

Overstrand to Walcott Strategy Study

Option identification and appraisal

Part II: Technical Support Information

**Report EX 4692
October 2004**

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Summary

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This report details the process used in evaluating various defence options and selecting the preferred option for each defence length in the study area from Overstrand to Walcott. For each defence length a variety of generic options were identified and costed, these include do nothing, demolish existing defences, repair, replace with rock revetment, add scour protection, add rock sill, replace with sea wall, renourish beach and a number of sub options such as enhance groynes. The impact of each of these defence options was assessed in three different areas; these were economics, engineering and the environment.

The economic assessment evaluates whether the options are fiscally worthwhile. To do this an assessment of the flood or erosion damage that may be expected once the scheme is implemented is made and compared to the damage that maybe accepted assuming the adoption of a *do nothing* approach. The damage avoided by the scheme is the so-called scheme benefit. In establishing the preferred economic option the ratio between the benefit and the costs are evaluated. As long as this ratio is greater than one, the option is considered to be economically justifiable.

Both the engineering and environmental assessments evaluate the impact of an option in a number of different areas. For each area a classification of either beneficial, acceptable, no impact, likely to be unacceptable or unacceptable is made. Additionally an assessment is made of whether the defence maintains, sustains or improves the standard of protection.

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1. INTRODUCTION

1.1 Background

Flood and coastal defences designed to reduce flood or erosion risk must be technically sound, economically viable and environmentally acceptable. To achieve these objectives it is necessary to take a strategic approach to option identification and evaluation. This report describes the options considered and details both the approach and the preferred options.

2. IDENTIFICATION OF STRATEGIC COASTAL DEFENCE OPTIONS

It is recognised that the option identification, evaluation and selection process is a cyclic, iterative process of exploring the problem, generating options and selecting the preferred approach. The first stage of this process has been completed as part of the Shoreline Management Plan (SMP, 1996) prepared for the stretch of coast between Sheringham and Lowestoft. Within the SMP the various policy options of Do-nothing, Managed retreat, or Hold the Line were assessed and the 'Preferred Policy' identified. Within the current Strategy Study, a list of defence options capable of achieving the Policy goals has been identified.

2.1 Generic Option Types

The type of options considered consist of a range of investment levels and performance responses and have been developed based on one of the following generic option types:

- **Do nothing** – this is discussed in Section 1.4 of the “Do nothing”- Erosion probability and Erosion Losses report
- **Monitor shoreline and maintain public safety standards** - this is the basic minimum shoreline management option, involving no attempt to maintain or improve standards of flood or erosion defence, but possibly involving emergency works.
- **Maintain existing standards** - carry out works to maintain existing standards of defence along the existing defence alignment, possibly including upgrading in response to future changes in sea conditions. This option does not include any measure designed to sustain or improve the overall response to the assets in place.
- **Sustain existing standards** - carry out works to sustain the standards of defence, maintaining the approximate alignment of the existing defence (e.g. includes beach renourishment that moves the high water line seaward, or set back walls added at the landward edge of a promenade). Taking steps to ensure that the defences in place at least cause no deterioration in processes or the environment.
- **Improve existing standards** - carry out works to sustain the standards of defence, maintaining the approximate alignment of the existing defence (e.g. includes beach renourishment that moves the high water line seaward, or set back walls added at the landward edge of a promenade). Taking steps to improve coastal processes and the environment.

The details of the above cannot be considered at a strategic level. Therefore, within the following chapters, only the appropriate detail is provided on each option to determine the preferred approach at any given location. Further study during the scheme appraisal stage would then be required to consider the details of option performance and design.

2.2 Option Costing

A key element of the engineering assessment is to establish a reliable cost for each option. Given the number of defence lengths considered and the variable number of options available per defence length, a

recipe system of valuing the options has been developed. The outcome is a range of generic options, and hence prices, applied appropriately to individual defence lengths. Thus, similar options in differing defence lengths have been valued using a standard recipe of estimated rates and costs - no allowance having been made for the variable working environments at differing locations.

The rates used are based on unit rates collated from a number of sources supplemented using published pricing data. The base date for all costs is March 2003. The estimated costs for each and every option has been determined for the full 100 years of the strategy. In respect of major replacements or renewals, it has been assumed that these will be implemented towards the end of the estimated residual life for existing defences. The following items have also been included in the estimates.

- Annual maintenance
- Cyclic refurbishment
- Annual inspections
- Routine coastal monitoring
- Professional fees
- In-house staff costs.

The estimated costs of the options do not include any contingency or risk allowances.

The present value of each option has been determined using the procedures referred to in DEFRA FCDPAG3 “Flood and Coastal Defence Project Appraisal Guidance – Economic Appraisal” as modified by the supplementary note to operating authorities issued by DEFRA in March 2003. Hence, a test discount rate of 3.5% has been used for years 0 – 30, 3.0% for years 31 – 75, and 2.5% thereafter. A starting value for optimism bias of 60% of total present value costs has been applied.

2.3 Defence length options

A range of defence options has been examined for each defence length. These options range from the maintenance of the existing asset to replacing an asset with defences that either sustain the present coastal environment or with defences that improve on the present coastal environment. In each case, defences are monitored and repaired annually with major repairs or renewals taking place as they approach the end of their original or extended residual lives.

It has been assumed in generating the fullest possible range of defence options that there is no requirement to increase existing standards of protection. An assessment of the impact of each of these options on property, environment, amenity, health and safety, commerce, heritage and coastal processes is given with the summary of the present values for each defence length.

The generic types of ameliorative options are discussed below. All appropriate defence options have been considered for each defence length.

- **Maintain/Repair:** All assets are maintained until the expiry of their residual lives. The assets are then replaced using appropriate technology and maintained thereafter.
- **Repair piles:** The major components of this maintenance option are the repair of the derelict toe piles. This can be combined with the encasing of the sea walls and the renewal of the toe apron. All assets are maintained on an annual basis and renewed at the end of their design or residual lives.
- **Renew piles:** The major components of this maintenance option are the replacement of the derelict toe piles. This can be combined with the encasing of the sea walls and the renewal of the toe apron. All assets are maintained on an annual basis and renewed at the end of their design or residual lives.
- **Rock scour protection:** In this option, the derelict piles are effectively ignored and their duty is done instead by a rock revetment at the toe of the wall.

- Rock revetment: The timber revetment is replaced at year 0 with a rock revetment at the foot of the cliff or along the line of the existing defences. All assets are maintained for the duration of the study period.
- Rock sill: A continuous rock sill is built shore parallel in front of the existing defences. The purpose here is to hold the toe of the beach and to minimise the loss of beach material due to offshore transport.
- Part new sea wall: The older and poorer sections of seawall are replaced at year 0 with a new wall.
- All new sea wall: A sea wall is built along the entire frontage to replace the existing defences, irrespective of their condition. Where the existing defence is a timber revetment, this is demolished before the sea wall is built along the same line. If there is a sea wall already in existence then a new wall is built directly in front of this.
- Beach recharge: This defence option tends to avoid the need to maintain and renew linear defences. A new terminal groyne(s) is provided for each defence length at year 0 with the existing groynes being renewed at the end of their residual life. Suitable beach material is deposited on the beach and renewed periodically throughout the study period. No provision has been made in the estimated costs for unforeseen loss events.
- Increase rock crest (Sub Option): The existing defence is further improved by raising the crest of the defence to its original design level, or higher. Advantage is taken in this approach to reduce the level of maintenance to the existing structure (usually a sea wall) as it is now the core of a composite defence.
- Enhance groynes (Sub Option): Another common feature shared by these defence lengths is that the groynes are permeable in construction. There may be a benefit locally in enhancing the groynes by sealing the large gaps in the planking. This sub-option can be combined with any of the main options to give an improved standard of performance.

2.4 Cliff Stability

In acknowledgement of the significance of surface and ground water on the stability of the cliffs, the following engineering works have been considered for Overstrand, West Mundesley and in front of Bacton Gas Terminal. An issue associated with the implementation of cliff stability work is that of land ownership.

- Dewatering – Deep wells: The purpose of this work is to reduce pore water pressure by installing gravity wells thereby increasing the factor of safety against deep seated failure. A screen of wells will be necessary located well back from the cliff edge.
- Regrading of the cliff: By regarding the overstep sections of cliff, the future stability of the cliffs is improved. This can only be done in conjunction with dewatering works.
- Dewatering – Surface drainage: By intercepting surface water run off at the cliff top and on the cliff face, local surface instability is prevented.

3. OPTION PERFORMANCE EVALUATION

It is recognised that the option identification, evaluation and selection process is a cyclic, iterative process of exploring the problem, generating viable options and selecting the preferred approach. The first stage of this process has been completed as part of the Shoreline Management Plan (SMP). Within the SMP the various Policy options of *Do Nothing*, *Retreat the Line*, *Hold the Line* and *Advance the Line* were assessed and *The Preferred Policy* was identified. Within the current Strategy Study, these Policy choices are reviewed. To evaluate *The Preferred Policy*, the BCR for the least cost options that will achieve the preferred policy in each area have been evaluated. Where the SMP requires “Hold the Line”, active intervention is required. In the remaining areas active intervention to maintain the existing coastline would provide very little benefit and could possibly have a detrimental effect on adjoining defence lengths due to interrupting coastal processes. Therefore in these areas no active intervention has been considered other than annual monitoring to ensure public safety.

3.1 Engineering Performance

The development of an appropriate strategic approach to coastal management demands an appreciation of the available engineering options and their likely performance. The appraisal of engineering performance therefore aims to:

- Establish a list of possible solutions based on the generic policies of Maintain, Sustain and Improve.
- Present an engineering overview of these options.
- Establish a broad brush, but strategically reliable cost of the options.
- Highlight CDM issues related to construction of the options.
- Review the likely performance of the options in terms of overtopping, breaching and erosion as well as the options overall practical sustainability (i.e. recycling with time may alter the performance of a beach and reduce its ability to perform as required in the future).

3.2 Environmental Performance

The UK Government expressed its commitment to biodiversity by signing the Convention on Biological Diversity in Rio de Janeiro in June 1992. The definition of biodiversity given in the Convention is:

“The variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and ecosystems.”

Since Rio, the Government has published an overall action plan for implementing the Convention and a series of Habitat and Species Action Plans which contain objectives and targets for the maintenance and increase of the various habitats and species. Defra High Level Target 9 provides for returns to be made regarding biodiversity.

Within its objectives on biodiversity and social development, central Government is committed to the principles of sustainable development i.e. ensuring that the actions of today do not compromise the needs of tomorrow. This commitment is reflected in guidance to District Planning Authorities mainly through PPG 12 "Development Plans and Regional Guidance" which advises that

“...the preparation of development plans can contribute to the objectives of ensuring that development and growth is sustainable.”

To ensure due recognition of environmental concerns within the option selection process, and promote environmental enhancement, each generic option has been assessed based on its impact on four key areas:

- Built environment (Property/Commercial)
- Nature conservation and geological designations (Environment)
- Tourism and leisure (Amenity)
- Archaeology and cultural heritage (Heritage)

The overview of human and natural environmental assets, including nature conservation, landscape and archaeological interests, needs to put in context the environmental objectives of interested parties and to judge the environmental acceptability of the management options. The purpose is therefore, to provide an overview of the likely impacts of the various coastal defence options on the different aspects of the natural, human and built environment. Based on this assessment of impacts the performance of each generic option has then been determined as either beneficial, likely to be acceptable, no impact, likely to be unacceptable and unacceptable.

3.3 Economic Performance

The appraisal of economic performance is a key stage in the development of the preferred strategic approach. The aims and objectives of the strategic economic appraisal may be summarised as follows:

- **To ensure best use of public money**

Demands for public funding always exceed the money available. It is therefore necessary to aim for economic efficiency in the investments that are made. This can only be done by maximising benefit relative to the resource used to achieve that benefit. Using guidance published by DEFRA (PAG 3) the economic worthiness of any particular intervention is established. To do this an assessment of the flood or erosion damage that may be expected once the scheme is implemented is made and compared to the damage that maybe accepted assuming the adoption of a *do nothing* approach. The damage avoided by the scheme is the so-called scheme benefit. The scheme benefits are then compared with the cost of implementation enabling the evaluation of the so-called Benefit Cost Ratio (BCR).

- **To ensure economic sustainability**

Sustainability is a key issue in any decision making process. To ensure economic sustainability the decision making process must be mindful of the needs of future generations and should not commit them to unnecessarily expensive solutions or tie in excessive maintenance requirements.

- **To demonstrate accountability**

A formal process of project appraisal (engineering, environmental and economic) can demonstrate that a wide range of different alternatives has been considered. Economic appraisal is the most auditable of these appraisals and provides the most effective audit trail of the decision making process.

- **Appraisal period and accounting for inflation**

Options are assessed over a time span of 100 years, with option costs being discounted to a common date (for this study this has been assumed as 2004) using the Test Discount Rate, which was set by the Treasury at 3.5% pa in years 0 – 30, 3.0% pa in years 31 – 75 and 2.5% pa in years 76 - 100. The Test Discount Rate represents the assumed difference between inflation and the likely returns from an investment on the open market and therefore inflation is implicitly included within the discounting process. Once scheme benefits and costs have been discounted to the common base date they are then referred to as Present Values (PVs).

4. OPTION EVALUATION

The full range of options is presented for each individual defence length for the entire study frontage. Reference is made in each defence length to a preferred option. In every case, the present value costings have been compared against impact and the opportunity to sustain or improve coastal processes and the environment. Hence, the preferred option may not, in every case, be the most economical.

4.1 Management Unit TRI 1: Cromer to Overstrand

SMP Policy Option: Do Nothing

Description: This management unit includes the defence lengths TRI 1.01 & 1.02. It is located immediately to the west of Overstrand and the majority of the hinterland is occupied by the Royal Cromer Golf Club, a proportion of which would be lost to erosion in the *Do Nothing* scenario.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.1.1 TRI 1 Summary of Economic Assessment

Management Unit: TRI 1 Options	Whole life (100 years) Costs and Benefits (£k)		BCR			
	PV cost per Defence Length	Option Benefits	No Active Intervention After Year			
	TRI 1.01 & 1.02		20	30	50	100
Do Nothing	0	-	-	-	-	-
Maintain Defences	1,465	329	0.11	0.13	0.17	0.22
Demolish Defences	67	0	0	0	0	0

Economic Assessment: The potential benefits in TRI 1 are very low and on their own cannot justify active intervention. The economically preferred option would be to “Do Nothing”.

Table 4.1.2 TRI 1 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	1.01 & 1.02	Do Nothing	**	✓✓	•	•	•	×	✓✓
Least Cost Option	1.01 & 1.02	Do Nothing	**	✓✓	•	•	•	×	✓✓
Engineering and Environmentally Preferred Option	1.01 & 1.02	Demolish Defences	**	✓✓	•	•	•	×	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable '×', Unacceptable '**', Impact not determined '?'.

Engineering and Environmental Assessment: The preferred engineering and environmental option would be to remove the remaining defences entirely. This ensures that there is no residual health and safety problem stemming from derelict defences and the improvement to both coastal processes and the environment begins to accrue immediately. In recommending this as the preferred option, no account has been taken of the social impact of the works.

Table 4.1.3 TRI 1 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	128	-	-	-	-	-
Least Cost Option: Do Nothing	0	128	-	-	-	-	-
Preferred Engineering and Economic Option: Demolish Defences	67	128	0	0	0	0	0

Selection of Preferred Option: Although demolishing the defences would ensure that there were no residual health and safety problems with derelict defences, this would incur an additional cost of £67,000. The differences between the engineering and environmental assessments for both options is relatively minor and the classifications attributed in each category are identical. Since there is no significant advantage in the more expensive option, the preferred option is to “Do Nothing”.

4.2 Management Unit TRI 2: Overstrand

SMP Policy Option: Hold the Line

Description: This management unit includes the defence lengths TRI 2.01, 2.02, 2.03 2.04 & 2.05. The frontage protects the village of Overstrand and there are about 164 residential and commercial properties that are at risk from erosion during the 100-year duration of this strategy study. Due to the coastal defences, which have protected the village since the late 19th century, the coastline has eroded to either side forming a promontory at Overstrand. If the defences were allowed to fail then the coastline would start to rapidly erode back to a more stable position.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.2.1 TRI 2 Summary of Economic Assessment

Management Unit: TRI 2 Options	Whole life (100 years) Costs and Benefits (£k)						BCR			
	PV cost per Defence Length					Option Benefits	No Active Intervention After Year			
	2.01	2.02	2.03	2.04	2.05		20	30	50	100
Do Nothing	0	0	0	0	0	-	-	-	-	-
Repair	1,674	56	3,943	660	928	8,396	0.57	0.70	0.92	1.16
Rock Revetment	1,469	57	5,553	689	849	8,396	0.47	0.58	0.76	0.97
Rock Sill	1,840	83	-	887	1,002	8,396	0.43	0.53	0.70	0.90
Sea Wall	5,751	369	10,687	1,824	2,572	8,396	0.20	0.24	0.32	0.40
Beach Recharge	4,479	256	8,078	2,560	2,435	8,396	0.27	0.31	0.39	0.47
Enhance Groynes – Sub option	176	-	-	125	185	-	-	-	-	-

Economic Assessment: The potential benefits in TRI 2 are £8,396,000; the least cost option to fulfil the SMP policy of “hold the line” and achieve these benefits is to repair the existing defences. This would give a benefit cost ratio of 1.16 over the 100-year strategy duration, which would justify active intervention. If the defences were to be improved then the increase in costs would mean that the economic benefit would drop below 1.00 for the duration of the strategy study, and it would not be possible to justify them economically. Therefore, the economically preferred option would be to “Repair”.

Table 4.2.2 TRI 2 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	2.01	Do Nothing	xx	✓✓	•	xx	•	xx	✓✓
	2.02		xx	✓✓	xx	xx	xx	✓✓	
	2.03		xx	✓✓	x	x	xx	✓✓	
	2.04 & 2.05		xx	✓✓	•	xx	•	xx	✓✓
Least Cost Option	2.01	Repair	✓	•	•	✓	•	✓✓	xx
	2.02	Blockwork Renovation	•	•	•	•	•	•	•
	2.03	Repair Piles	✓✓	xx	✓	•	✓✓	✓✓	xx
	2.04 & 2.05	Repair	✓	•	•	✓	•	✓✓	xx
Engineering and Environmentally Preferred Option	2.01 & 2.02	Rock Revetment	✓	x	✓	•	•	✓✓	✓
	2.03	Rock Scour Protection & Impermeable Groynes	✓✓	✓	✓	•	✓✓	✓✓	✓
	2.04 & 2.05	Rock Revetment	✓	x	✓	•	•	✓✓	✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
 ✓✓: Likely to be beneficial
 ✓: Likely to be acceptable
 •: No impact
 x: Likely to be unacceptable
 xx: Unacceptable
 ?: Impact not determined

Engineering and Environmental Assessment: In defence lengths TRI 2.01 and 2.04 the preferred option is to demolish the timber revetment and replace it with a rock revetment on the same line. Long-term maintenance liabilities are avoided with the construction of a defence that will, at least, tend to hold existing beach levels and perhaps encourage a build up of the beach. Such a defence is also less vulnerable to damage from cliff failure. In defence length TRI 2.02 replacing the blockwork with a rock revetment costs almost the same as renovating it but improves the level of performance whilst having a less detrimental impact. It also ensures continuity with TRI 2.01. However, in TRI 2.03 the provision of scour protection and the improvement of the groynes is the preferred option since it is the least expensive option that is assessed as having an acceptable impact on coastal processes.

Table 4.2.3 TRI 2 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	141	-	-	-	-	-
Least Cost Option: Repair existing defences	7,261	141	8,396	0.56	0.69	0.90	1.13
Preferred Engineering and Economic Option: Rock Revetment in TRI 2.01, 2.02, 2.04 and 2.05, Scour Protection and Impermeable Groynes in TRI 2.03	7,982	141	8,396	0.51	0.62	0.82	1.03

Selection of Preferred Option: The benefit cost ratios for the two preferred options are very similar. To economically justify either of the schemes it would be necessary to continue active intervention for at least 50 years. Due to the similarity between the scores for economic assessment, it would be worthwhile investing in the preferred engineering and economic option.

4.3 Management Unit TRI 3: Overstrand to Trimmingham

SMP Policy Option: Do Nothing

Description: This management unit includes the defence length TRI 3.01, which covers the coastline from the edge of Overstrand to the edge of Trimmingham. The frontage is the most natural in the study area and is only defended at the western end where the defences tie into those in TRI 2.04. The cliff top land is primarily agricultural, however it is estimated that five properties will be lost to erosion between year 50 and year 100. If the defences were allowed to fail then the coastline would continue to erode at a similar rate, this will continue to expose the pre-glacial stratigraphic sequences in the cliff and hence maintain environmental interest.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.3.1 TRI 3 Summary of Economic Assessment

Management Unit: TRI 3 Options	Whole life (100 years) Costs and Benefits (£k)		BCR			
	PV cost per Defence Length	Option Benefits	No Active Intervention After Year			
	TRI 3.01		20	30	50	100
Do Nothing	0	-	-	-	-	-
Maintain Defences	1,831	173	0.05	0.06	0.08	0.09
Demolish Defences	103	0	0	0	0	0

Economic Assessment: The potential benefits in TRI 3 are very low and on their own cannot justify active intervention. The economically preferred option would be to “Do Nothing”.

Table 4.3.2 TRI 3 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	3.01	-	**	✓✓	•	•	•	•	✓✓
Least Cost Option	3.01	Do Nothing	**	✓✓	•	•	•	•	✓✓
Engineering and Environmentally Preferred Option	3.01	Demolish Defences	**	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable '**', Impact not determined '?'.

Engineering and Environmental Assessment: The preferred engineering and environmental option would be to remove the remaining defences entirely. This ensures that there is no residual health and safety problem stemming from derelict defences and the improvement to both coastal processes and the environment begins to accrue immediately. In recommending this as the preferred option, no account has been taken of the social impact of the works.

Table 4.3.3 TRI 3 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	71	-	-	-	-	-
Least Cost Option: Do Nothing	0	71	-	-	-	-	-
Preferred Engineering and Economic Option: Demolish Defences	103	71	0	0	0	0	0

Selection of Preferred Option: Although demolishing the defences would ensure that there were no residual health and safety problems with derelict defences, it would incur an additional cost of £103,000. The differences between the engineering and environmental assessment for both options is relatively minor and the classifications attributed in each category are identical. Since there is no significant advantage in the more expensive option, the preferred option is to “Do Nothing”.

4.4 Management Unit TRI 4: Trimingham

SMP Policy Option: Hold the Line

Description: This management unit includes the defence lengths TRI 4.01 and 4.02, which defend the village of Trimingham. The cliffs in front of Trimingham are classified as actively unstable and the existing defences do little to stabilise them. Erosion is already taking place and with a do nothing policy about 42 properties would be lost.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.4.1 TRI 4 Summary of Economic Assessment

Management Unit: TRI 4 Options	Whole life (100 years) Costs and Benefits (£k)			BCR			
	PV cost per Defence Length		Option Benefits	No Active Intervention After Year			
	TRI 4.01	TRI 4.02		20	30	50	100
Do Nothing	0	0	-	-	-	-	-
Maintain / Repair	5,543	1,820	2,820	0.19	0.23	0.29	0.38
Rock Revetment	6,473	1,543	2,820	0.17	0.20	0.27	0.35
Rock Sill	-	2,042	2,820	0.13	0.16	0.22	0.28
Rock Crest	7,349	-	-	-	-	-	-
Rock Scour Protection	6,171	-	-	-	-	-	-
As Above with Impermeable Groynes	6,462	-	-	-	-	-	-
As Above with Rock Crest	5,357	-	-	-	-	-	-
Rock Crest & Scour Protection	5,067	-	-	-	-	-	-
Rock Sill & Rock Crest	8,334	-	-	-	-	-	-
Rock Sill & Impermeable Groynes	7,858	-	-	-	-	-	-
Sea Wall	-	7,161	-	-	-	-	-
Beach Recharge	12,808	5,401	2,820	0.09	0.10	0.13	0.15

Economic Assessment: The potential benefits in TRI 4 are very low and on their own can not justify active intervention. The maximum benefits are £2,820,000, which is significantly less than the cost to implement any of the management options. Therefore, the economically preferred option would be to “Do Nothing”.

Table 4.4.2 TRI 4 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	4.01		xx	✓✓	•	x	•	xx	✓✓
	4.02		xx	✓✓	•	xx	•	xx	✓✓
Least Cost Option	4.01	Rock Crest & Scour Protection	✓	x	✓	•	•	✓	x
	4.02	Rock Revetment	✓	x	✓	•	•	✓✓	x
Engineering and Environmentally Preferred Option	4.01	Rock Crest & Scour Protection	✓	x	✓	•	•	✓	x
	4.02	Rock Revetment	✓	x	✓	•	•	✓✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
 xx: Unacceptable, x: Likely to be unacceptable, ✓: Likely to be acceptable, ✓✓: Likely to be beneficial, •: No impact, ?: Impact not determined.

Engineering and Environmental Assessment: In terms of overall impact there is little to choose between the options considered, therefore the preferred engineering and environmental option is the least cost options which will sustain the standard of protection, protecting the properties and amenities at risk. To sustain the standard of protection in defence length 4.01 a rock crest and scour protection should be added to the existing concrete wall and in defence length 4.02 the existing timber revetment should be replaced with a more durable rock revetment. However, these options are unlikely to improve the coastal processes in this management unit.

Table 4.4.3 TRI 4 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	148	-	-	-	-	-
Least Cost Option: Improve rock crest & scour protection in TRI 4.01 and rock revetment in TRI 4.02	6,610	148	2,820	0.20	0.24	0.32	0.42
Preferred Engineering and Economic Option: Improve rock crest & scour protection in TRI 4.01 and rock revetment in TRI 4.02	6,610	148	2,820	0.20	0.24	0.32	0.42

Selection of Preferred Option: Although the SMP policy is to hold the line, this can not be justified due to the low value of the benefits relative to the cost required to sustain the defences. The strategy study recommends that the preferred policy option is revised to a policy of “Do Nothing”. Although allowing erosion to occur at a natural rate is unacceptable with regard to the lost of property and the risk to health and safety, it will be beneficial to the natural environment and the coastal processes. Therefore, the preferred option is to “Do Nothing”.

4.5 Management Unit TRI 5: Trimmingham to Mundesley

SMP Policy Option: Managed Retreat

Description: This management unit contains defence lengths TRI 5.01 and 5.01. These defences protect the coastline between Trimmingham and Mundesley. The cliffs along this frontage are described as marginally stable and they are protected by a timber revetment. If the defences were allowed to fail, approximately 20 residential properties, and a sizeable proportion of the hard standing at the caravan parks, would be lost to erosion.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.5.1 TRI 5 Summary of Economic Assessment

Management Unit: TRI 5 Options	Whole life (100 years) Costs and Benefits (£k)		BCR			
	PV cost per Defence Length	Option Benefits	No Active Intervention After Year			
	TRI 5.01 & 5.02		20	30	50	100
Do Nothing	0	-	-	-	-	-
Maintain Defences	2,846	507	0.09	0.11	0.15	0.18
Demolish Defences	149	0	0	0	0	0

Economic Assessment: The potential benefits in TRI 5 are very low and on their own can not justify active intervention. The economically preferred option would be to “Do Nothing”.

Table 4.5.2 TRI 5 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	5.01 & 5.02	-	**	✓✓	•	•	•	•	✓✓
Least Cost Option	5.01 & 5.02	Do Nothing	**	✓✓	•	•	•	•	✓✓
Engineering and Environmentally Preferred Option	5.01 & 5.02	Demolish Defences	**	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable '**', Impact not determined '?'.

Engineering and Environmental Assessment: The preferred engineering and environmental option would be to remove the remaining defences entirely. This ensures that there is no residual health and safety problem stemming from derelict defences and the improvement to both coastal processes and the environment begins to accrue immediately. In recommending this as the preferred option, no account has been taken of the social impact of the works.

Table 4.5.3 TRI 5 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	153	-	-	-	-	-
Least Cost Option: Do Nothing	0	153	-	-	-	-	-
Preferred Engineering and Economic Option: Demolish Defences	149	153	0	0	0	0	0

Selection of Preferred Option: Although demolishing the defences would ensure that there were no residual health and safety problems with derelict defences, it would incur an additional cost of £149,000. The differences between the engineering and environmental assessment for both options is relatively minor and the classifications attributed in each category are identical. Since there is no significant advantage in the more expensive option, the preferred option is to “Do Nothing”.

4.6 Management Unit TRI 6: Mundesley

SMP Policy Option: Hold the Line

Description: This management unit contains defence lengths TRI 6.01, 6.02, 6.03 and 6.04. These defences protect the village of Mundesley. The defences in TRI 6.01 and 6.04 consist of sloping timber revetments that tie into the defences in the management units on either side. TRI 6.02 is defended by a concrete blockwork revetment and TRI 6.03 is protected with a vertical sea wall. If the defences were allowed to fail in a do nothing scenario a total of 261 residential and commercial properties as well as a number of heritage sites, including the Pleasurance rose garden, would be lost to erosion by year 100.

existing beach levels and perhaps encourage a build up of the beach. This will improve both the amenity value of the beach and the coastal process. In defence length TRI 6.03 the defences are in relatively good condition, the preferred option here is to strive for some improvement by carrying out an extensive maintenance programme but add to that the converting the permeable groynes to impermeable groynes, which will improve the level of performance whilst having a less detrimental impact.

Table 4.6.3 TRI 6 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	169	-	-	-	-	-
Least Cost Option: Repair existing defences	4,773	169	13,230	1.43	1.77	2.11	2.68
Preferred Engineering and Economic Option*: Rock Revetment in TRI 6.01 and 6.02, Maintain and build impermeable groynes in TRI 6.03, but Repair timber revetment in TRI 6.04	5,087	169	13,230	1.33	1.65	1.98	2.54

*Note: Preferred option in TRI 6.04 changed to Repair in line with overall preferred options.

Selection of Preferred Option: In defence lengths TRI 6.01, 6.02 and 6.03 the economic and engineering and environmentally preferred options agree. Therefore the preferred options are to replace the existing timber revetments with rock revetments in defence lengths TRI 6.01 and 6.02. In TRI 6.03 carry out an extensive maintenance programme on the existing sea wall and enhance the groynes. In TRI 6.04 the economics are such that the investment, of replacing the timber revetment with a rock revetment, is better deferred. Hence, the preferred option here is to maintain the existing revetment in the short term with the option to change the management option in the long term.

4.7 Management Unit BAC 1: Mundesley to Bacton

SMP Policy Option: Do Nothing

Description: This management unit contains defence lengths BAC 1.01 and 1.02. These defences protect the coastline between Mundesley and Bacton. The coastline is protected by a sloping timber revetment, presently the beach is stable and there are even dunes building behind the revetment. This frontage is relatively undeveloped, with relatively few assets at risk. If the defences were allowed to fail about 29 residential homes and about 12 hectares of agricultural land would be lost to erosion over 100 years.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.7.1 BAC 1 Summary of Economic Assessment

Management Unit: BAC 1 Options	Whole life (100 years) Costs and Benefits (£k)		BCR			
	PV cost per Defence Length	Option Benefits	No Active Intervention After Year			
	BAC 1.01		20	30	50	100
Do Nothing	0	-	-	-	-	-
Maintain Defences	3,216	393	0.06	0.08	0.11	0.12
Demolish Defences	121	0	0	0	0	0

Economic Assessment: The potential benefits in BAC 1 are very low and on their own cannot justify active intervention. The economically preferred option would be to “Do Nothing”.

Table 4.7.2 BAC 1 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	1.01	-	**	✓✓	•	•	•	•	✓✓
Least Cost Option	1.01	Do Nothing	**	✓✓	•	•	•	•	✓✓
Engineering and Environmentally Preferred Option	1.01	Demolish Defences	**	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable '**', Impact not determined '?'.

Engineering and Environmental Assessment: The preferred engineering and environmental option would be to remove the remaining defences entirely. This ensures that there is no residual health and safety problem stemming from derelict defences and the improvement to both coastal processes and the environment begins to accrue immediately. In recommending this as the preferred option, no account has been taken of the social impact of the works.

Table 4.7.3 BAC 1 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	138	-	-	-	-	-
Least Cost Option: Do Nothing	0	138	-	-	-	-	-
Preferred Engineering and Economic Option: Demolish Defences	121	138	0	0	0	0	0

Selection of Preferred Option: Although demolishing the defences would ensure that there were no residual health and safety problems with derelict defences, it would incur an additional cost of £121,000. The differences between the engineering and environmental assessments for both options is relatively minor and the classifications attributed in each category are identical. Since there is no significant advantage in the more expensive option, the preferred option is to “Do Nothing”.

4.8 Management Unit BAC 2: Bacton, Walcott and Ostend

SMP Policy Option: Hold the Line

Description: This management unit contains defence lengths BAC 2.01, 2.02, 2.03, 2.04, 2.05 and 2.06. These defences protect the villages of Bacton, Walcott and Ostend and also the Bacton Gas Terminal, which is located at the western end of the management unit. Although all the beaches throughout the frontage are in good condition the cliffs at the western end are actively unstable, the cliffs in the centre of the frontage are described as relatively stable and at the eastern end are marginally stable. The coastline is protected by sloping timber revetments in BAC 2.01, 2.02 and 2.06, a sloping sea wall protects the coastline in the remaining defence lengths. If the defences were allowed to fail in a do nothing scenario, approximately 263 residential and commercial properties will be lost to erosion by year 100. In addition to this there is a probability that erosion will influence the operation of Bacton Gas Terminal.

Option Assessment: The following tables summarise the economic, engineering and environmental assessments and detail the selection of the preferred option for each defence length.

Table 4.8.1 BAC 2 Summary of Economic Assessment

Management Unit: BAC 2 Options	Whole life (100 years) Costs and Benefits (£k)					BCR			
	PV cost per Defence Length				Option Benefits	No Active Intervention After Year			
	2.01	2.02	2.03 – 2.05	2.06		20	30	50	100
Do Nothing	0	0	0	0	-	-	-	-	-
Repair	2,714	793	6,817	1,163	72,250	2.84	3.07	3.11	4.14
Impermeable Groynes	-	-	8,203	-	-	-	-	-	-
Impermeable Groynes & Rock Scour Protection	-	-	19,114	-	-	-	-	-	-
Rock Revetment	2,738	722	22,921	1,376	72,250	1.18	1.34	1.71	2.49
Rock Sill	3,744	916	15,789	1,821	72,250	1.47	1.66	1.97	2.86
Sea Wall	12,444	2,401	41,064	5,922	72,250	0.53	0.60	0.75	1.07
Beach Recharge	8,039	1,823	31,412	3,794	72,250	0.72	0.77	0.91	1.24
Enhance Groynes – Sub option	364	71	-	245	-	-	-	-	-

Economic Assessment: The potential benefits in BAC 2 are the greatest in the study area, they can even provide a BCR greater than 1 if active intervention is only considered up until year 20 for a couple of the defence options. The least cost option in the majority of the defence lengths is to repair the existing defences. However due to the value of the benefit the standard of protection should be sustained to allow for sea level rise. The difference in cost between repairing the defences and replacing them with rock revetments is relatively small in BAC 2.01, 2.02 and 2.06, and in the long-term, will reduce maintenance liabilities. Therefore this is the preferred option in these defence lengths. In BAC 6.03 to 6.05 the main defence is a seawall that is in a reasonable condition, therefore the most economical option to sustain the standard of protection is to repair the wall and enhance the groynes.

Table 4.8.2 BAC 2 Summary of Engineering and Environmental Assessment

Option	Defence Length	Description	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	2.01 & 2.02	-	xx	✓✓	•	xx	•	xx	✓✓
	2.03 – 2.05		xx	✓✓	x	x	xx	x	✓✓
	2.06		xx	✓✓	•	xx	•	xx	✓✓
Least Cost Option	2.01 & 2.02	Repair existing defences	✓	•	•	✓	•	✓✓	xx
	2.03 – 2.05		✓✓	x	✓	✓	✓✓	✓	x
	2.06		✓	•	•	✓	•	✓✓	xx
Engineering and Environmentally Preferred Option	2.01 & 2.02	Rock Revetment	✓	x	✓	•	•	✓✓	✓
	2.03 – 2.05	Repair defences and improve groynes	✓✓	x	✓	✓	✓✓	✓	xx
	2.06	Rock Revetment	✓	x	✓	•	•	✓✓	✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
 Unacceptable 'xx', Impact not determined '?'.

Engineering and Environmental Assessment: The preferred engineering and environmental options are to replace the existing timber revetments in defence lengths BAC 2.01, 2.02 and 2.06 with rock revetments since this is the least cost option that improves the amenity value and has an acceptable impact on coastal processes. In defence lengths BAC 2.03 to 2.05 the only option that has an acceptable impact on coastal processes is beach renourishment, which is prohibitively expensive. Therefore it is considered that the most appropriate option will be one that at least sustains prevailing beach conditions etc. Hence the

preferred option in these defence lengths is to maintain the defences but to convert the groynes to become impermeable.

Table 4.8.3 BAC 2 Summary of Selected Options

Option Summary and Description	Option Costs	Annual Monitoring	Option Benefits	BCR			
				20	30	50	100
Do Nothing	0	487	-	-	-	-	-
Least Cost Option: Repair existing defences	17,447	487	72,250	2.78	2.99	3.04	4.03
Preferred Engineering and Economic Option: Rock Revetments in BAC 2.01, 2.02 and 2.04, repair defences and impermeable groynes in BAC2.03	19,162	487	72,250	2.46	2.65	2.75	3.68

Selection of Preferred Option: Since both the economic and engineering and environmental assessment are in agreement, the preferred option is to replace the timber revetments with rock revetments in BAC 2.01, 2.02 and 2.06 and then to repair the sea wall and enhance groynes in defence lengths BAC 2.03 to 2.05.

5. CLIFF STABILITY OPTIONS

The foreshore for the entire study frontage is backed by cliffs varying in height from a few metres to 70+ metres in height. Whilst it is plausible to consider cliff stabilisation measures for all cliffs, this study has adopted a pragmatic approach to the issue. Cliff stability works have only been examined where there are SMP “Hold the Line” policies, where there are no environmental constraints, in particular, sites of special scientific interest (SSSI) and there are existing or predictable stability issues. The centre of Mundesley, for example, does not have a cliff stability problem. Hence, no measures have been considered for that location. Cliff stability options also tend to traverse defence lengths. Hence, the options are presented by location rather than defence length as in the case of sea defences above.

In acknowledgement of the significance of surface and ground water on the stability of the cliffs, the following engineering works have been considered for Overstrand, West Mundesley and Bacton Gas. An issue associated with the implementation of cliff stability work is that of land ownership.

- Dewatering – Deep wells: The purpose of this work is to reduce pore water pressure by installing gravity wells thereby increasing the factor of safety against deep seated failure. This will necessitate a screen of wells to be located well back from the cliff edge.
- Regrading of the cliff: By regarding the overstep sections of cliff, the future stability of the cliffs is improved. This can only be done in conjunction with dewatering works.
- Dewatering – Surface drainage: By intercepting surface water run off at the cliff top and on the cliff face, local surface instability is prevented.

The approximate cost of these works, in each area that they have been considered is:

<u>Location</u>	<u>PV + Optimism bias (£)</u>
West Mundesley	7,418,500
Overstrand	4,066,500
Bacton Gas Terminal	1,514,000

6. SUMMARY OF BENEFIT COST RATIOS FOR LEAST COST AND PREFERRED ENGINEERING AND ENVIRONMENTAL OPTIONS

The costs of “doing nothing” in terms of sea defence are presented in table 7 of the appendix in the “Do nothing” – Erosion probability and erosion losses report. For the consideration of option comparison it is assumed here that the scheme options described above will deliver a level of protection that will prevent the loss of the assets that constitute the “Do nothing costs”. Thus these do nothing costs reflect the benefits of the defence option choices described.

The costs of the preferred option choices are given in the tables below for each management unit, where active intervention is performed up to years 20, 30, 50 and 100 in management units where the SMP policy is “hold the line”. Where defence lengths constitute more than one type, the preferred option costs for each have been summed to give one figure for the entire defence length (e.g. the sum of TRI 6.01, 6.02, 6.03 & 6.04). This was necessary as the ‘do nothing’ costs were not calculated according to defence ‘type’ but according to management unit.

The BCRs, evaluated for the different policies and preferred options, are summarised for the scenario involving no active intervention beyond year 100 in Table 6.1. In each case the BCR has been calculated including the cost of annual monitoring, both in areas with active intervention and within the areas where the strategy policy is *Do Nothing*.

Table 6.1 Summary table of the BCRs for least cost and preferred options for the existing and revised policy options

Management Unit	Existing SMP Policy Options	Revised Policy Options	BCR Least Cost Option: Existing SMP Policy Options	BCR Least Cost Option: Revised Policy Options	BCR Preferred Option: Revised Policy Options
TRI 1	Do Nothing	Do Nothing	0	0	0
TRI 2	Hold the Line	Hold the Line	1.1	1.1	1.0
TRI 3	Do Nothing	Do Nothing	0	0	0
TRI 4	Hold the Line	Do Nothing	0.4	0	0
TRI 5	Managed Retreat	Do Nothing	0	0	0
TRI 6	Hold the Line	Hold the Line	2.7	2.7	2.5
BAC 1	Do Nothing	Do Nothing	0	0	0
BAC 2	Hold the Line	Hold the Line	4.0	4.0	3.7
BCR for whole frontage			2.6	3.0	2.8

* Although this table is only show for no active intervention beyond Year 100, similar comparisons can be made between the other periods.

Table 6.2 Description of preferred options

Management Unit	Defence Length	Preferred Option	Cost (£K)	Annual Monitoring (£K)
TRI 1	1.01 & 1.02	Do Nothing	0	128
TRI 2	2.01 & 2.02	Demolish existing timber revetments and replace with rock revetment	1,526	45
	2.03	Add scour protection to existing sea wall and enhance groynes making them impermeable	4,917	57
	2.04 & 2.05	Demolish existing timber revetments and replace with rock revetment	1,539	39
TRI 3	3.01	Do Nothing	0	71
TRI 4	4.01 & 4.02	Do Nothing	0	148
TRI 5	5.01 & 5.02	Do Nothing	0	153
TRI 6	6.01 & 6.02	Demolish existing timber revetments and replace with rock revetment	3,115	102
	6.03	Maintain existing seawall and enhance groynes making them impermeable	1,481	52
	6.04	Repair timber revetment	490	16
BAC 1	1.01	Do Nothing	0	138
BAC 2	2.01 & 2.02	Demolish existing timber revetments and replace with rock revetment	3,703	137
	2.03 to 2.05	Maintain existing seawall and enhance groynes making them impermeable	13,987	299
	2.06	Demolish existing timber revetments and replace with rock revetment	1,472	51

The preferred options resulting from the analysis in this report are summarised for each defence length in Table 6.2. The benefit cost ratios for active intervention of these options up to years 20, 30, 50 and 100 is shown in Table 6.5.

The BCRs of the least cost options in support of the existing SMP policies are shown in Table 6.3. Results are shown for active intervention up until years 20, 30, 50 and 100 years. As can be seen from this table active intervention at Trimingham (TRI 4) has a BCR of significantly less than 1, even after 100 years. It is therefore necessary to revise the policy option in this area to a policy of *Do Nothing*.

Table 6.4 shows the BCRs for the revised least cost options assuming a *Do Nothing* policy in area TRI 4. Table 6.5 shows the BCRs for the Engineering and Environmentally preferred options for the revised policy options. These two tables show that it is economically justifiable to Hold the Line at Mundesley (TRI 6), Bacton and Walcott (BAC 2) for a period of 20 years or more. However, Holding the Line at Overstrand (TRI 2) has a BCR of less than 1.0 unless active intervention is carried out for at least 50 years.

Table 6.3 Implementation of least cost options in support of existing SMP Policies

No active intervention beyond Year 20

LMU	SMP Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	65	0	0
TRI 2	Hold the Line	3,878	6,805	72	0.6	0.6
TRI 3	Do Nothing	0	0	36	0	0
TRI 4	Hold the Line	1,282	6,364	75	0.2	0.2
TRI 5	Managed Retreat	0	0	78	0	0
TRI 6	Hold the Line	6,030	4,121	86	1.5	1.4
BAC 1	Do Nothing	0	0	70	0	0
BAC 2	Hold the Line	32,625	11,486	248	2.8	2.8
Total		43,815	28,776	731	1.5	1.5

No active intervention beyond Year 30

LMU	SMP Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	83	0	0
TRI 2	Hold the Line	4,837	6,889	92	0.7	0.7
TRI 3	Do Nothing	0	0	46	0	0
TRI 4	Hold the Line	1,572	6,430	96	0.2	0.2
TRI 5	Managed Retreat	0	0	100	0	0
TRI 6	Hold the Line	7,659	4,218	110	1.8	1.8
BAC 1	Do Nothing	0	0	89	0	0
BAC 2	Hold the Line	37,592	12,249	316	3.1	3.0
Total		51,660	29,787	932	1.7	1.7

No active intervention beyond Year 50

LMU	SMP Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	106	0	0
TRI 2	Hold the Line	6,483	7,063	117	0.9	0.9
TRI 3	Do Nothing	0	0	59	0	0
TRI 4	Hold the Line	2,107	6,521	122	0.3	0.3
TRI 5	Managed Retreat	0	0	127	0	0
TRI 6	Hold the Line	10,147	4,662	140	2.2	2.1
BAC 1	Do Nothing	0	0	114	0	0
BAC 2	Hold the Line	48,833	15,680	403	3.1	3.0
Total		67,570	33,926	1,187	2.0	1.9

No active intervention beyond Year 100

LMU	SMP Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	128	0	0
TRI 2	Hold the Line	8,396	7,261	141	1.2	1.1
TRI 3	Do Nothing	0	0	71	0	0
TRI 4	Hold the Line	2,820	6,610	148	0.4	0.4
TRI 5	Managed Retreat	0	0	153	0	0
TRI 6	Hold the Line	13,230	4,773	169	2.8	2.7
BAC 1	Do Nothing	0	0	138	0	0
BAC 2	Hold the Line	72,250	17,447	487	4.1	4.0
Total		96,696	36,091	1,435	2.7	2.6

Table 6.4 Implementation of least cost options in support of revised policies

No active intervention beyond Year 20

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	65	0	0
TRI 2	Hold the Line	3,878	6,805	72	0.6	0.6
TRI 3	Do Nothing	0	0	36	0	0
TRI 4	Do Nothing	0	0	75	0	0
TRI 5	Do Nothing	0	0	78	0	0
TRI 6	Hold the Line	6,030	4,121	86	1.5	1.4
BAC 1	Do Nothing	0	0	70	0	0
BAC 2	Hold the Line	32,625	11,486	248	2.8	2.8
Total		42,533	22,412	731	1.9	1.8

No active intervention beyond Year 30

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	83	0	0
TRI 2	Hold the Line	4,837	6,889	92	0.7	0.7
TRI 3	Do Nothing	0	0	46	0	0
TRI 4	Do Nothing	0	0	96	0	0
TRI 5	Do Nothing	0	0	100	0	0
TRI 6	Hold the Line	7,659	4,218	110	1.8	1.8
BAC 1	Do Nothing	0	0	89	0	0
BAC 2	Hold the Line	37,592	12,249	316	3.1	3.0
Total		50,088	23,357	932	2.1	2.1

No active intervention beyond Year 50

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	106	0	0
TRI 2	Hold the Line	6,483	7,063	117	0.9	0.9
TRI 3	Do Nothing	0	0	59	0	0
TRI 4	Do Nothing	0	0	122	0	0
TRI 5	Do Nothing	0	0	127	0	0
TRI 6	Hold the Line	10,147	4,662	140	2.2	2.1
BAC 1	Do Nothing	0	0	114	0	0
BAC 2	Hold the Line	48,833	15,680	403	3.1	3.0
Total		65,463	27,405	1,187	2.4	2.3

No active intervention beyond Year 100

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	128	0	0
TRI 2	Hold the Line	8,396	7,261	141	1.2	1.1
TRI 3	Do Nothing	0	0	71	0	0
TRI 4	Do Nothing	0	0	148	0	0
TRI 5	Do Nothing	0	0	153	0	0
TRI 6	Hold the Line	13,230	4,773	169	2.8	2.7
BAC 1	Do Nothing	0	0	138	0	0
BAC 2	Hold the Line	72,250	17,447	487	4.1	4.0
Total		93,876	29,481	1,435	3.2	3.0

Table 6.5 Implementation of preferred options, in support of revised policies

No active intervention beyond Year 20

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	65	0	0
TRI 2	Hold the Line	3,878	7,582	72	0.5	0.5
TRI 3	Do Nothing	0	0	36	0	0
TRI 4	Do Nothing	0	0	75	0	0
TRI 5	Do Nothing	0	0	78	0	0
TRI 6	Hold the Line	6,030	4,435	86	1.4	1.3
BAC 1	Do Nothing	0	0	70	0	0
BAC 2	Hold the Line	32,625	13,039	248	2.5	2.5
Total		42,533	25,055	731	1.7	1.6

No active intervention beyond Year 30

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	83	0	0
TRI 2	Hold the Line	4,837	7,685	92	0.6	0.6
TRI 3	Do Nothing	0	0	46	0	0
TRI 4	Do Nothing	0	0	96	0	0
TRI 5	Do Nothing	0	0	100	0	0
TRI 6	Hold the Line	7,659	4,532	110	1.7	1.6
BAC 1	Do Nothing	0	0	89	0	0
BAC 2	Hold the Line	37,592	13,848	316	2.7	2.7
Total		50,088	26,065	932	1.9	1.9

No active intervention beyond Year 50

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	106	0	0
TRI 2	Hold the Line	6,483	7,834	117	0.8	0.8
TRI 3	Do Nothing	0	0	59	0	0
TRI 4	Do Nothing	0	0	122	0	0
TRI 5	Do Nothing	0	0	127	0	0
TRI 6	Hold the Line	10,147	4,976	140	2.0	2.0
BAC 1	Do Nothing	0	0	114	0	0
BAC 2	Hold the Line	48,833	17,338	403	2.8	2.8
Total		65,463	30,148	1,187	2.2	2.1

No active intervention beyond Year 100

LMU	Revised Policy Option	Benefits (£k)	Cost (£k)	Annual Monitoring (£k)	BCR	BCR (inc. AM)
TRI 1	Do Nothing	0	0	128	0	0
TRI 2	Hold the Line	8,396	7,982	141	1.1	1.0
TRI 3	Do Nothing	0	0	71	0	0
TRI 4	Do Nothing	0	0	148	0	0
TRI 5	Do Nothing	0	0	153	0	0
TRI 6	Hold the Line	13,230	5,087	169	2.6	2.5
BAC 1	Do Nothing	0	0	138	0	0
BAC 2	Hold the Line	72,250	19,162	487	3.8	3.7
Total		93,876	32,230	1,435	2.9	2.8

Appendix

Appendix A

Engineering and Environmental assessment of defence options

A.1 Management Unit TRI 1: Cromer to Overstrand

TRI 1.01. (Start 622762E 341972N. Finish 623097E 341800N).

TRI 1.02. (Start 623097E 341800N. Finish 624320E 341257N).

TRI 1.01, TRI 1.02

Table A.1 Environmental performance of options - Cromer to Overstrand

Defence Length Policy Options	TRI 1.01 & 1.02	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	•	•	x	✓✓
Maintain / Renew Defences		x	✓	•	•	•	x	x
Demolish Defences		xx	✓✓	•	•	•	x	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

A.2 Management Unit TRI 2: Overstrand

TRI 2.01. (Start 624320E 341257N. Finish 624734E 341106N).

TRI 2.02 (Start 624734E 341106N. Finish 624763E 341098N).

TRI 2.03. (Start 622846E 342356N. Finish 623436E 342251N).

TRI 2.04 (Start 623436E 342251N. Finish 625432E 340612N).

TRI 2.05 (Start 625432E 340612N. Finish 625555E 340483N).

TRI 2.01

Table 3.2.b Environmental performance of options – Overstrand (01)

Defence Length Policy Options	TRI 2.01 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 2.02

Table 3.3.b Environmental performance of options – Overstrand (02)

Defence Length Policy Options	TRI 2.02 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	xx	xx	xx	xx	✓✓
Blockwork Renovation		•	•	•	•	•	•	•
Rock Replacement		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 2.03

Table 3.4.b Environmental performance of options – Overstrand (03)

Defence Length Policy Options	TRI 2.03 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	x	x	x	xx	✓✓
Repair Piles		✓✓	xx	✓	•	✓✓	✓✓	xx
Renew Piles		✓✓	xx	✓	•	✓✓	✓✓	xx
Renew Piles & Impermeable Groynes		✓✓	✓	✓	•	✓✓	✓✓	x
Repair Piles & Impermeable Groynes		✓✓	✓	✓	•	✓✓	✓✓	x
Rock Scour Protection & Impermeable Groynes		✓✓	✓	✓	•	✓✓	✓✓	✓
Rock Revetment in Lieu of Sea Wall		✓✓	✓	✓	•	✓✓	✓✓	✓
Encase Walls & Rock Scour Protection		✓✓	✓	✓	•	✓✓	✓✓	✓
Beach Recharge		✓	✓	✓✓	✓	✓✓	✓✓	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

TRI 2.04

Table 3.5.b Environmental performance of options – Overstrand (04)

Defence Length Policy Options	TRI 2.04 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 2.05

Table 3.6.b Environmental performance of options – Overstrand (05)

Defence Length Policy Options	TRI 2.05 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

A.3 Management Unit TRI 3: Overstrand to Trimingham

TRI 3.01 (Start 625551E 340487N. Finish 626152E 340043N).

TRI 3.01

Table 3.7.b Environmental performance of options – Overstrand to Trimingham

Defence Length Policy Options	TRI 3.01 Do Nothing	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	•	•	•	✓✓
Maintain / Renew Defences		•	✓	•	•	•	•	x
Demolish Defences		xx	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

A.4 Management Unit TRI 4: Trimingham

TRI 4.01. (Start 627781E 339129N. Finish 628660E 338641N).

TRI 4.02 (Start 628660E 338641N. Finish 629138E 338391N).

TRI 4.01

Table 3.8b Environmental performance of options – Trimingham (01)

Defence Length Policy Options	TRI 4.01 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	x	•	xx	✓✓
Maintain		✓	x	•	x	•	x	x
Rock Scour Protection		✓	x	•	x	•	✓	x
As Above with Impermeable Groynes		✓	x	•	•	•	✓	x
As Above with Rock Crest		✓	x	•	•	•	✓	x
Rock Crest & Scour Protection		✓	x	✓	•	•	✓	x
Rock Sill & Rock Crest		✓	x	✓✓	x	•	✓	x
Rock Crest		✓	x	✓✓	x	•	✓	x
Rock Revetment		✓	x	✓	x	•	✓	x
Rock Sill & Impermeable Groynes		✓	x	✓✓	x	•	✓	x
Beach Recharge		✓	✓	✓✓	✓	•	✓	✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 4.02

Table 3.9a Environmental performance of options – Trimingham (02)

Defence Length Policy Options	TRI 4.02 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	x
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

A.5 Management Unit TRI 5: Trimingham to Mundesley

TRI 5.01 (Start 629318E 338391N. Finish 629988E 337829N).

TRI 5.02 (Start 629988E 337829N. Finish 630474E 337499N).

TRI 5.01 & 5.02

Table 3.10b Environmental performance of options – Trimingham to Mundesley

Defence Length Policy Options	TRI 5.01 & 5.02 Managed Retreat	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	•	•	•	✓✓
Maintain Defences		•	✓	•	•	•	•	x
Demolish Defences		xx	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

A.6 Management Unit TRI 6: Mundesley

TRI 6.01. (Start 630474E 337499N. Finish 630973E 337130).

TRI 6.02 (Start 630973E 337130N. Finish 631320E 336850N).

TRI 6.03 (Start 631115E 336782N. Finish 631632E 336701N).

TRI 6.04 (Start 631711E 336486N. Finish 631814E 336358N).

TRI 6.01

Table 3.11b Environmental performance of options - Mundesley (01)

Defence Length Policy Options	TRI 6.01 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 6.02

Table 3.12b Environmental performance of options - Mundesley (02)

Defence Length Policy Options	TRI 6.02 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	xx	xx	xx	xx	✓✓
Blockwork Renovation		•	•	•	•	•	•	•
Rock Replacement		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓	✓✓	✓	✓✓	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

TRI 6.03

Table 3.13b Environmental performance of options - Mundesley (03)

Defence Length Policy Options	TRI 6.03 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	xx	x	x	xx	✓✓
Maintain		✓✓	x	✓✓	•	✓	✓	x
Impermeable Groynes		✓✓	x	✓✓	•	✓	✓	x
Impermeable Groynes & Rock Scour Protection		✓✓	x	✓	x	✓	✓	x
Rock Revetment		✓✓	x	✓✓	x	✓	✓	x
Part New Sea Wall		✓✓	x	✓✓	✓	✓	✓	x
Rock Sill		✓✓	x	✓	x	✓	✓	x
All New Sea Wall		✓✓	x	✓✓	✓	✓	✓	x
Beach Renourishment		✓✓	✓	✓✓	✓	✓	✓	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

TRI 6.04

Table 3.14b Environmental performance of options - Mundesley (04)

Defence Length Policy Options	TRI 6.04 Hold the Line	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	xx	•	xx	✓✓
Repair		✓	•	•	✓	•	✓✓	xx
Rock Revetment		✓	x	✓	•	•	✓✓	✓
Rock Sill		✓	x	x	•	•	✓	x
Sea Wall		✓	xx	xx	x	✓	✓✓	xx
Beach Recharge		✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option		✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

A.7 Management Unit BAC 1: Mundesley to Bacton

Defence length BAC 1.01 (Start 631814E 336358N. Finish 632869E 335376N).

BAC 1.01

Table 3.15b Environmental performance of options - Mundesley to Bacton

Defence Length Options	BAC 1.01	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing		xx	✓✓	•	•	•	•	✓✓
Maintain Defences		•	✓	•	•	•	•	x
Demolish Defences		xx	✓✓	•	•	•	•	✓✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

A.8 Management Unit BAC 2: Bacton, Walcott and Ostend

BAC 2.01. (Start 632869E 335376N. Finish 633776E 334585N).

BAC 2.02 (Start 633776E 334585N. Finish 633963E 334445N).

BAC 2.03 – 2.05 (Start 633963E 334445N. Finish 636476E 332584N).

BAC 2.06 (Start 636476E 332584N. Finish 636918E 332294N).

BAC 2.01

Table 3.16b Environmental performance of options - Bacton, Walcott and Ostend (01)

Defence Length Options BAC 2.01	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	xx	✓✓	•	xx	•	xx	✓✓
Repair	✓	•	•	✓	•	✓✓	xx
Rock Revetment	✓	x	✓	•	•	✓✓	✓
Rock Sill	✓	x	x	•	•	✓	x
Sea Wall	✓	xx	xx	x	✓	✓✓	xx
Beach Recharge	✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option	✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
Unacceptable 'xx', Impact not determined '?'.

BAC 2.02

Table 3.17b Environmental performance of options - Bacton, Walcott and Ostend (02)

Defence Length Options BAC 2.02	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	xx	✓✓	•	xx	•	xx	✓✓
Repair	✓	•	•	✓	•	✓✓	xx
Rock Revetment	✓	x	✓	•	•	✓✓	✓
Rock Sill	✓	x	x	•	•	✓	x
Sea Wall	✓	xx	xx	x	✓	✓✓	xx
Beach Recharge	✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option	✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

BAC 2.03 – 2.05

Table 3.18b Environmental performance of options - Bacton, Walcott and Ostend (03)

Defence Length Options BAC 2.03 – 2.05	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	xx	✓✓	x	x	xx	x	✓✓
Maintain	✓✓	x	✓	✓	✓✓	✓	x
Impermeable Groynes	✓✓	x	✓	✓	✓✓	✓	xx
Impermeable Groynes & Rock Scour Protection	✓✓	x	✓	x	✓✓	✓✓	x
Rock Revetment	✓✓	x	✓	x	✓✓	✓✓	x
Rock Sill	✓	x	✓	x	✓✓	✓✓	x
New Sea Wall	✓✓	xx	✓✓	✓	✓✓	✓✓	xx
Beach Recharge	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.

BAC 2.06

Table 3.18b Environmental performance of options - Bacton, Walcott and Ostend (06)

Defence Length Options	Property	Environment	Amenity	Health & Safety	Commerce	Heritage	Coastal Processes
Do Nothing	xx	✓✓	•	xx	•	xx	✓✓
Repair	✓	•	•	✓	•	✓✓	xx
Rock Revetment	✓	x	✓	•	•	✓✓	✓
Rock Sill	✓	x	x	•	•	✓	x
Sea Wall	✓	xx	xx	x	✓	✓✓	xx
Beach Recharge	✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Enhance Groynes – Sub option	✓	x	✓	✓	•	✓	x

Key: Likely to be beneficial '✓✓', Likely to be acceptable '✓', No impact '•', Likely to be unacceptable 'x', Unacceptable 'xx', Impact not determined '?'.
 ?

