impact of any proposed scheme must be considered. An Environmental Statement was prepared in parallel with the PAR. Significant public consultation was also completed to predict and assess the significance of potential impacts and allow appropriate mitigation measures to be developed and incorporated for consideration of the different options.

Previous Studies

- 2.2.8 The 1999 Shoreline Management plan (SMP1) set out the coastal management policy for this area, which was superseded by the NECAG SMP2 which was approved in 2009. The appraisal area is covered by the 2006 Hartlepool Coastal Strategy North Sands to Newburn Bridge.

Social and Political Background

- 2.2.9 The Town Wall currently protects 230 residential properties which are at risk of coastal flooding from wave overtopping and tidal inundation. The structure also maintains the defence line to prevent coastal erosion. The reinforcement of the Town Wall is a priority for HBC in order to maintain the strong heritage, residential, recreational, commercial and industrial links throughout the MA12.1 frontage.
- 2.2.10 The Index of Deprivation (2007) for England shows that the area immediately behind the Town Wall is ranked in 6,964th position and is in the top 21% of the index. The area further to the north and around the Fish Quay and Victoria Harbour is ranked in 1,975th position and is in the top 6% of the index. Therefore the appraisal area includes a significant proportion of deprived households, which as part of the UK Government 2007 Spending Review are a priority for future improvements.

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Location Description

- 2.2.11 The Headland area of Hartlepool is located in North East England, approximately 1.5 miles from Hartlepool Town Centre. In terms of wave exposure, the Headland can be divided into two distinct areas. The outer area which is fully exposed to the North Sea and the inner area which is afforded some shelter by the Heugh Breakwater and forms the approach to the Port of Hartlepool. The inner area includes a deep water navigation channel into the Victoria Dock which is further protected by the smaller Middleton and Pilot Piers.
- 2.2.12 The linear boundaries of the appraisal area are the Pilot Pier and Victoria Dock. The Town Wall structure forms the defence line along most of this frontage, preventing coastal erosion and providing protection from wave overtopping and inundation (Plate 1 & 2 Appendix C). The Town Wall comprises a vertical masonry wall with a parapet and was originally built in the 13th Century. Investigations conducted during the conditions and performance assessment indicate that the Town Wall is a double skinned masonry seawall and has a masonry apron with timber toe piles on the seaward side. The Town Wall is topped by a parapet wall approximately 1.0m high which provides some protection against wave overtopping.
- 2.2.13 The foreshore at the eastern end of the frontage consists of a narrow 100m length of sandy beach, in the lee of the Pilot Pier. At the low water mark rocky outcrops reveal the underlying geology below the beach. Further to the west is Sandwell Gate, a historic stone gateway providing pedestrian access to the beach during low tide. To the west of the gate, beach levels fall and the beach material becomes coarser in response to the increasing exposure to waves from the south. This area includes a narrow cobble and pebble beach between a series of dilapidated beach groynes. Where beach levels are particularly low, previous repairs to the wall toe are now exposed and are of most concern.
- 2.2.14 Approximately 300m west of Pilot Pier, at the start of the main navigation channel, a terminal groyne leads to a natural build up of pebbles and cobbles in front of the Town Wall, and limits the migration of sediment into the inner harbour. At the root of the groyne the Town Wall continues and turns towards the north to form the southern face of the Fish Quay. This area is afforded significant shelter by the piers and is fronted by a pebble and cobble beach. Beyond the Town Wall is the Victoria Harbour, which is formed of vertical walls and provides shelter and facilities for the local fishing fleet and provides berths for leisure craft.

History of Flooding and Erosion

- 2.2.15 The Town Wall currently protects 230 residential properties on the Headland from coastal flooding. Coastal flooding occurs from wave overtopping due to the Town Wall's direct exposure to North Sea waves emanating from a southerly direction. Overtopping occurs most frequently in the central section of the wall, which receives less shelter from the piers and has very low beach levels, causing waves to break directly on to the wall.
- 2.2.16 Although wave overtopping occurs regularly throughout the year, current overtopping rates are sufficiently low such that the existing parapet wall and road drainage systems can remove overtopped water back to the sea. The residential properties behind the wall have not historically been subject to significant

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flooding, however their cellars are prone to flooding during overtopping events, and the Headland Area is identified within the Environment Agency indicative flood risk outline maps (Plate 3 to 7 Appendix C).

- 2.2.17 Protection against coastal erosion along this frontage is currently provided by one remaining groyne structure, a fluctuating beach of varying make up and the Town Wall itself. Investigations conducted during the condition and performance assessment indicate that the Town Wall shows signs of bulging and numerous areas of repair work of varying ages particularly at the wall toe, highlight the significant effect of ongoing coastal erosion (Plate 2, 8, 9 & 10, Appendix C).
- 2.2.18 At the wall toe, recent site inspections show that undermining is a particular issue to the west of Sandwell Gate (Figure 2). Previous attempts to stabilise the wall toe were completed and these have been successful to an extent but due to a further reduction in beach levels are at a risk themselves of being undermined. The public perception is that beach lowering of the once wide sandy beach is a direct consequence of maintenance dredging of the port navigation channel. However it is understood that the dredge arisings are generally fine silty sand as opposed to the coarser sediments forming the beach in front of the Town Wall.
- 2.2.19 Previous attempts to protect the foundations of the wall by constructing beach groynes and then replacing the beach material have not been successful as the groynes are not effective in controlling cross-shore sediment movement. With the exception of the terminal groyne, these groynes have been destroyed by natural coastal processes and do not appear to exert any influence on retention and accretion of beach material in front of the wall. Beach levels are not predicted to increase due to a lack of natural sediment supply, but are therefore predicted to be drawn down further in response to climate change and sea level rise.
- 2.2.20 Following a significant breach of the wall a 12m section was replaced with concrete blocks in 1953 by PD Teesport (Plate 9) to reinstate the wall and prevent further damage to the adjoining sections of the Town Wall and loss of the road behind the wall. A further significant repair was completed to the east of Sandwell Gate in 1987 by HBC (Plate 10). The current bulging and historic repair work, highlights the potential for further deterioration of the wall and catastrophic failures.
- 2.2.21 In summary, the fragility of the Town Wall is of concern. These concerns are reinforced by the evidence of previous breaches in the wall. The beach levels are currently low and there is a high likelihood that beach levels will fall further, particularly in response to sea level rise and climate change, putting the wall and Headland properties behind the wall at significantly increased risk.

2.3 Current Approach to Coastal Flood and Erosion Risk Management

- 2.3.1 HBC and PD Teesport currently manage the coastal and flood defences along the frontage through routine monitoring, general proactive and reactive maintenance and emergency works. Maintenance costs are currently funded by Hartlepool Borough Council and PD Teesport to ensure that any necessary works are carried out and the overall integrity of the wall is maintained.

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3 Problem Definition and Objectives

3.1 Outline of the Problem

Structural Integrity

- 3.1.1 In order to carry out a full assessment of the condition and performance of the existing defences and to inform the development of options to provide the required level of protection for the future, a significant level of data gathering was required. This included a topographic survey, visual inspection, masonry block removal and inspection, radar and resistively geotechnical surveys, boreholes and trial pits. The results of these surveys and investigations were considered to evaluate the integrity of the Town Wall structure.
- 3.1.2 The Town Wall investigations show that whilst the existing wall appears to be effectively functioning as a coastal protection structure, the bulges in the wall alignment and previous breaches are a significant concern. These investigations have allowed the fragility of the Town Wall to be assessed and potential failure mechanisms to be considered. It is considered that without proactive capital works and maintenance, the structure is at risk of serious breach failure within the next 10 years.
- 3.1.3 This ongoing deterioration occurs under typical annual wave conditions and is most prevalent at the existing wall foundations and in areas of significant cracking or bulging. The greatest immediate threat to the wall is the risk of an extreme storm, which could expose these areas to wave impact damage, thus enlarging existing voids and potentially leading to more widespread damage or collapse of the outer skin of the wall and coastal erosion.
- 3.1.4 Also of concern is the parapet wall, which appears to be a more recent addition to the existing Town Wall structure, installed to reduce overtopping which raised the height of the wall by around 1m. The parapet wall was identified to be in a poor condition with a seaward lean and at risk of failure during heavy overtopping or due to direct wave impact.
- 3.1.5 Notwithstanding the fragility of the wall structure, beach levels have been noted to be steadily falling over the past 30 years, with the wall originally being protected by a sandy beach. The material is considered to have been lost through cross shore sediment transport processes and the fact that the beach has no natural source of sediment supply and replenishment. To prevent undermining and voiding behind the wall, buttresses, stone aprons and concrete and timber toe protection have been constructed at various times, but within the central section these are also being undermined.
- 3.1.6 Whilst a proactive approach to capital works and maintenance will address the ongoing deterioration and localised damage, more significant works are required to prevent a more widespread failure of the wall toe and subsequent damage to the residential and commercial properties behind the wall. Future storms, exacerbated by predicted rises in sea level and storm severity will accelerate the undermining process.

Flooding Due To Overtopping and Inundation

- 3.1.7 The wall is currently overtopped on an annual basis leading to localised flooding of the roadway. The risk of more widespread flood damage is highly dependent on the local drainage systems capacity to return flood water back out to sea and the presence of the parapet wall to prevent direct inundation from breaking waves. The current standard of protection against flooding is estimated to be 1:20 years return period. However due to the fragility of the Town Wall structure there is a high risk that an extreme event greater than a typical annual event could cause failure of the parapet wall, which would significantly increase overtopping volumes and decrease the standard of protection to less than 1:10 years within the next 10 years.
- 3.1.8 In addition to posing a flood risk, the annual overtopping rates significantly exceed the current recommended safe levels for pedestrian access on the footpath behind the wall parapet and present a health and safety risk. Loss of the parapet would mean that overtopping rates will be of sufficient level to damage the paving behind the wall and be a danger to trained staff and vehicles. Furthermore, at the narrowest point, residential properties are only setback 4.5m from the Town Wall and will be directly exposed to overtopping waves.
- 3.1.9 Along the remainder of the frontage, to the east of Sandwell Gate and at the terminal groyne, shelter from wave overtopping is currently provided by the piers and higher beach levels (Plates 10 to 12). However inspection of the local ground elevation and modelling of the predicted future extreme sea level shows that tidal inundation via the Victoria Harbour is predicted to become a risk and will outflank the Town Wall defences by year 2070 (Figure 7 and 8, Appendix D).

Summary

- 3.1.10 The Town Wall appears to be effectively functioning as a coastal protection structure to prevent erosion. However typical annual wave conditions are leading to ongoing deterioration and damage to the wall face. While an ongoing maintenance programme will continue to address these aspects, of greater concern is the low standard of protection provided against overtopping and the risk that during more extreme events undermining will cause a failure of a section of the wall or collapse of the wall parapet. A sudden failure would pose a health and safety risk to the general public, would lead to erosion of the road and residential properties and increase the risk of flooding to the Headland area.

3.2 Consequences of Doing Nothing

- 3.2.1 A realistic 'Do Nothing' scenario was developed from a numerical and physical modelling study as a baseline to evaluate all options considered on a benefit-cost basis. The 'Do Nothing' scenario excludes all future repair, maintenance and upgrades to the Town Wall over a 100 year period.

Numerical and Physical Modelling Studies

- 3.2.2 To understand the 'Do Nothing' flood risk from overtopping a detailed modelling study was completed. Numerical modelling was applied to determine extreme wave conditions offshore of Hartlepool and to transform these inshore to selected points along the Town Wall. A series of extreme wave height and extreme water

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level combinations were generated and adapted for future rises in sea level and storminess. The Environment Agency released new guidance on extreme water levels in 2011 (Coastal Flood Boundary Conditions). A comparison of these values to those considered in the numerical and physical modelling studies shows an insignificant difference (<5cm) and would not affect the option appraisal.

- 3.2.3 Due to the unique cross section of the Town Wall, and in particular to understand the impact of the loss of the parapet wall on overtopping rates, a 2D physical modelling study was commissioned. Based on the physical modelling results overtopping rates were calculated for a range of different return periods.
- 3.2.4 To consider the potential flood risk posed by each overtopping event a 2D hydrodynamic model was setup of the Headland area. The overtopping rates were simulated along the length of the Town Wall over a representative tidal cycle and enabled the flooding extent and depth to be evaluated for a specific return period event (Figures 3 to 6, Appendix D) based on a ground model developed from the detailed topographic survey.
- 3.2.5 Based on the detailed physical and numerical studies into the overtopping and flood protection, the Town Wall has been assigned a standard of flood protection of 1:20 years with the parapet wall in place.

The Do Nothing Scenario

- 3.2.6 The 'Do Nothing' scenario for flooding considers that current overtopping rates continue to pose a threat to public safety, with an event greater than 1:20 years causing significant flood damage. A total of 136 properties are currently (Year 0) at risk of flooding from overtopping during a 1:50 year event leading to potential damages of £2,800k. At Year 10 the parapet wall is considered to have failed, reducing the standard of protection to less than 1:10 years and increasing the number of properties at increased risk of flooding. By 2042 (Year 30) the standard of protection will be less than 1:5 years. Further predicted rises in sea level and climate change will exacerbate the risk of flooding by 2110. Given the high rates of overtopping and potential for a sudden failure of the wall parapet there is considered a high risk of a fatality over the 100 year appraisal period.
- 3.2.7 A potential future flood inundation pathway also exists from the Victoria Harbour where flood waters can enter the Headland Area behind the Town Wall through gaps in the existing flood defences. Currently the quay wall and surrounding ground levels around the harbour area are at around +4.2mODN, and therefore provide a >1:200 year current standard of protection. However by 2082 (Year 70) sea level rise will reduce this standard to less than 1:100 years, putting the Headland area at increased risk of coastal flooding.
- 3.2.8 In relation to coastal erosion, under average annual conditions there is no imminent threat to the stability of the wall in the 'Do Nothing' scenario, but under less frequent conditions a breach in the wall can be expected due to failure of the wall toe. Without reinforcement of critical areas of the toe, a significant breach of the wall is anticipated to occur within the next 10 years.

- 3.2.9 Failure of sections of the wall would steady erode the material behind the wall and lead to a loss of the road, services and residential properties. Although failure would cause significant damage to the structure and could lead to localised collapse of sections of the wall, it is thought unlikely that it would lead to a sudden collapse of the entire Town Wall. This is due to the masonry construction and resulting foreshore debris providing some temporary protection. The breach is likely to progressively increase during further storm events.
- 3.2.10 In advance of a potential failure HBC would be forced to close off areas of the Town Wall and beach for public safety and would need to consider the risk of loss of life to residents in the 12 Headland properties situated directly behind the wall. The closure of the road and abandonment of properties would have a significant adverse impact on the economic future of this deprived area. This would lead to a significant and long term negative impact on social well being and health. Table 3-1 below outlines the key damages and their economic value.

Table 3-1 Town Wall key damages over 100 year period

Asset Type	Number of or area at risk	Cash Value £k
Residential Property (flooding)	230	18,194
Commercial Property (flooding)	6	2,000
Residential Property (erosion)	12	1,810
Heritage loss	1	1,000
Fatality loss	1	1,500

3.3 Key Constraints

- 3.3.1 As a Scheduled Monument of national heritage importance, conservation requirements impose significant constraints on the level and scale of permitted intervention for any of the proposed options. Also the close proximity of residential properties to the Town Wall, which in areas are within 5 metres of the Town Wall parapet, present a significant constraint on space available to construct any improvement works behind the wall, without leading to a significant adverse impact on these residents. These constraints are compounded by the conservation status of the local area.
- 3.3.2 Although there are no environmental designated sites within the appraisal frontage, the site is adjoined by the Tees and Hartlepool Foreshore & Wetlands SSSI, a component site of the Teesmouth & Cleveland SPA. Therefore the wider implications of each option need to be considered to ensure that the scheme does not adversely impact these receptors.
- 3.3.3 Fundamentally in its present condition, when measured against today's defence standards, the Town Wall does not provide a robust standard of protection against flooding and coastal erosion. Any significant improvement works to the Town Wall would compromise the Scheduled Monument statutory designation and adversely impact upon this sensitive Conservation Area. Therefore the preferred option must carefully balance these environmental (including heritage), technical and economic constraints.

3.4 Objectives

- 3.4.1 The overarching objective is to address the risk of coastal erosion and reduce the flood risk from overtopping without compromising the sensitive heritage and environment features within the area. In developing the PAR, a series of long term management objectives were established to guide option development and appraisal, and are summarised in Appendix E.

4 Options for Managing Coastal Risk

4.1 Long List of Options

- 4.1.1 Based on recent intrusive, structural and ground investigations of the Town Wall and surrounding area a performance assessment was completed. It concluded that during extreme events undermining will cause a failure of a section of the Town Wall or collapse of the wall parapet, and that the wall provides an inadequate standard of protection against flooding. To address these concerns a three stage approach was adopted to explore potential options and determine the optimum approach to managing coastal risk.
- 4.1.2 The long list took a 'high-level' approach and considered all potential options; from large scale solutions, for example extending the Heugh Breakwater; to local solutions, for example improving the drainage behind the wall. Each option was then evaluated against the strategic objectives, issues and constraints, as shown in Appendix E. The merits of each option were scored to produce a short list of potential options to take forward for more detailed appraisal. These short listed options are summarised below

4.2 Short List of Options

- 4.2.1 Table 4-1 below appraises the short listed options for the Hartlepool Town Wall. The colour coding represents the level of compatibility of the option against the technical, economic and environmental (including heritage) constraints.
- 4.2.2 A 'Do Minimum' approach such as maintenance was rejected on the grounds that the risk of wall failure at the toe and overtopping flood risk would not be reduced. Although this option would lead to the lowest environmental impact and initial capital costs would be relatively low, it is not considered technically feasible as future deterioration and damage would require substantial capital investment.
- 4.2.3 Improvement works to heighten and strengthen the parapet wall were considered but discounted due to the height required and the construction risks. There was also significant uncertainty as to structural stability of a heightened parapet wall against wave loading and overtopping water.
- 4.2.4 Softer engineering approaches such as beach nourishment and groynes or toe protection would theoretically protect the wall from erosion and be sympathetic to the natural environment, but as is evident from the current low beach levels, losses would continue and frequent nourishment would be required. The new beach could also potentially impact inter tidal habitat or enter the navigation channel. This option is not considered technically or environmentally feasible.
- 4.2.5 Hard engineering solutions (e.g. an offshore breakwater which was the preferred original strategy option) would involve the placement of a large volume of rock just offshore of the Town Wall at high cost. This option would lead to an adverse environmental impact on the designated environmental sites adjacent to the Town Wall. If constructed, this type of structure would significantly alter the character of the frontage, and have high landscape impact. A rock revetment

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type solution would bury the Scheduled Monument and could potentially damage the Town Wall structure. While these solutions would work technically, the economic and environmental issues are significant.

Table 4-1 Appraisal of short listed of options

Option	Technical	Economic	Environmental	Rejected
Do Minimum: Repair and Maintain	Undermining would continue. Risk of future parapet. Flood risk remains. Works constrained by heritage designation.	Initial low cost but likely to increase significantly.	Negligible visual, heritage, construction, or ecology impacts	YES
Beach Nourishment and groynes	Would improve and maintain beach levels. Previous nourishment scheme has failed due to cross shore losses.	Unsustainable in the long-term, frequent nourishment required.	Beneficial heritage and visual impact. Long term adverse impact on landscape, ecology. Major adverse construction.	YES
Offshore Breakwaters	Provides shelter, promotes sediment build. Reduces flood and erosion risk. Foundation stability difficult to achieve	Significant structures required in deep water. Very high cost.	Adverse visual impact and would compromise statutory ecology designations.	YES
Rock revetment	Reduced overtopping and protection of wall toe. High standard of protection.	Moderate costs but all in Year 0. Low future maintenance.	Major environmental impact. Unacceptable to English Heritage.	YES
Concrete toe	Protects toe from scour. No change in overtopping rate or risk following parapet wall failure.	Low costs, low maintenance.	Minor adverse heritage and ecology impact. Moderate adverse landscape. Major adverse visual and construction noise.	YES
Setback wall and toe protection	Protects toe from scour. Reduces overtopping if parapet fails. Dependent on proactive maintenance of the Town Wall.	Moderate cost, but spread over next 100 years.	Major landscape and visual impact, but acceptable to English Heritage. Minor ecology impact. Major noise and vibration construction impacts.	NO

4.3 Short Listed Options Taken Forward

- 4.3.1 None of the short listed options provides a simple, outright solution to the constraints and requirements of the Town Wall due to the conflicting technical, environmental and economic constraints of this frontage. The preferred original strategy option of an offshore breakwater was found to incur high capital construction costs (£5.5M) and was based on a wider set of regional objectives. At the time the detailed local studies competed as part of this PAR were not available to allow the local heritage constraints to be fully considered.
- 4.3.2 The only option to achieve a modest overall environmental impact and an acceptable technical and economic threshold is the setback wall and toe protection option. Given the sensitivity of this location and prior to taking this option forward for detailed appraisal, this option was presented to local residents and statutory consultees for consultation in September 2010 via a public consultation and workshop. The level of response from local residents was low, but overall broadly neutral. The residents were primarily concerned with the visual impact of the setback wall. A positive response was received from English Heritage. Based on the outcome of the short list option appraisal and the consultee responses, this was the only option taken forward for detailed appraisal.

5 Options Appraisal and Comparison

5.1 Scheme Options

5.1.1 This PAR analyses the technical, environmental, and economic merits of the preferred approach to consider the design, potential environment mitigation measures, standard of protection and the phasing of the works. The potential variations on the preferred approach are summarised in Table 5-1 and preliminary designs are shown in Appendix F.

5.1.2 All structures would be engineered to minimise visual impact on local residents and avoid interfering with the local Conservation Area. Through future upgrades the standard of protection to the Headland Area would be maintained using relatively small interventions spread over the next 100 years to mitigate construction, visual and heritage impacts.

Table 5-1 Variation on the configuration of the preferred approach

	Erosion protection construction works	Inundation protection construction works	Flood standard of protection	Flooding prevention construction works
Configuration 1	Concrete toe protection constructed Year 0	Victoria Harbour wall constructed Year 70	1:50 year	Phase 1 Setback wall (0.5m high) constructed Year 0, raised in Year 30 (1.0m high) and replaced Year 70 (1.5m high). Phase 2 Setback wall (1.0m high) constructed Year 30, raised in Year 70 (1.5m high)
Configuration 2	Concrete toe protection constructed Year 0	Victoria Harbour wall constructed Year 70	1: 100 year	Phase 1 Setback wall (0.7m high) constructed Year 0, raised in Year 30 (1.2m high) and replaced Year 70 (1.7m high). Phase 2 Setback wall (1.2m high) constructed Year 30, raised in Year 70 (1.7m high)
Configuration 3	Concrete toe protection constructed Year 0	Victoria Harbour wall constructed Year 70	1:150 year	Phase 1 Setback wall (1.0m high) constructed Year 0, raised in Year 30 (1.5m high) and replaced Year 70 (2m high) Phase 2 Setback wall (1.5m high) constructed Year 30, raised in Year 70 (2m high)
Configuration 4	Concrete toe protection constructed Year 0	Victoria Harbour wall constructed Year 70	1:200 year	Phase 1 & Phase 2 Setback wall (1.3m high) constructed Year 0. Both walls raised in Year 30 (2.0m high) & replaced Year 70 (2.5m high)

- 5.1.3 All configurations include construction of concrete toe protection (Year 0) and construction of a wall around Victoria Harbour (Year 70). The toe protection will stabilise the Town Wall by providing a strong toe structure to resist further beach lowering and scour. This protection would be extended in future years if beach levels reduce further. The wall around Victoria Harbour is required to be approximately 0.5m in height and will prevent a tidal surge from outflanking the Town Wall and the proposed setback wall defences.
- 5.1.4 To support these capital works, remedial repairs would be conducted throughout the appraisal period to address critical areas which could, in the long term, compromise the residual life of the Town Wall and terminal groyne structures. These would focus on re-pointing and replacement of blocks in the Town Wall and mass concrete infill repairs to the terminal groyne. By conducting remedial repairs the residual life of these structures can be maximised with minimal impact on their surroundings and high capital costs associated with their replacement.

Configuration 1: 1:50 Year Standard of Flood Protection

- 5.1.5 In Year 0, behind the central section of the Town Wall, a Phase 1 100m long 0.5m high, setback flood defence wall would be constructed behind the existing parapet wall to primarily act as a second line of defence in the event that the parapet wall fails and secondly to trap overtopped water and drain it back into the current surface water drainage system. The wall presents an adaptive barrier to mitigate against the effects of climate change and sea level rise.
- 5.1.6 A wall height of 0.5m will initially improve the current standard of protection to at least 1:50 years and would continue this standard even in the event of a parapet wall failure. The setback wall will be raised by a further 0.5m in 2042 and replaced and raised in 2082 to accommodate sea level rise to maintain a 1:50 year standard of protection over the whole appraisal period. A further setback wall (Phase 2) 131m in length and 1m high will be built to the west of the terminal groyne in 2042 and raised by 0.5m in 2082.

Configuration 2: 1:100 Year Standard of Flood Protection

- 5.1.7 In this option the height of the Phase 1 setback wall has been increased by 0.2m to provide a higher standard of protection against flooding. The Phase 1 setback wall will follow the same alignment as Configuration 1, but will be 0.7m high and will therefore provide an improved 1:100 year standard of protection against flooding. The setback wall will be raised by a further 0.5m in 2042 and replaced and raised in 2082 to accommodate sea level rise to maintain a 1:100 year standard of protection over the whole appraisal period. A further setback wall (Phase 2) 131m in length and 1.2m high will be built to the west of the terminal groyne in 2042, and raised by 0.5m in 2082.

Configuration 3: 1:150 Year Standard of Flood Protection

- 5.1.8 In this option the height of the Phase 1 setback wall has been further increased to 1.0m to provide an even higher standard of protection against flooding. The Phase 1 setback wall will follow the same alignment as Configuration 1 and 2, but will be 1.0m high and provide an improved 1:150 year standard of protection. The setback wall will be raised by a further 0.5m in 2042 and replaced and raised in 2082 to accommodate sea level rise to maintain a 1:150 year standard of protection over the whole appraisal period. A further setback wall (Phase 2)

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131m in length and 1.5m high will be built to the west of the terminal groyne in 2042, and raised by 0.5m in 2082.

Configuration 4: 1:200 Year Standard of Flood Protection (Non-Phased)

- 5.1.9 This configuration includes the same capital works as Configuration 3, but both setback walls (Phase 1 and 2) would be completed in Year 0 at a height of 1.3m. In Year 30 the setback walls would be raised by 0.5m to accommodate sea level rise and climate change, and the toe protection works would be extended. The walls would then be replaced and raised in Year 70. This option provides the highest standard of protection of all the options, at a minimum of 1:200 years over the appraisal period and minimises future construction disruption as all the main capital works will be completed in Year 0. Throughout the appraisal period routine maintenance will be required to maintain the defence standard and to repair any damage to the Town Wall structure and parapet wall.

5.2 Technical Issues

- 5.2.1 The setback wall in Configuration 1 will only improve the current standard of protection to 1:50 years, and a significant residual risk will remain in the event of failure of the parapet wall. All the other configurations significantly improve the standard of protection against overtopping and flooding.
- 5.2.2 By installing all the flood and toe protection works in Year 0, Configuration 4 immediately provides the highest standard of protection (1 in 200 years). However this would significantly increase the disruption and the visual impact of the works would have a negative effect on local residents. The design would not be adaptable to future requirements for sea level rise and climate change.
- 5.2.3 In all the configurations, toe protection works will reinforce the wall foundations. This is a proven and straight forward method of construction and would be completed in dry conditions during periods of low tide. In future years when the beach level is anticipated to have fallen further, the concrete toe can be extended, as has occurred with the previous toe protection measures installed at the Town Wall. This will be relatively simple to achieve with excavation of the beach material and re-casting of the toe.
- 5.2.4 Alternative techniques such as sheet piling are not technically possible due to the shallow bedrock. The installation of a rock berm toe protection could damage the Town Wall, would conflict with the heritage designation and would leave the foundation vulnerable should the berm be damaged.
- 5.2.5 The tidal inundation wall to protect from the flooding from Victoria Harbour will be relatively small in height and unobtrusive and is consistent between all the options. These works are required to prevent outflanking of the setback wall defence. The alignment of the wall will enable the existing high ground to be utilised to minimise the disruption caused by these works.

5.3 Environmental Impact Assessment

- 5.3.1 A detailed Environmental Impact Assessment (EIA) has been prepared. The EIA was prepared in conjunction with the PAR report to ensure that environmental

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aspects were fully considered in the appraisal. The following sections describe the local environmental, heritage and social considerations and constraints identified by the EIA, followed by a summary of the key impacts and proposed mitigations measures associated with the preferred approach.

Environment Issues

- 5.3.2 There are no designated sites within the boundary of the site. However, the foreshore directly east of the site, on the opposite side of the Pilot Pier is designated as a Ramsar Site, Special Protection Area and a Site of Special Scientific Interest (SSSI). The key ecological considerations to the design are the need to maintain intertidal habitat and avoid works during the most sensitive time of the year which could disturb over-wintering birds. Due to the small profile of the toe protection works, these impacts are considered to be minimal for all configurations.

Heritage Issues

- 5.3.3 The Town Wall dates from the 14th Century, is a Scheduled Monument, a Grade I listed structure, a site of national importance and is located within the Headland Conservation Area. These designations severely constrain the potential techniques to reduce flood risk and undermining and prohibit significant reconstruction works or replacement of the Town Wall.
- 5.3.4 Furthermore the finish of any proposed works in the vicinity of the Town Wall must be sympathetic to the character of the local heritage and must not adversely compromise the wall's statutory designation, otherwise planning permission could be withheld. These constraints have been considered and English Heritage have been consulted throughout the option development and appraisal process and are broadly agreeable with the preferred approach, subject to final detailed design and agreement on appropriate mitigation measures.

Social and Community Issues

- 5.3.5 Providing a suitable standard of flood protection to this residential area and to the highway assets is a primary objective for Hartlepool Borough Council.
- 5.3.6 Consultation with statutory and local stakeholders has been carried out throughout the project via letter drop, local workshops, public presentations and a project webpage to gather feedback. The stakeholder engagement process included presentation of the results of the condition and performance assessment and short list of potential options (July 2009), and the preferred short listed option (September 2010).
- 5.3.7 As part of the PAR development, a third round of consultation commenced in December 2010 to update local residents on progress and to present further refinements to the proposed scheme, in light of the earlier consultation in September 2010. Over 200 responses were received from the public. Flood risk was identified as the aspect of most importance and over 90% were in favour of the preferred option. However concerns remained regarding the look, height, construction materials and long term maintenance of the setback wall. Further consultation will form an integral part of the consents and planning application.

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Summary of Impacts for the Preferred Approach

5.3.8 The key positive and negative impacts and potential mitigation opportunities are summarised in Table 5-2 and Table 5-3 below for the preferred approach (toe protection and setback wall). The impact of the tidal inundation wall proposed in Year 70 is considered minimal as this wall will closely following the alignment of the existing wall.

Table 5-2 Key Impacts and Mitigation- Toe protection

Key Positive Impacts	Key Negative Impacts	Mitigation/ Enhancement Opportunity
Toe Protection would reduce the risk of undermining	Minor visual impact, minor impact on wall character	Minimise visible extent and selection of appropriate material colour and texture.
Health and safety benefits to local residents	Construction impacts on local residents	Considerate appropriate construction methodology.
Stabilise the wall and prevent collapse	Long term impact on heritage/ conservation area	Archaeological monitoring and recording as necessary.
-	Impact on foreshore ecology during construction	Avoid wash out of concrete fines etc.

Table 5-3 Key Impacts and Mitigation- Setback wall

Key Positive Impacts	Key Negative Impacts	Mitigation/ Enhancement Opportunity
Reduced flood risk to people and property	Visual impact on local residents.	Careful consideration of wall height, in addition to standard of protection
Secondary defence following parapet failure.	Construction impacts on local residents	Design sympathetic to conservation area and other structures.
Health and safety benefits to local residents	Long term impact on heritage/ conservation area	Archaeological monitoring and recording as necessary.
-	-	Further consultation as part of the planning application to satisfy the concerns of stakeholders

5.3.9 The environmental assessment highlights the need for the project appraisal to carefully balance the standard of protection (i.e. wall height) against the visual and heritage impacts and statutory requirements when determining a final scheme option.

5.4 Configuration Costs

5.4.1 Configurations 1 to 4 were taken forward for detailed costing. To ensure complete whole-life costings, the calculations include life time capital construction and routine maintenance costs. The costings also include the anticipated detailed design, project management, environmental enhancement and supervision costs.

5.4.2 Configuration costs have been estimated using Price Guides factored for restricted access, tidal working and heritage requirements. These costs have been subsequently benchmarked against Contractor's estimates. Breakdowns of costs are provided in Appendix G. Investment timings have been based on the estimated residual life of existing structures. The appraisal base date is January 2011, with construction anticipated to commence in April 2012.

- 5.4.3 All materials selected for the construction works are typical of civil engineering projects (e.g. concrete, steel, sheet piles, imported fill) and are therefore considered at less risk of price volatility.
- 5.4.4 Implementation costs include £20k for Local Authority project management, £100k for development of the detailed design, £80k for site investigations and survey associated with the setback wall piling and £90k for site supervision and environmental monitoring. All option costs include future upgrades and maintenance; to replace lost wall blocks, re-point and maintain wall joints as necessary. Table 5-4 shows a summary of the cash and PV costs.

Table 5-4 Summary of Configuration Costs (£k)

£k (2011)	Configuration 1 (1:50yr SOP, phased)	Configuration 2 (1:100yr SOP, phased)	Configuration 3 (1:150yr SOP, phased)	Configuration 4, (1:200yr SOP)
Local authority costs	20.0	20.0	20.0	20.0
Additional Staff costs	-	-	-	-
Consultant Design fees	100.0	100.0	100.0	215.0
Contractor fees	0.0	0.0	0.0	0.0
Cost consultant fees	0.0	0.0	0.0	0.0
Site investigation & survey	80.0	80.0	80.0	80.0
Construction	647.3	657.1	671.3	1377.3
Environmental mitigation	80.0	88.0	100.0	100.0
Site supervision	90.0	90.0	90.0	90.0
Compensation	0.0	0.0	0.0	0.0
Risk contingency (50%ile)	142.9	147.1	151.9	213.4
Other				
Sub Total	1160.2	1182.2	1213.2	2095.7
Future costs (const. + maintenance)	926.7	950.8	972.7	766.9
Total PV Cost	2086.9	2133.0	2185.9	2862.6

- 5.4.5 Based on the EIA and guidance from English Heritage, it is proposed to provide environmental improvement measures to mitigate the long term impact of the wall on the Headland Conservation Area. A provision has been included in each of the options to clad or finish the setback walls in a suitable material and to provide a handrail and access gates of similar appearance to the existing footway. There are different construction and finish options for the wall which could include steel, concrete, stone etc, which will be explored further during the detailed design stage and as part of the planning application.
- 5.4.6 Under the current agreement, PD Teesport and HBC are responsible for maintenance of the Town Wall. This will continue but through more formal monitoring to identify key areas for repair as part of a 10 year rolling programme, at a cash cost of £150k.
- 5.4.7 An Optimism Bias was developed in accordance with the Defra Supplementary guidance note (2003). Appendix K includes a summary table of positive and negative bias items and their relative significance. On this basis a 50 percentile contingency was added to the whole life PV costs of each configuration.

5.5 Benefits (Damages Avoided)

- 5.5.1 The short-listed option benefits have been derived using the latest guidance provided in EA FCERM-AG, associated Supplementary Guidance, the Green Book (HM Treasury, 2003) and flood damages from the Multi-Coloured-Manual (MCM, 2003). The base date for appraisal is January 2011. Where required damages have been corrected to the base date using the retail price index. The economic appraisal summary tables are shown in Appendix H.
- 5.5.2 An assessment of the flood damages due to overtopping is based on the 'Do Nothing' numerical and physical modelling discussed in Section 3.1. A list of properties and infrastructure at risk was compiled based on the flood outline from the modelling. For the predicted flood extents for the 'Do Nothing' baseline case under different return period events, refer to Appendix D.
- 5.5.3 Residential and commercial property values were obtained from the Land Registry and checked against available local house pricing websites, which have included historical data of sales values. For flood damage write-off, when a property is flooded by a 1:3 year return period or lower, damages were set to the property value. All flood damages were capped at a value less than or equal to the property value, where this was applicable.
- 5.5.4 The overtopping rates included in the appraisal include an allowance for reduction due to drainage within the existing wall scuppers and the road drainage network; it is assumed this function will continue thorough the appraisal period. Emergency response costs to flooding have been included in the appraisal at 10.7% of the flood damages in accordance with the MCM.
- 5.5.5 Following discussions with English Heritage a nominal conservative allowance was made for the national heritage loss should a section of the Town Wall fail leading to abandonment of the structure. This was estimated at £1,000k cash (£808k PV) and would occur within the next 10 years without intervention. No erosion benefits have been included in the appraisal for the 12 properties immediately behind the Town Wall (valued at £1,810k cash, £1,280k PV) as the risk of failure and future retreat of the coastline cannot be determined with confidence due to the shelter provided by the nearby port structures, and to avoid double counting damages associated with flooding of these properties.
- 5.5.6 Due to the rate of overtopping significantly exceeding safe and acceptable levels for pedestrians, particularly after failure of the parapet, an allowance for a single fatality loss has been included. A sum of £1,508k (£449k PV), based on the Defra publication *"Assessing and valuing the risk to life from flooding for use in Appraisal of Risk Management Measures"* and uplifted accordingly. The fatality risk was assigned a probability of 1% in each year of the appraisal and discounted accordingly.
- 5.5.7 The economic benefits do not consider flood damages associated with the inundation from the Victoria Harbour in Year 70. These damages were considered to be small compared to the overtopping damages, which occur with greater frequency and earlier in the appraisal period. This is a conservative assumption and avoids the risk of double counting flood damaged properties.

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5.5.8 Over the 100 year appraisal period there are a total of 230 properties at risk from flooding. The total 'Do Nothing' PV damages including residential, commercial, infrastructure, fatality and heritage loss is £11,069k. It is noted that the 'Do-Nothing' scenario would also include a series of key non-monetarised damages:

- a. Reduction in economic activity, and loss of future regeneration funding;
- b. Disruption to local services;
- c. Negative impacts on local community social well being and health.

5.5.9 Quantifying these aspects as economic damage is extremely uncertain and therefore they have not been included in the economic appraisal of the options but are nevertheless damages associated with the 'Do Nothing' scenario. The Do-Nothing damages do not consider potential re-construction costs following a significant failure of the Town Wall. Intervening once the wall had failed would require far greater investment than intervening now.

5.5.10 Residual flood damages and total benefits were estimated for Configurations 1 to 4 (Table 5-5). Each configuration includes future capital works to ensure a single, continuous standard of protection over the 100 year appraisal period. Therefore damage only occurs for flood events over the design standard. The detailed benefit appraisal sheets are contained in Appendix H and were taken forward with the PV costs to consider the preferred option.

Table 5-5 Summary of Present Value (PV) Damages and Benefits (£k)

	Damage (PVd)	Benefits (PVb)	Key non-monetarised Benefits
Do nothing	11,069		Disruption, social well being
Configuration 1 (1:50 SOP)	985	10,084	Improved H&S
Configuration 2 (1:100 SOP)	171	10,897	Improved H&S
Configuration 3 (1:150 SOP)	142	10,926	Improved H&S
Configuration 4 (1:200 SOP, non phased)	78	10,990	Improved H&S

6 Selection and Details of the Preferred Option

6.1 Selecting the Preferred Option Configuration

- 6.1.1 The preferred option configuration should provide the best level of coastal protection that the economics allow, meet statutory environmental requirements and provide and maintain an appropriate standard of protection over the appraisal period.
- 6.1.2 The SMP2 requires a 'Hold the Line' policy within MA12.1. The options considered in detail within this PAR achieve this policy and reduce the risk of wall toe failure and flooding from overtopping. The appraised options avoid the need to significantly disturb the Town Wall Scheduled Monument.
- 6.1.3 Of the options taken forward for detailed appraisal, Configuration 4 provides the highest standard of protection but requires early investment and therefore the PV cost is significantly higher than the phased options (Configuration 1 to 3). Furthermore the need to incorporate a sea level rise allowance into the design in Year 0 will lead to a significantly higher visual impact on the local landscape and would be a significant project risk.
- 6.1.4 Configuration 1 provides the lowest standard of protection (1:50) and a moderate benefit cost ratio, however only a modest design change is required to achieve a much improved standard of protection, as most of the capital costs is contained in the installation of the support piles for the setback wall. The additional pile extension and infill panels cost are small and therefore the difference in scheme capital cost between Configuration 1 to Configuration 3 is minimal.
- 6.1.5 For the existing case, overtopping rates exceed those required for public safety. Configurations 1 to 4 will not reduce the current rates of overtopping to pedestrians immediately behind the Town Wall parapet, but will provide enhanced flood protection to properties behind the setback wall in the Headland area. To manage the overtopping risk HBC would close off the footway to contain flood water and restrict public access during extreme events, as required.
- 6.1.6 The configurations are compared below (Table 6-1) using the FCERM-AG decision making criteria and were sorted by benefit cost ratio. The leading benefit cost ratio (5.11) relates to a configuration which has a 1:100 year Standard of Protection. The guidance notes that the incremental benefit cost ratio of the next standard of protection should be tested to confirm if that standard can be recommended. Configuration 3 has a 1:150 year standard of protection however the incremental benefit ratio is well below the threshold of 3. Configuration 4 also does not meet the required economic threshold. Therefore on an economic basis Configuration 2 with a 1:100 year standard of protection is the leading configuration option.

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Table 6-1 Benefit-Cost Assessment

Option	PV Costs (£k)	PV Benefits (£k)	Av. Benefit/Cost Ratio	Incremental Benefit/Cost Ratio
Configuration 1 (1:50 SOP)	2,087	10,084	4.83	-
Configuration 2 (1:100 SOP)	2,133	10,897	5.11	17.64
Configuration 3 (1:150 SOP)	2,186	10,926	5.00	0.55
Configuration 4 (1:200 SOP, non phased)	2,863	10,990	3.84	0.09

6.1.7 In terms of environmental and heritage impacts Configuration 1 to 3 were considered to be the same for the toe protection element, as the works are identical across these options. Configuration 4 results in slightly more disruption to the foreshore as a longer length of toe protection is to be constructed.

6.1.8 For the setback wall, Configuration 1 is the lowest in height and would lead to the lowest visual impact, followed by Configuration 2. Configuration 3 has a more significant visual impact than Configuration 2 as the setback wall height would be of sufficient height to obscure seaward views from local properties. Configuration 4 would lead to the most significant negative impact with a high wall and significant level of disruption during the construction works. Based on feedback received, the increased visual impact of a higher standard of protection associated with Configurations 3 and 4 would be likely to lead to public objection.

6.2 The Preferred Option

6.2.1 Based on the FCERM-AG decision making process, Configuration 2 was found to have the highest benefit cost ratio and was taken forward as the preferred option.

6.2.2 Of the other options Configuration 1 has a lower benefit/cost ratio and the Standard of Protection achieved falls below that required for flood insurance and was not considered adequate for a residential area. Configuration 4 incurs high costs, was inflexible to future uncertainty regarding climate change and would lead to significant environmental impact. Based on feedback received on Configuration 3, this option could generate significant objection due to the increased height of the wall.

6.2.3 To confirm the robustness of the preferred option, sensitivity testing including a delay in parapet wall failure (reducing scheme benefits) and a potential 20% increase in piling costs as a result of poor ground conditions were considered (Table 6-2).

Table 6-2 Benefit-Cost Sensitivity Testing

	PV Cost (£k)	PV Benefits (£k)	Benefit /Cost Ratio
Config 2 - Baseline	2,133	10,897	5.11
Config 2 - Parapet failure Yr 50	2,133	8,216	3.85
Config 2 + 20% piling costs	2,233	10,897	4.88

6.2.4 The leading option (Configuration 2) was found to be sensitive to the anticipated timing of the parapet wall failure however the benefit cost ratio remains at 3.8 or

greater. A 20% increase in piling costs leads to a reduced benefit cost ratio, but this remains greater than 4.8.

- 6.2.5 On the basis of technical, environmental, and economic merit, Configuration 2 was selected as the preferred scheme for the Town Wall MA12.1 frontage. This option increases the standard of protection to 1:100 years and maintains this standard over the next 100 years. The option design represents a balanced compromise between the need for a technically, economically robust and efficient scheme given the Scheduled Monument designation and environmental impacts.
- 6.2.6 Configuration 2 is flexible to future climate change and the foundations will be designed so that the wall can be adapted and extended when required. The preferred option's setback wall will not have any significant long-term adverse impacts and will enhance the safety of residents and pedestrians on the road behind the Town Wall. Combined with a programme of maintenance to address long term deterioration of the wall and toe protection works, Configuration 2 will address the key flood and wall toe failure risks.
- 6.2.7 The total sum for capital grant aid approval is £1,307k, while providing benefit of £10,897k. The scheme achieves a benefit cost ratio of 5.11. This option will protect 230 residential households from flooding to a 1:100 year standard of protection for the next 100 years and provides a secondary line of flood defence in the event of a parapet wall failure.

6.3 Details of the Preferred Option

Technical Aspects

- 6.3.1 The preferred option is to construct a series of setback walls to act as a secondary line of defence in the event of parapet wall failure and to trap overtopped water and drain it back into the sea (Appendix I). The first section of wall 100m long will be constructed in Year 0 (2012, Phase 1) using piled steel posts and infill panels to provide a setback wall 0.7m high. Given the close proximity of residential houses, a short section of precast concrete wall is also being considered to help mitigate some of the anticipated difficulties associated with achieving plant access behind the wall.
- 6.3.2 A handrail will be provided on top of the wall for public safety. As part of the works the existing drainage through the wall will be cleaned, inspected and improved where required. A further setback wall (Phase 2) is to be constructed in Year 30 (2042) (1.2m high) at a location further to the west.
- 6.3.3 By adopting a 'king pile' wall design, the piles for the setback wall can be installed efficiently, without the need to excavate significant foundations which would be required for an insitu concrete or blockwork wall and present a risk to the Town Wall. The piles will be designed to accommodate future sea level rise.
- 6.3.4 Between each pile, the use of pre-cast units will enable off site fabrication and delivery by road when required and allow different types of finish to be considered and applied to a consistently high standard. The final finish of the wall will be determined as part of the planning application, but could include concrete cladding, blockwork effect concrete, plastic or masonry.

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- 6.3.5 The concrete toe protection will be constructed along the most critical section of the Town Wall. The protection will be constructed of mass concrete. In Year 0 short sections of the foreshore will be carefully excavated along a 140m length to reveal the wall toe and competent ground. A blinding layer will be placed, and formwork setup, before encasing the wall toe with a concrete block up to 0.6m by 2.0m. The existing beach groyne will be maintained and provided with additional toe protection to prevent undermining. Future extensions to the toe of the wall, the set back walls and the groyne will be constructed in Year 30 (2042) with further extensions and replacements in Year 70 (2082).
- 6.3.6 The tidal inundation wall will be constructed in Year 70 (2082). The construction materials and final alignment will be selected to be sympathetic to the local environment as part of a future design study. Where possible the existing walls and bunds around the harbour will be used in the defence, or upgraded.
- 6.3.7 An essential part of the preferred option is the proactive approach to monitoring and maintenance of the Town Wall to address the ongoing deterioration of the wall. These annual works will re-point loose masonry, replace damaged blocks and maintain the wall drainage. These repairs will be made good using appropriate materials in accordance with English Heritage guidance and will help to maintain the residual life of the Town Wall. This proactive approach will significantly reduce the risk of catastrophic failure of a section of the historic wall. This risk cannot be completely eliminated without either complete reconstruction of the entire wall or encasement of the wall, both of which are considered unacceptable.

Environmental Aspects

- 6.3.8 As part of the planning application and detailed design, the EIA completed for this PAR will be updated to consider specific environmental impacts associated with the preferred option design, in particular the impact of the setback wall on the local landscape, residents and Scheduled Monument designation. The EIA will also consider any ecological impacts on the neighbouring SPA and SSSI sites. Prior to commencing the works, an environmental management plan will be formulated to take temporary construction impacts (e.g. noise) and longer term environmental impacts (e.g. visual) and associated mitigation and supervision measures into the scheme detailed design and construction.
- 6.3.9 The preferred option addresses the flood and undermining risk through a sympathetic approach to the character of the Town Wall and Headland Conservation Area. The preferred option has been widely consulted on and has shown that over 90% of those that responded were in favour of the preferred option. Remaining stakeholder concerns will be addressed through further consultation as part of the planning application.
- 6.3.10 Letters of support have been provided by Natural England and English Heritage (Appendix L). Both consider that the setback wall and toe protection option is likely to lead to an acceptable solution. A Marine Licence is being sought for the project.
- 6.3.11 With regard to the Water Framework Directive (WFD), the 2011 Seaton Carew Coastal Strategy WFD assessment (for the neighbouring coastal management

unit) confirmed that within the context of the wider water body, any potential effects of the strategy options on ecological elements in this locality were unlikely to prevent achievement of the WFD Objectives within the water body as a whole. Given the similarities between the foreshore toe protection works proposed for the Town Wall and the foreshore works in the coastal strategy, a similar outcome is anticipated for the Town Wall scheme and will be confirmed during the detailed design stage of the project as part of the update to the EIA.

Cost for the Preferred Option

- 6.3.12 The PV, Whole Life Capital and Capital Grant Approval Project costs are shown overleaf (Table 6-3). Capital costs have been benchmarked using experienced Contractors and a full breakdown is shown in Appendix G. The scheme costs include for further site investigations to determine the ground conditions for the setback wall, detailed design of the setback wall, toe protection works and upgrading the terminal groyne. During construction both engineering and environmental supervision will be required to monitor the works and ensure the Scheduled Monument is not damaged or compromised and appropriate costs have been included in the economic appraisal.
- 6.3.13 To mitigate the visual impact of the scheme on the Conservation Area, allowances have been included to clad the wall in a suitable material, and provide a handrail, access gates and signage to limit access to the footway in front of the setback wall during overtopping events.
- 6.3.14 The approval sum also includes a 95th percentile risk contingency equating to 30% of the capital construction cost (£255.5k). This includes for the key project risks identified in Chapter 7 and is considered appropriate at this stage for budgetary purposes. The risk contingency will be further refined as detailed design and procurement progresses.

Contributions and Funding

- 6.3.15 The project is seeking approval for £1,307k Grant-in-Aid funding. The preferred option includes a proactive approach to ongoing maintenance and repair of the Town Wall. This has been estimated at £150k every 10 years and is the joint responsibility of PD Teesport and HBC.
- 6.3.16 Further discussions are currently ongoing between HBC and English Heritage, to determine if a heritage grant can be made available. Other sources of external contribution, including PD Ports, have been thoroughly investigated. However the only benefit the Port will receive from the scheme is enhancement of the toe works that they installed and subsequent transfer to HBC. Maintenance of the wall in the future will still be the joint responsibility of HBC and PD Ports.

Table 6-3 Project Costs for Preferred Option (£k)

	Cost for economic appraisal (PV)	Whole life cash cost	Capital Grant approval project cost
Costs to PAR: (excluding costs of approved study)			
Local authority staff costs	Sunk Costs	-	
Additional Staff costs	Sunk Costs	-	
Site investigation & survey	Sunk Costs	-	
Consultant fees	Sunk Costs	400	
Contractor fees	Sunk Costs	-	
Cost consultant fees	Sunk Costs	-	
Sub-total	Sunk Costs	400	400
PAR to Construction:			
Local authority staff costs	20	20	20.0
Site investigation & Survey	80	80	80.0
Consultant fees	100	100	100.0
Sub-total	200	200	200.0
Construction:			
Construction costs	657	657	657.1
Inflation allowance for 12 months			16.4
Environmental enhancement	88	88	88.0
Site supervision	90	90	90.0
Compensation	0	0	0.0
Sub-total	835	835	851.5
Future Costs:			
Maintenance	515	1500	
Future construction	436	1932	
Risk Contingency:			
Monte Carlo 95% or similar			255.5
Monte Carlo 50% or similar	147	147	
Contributions			0.0
TOTAL	2133	5015	1307.0

Economic Summary Flood and Coastal Resilience Partnership Funding

6.3.17 The scheme has been appraised in accordance with the May 2011 Defra policy statement on Flood and Coastal Resilience Partnership funding as summarised in Table 6-4 below. The only Outcome Measures relevant to the MA12.1 frontage are OM1, OM2 and OM3. The scheme achieves a robust score of 174.8%, a benefit to cost ratio of 4.92 and reduces the flood risk to 230 households over a period of at least 70 years. Under the previous system the scheme achieved an OM score of 6.12.

6.3.18 The OM score was tested for sensitivity for the following scenarios: a 30% increase in whole-life costs; 50% of the assumed households at risk of flooding being downgraded from 'Very Significant' to 'Significant' Risk; and 50% of households at risk of erosion being downgraded from medium term to long term risk. In each case the OM score remained above 130%.

Table 6-4 Benefit-Cost Ratios and Outcome Measures

Outcome Measure	Value	FDGiA Contribution
OM1- Economic Benefit		£22,107
PV Benefits (£k)	£9.10M	
PV Costs (£k)	£1.85M	
Benefit/Cost Ratio	4.92	
OM2 Households at risk from Flooding		£2,886,102
20% Most Deprived	120	
21-40% Deprived	110	
60% Least Deprived	0	
OM3 Households at risk from Erosion		£324,078
20% Most Deprived	0	
21-40% Deprived	12	
60% Least Deprived	0	
Total FDGiA Contribution		£3,232,464
'Raw' Outcome Measure Score		174.83%

7 Implementation

7.1 Project Planning

Programme and Spend Profile

7.1.1 An overview of the key project dates and approvals are shown in Table 7-1 and Appendix J. The works are programmed to commence during the spring 2012 and be concluded by early autumn 2012 to minimise any disturbance to birds on the neighbouring environmentally designated sites. The annualised spend profile is shown in Table 7-2. The project expenditure is compatible with the HBC Medium Term Plan.

Table 7-1 Key Dates

Activity	Date
PAR approval and sign off	October 2011
EIA complete by	November 2011
Risk workshop/value engineering complete by	November 2011
Detailed design complete by	February 2012
Planning permission received	May 2012
Target price agreed by	April 2012
Works start on site in	June 2012
Works substantially complete by	December 2012
Project closure	March 2013

Table 7-2 Annualised Spend Profile £k (FDGiA spend only)

	2011/12	2012/13	2013/14	2014/15	Future Years	Total
Authority staff costs	-	20.0	-	-	-	20.0
Design fees	-	100.0	-	-	-	100.0
Site investigation	-	80.0	-	-	-	80.0
Construction	-	673.5	-	-	-	673.5
Supervision	-	90.0	-	-	-	90.0
Environmental Enhancement	-	88.0	-	-	-	88.0
Risk contingency	-	255.5	-	-	-	255.5
Less non grant eligible costs	-	-	-	-	-	-
Total grant eligible sum *	-	1,307.0	-	-	-	1,307.0

Notes: Capital Construction figures include inflation at 2.5%.

Phasing and Approach

7.1.2 The project will be designed and managed by Hartlepool Borough Council. HBC are an experienced coastal protection authority, with recent management

experience of similar coastal protection projects. The works will be procured in accordance with HBC procedures and standing orders relating to contracts.

- 7.1.3 The contractor will mobilise in June 2012, subject to funding, by establishing a site compound at the root of the Pilot Pier, adjacent of York Place road (Figure 2). The site will be suitably screened to mitigate any potential adverse impact on birds at the SPA to the east of the Pier. The works will commence with construction of the mass concrete toe protection. Access to the beach for plant will be via the slipway to the north of the Pilot Pier. It is proposed to close the beach to the public during construction.
- 7.1.4 The second stage will be to install the setback wall. This will lead to some disruption to local residents, but will be mitigated accordingly. Appropriate pre and post condition surveys will be made of local resident's homes and any vibration damage as a result the piling works will be made good. The construction of the setback wall and toe protection will require delivery of concrete and piles to the site. This will likely be by road, however the possibility of bringing piling materials by sea is also being considered, due to the restricted access.
- 7.1.5 There are no land purchase requirements. Enabling works will be required to protect the foreshore access route and to provide safe access for plant to the Town Wall. Careful site supervision will be required to manage resident's access to their properties and as part of the heritage conservation requirements to avoid damage to the Scheduled Monument. Any specific requirements to limit construction works timing, extent and / or to adopt a particular style or finish to the setback wall will be determined in the final EIA.

7.2 Delivery Risks

- 7.2.1 A risk register was developed (Appendix K) based on HBC's experience of similar works on the Hartlepool Headland to identify the scheme risks and to determine the risk contingencies. Table 7-3 highlights the most significant high level risks and corresponding mitigation measures. Of most concern are the poor ground conditions identified by the recent site investigation to be technically challenging, with uncertainty as to the exact position of the inner skin of the Town Wall and presenting a risk to the piling works.
- 7.2.2 This risk is mitigated by utilising the detailed site investigation (which includes both passive and invasive surveys) supplemented with further information, which will be applied when developing the detailed design of the piling works. However, the contingency sum may need to compensate for having to locally change the foundation designs of the wall at critical locations.
- 7.2.3 The risks posed by difficult access and potential damages to the Scheduled Monument, road and properties will be mitigated through careful supervision of the works. HBC will apply their recent experience in successfully obtaining planning permission for other coastal protection works.
- 7.2.4 A 95%ile risk contingency of 30% of the construction cost (£255.5k) was applied for budget approval purposes. This is considered reasonable at this stage given the nature of the scheme and the potential uncertainties discussed above. Upon

Title	Hartlepool Town Wall Model Study and Construction C6-3					
No.	HP11	Status:	1	Issue Date:	September 2011	Page 36

receipt of competitive tenders this can be reviewed and potentially reduced for the construction allocation.

Table 7-3 Level Risk Schedule and Mitigation

Key Project Risk	Adopted Mitigation Measure
Storm damage prior to or during the works.	HBC routinely monitor site for damage. Works programmed to start in the summer months.
Difficult ground conditions.	Stage A studies included extensive ground and structure investigations. These will be applied in the design and further site investigations studies are planned.
Difficult site access-setback wall construction.	Detailed design to be developed in conjunction with specialist piling contractor.
Objections from Local or Statutory consultees to the planning application.	Extensive consultation has been completed at each stage of the project to mitigate this risk. The preferred option is sensitive to the location and statutory designations.
Construction damage to residential properties or the Town Wall.	This risk will be managed by the contractor using risk assessments, method statements and conditions surveys in accordance with industry best practice.

7.2.5 Design and construction risks could be further mitigated through HBC adopting an Early Contractor Involvement (ECI) approach to the contract and a report to the Council's Portfolio Holder has been drafted to seek approval to adopt this approach.

7.2.6 Consultee approval risk will be mitigated through further consultation with residents which is currently ongoing. An appropriate risk contingency has been included in the 'Sum for Approval' and is considered reasonable at this stage.

Safety Plan

7.2.7 A Public Safety Risk Assessment will be established prior to construction. The detailed design of the works is being undertaken by HBC. HBC will appoint key parties under the CDM Regulations. All parties will be fully engaged in the detailed design processes to manage construction safety and risks.

Appendix A**Project Report Data Sheet**

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):

HP11

Project Name
(60 characters
max.):

Town Wall Model Study & Construction C6-3

Promoting Authority: Defra ref (if known)
Name

CPW 1995

Hartlepool Borough Council

Emergency Works:

No

Yes/No

Strategy Plan Reference:

Hartlepool Coastal Strategy (2006)

River Basin Management Plan

NA

System Asset Management Plan

NA

Shoreline Management Plan:

River Tyne to Flamborough Head

Project Type:

Project within Strategy / Coastal
Protection

Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project/
Strategy Implementation/Sustain STANDARD OF SERVICE. 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:

April 2012

Estimated duration in months:

6

Contract type*

External Contractor

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

Costs

PAR Preparation:

400

Capital Grant for Environment

1,307

Agency approval:

Total Whole Life Costs (cash):

5,015

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Own Resources:

0

Windfall Contributions:

0

Deductible Contributions:

0

Loans:

0

ERDF Grant:

0

Other excluded Items:

0

LOCATION – to be completed for all projects

EA Region/Area of project site (all projects):

Yorkshire & North East/North East

Name of watercourse (fluvial projects only):

N/A

District Council Area of project (all projects):

Hartlepool Borough Council

Grid Reference (all projects):

NZ525336

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

DESCRIPTION

Specific town/district to benefit:

Headlands, Hartlepool

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

Carry out toe protection works to the Hartlepool Town Wall, a Scheduled Monument that provides coastal erosion and flood protection. The works also include construction of a setback wall to provide a secondary defence line to capture overtopping water in the event of parapet wall failure. The works include a proactive approach to monitoring and maintenance of the Town Wall to manage the condition of the wall.

DETAILS

Design standard (chance per year):	1 in 100	yrs
Existing standard of protection (chance per year)	1 in 20	yrs
Design life of project:	70	yrs
Fluvial design flow (fluvial projects only):	NA	m ³ /s
Tidal design level (coastal/tidal projects only):	Varies	m
Length of river bank or shoreline improved:	150	m
Number of groynes (coastal projects only):	1	
Total length of groynes* (coastal projects only):	NA	m
Beach Management Project?	No	Yes/No
Water Level Management (Env) Project?	No	Yes/No
Defence type (embankment, walls, storage etc)	Wall	

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

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):	Awaited	Not Applicable/Received/Awaited
EA Region Consent :	NA	Not Applicable/Received/Awaited
Non Statutory Objectors:	No	Yes/No (For coastal schemes complete CPA1/CPA2)
Date Objections Cleared:	-	
Other:	NA	Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:	Received	Not Applicable/Received/Awaited
Date received	22/04/11	

SITES OF INTERNATIONAL IMPORTANCE

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

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

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

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

OTHER ENVIRONMENTAL CONSIDERATIONS

Listed structure consent	Awaited	Not Applicable/Received/Awaited
Water Level Management Plan Prepared?	NA	Yes/No
FEPA licence required?	Awaited	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	NA	Yes/No/Not Applicable
Catchment Flood Management Plan	NA	Yes/No/Not Applicable
Water Level Management Plan	NA	Yes/No/Not Applicable

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

SEA	NA	Statutory required/ voluntary/not applicable
EIA	Yes	Yes (schedule 1); Yes (schedule 2); SI1217; not applicable
SEA/EIA status	Draft	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:	6.2		Ha
of which present use is:	FRM	CERM	
Agricultural:	0	0	Ha
Developed:	5.6	0	Ha
Environmental/Amenity:	0.6	0	Ha
Scheduled for development	0	0	Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
¹ Residential	230	0	15,652	0
Commercial/industrial	6	0	2,000	0
Critical Infrastructure	0	0	0	0
Key Civic Sites	0	0	0	0
Other (description below):	0	0	0	0
Description:	-			

Costs and Benefits

¹ Present value of total project whole life costs (£'000s): Include all costs including ineligible	2,133	
Project to meet statutory requirement? Y/N	N	
	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	9,277.7	0
Present value of commercial/industrial benefits:	362.2	0
Present value of public infrastructure benefits:	0	0
Present value of agricultural benefits:	0	0
Present value of environmental/amenity benefits:	1,257.5	0
¹ Present value of total benefits (FRM & CERM)	10,897.4	
Net present value:	8,764	
Benefit/cost ratio:	5.1	
Base date for estimate:	Jan. 2011	
PAG Decision Rule stage 3 applied	Yes	Yes/No
PAG Decision Rule stage 4 applied	Yes	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*:	E01011 991 & E01011 993	Indicate if deprived:	Yes	Yes/No
(*as ranked by Indices of Multiple Deprivation)				
Risk:	Na	VH, H or N/A		
Net gain of BAP habitat:	Wetland	Saltmarsh/ Mudflat	Ha	
	0	0		
SSSI protected:	0	ha		
Other Habitat:	0	ha		
Heritage Sites:	I	"I or II" , "II or other" or "N/A"		

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring:	No	Yes/No
Reason (max 100 chars):		

Outcome Measure Prioritisation Priority Score

FDGiA Calculator, based on interim funding arrangements announced 23rd May 2011										
ePublications Catalogue Product Code - FLHO0511BTXS-E-E										
Project Name/ref: Town Wall Model Study & Construction C6-3					Key					
					Input cells					
					Calculated cells					
Summary: prospect of FDGiA funding										
"FDGiA Contribution":					£ 3,232,464					
"Raw OM Score":					174.83%		Scheme Benefit to Cost Ratio: 4.92 to 1			
Cost saving and/or external contribution required					£ -		Effective return to taxpayer: 4.92 to 1			
Less scheme contributions secured:					£ -		Effective return to area: n/a to 1			
"Adjusted OM Score":					174.83%					
Result:					Candidate for the Regional Programme subject to RFCC approval					
FDGiA required for next phase(s):					£ 1,136,697					
1. Scheme details										
Who will maintain asset?					LA					
PV Whole-Life Costs:					£ 1.85 million					
PV Whole-Life Benefits:					£ 9.10 million					
Cash cost of next phase(s):					£ 1.14 million					
Duration of Benefits:					70 years					
Average flood damages:					£ 30,000 per household					
Construction phase?					Yes - costs for approval include construction					
2. Qualifying benefits under Outcome Measure 2: households better protected against flood risk										
Number of households in:					Before		After		Change due to scheme	
20% most deprived areas					5 115		130		130 -5 -115	
21-40% most deprived areas					18 92		64		64 -18 -92	
60% least deprived areas							0		0 0	
At: Moderate Significant Very					risk risk significant		Moderate Significant Very		risk risk significant	
					risk risk significant		risk risk significant		risk risk significant	
Annual damages avoided, compared with a household at low risk					£ 150		£ 600		£ 1,350	
Change in household damages, in:					Per year		Over lifetime of scheme		Qual. benefits (discounted)	
20% most deprived areas					-£ 138,750		-£ 9,712,500		OM2 (20%) £ 4,002,166	
21-40% most deprived areas					-£ 125,400		-£ 8,778,000		OM2 (21-40%) £ 3,617,092	
60% least deprived areas					£ -		£ -		OM2 (60%) £ -	
3. Qualifying benefits under Outcome Measure 3: households better protected against coastal erosion										
Number of households in:					Before		Damages per household avoided:			
20% most deprived areas					- -		Annual damages avoided		£ 6,000 £ 6,000	
21-40% most deprived areas					- 12		Loss expected in		50 20 years	
60% least deprived areas					- -		Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)		£ 1,410 £ 3,121	
					Long-term loss Medium-term loss				Long-term loss Medium-term loss	
Change in household damages, in:					Year 1 loss avoided:		Over lifetime of scheme:		Qual. benefits (discounted):	
20% most deprived areas					£ -		£ -		OM3 (20%) £ -	
21-40% most deprived areas					-£ 37,451		-£ 2,621,585		OM3 (21-40%) £ 1,080,259	
60% least deprived areas					£ -		£ -		OM3 (60%) £ -	
4. Qualifying benefits under Outcome Measure 4: statutory environmental obligations met										
Payments under:					Assumed benefits per unit:		Qual. benefits (discounted):			
OM4a - Hectares of net water-dependent habitat created					£ 15,000		OM4a £ -			
OM4b - Hectares of net intertidal habitat created					£ 50,000		OM4b £ -			
OM4c - Kilometres of protected river improved					£ 80,000		OM4c £ -			
							OM4 £ -			
5. Qualifying benefits arising from the overall scheme, for entry into the Medium-Term Plan										
OM, deprivation:		Qual. benefits:		Payment rate:		FDGiA contribution:				
OM1		£ 401,112		5.56 p in the £1		£ 22,284				
OM2		£ 4,002,166		45.0		£ 1,800,974				
20% most		£ 3,617,092		30.0		£ 1,085,128				
21-40%		£ -		20.0		£ -				
Least 60%		£ -		45.0		£ -				
OM3		£ 1,080,259		30.0		£ 324,078				
20% most		£ -		20.0		£ -				
21-40%		£ -		100.0		£ -				
Least 60%		£ -				£ -				
OM4		£ -				£ -				
Total		£ 9,100,629				£ 3,232,464		The "FDGiA Contribution" towards the scheme's whole-life benefits		
Sensitivity Testing. It is important that users of this calculator appreciate the implications on funding from changes to input data which may become necessary as the project develops and better information is available. Three typical tests are provided below. Users should consider how appropriate these are their project, what other tests may be appropriate and how best to use the information with all those that may be involved in the project.										
Revised:					FDGiA Contribution		Raw OM Score			
1. Change in PV Whole Life Cost (30% increase)					£ 3,232,464		134.49%			
2. Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band					£ 2,498,553		135.14%			
3. Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss					£ 3,160,070		170.92%			

Appendix B List of Reports Produced

URS/Scott Wilson (2011a) Hartlepool Town Wall Coastal Modelling Study Stage A report– Condition and Performance Assessment

URS/Scott Wilson (2011b) Hartlepool Town Wall Coastal Modelling Study Stage B: Technical and Environment Assessment Report

URS/Scott Wilson (2011c) Hartlepool Town Wall Environmental Statement.