LYME REGIS ENVIRONMENTAL IMPROVEMENTS

STRATEGY PLAN

August 2002

WEST DORSET DISTRICT COUNCIL, ENGINEERING DIVISION

LYME REGIS ENVIRONMENTAL IMPROVEMENTS

STRATEGY PLAN

CONTENTS

1.0 INTRODUCTION

1.1 Background

Lyme Regis is an ancient coastal town situated in Lyme Bay on the south coast of Britain. It is both a popular residential area and a major holiday resort, with a summer population of approximately 14,000. Lyme Regis is famous for its unique harbour structure, the Cobb, which is the oldest working breakwater of its type in the country. The town's economy relies heavily upon tourists who are attracted by the harbour, the beaches and the spectacular coastal scenery.

The historical development of the town has been strongly influenced by coastal erosion and landslipping. Over the centuries the coastline has been protected against marine erosion by the construction of a series of sea walls, jetties and other defences of various forms. These defences have been repaired and replaced in a piecemeal fashion in response to storm damage and general decay so that today the town is protected by a variable complex of ageing structures.

Although the town has been partly protected from the direct erosive action of the sea, large areas of it have been constructed on ancient coastal landslides which periodically become reactivated resulting in disruption and damage to property.

1.2 The Lyme Regis Environmental Improvements

In the early 1990's West Dorset District Council initiated the Lyme Regis Environmental Improvements with the aim of safeguarding the integrity of the coastal areas of Lyme Regis in the long term. The initial emphasis was upon the implementation of a new coast protection scheme for the central part of the town adjacent to the River Lim, the existing 250 year old sea walls at which were approaching the point of failure.

The construction work for this first phase, which comprises a new sea wall and rock armour revetment, was completed in 1995. Since then, West Dorset District Council has been carrying out an extensive series of Preliminary Studies in order to gain an understanding of the coast protection problems affecting the remaining areas of Lyme Regis. The Preliminary Studies have been deliberately holistic in approach, considering all of the Lyme Regis coastline (not just a series of isolated problem areas) and the whole of the physical coastal system from the offshore submarine environment to the top of the coastal slope. Thus the information obtained may be used at a strategic level in determining an integrated management policy and preparing coordinated design concepts and programming for coast protection schemes.

1.3 Objectives of the Strategy Plan

The purpose of this Strategy Plan is essentially to bring together the findings of the Preliminary Studies, including early work on the conceptual design of engineering schemes, in order to establish an action plan for improving the coast protection situation at Lyme Regis in the long term. The principal objectives of the report are:

1) to review the coast protection problems facing Lyme Regis;

2) to consider coast protection policy objectives;

3) to determine preferred coast protection management objectives including, where appropriate, engineering scheme options;

4) to develop a programme for implementation of the management options.

1.4 Study Framework

The data used to develop the Strategy Plan have come from the Preliminary Studies carried out by West Dorset District Council and its consultants in the period 1996 - 2000. A summary of the methodology and findings of the studies is given in the Preliminary Studies Summary Report prepared by WDDC (August 2000). The Summary Report is a companion volume to this Strategy Plan and it is recommended that the two reports should be read in conjunction.

Slope stabilisation scheme options were developed in the reports entitled 'Conceptual Management Strategy and Scheme Options for Slope Stabilisation' for both Cobb Gate to Harbour and East Cliff, prepared by High Point Rendel (September 2000). Foreshore scheme options were developed in the report entitled 'Preliminary and Secondary Appraisal of Coast Defence Options' prepared by HR Wallingford (July 2001).

The relevant Shoreline Management Plan for Lyme Regis is the Lyme Bay and South Devon Shoreline Management Plan, prepared by Posford Duvivier in 1998.

The flow chart in Figure 1.1 indicates the interrelationships between the various studies and their outputs.

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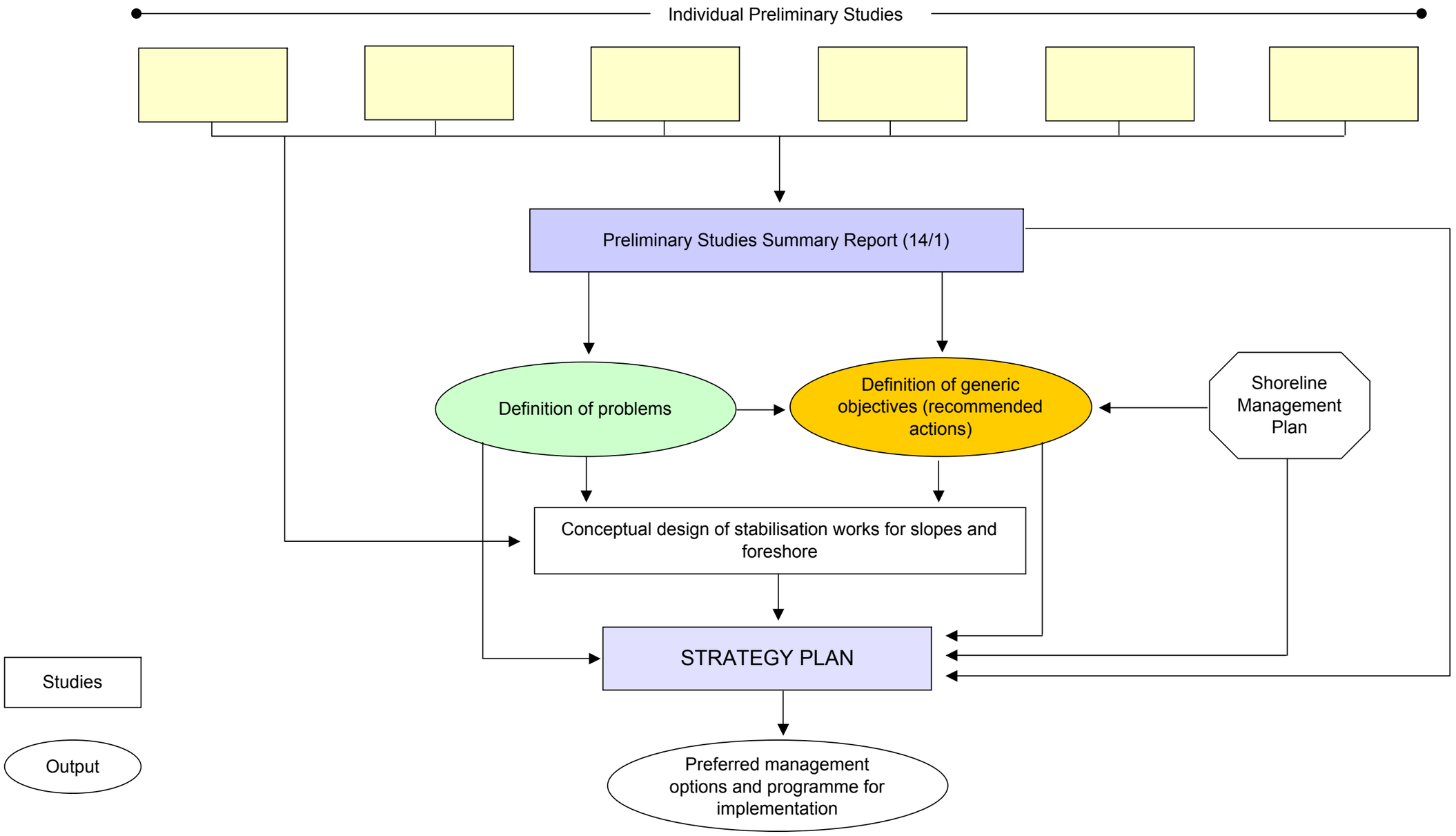
FIGURE 1.1
INTERRELATIONSHIPS BETWEEN STUDIES



2.0 DEFINITION OF THE PROBLEMS

2.1 Boundaries

The area under consideration extends from Devonshire Head in the west to the Spittles in the east, covering the whole of the urban coastal area of Lyme Regis (Figure 2.1).

The Devonshire Head boundary is defined as the westernmost limit of significant beach deposits at Lyme, at the end of Monmouth Beach. It is also, coincidently, the point at which the county boundary between Devon and Dorset crosses the foreshore and hence marks the westernmost extent of West Dorset District Council's jurisdiction as coast protection authority. The eastern boundary is defined as the point furthest to the west at which significant amounts of beach-forming material are issued from the highly active landslide areas of the Spittles/Black Ven landslide complex. The Preliminary Studies have shown that there is no significant longshore transport of beach-forming material into Lyme Regis either from the west or east. In west there is no supply. In the east the material from the Spittles and Black Ven is taken eastwards rather than westwards. Furthermore, there are no sources of material in between. The area within the boundaries of the Strategy Plan is therefore independent of the adjacent areas in terms of longshore sediment transport.

The inland boundary of the Strategy Plan may be defined as the crest of the coastal slope, which represents the current landward influence of the sea on landslide processes.

In practice, areas outside of these boundaries have received attention in the studies. For example, when considering future landslide regression scenarios and cost benefit analyses, the study area was extended a nominal distance landward in order to allow for a hypothetical small expansion of the coastal landslide systems beyond their present boundaries.

2.2 Interconnection between Study Areas

For the purposes of the Environmental Improvements, five study areas have been defined as indicated on Figure 2.1:

Phase I: Cobb Gate to Church Cliff (scheme completed)
Phase II : Cobb Gate to the Harbour
Phase III: Monmouth Beach and Ware Cliffs
Phase IV: East Cliff
Phase V: The Cobb

(2.2 continued)

Phases II, III and V are separated physically from Phase IV by the new coast protection scheme for Phase I. As a result, it is considered that there is no interconnection between Phases II, III, V and Phase IV either in terms of overlapping benefit areas or physical coastal process such as sediment transfer.

In theory, there is some overlap of the benefit areas for the Cobb and Phases II & III. For example, some of the properties to the north of the Cobb are under threat both from flooding as a result of a breach in the Cobb and landsliding from the slope behind. For the sake of simplicity, however, a simple boundary has been drawn between them as shown in Figure 2.1and the conservative assumption made that there is no overlap (i.e. no one property would be under threat by both a breach in the Cobb and a landslide).

2.3 Time Frame

This Strategy Plan considers coast protection in the period extending up to the next fifty years, i.e. 2002 to 2052.

It is envisaged that the principal coast protection schemes described in the plan would be implemented within the next ten years, i.e. before 2012.

2.4 Summary of the Problems

The coast protection challenges facing Lyme Regis have been established from the findings of the Preliminary Studies. The main problems are essentially as follows:

1) the foreshore rock platforms are starved of beach material and are being lowered by the erosive action of the sea;

2) previous coast protection works, such as sea walls and slope drainage systems, are in a poor condition and some elements are approaching the end of their practical life;

3) the coastal slopes are inherently unstable and prone to rapid and large scale landslide activity;

As a result, a large part of the town is at risk from coastal erosion and landsliding.

Figure 2.2 gives a more detailed summary of the problems and the consequences that would arise from them in the 'do nothing ' scenario.

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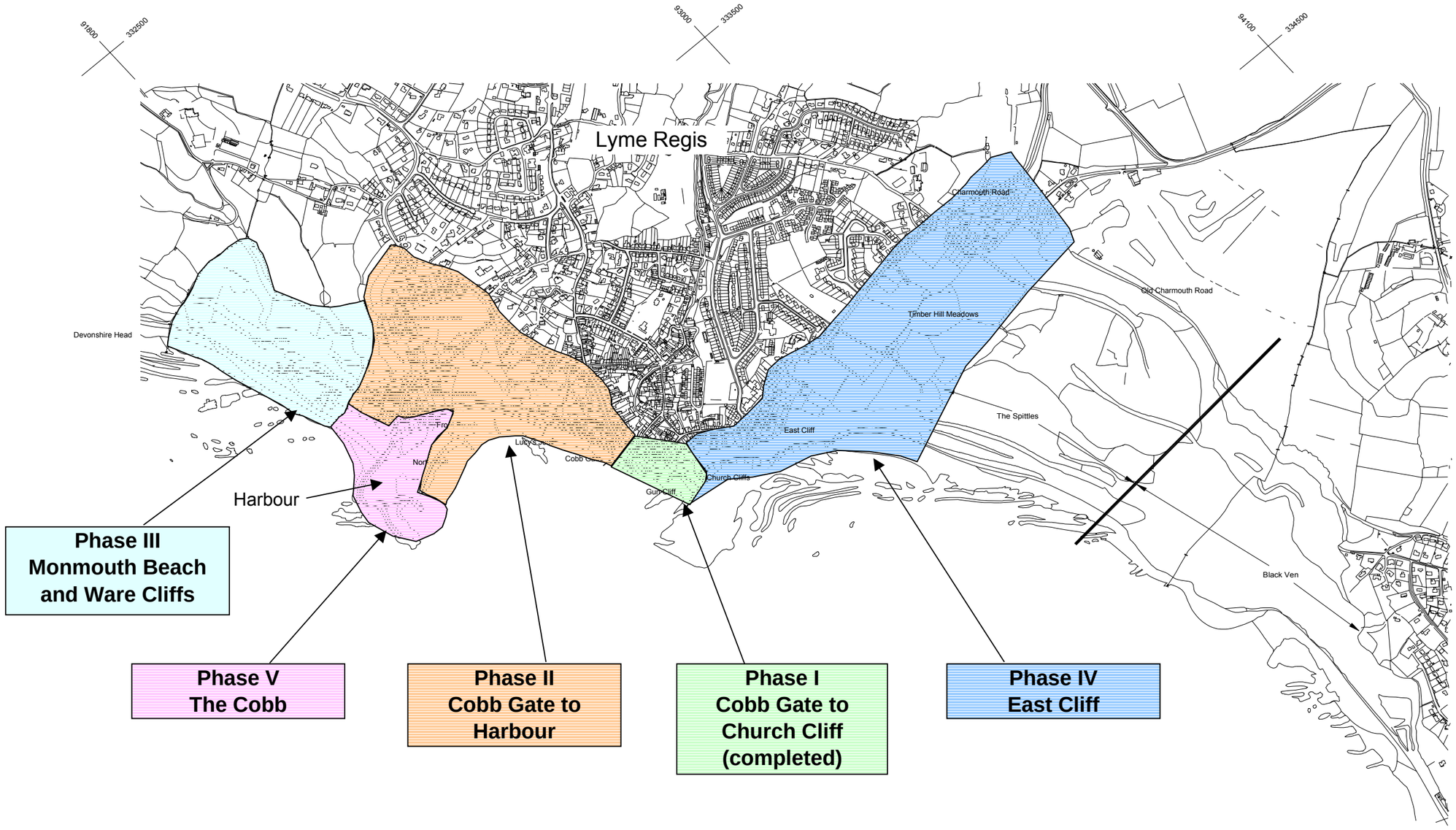
FIGURE 2.1
LOCATION PLAN



Coloured areas indicate areas at risk from coastal erosion and landsliding

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FIGURE 2.2
SUMMARY OF COAST PROTECTION PROBLEMS

SHEET 1 OF 2

Phase II: Cobb Gate to Harbour

Problem	Consequences
1 Large areas of the coastal slopes are inherently unstable and there is a high probability that there will be a major reactivation of the landslide systems within the next 1 to 5 years.	1 Destruction of property over a wide area; loss of the sea wall; loss of amenity; loss of roads and utilities; loss of town's economy.
2 The sea wall is under threat from large-scale slope failure.	2 Loss of the sea wall; loss of amenity, triggering of further landslides.
3 The drainage system has many defects and some elements are likely to fail completely within the next 1 - 5 years.	3 The triggering of major landslipping through raised groundwater levels.
4 The foreshore rock platform is lowering and breaking up and the sea wall is being undermined.	4 The sea wall will collapse leading to the loss of the Cart Road, Marine Parade and buildings. Landslides will be triggered.
5 The beaches are in long term decline.	5 The undermining of the sea wall and break up of the foreshore platform will accelerate. The sea wall will be subject to an increasing severity of wave attack.
6 The groynes and jetties are deteriorating.	6 The groynes and jetties will become ineffective, allowing redistribution and further loss of beach material and increased wave attack on the sea wall.

Phase III: Monmouth Beach and Ware Cliffs

Problem	Consequences
1 Monmouth Beach is changing shape such that the crest height is reducing in the west.	1 Property on the beach will become more vulnerable to flooding and erosion.

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FIGURE 2.2
SUMMARY OF COAST PROTECTION PROBLEMS

SHEET 2 OF 2

Phase IV: East Cliff

Problem	Consequences
1 Large areas of the coastal slopes are inherently unstable and there is a high probability that there will be a major reactivation of the landslide systems within the next 1 to 5 years.	1 Destruction of property over a wide area; loss of roads and utilities.
2 The sea wall is under threat from large-scale cliff failure.	2 Loss of the sea wall, leading to further landsliding.
3 The eastern part of Lyme Regis is under threat from the continuing long-term westwards expansion of the Spittles/Black Ven landslide system.	3 Loss of meadows and allotments.
4 The drainage system has defects and its outfall is under threat from continuing ground movements.	4 Raised groundwater levels triggering destructive landslipping.
5 The sea wall is being outflanked at its eastern end.	5 Local loss of sea wall, local erosion of cliff, triggering of existing landsides.
6 The shore platform is lowering and breaking up, the sea wall is in a poor condition and is starting to be undermined. There is very little protection from beach material.	6 The sea wall will be subject to an increasing severity of wave attack, will continue to deteriorate and will eventually fail.
7 The groynes are dilapidated and may become a danger to the public.	7 Unacceptable danger to members of the public.

Phase V: The Cobb

Problem	Consequences
1 The lower parts of the High Wall are deteriorating and are difficult to maintain.	1 The Cobb will fail by progressive collapse of the external masonry and hearting of the High Wall. This will lead to the loss of the harbour and flooding and erosion of nearby properties.
2 The Low Walkway is vulnerable to scouring by seawater and shingle overtopping the High Wall during storms.	2 Excessive scouring of the surface of the Low Walkway will lead quickly to the destruction of the Walkway. There is the possibility that the Cobb could then fail by the High Wall sliding on its mudstone foundation under extreme wave conditions.

3.0 GENERIC OBJECTIVES

3.1 Shoreline Management Plan

The Lyme Bay and South Devon Shoreline Management Plan (prepared by Posford Duvivier, 1998) gives the following Preferred Strategic Options for Lyme Regis:

Coastal Process Unit	Management Unit	Location in Lyme Regis	Preferred Strategic Option
CPU 3	MU 6	Cobb Gate to Harbour and East Cliff	Hold the Line
CPU 4	MU 7	Monmouth Beach	Do nothing

That is, hold the line for the urban areas and do nothing where there is little or no development.

3.2 Recommended Generic Objectives

Lyme Regis is faced with a formidable array of coast protection challenges. In order to fulfil the recommendation of 'hold the line' in the Shoreline Management Plan, it is considered that there is no other realistic alternative in the long term other than to implement new coast protection schemes.

On this basis, general objectives or actions have been determined that could be used to improve the coast protection situation as part of new schemes (Figure 3.1). Section 9 of the Preliminary Studies Summary Report spells out how these have been developed from the data obtained in the Preliminary Studies.

As the probability of damage due to marine erosion and landsliding are both relatively high, there would be little benefit in implementing foreshore protection works without also carrying out slope stabilisation works, and vice versa.

3.3 Alternative Philosophies

The following alternatives have been considered :

Do nothing: would lead to severe consequences for the long term future of the town (Figure 2.2). Discordant with Preferred Strategic Options of the Shoreline Management Plan. Only acceptable for Monmouth Beach where there are just minor assets under threat.

Do minimum: i.e. ongoing maintenance of structures, 'patch and mend'. This is essentially the philosophy which is currently in force. It does nothing to address the inherent instability of the foreshore and coastal slopes, nor the fundamental defects of the coast protection structures. Hence it would lead to much the same consequences as in the 'do nothing' case, and is discordant with the recommendations of the Shoreline Management Plan. It is considered that ongoing maintenance would only be an acceptable coastal management strategy in non-urgent cases, such as the Cobb, in the short term - in the long term it would become unsustainable.

React to failures once they have occurred: this is often what happened historically and is the equivalent of shutting the stable door after the horse has bolted. Although failures would not be allowed to develop and extend inland as they would in the 'do nothing' case, there would still be the potential for severe damage and disruption. The remedial works to treat a failure once it had caused the damage would be significantly greater in cost than those required to prevent the failure in the first place, and would take place after the assets had been lost. Discordant with the Preferred Strategic Options of the Shoreline Management Plan.

Early warning systems: in theory, these would give prior warning of landslide events to allow occupiers to leave premises and areas to be evacuated to help ensure public safety. They would do nothing to protect assets, hence if used in isolation would be discordant with the guidelines in the Shoreline Management Plan. However, it may be appropriate to install them in any areas in which there is a high risk to life, but where it is not feasible to carry out stabilisation works, for example because of access restrictions.

Coast protection works: major strengthening works comprising improvements to the coast protection walls, the provision of beach renourishment and control structures, slope stabilisation and drainage works, is considered to be the only realistic philosophy which will meet the objectives of the Shoreline Management Plan. These are discussed in the following sections (4 and 5).

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FIGURE 3.1
SUMMARY OF RECOMMENDED GENERIC ACTIONS

	Foreshore	Slopes
Phase II: Cobb Gate to Harbour	Repair and strengthen the sea wall. Repair and strengthen the foreshore rock platform. Improve/add to the existing beach control structures and replenish the beach.	Implement slope stabilisation schemes, including drainage improvements, in the most critical areas. Install landslide early warning systems in high risk areas where it is not feasible to carry out stabilisation works.
Phase III: Monmouth Beach and Ware Cliffs	Do nothing.	NA
Phases IV: East Cliff	Repair and strengthen the sea wall and the foreshore rock platform. Provide further protection at the eastern end of the sea wall to prevent outflanking.	Implement slope stabilisation schemes, including drainage improvements, on the lower slopes. Carry out strengthening works to the foreshore and sea wall to improve overall cliff stability.
Phase V: The Cobb	Carry out strengthening works to the lower part of the external face of the High Wall. Refurbish the surface of the Low Walkway.	NA

4.1 Description of Options

Conceptual designs for coast protection management options have been developed to satisfy the generic objectives defined in Section 3, and are based upon the information obtained in the Preliminary Studies. A description of each of the main scheme elements together with the coast protection benefits is given in Figures 4.1 and 4.2. At the time of preparing this strategy plan, designs were at a more advanced stage of development for Phase II than the other phases, hence the descriptions are more detailed than for the other phases.

The proposals for each Phase are as follows :

Phase II (Cobb Gate to Harbour) - coast protection scheme comprising new seawall and beach replenishment, slope strengthening and drainage. It is likely that the principal slope strengthening element would comprise of bored piles and counterfort drains. Drainage would probably comprise improvements to surface water drainage, trench and counterfort drains, and sub-horizontal drainage arrays. The newly replenished beach would be held in place by new masonry jetties and an extension to the southern arm of Cobb in rock armour.

Phase III (Monmouth Beach and Ware Cliffs) - Do minimum. There would be no economic justification for carrying out any coast protection actions in this area. However, in practice it is likely that ongoing maintenance would be carried out as a public service.

Phase V (The Cobb) - coast protection scheme comprising strengthening the foundation of the High Wall and resurfacing the Low Walkway.

4.2 Preferred Options

Such are the technical, economic and environmental constraints in the area between Cobb Gate and the Harbour that it is considered that there are no other general concepts which could be pursued as realistic alternatives to those presented.

The scheme options, illustrated in Figure 4.1 are therefore recommended as the preferred coast protection options. Appendix A shows the considered alternatives to the preferred options, and gives reasons for their rejection. A rigorous process was undertaken to arrive at the preferred options, including brainstorming by a team of engineering staff and consultants with coastal experience from both academic and practical backgrounds, in order to produced a comprehensive list of coast protection options. These were appraised and filtered to eliminate those which were not technically viable. An in-depth analysis of the remaining options was carried out in order to develop a short list of preferred options. Further detailed information on the development of the preferred options is given in High-Point Rendel (Dec 2001) and HR Wallingford (July 2001).

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FIGURE 4.1
CONCEPTUAL DESIGN ELEMENTS
PHASES II AND V (COBB GATE TO HARBOUR)

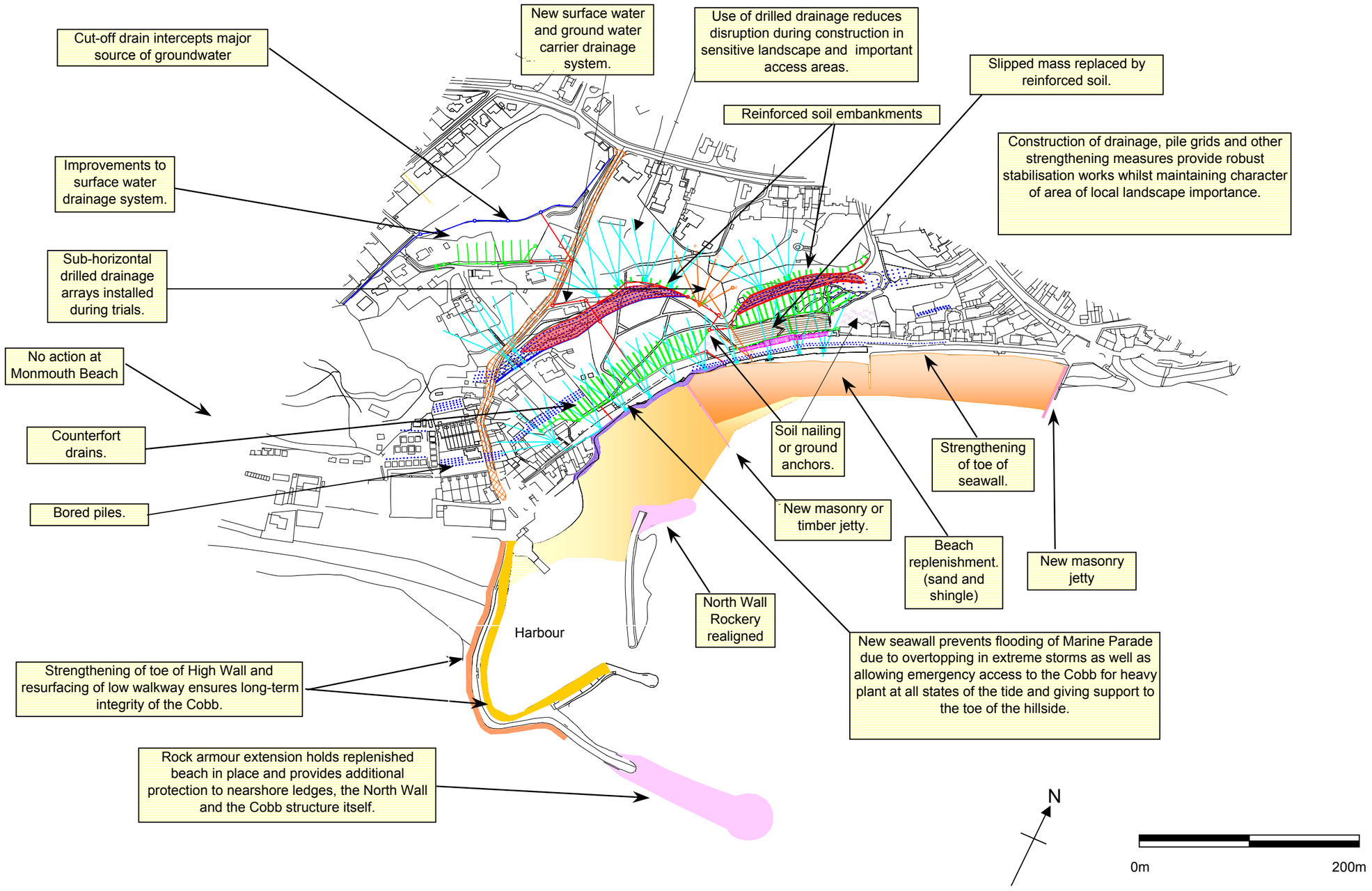

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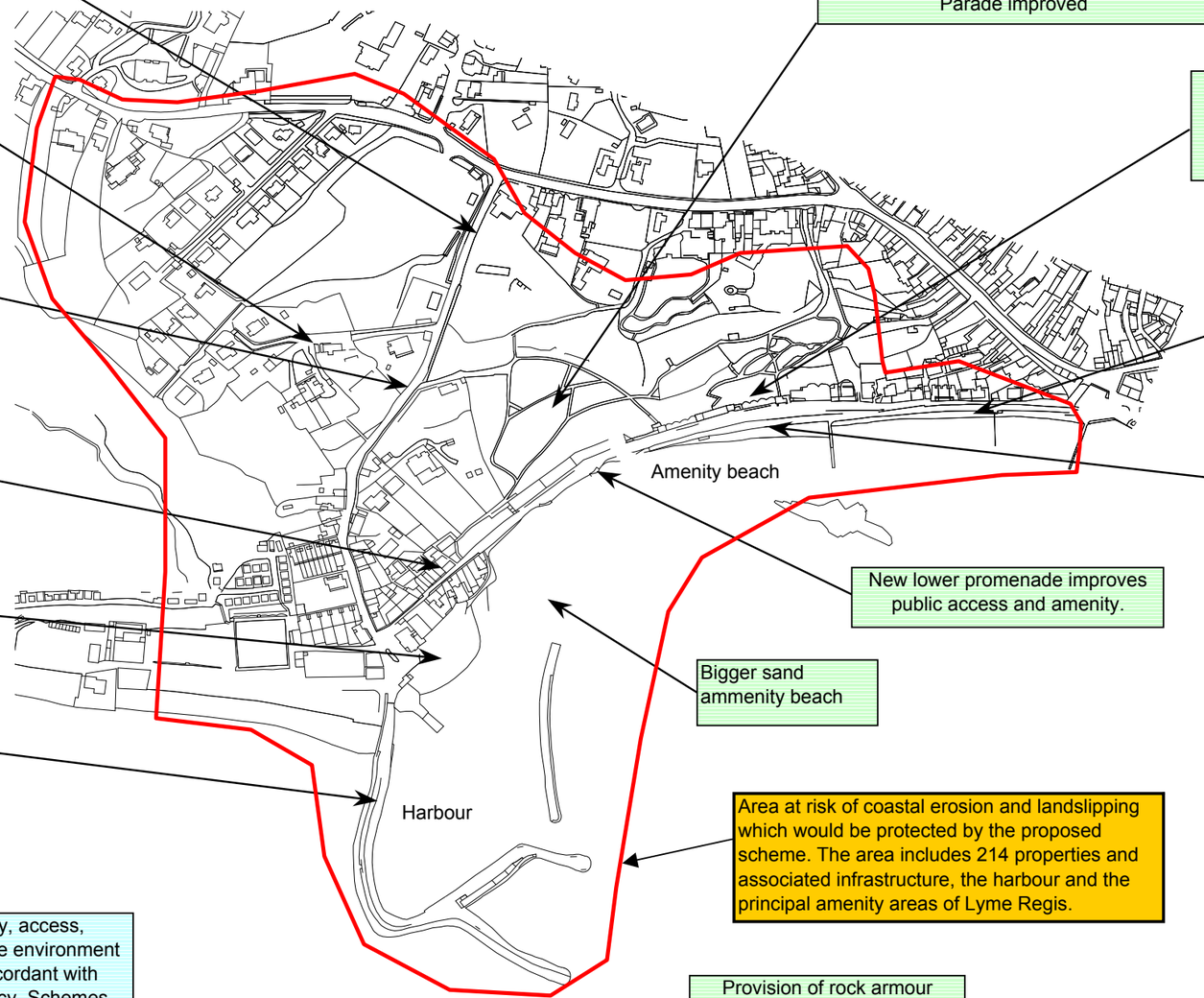
FIGURE 4.2
COAST PROTECTION BENEFITS
PHASES II AND V



Scope exists for scheme concept to be extended to include Cobb Road.

Proposals for new surface water drainage offer opportunities for surface water separation scheme.

Improvements to surface water drainage alleviate flash flooding in Cobb Road area during heavy rainfall.

Scope may exist to extend scheme to deal with derelict and unstable houses on Marine Parade.

Scheme elements are concordant with proposals to enhance Cobb Square and harbour slipway area.

New surface to low walkway enhances both amenity and working conditions in the harbour.

Improvements in stability, amenity, access, landscaping and general quality of the environment benefits local economy and is concordant with integrated tourism regeneration policy. Schemes would make the area more attractive and vibrant and may encourage further new landscaping, amenity and business initiatives.

Layout of gardens and access to Marine Parade improved

Scheme offers opportunities to refurbish or rebuild existing damaged buildings, and re-instatement of footpaths lost to landslipping.

Better access along Cart Road in severe conditions due to reduced overtopping .

Improvements to existing drainage outfall arrangement enhances visual appearance and amenity.

New lower promenade improves public access and amenity.

Bigger sand ammenity beach

New seawall, masonry jetties and beach replenishment provide effective protection for existing sea wall and foreshore, whilst maintaining the character of the frontage. Balance of sand and shingle on the beach maintains amenity value.

Area at risk of coastal erosion and landslipping which would be protected by the proposed scheme. The area includes 214 properties and associated infrastructure, the harbour and the principal amenity areas of Lyme Regis.

Provision of rock armour extension gives quieter conditions in the harbour and harbour mouth . May allow greater number of summer moorings outside harbour.

N

Principal Benefits

Secondary benefits

Broad environmental and social benefits

0m 200m

5.1 Description of Options

Conceptual designs for coast protection management options have been developed to satisfy the generic objectives defined in Section 3, and are based upon the information obtained in the Preliminary Studies.

There are two broad concepts :

Strengthening and Drainage - coast protection scheme comprising refurbishment or replacement of the seawall, slope strengthening and drainage and local slope regrading.

Slope Buttress - coast protection scheme comprising new seawall or revetment seaward of existing wall with a buttress of engineered fill to support the unstable slope.

A description of each of these concepts, together with coast protection benefits and disadvantages is given in Figures 5.1 and 5.2

5.2 Appraisal

The implementation of stabilisation measures at East Cliff will present considerable challenges in terms of the design and construction of an effective scheme and reconciling the technical requirements with ecological and landscape considerations in an environmentally sensitive area.

The strengthening and drainage solution would require the installation and maintenance of a complex array of varied stabilisation measures including drainage, ground anchors, piles, mesh support, reinforced soil and local regrading. Its implementation would entail risks in construction and operation which would require careful consideration and assessment. For example, the risk of triggering landslides during the installation of complex systems would need to be considered, together with the relatively heavy maintenance burden. There is the possibility that local failure of one component of the system, such as a drain or a ground anchor, could have adverse knock-on effects on the integrity of adjacent elements of the scheme.

(5.2 continued)

In contrast, the slope buttress concept would provide a simpler, more robust and less risky solution, and one which may offer more flexibility in landscaping and habitat recreation. A possible disadvantage of the slope buttress solution may be an additional cost over the strengthening and drainage solution. Preliminary costings indicate that the capital cost would be some 30-40% greater.

5.3 Preferred Option

The development of a preferred coast protection concept at East Cliff will require detailed consideration of the interrelationship between the technical requirements of the scheme and landscape and ecological issues, and balancing the advantages of robustness and relative simplicity of the slope buttress solution with the possible cost benefits of the strengthening and drainage solution.

The most appropriate option may prove to be a hybrid scheme incorporating a combination of the best features from both the strengthening and drainage and slope buttress concepts.

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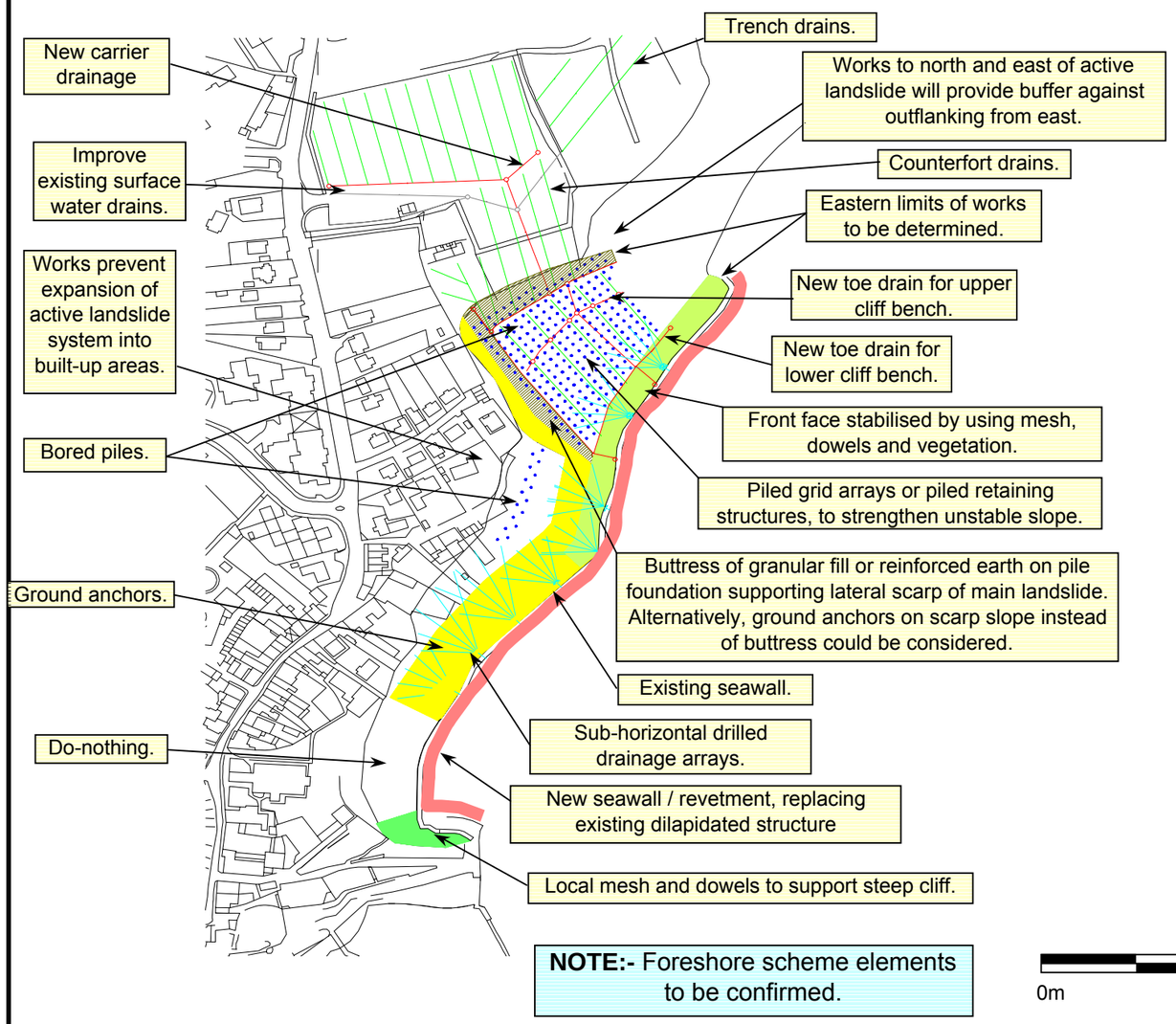
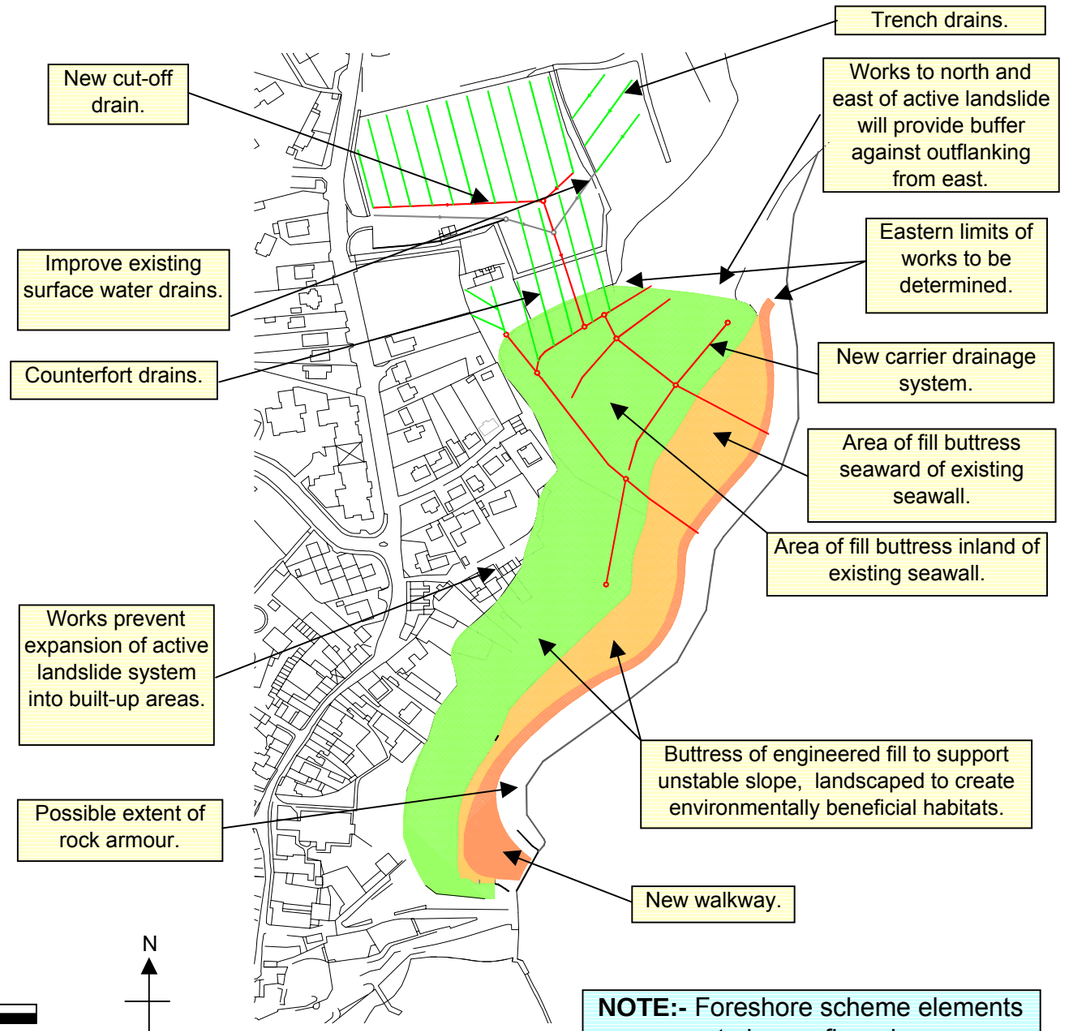
FIGURE 5.1
CONCEPTUAL DESIGN ELEMENTS : PHASE IV

STRENGTHENING AND DRAINAGE SOLUTION



NOTE:- Foreshore scheme elements to be confirmed.

SLOPE BUTTRESS SOLUTION



NOTE:- Foreshore scheme elements to be confirmed.

0m 100m

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FIGURE 5.2
COAST PROTECTION BENEFITS : PHASE IV

Construction of drainage, pile grids and other strengthening measures provide stabilisation whilst maintain existing landform and broad character of the area.

Opportunities to enhance Charmouth Road Car Park and improve amenity, with footpath links to beaches and Gun Cliff Walk.

Area at risk of coastal erosion and landslipping which would be protected by the proposed scheme.The area includes 172 properties with associated infrastructure and amenities.

Improvements in amenity, access, safety, visual appearance and general quality of the environment benefit local economy.

Educational opportunities related to geology, ecology and geomorphology.

Substantial scope for improvements to visual appearance and amenity use of area.

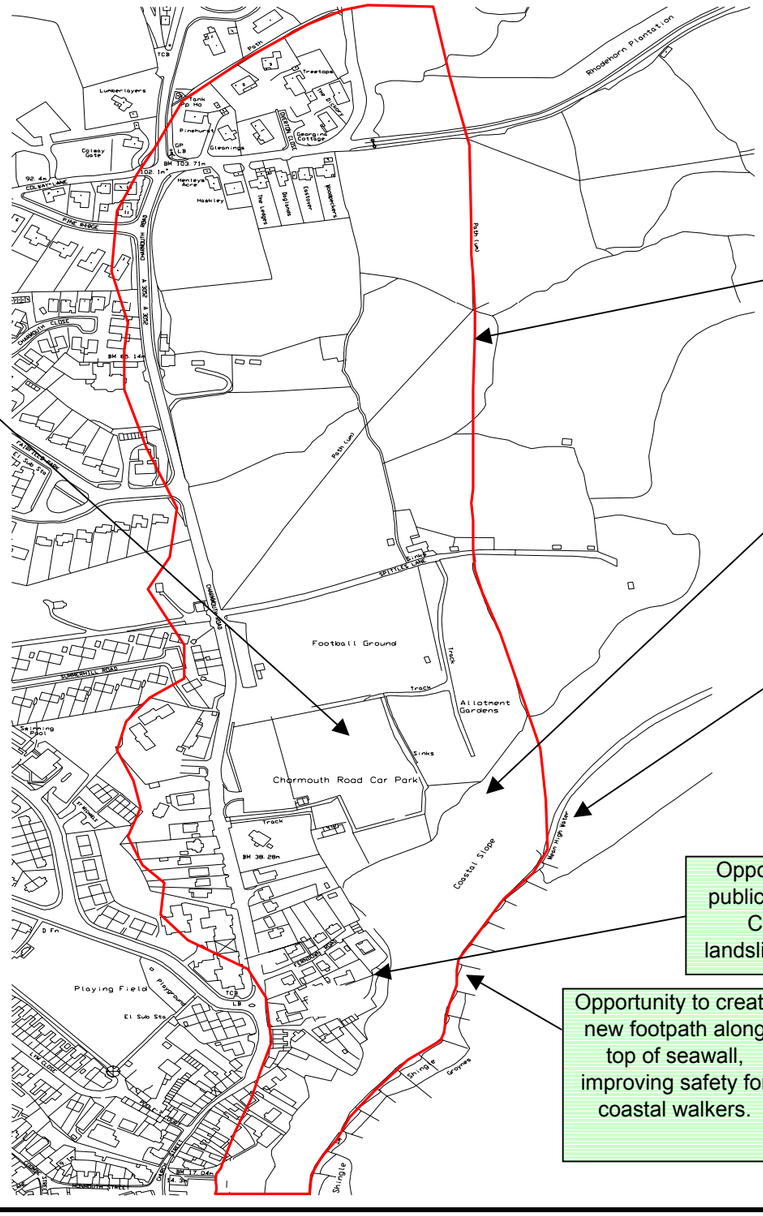
Habitat creation benefits nature conservation interests.

Improvements to visual appearance of area.

Intensive works to toe of slope alleviates risk of landslide recession inland, hence reduce need for disruptive works in sensitive environmental areas higher on hillside.

Improved and safer access to internationally important geological exposures, and to beach at the Spittles and Black Ven to the east.

Slope buttress provides relatively simple and robust stabilisation. Low risk of landslide reactivation during construction. Low maintenance burden.



Opportunity to reinstate public footpath from East Cliff Lane, lost to landslipping in the 1970's.

Opportunity to create new footpath along top of seawall, improving safety for coastal walkers.

N

0m 200m

Principal Benefits

Secondary benefits

Broad environmental and social benefits

SLOPE BUTTRESS SOLUTION DISADVANTAGES:

Substantial disruption to environmentally sensitive area.

Relatively high cost.

Aesthetics: Uniform engineered appearance abutting natural slope

STRENGTHENING AND DRAINAGE SOLUTION DISADVANTAGES :

Intensive and complex scheme involving significant risks during construction and operation in terms of both landslide reactivation and cost escalations.

Heavy maintenance burden.

Substantial disruption to environmentally sensitive area.

6.0 PROGRAMME

6.1 Principles

A summary programme for the entire programme of coast protection works is given in Figure 6.1, extending from 2001 to 2008.

The principles on which it is based are given below:

1) The length of time required for each stage of each scheme had been estimated to be as follows:

Detailed design	9 - 12 months
Planning process and tender	9 - 12 months
Construction	18 - 24 months

2) Phases II and IV (Cobb Gate to Harbour and East Cliff) are considered to be the most urgent and Phase V (the Cobb) the least urgent. Therefore, the Phase V scheme is the last of the three schemes in the programme. Information on the derivation of priorities is given in Section 9 of the Preliminary Studies Summary Report.

3) There is a greater value of both direct assets and amenity benefits at risk in the area of Phase II than in that of Phase IV. Therefore, Phase II comes before Phase IV. This has the additional advantage that it will allow 18 months to carry out the environmental lead-in work necessary for Phase IV due to the sensitive nature of the area.

4) To avoid excessive disruption to the town during the implementation of the major civil engineering schemes, the construction work for each phase takes place in succession, rather than at the same time.

6.2 Sub-phasing of Phase II

It is possible that the Phase II works may be split up into the following sub-phases in order to complete the more urgent works ahead of the main contract:

Phase IIa - Urgent Slope Stabilisation Works

An advanced piling scheme would take place in the extremely vulnerable area around the western end of the frontage which has experienced large slope movements in the last two years. It is considered that if left until the main works take place there is a high risk that properties and infrastructure in this area may suffer severe damage.

Phase IIb - Beacon Rocks

There is the possibility of carrying out the works to realign and extend the Beacon Rocks off the Southern Arm of the Cobb in advance of the main works, in order to give a level of immediate protection to the town frontage.

Phase IIc - Main Works

Phase IIc would consist of the main contract to construct the principal coast protection works for Phase II.

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FIGURE 6.1
PROGRAMME CHART

Year	2001				2002				2003				2004				2005				2006				2007				2008			
Quarter	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Financial year	2001/2				2002/3				2003/4				2004/5				2005/6				2006/7				2007/8				2008/9			
PHASE II: COBB GATE TO HARBOUR																																
COAST PROTECTION SCHEME					*																											
Design																																
Planning process and tender									*																							
Construction: Urgent Works																																
Construction: Beacon Rocks																																
Construction: Main Works																																
Maintenance																																
PHASE III: MONMOUTH BEACH																																
DO MINIMUM																																
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PHASE IV: EAST CLIFF																																
COAST PROTECTION SCHEME																																
Environmental lead-in work																																
Design																																
Planning process and tender													*																			
Construction																																
Maintenance																																
PHASE V: THE COBB																																
COAST PROTECTION SCHEME																																
Design																																
Planning process and tender																																
Construction																																
Maintenance																																

* Submit Strategy Plan

* DEFRA Approval

7.0 COST BENEFIT ANALYSIS

7.1 General

The purpose of this section is to demonstrate that there is sufficient economic benefit in implementing the proposed schemes to confirm the economic viability of the coast protection strategy and hence attract DEFRA grant aid funding.

Table 7.1 below gives a summary of estimated present value benefits and costs, and the benefit cost ratio, for each of Phases II, IV and V, based on conservative assumptions. Explanatory notes on the sources of data are given in Appendix B. The total cost of implementing all the proposed schemes is estimated at £33M.

The broad analysis indicates that there would be considerable economic benefits in implementing coast protection works for all three of the Phases II, IV and V, with benefit cost ratios in excess of five. It is likely that, in a rigorous cost benefit analysis carried out for each scheme, the benefit cost ratios would be significantly greater.

The relatively high benefit cost ratios demonstrating the economic viabilty of schemes are also concordant with the general impression that serious seawall failures or coastal instability would have a devestating effect on the town and, in the do nothing secenario, would threaten its very viability as a commercial town in its present form.

7.2 Sensitivity

Table 7.1 gives benefits and costs which are based upon "best estimates". Appendix F examines the sensitivity of the calculations by considering a 60% increase in the estimated cost of construction. This indicates that the calculations are robust in the sense that high benefit cost ratios are still acheived with quite pessimistic assumptions of construction costs. The sensitivity analysis shows that an increase of 60% in construction costs would still produce an overall benefit cost ratio of 3.74.

7.3 Additional benefits

In addition to the economic benefits described by the cost benefit analysis, there would be considerable other benefits to society of implementing coast protection schemes. These would include, for example, reduction of stress and worry of residents and business people with premises in vulnerable areas and improvements in amenity, access, landscaping and the quality of the environment, making the areas more attractive and vibrant and increasing the confidence of the town generally.

Table 7.1 Summary of estimated costs, benefits and benefit/cost ratios.

	Number of Properties	Non Discounted Value				TOTAL £M	Present Value (PV) Benefits				TOTAL £M
		Property	Services and infrastructure	Amenity	Harbour		Property	Services and infrastructure	Amenity	Harbour	
Scheme		£M					£M				
Phase II: Cobb Gate to Harbour	297	53.08	4.90			**57.98**	37.98	4.02	63.00		**105.00**
Phase IV: East Cliff	172	34.31	4.00			**38.31**	24.79	3.08	41.80		**69.67**
Phase V: The Cobb	63	7.06	1.00		7.84	**15.90**	2.51	0.36	10.09	3.86	**16.82**
TOTAL	**532**	**94.44**	**9.90**		**7.84**	**112.18**	**65.28**	**7.46**	**114.90**	**3.86**	**191.49**
% of Total		*84*	*9*		*7*	*100*	*34*	*4*	*60*	*2*	*100*

	Design Preliminaries		Construction Contract		Maintenance per Annum		TOTAL PV Cost £M	BENEFIT/COST RATIO
	Cost	PV Cost	Cost	PV Cost	Cost	PV Cost		
Scheme	£M		£M		£M			
Phase II: Cobb Gate to Harbour	1.35	1.32	16.70	15.20	0.01	0.24	**16.76**	**6.27**
Phase IV: East Cliff	0.95	0.88	13.00	11.04	0.01	0.22	**12.14**	**5.74**
Phase V: The Cobb	0.20	0.17	3.30	2.61	0.002	0.04	**2.82**	**5.96**
TOTAL	**2.50**	**2.37**	**33.00**	**28.85**	**0.02**	**0.50**	**31.72**	**6.04**

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8.0 SUMMARY

1) Large areas of Lyme Regis are at risk from coastal erosion and landsliding including:

   532 properties valued at £94M
   Associated services and infrastructure valued conservatively at £9.9M
   The harbour, and main tourist and amenity areas of the town.

2) In order to fulfil the recommendation in the Shoreline Management Plan of 'hold the line' for the urban areas of the town, there are no other realistic alternatives in the long term other than to implement new coast protection schemes.

3) The most appropriate coast protection management options are as follows:-

   Phase II (Cobb Gate to Harbour) - coast protection scheme comprising a new seawall and beach replenishment, with new structures to hold the replenished beach and slope strengthening and drainage.

   Phase III (Monmouth Beach and Ware Cliffs) - Do nothing or do minimum.

   Phase IV (East Cliff) - coast protection scheme comprising either a) strengthening and drainage, local slope regrading and refurbishment or replacement of the seawall or b) slope buttress of engineered fill with new seawall or revetment seaward of the existing wall.

   Phase V (The Cobb) - coast protection scheme comprising strengthening the foundation of the High Wall and resurfacing the Low Walkway.

4) The schemes would need to be implemented over a period of seven years in order to limit disruption to the town to an acceptable level, and to allow time for the design and lead-in work for the complex schemes.

5) The total cost of implementing all the schemes is estimated to be £33M

6) The overall benefit / cost ratio of implementing all the schemes is approximately 6 : 1

7) There would also be considerable secondary benefits to the environment and society of implementing the schemes.

References

Lyme Regis Environmental Improvements: Preliminary Studies Reports

10/1 Phases II & III: Conceptual Management Strategy and Scheme Options for Coastal Slope Stabilisation. Final report. September 2000.
10/2 Phase IV: Conceptual Management Strategy and Scheme Options for Coastal Slope Stabilisation. Final report. September 2000.
13/2 Phases II & III: Landslide Recession Scenarios. July 2000.
13/3 Phase IV: Landslide Recession Scenarios. July 2000.
13/4 Cobb Disaster Scenarios. August 1999.
13/5 Phases II & III: Preliminary Assessment of Amenity Benefits. June 1999.
13/6 Phases II & III and The Cobb: Preliminary Assessment of Property Benefits. March 2000.
13/7 Phase IV: Preliminary Assessment of Property Benefits. March 2000.
14/1 Summary Report. August 2000.

Lyme Regis Environmental Improvements: Phase II design reports

HR Wallingford. Preliminary and Secondary Appraisal of Coast Defence Options. July 2001.
High-Point Rendel. Preliminary Design of Scheme Options for Coastal Slope Stabilisation. December 2001.
Martin Diplock. Lyme Regis Environmental Improvements. Phase II. Property Valuation Survey. January 2002.

Shoreline Management Plan

Lyme Bay and South Devon Shoreline Management Plan. Posford Duvivier. 1998.

Many different coast protection options have been considered for both slope stabilisation and foreshore protection during the development of the conceptual designs for Phase II, Those rejected as unsuitable as a principal element in the works are listed below. For further information see the Phase II design reports listed in the References.

Foreshore Protection

No.	Ideas and suggestions	NOT Technically viable	NOT Economically viable	NOT Environmentally / Aesthetically viable	Does not contribute to meeting objectives	Remarks	Definitely rejected
1	Do nothing				X	Do nothing is not an option but needs to be considered as a basis for the comparison of all other scheme options	X
2	Cart Road-type buttress						
3	Simple rock apron			X		Would not be acceptable on amenity beach	X
4	Offshore reef	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
5	Beach dewatering system	X			X	Too high a tidal range, no long term evidence of system being effective in UK situation	X
6	Terminal groyne and beach recharge						
7	Sheet piles to toe of wall						
8	Groyne field and recharge						
9	Monitor sea wall for movement and undermining				X	Is not an option on its own but may be an integral part of the overall solution	C
10	Artificial ledges/foreshore reconstruction	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
11	Floating breakwater - nodding ducks				X	Not a feasible long term coastal defence option	X
12	Series of Lucy's jetties	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
13	Stepped concrete revetment						
14	Rock armour to toe			X		Would not be acceptable on amenity beach	X
15	Point ledges	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
16	Gabion revetment	X		X		Not robust enough to withstand wave conditions at Lyme Regis; Short design life; Environmentally unacceptable when gabions split - hazard to beach users	X
17	Imbricate rock ramp	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
18	Hollow typhoon wall						
19	Maintain sea wall	O				Does not meet all geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	

X: Does not meet requirements; O: May meet requirements in conjunction with other scheme options; C: Not an engineering solution but could be considered for incorporation within Coastal Defence System

APPENDIX A: REJECTED SCHEME OPTIONS
PHASE II

Foreshore protection continued…

No.	Ideas and suggestions	NOT Technically viable	NOT Economically viable	NOT Environmentally / Aesthetically viable	Does not contribute to meeting objectives	Remarks	Definitely rejected
20	Yacht marina		X			Too expensive within coastal defence decision making framework	X
21	Harbour structure on Broad Ledge		X			Too expensive within coastal defence decision making framework	X
22	Grouted rock pitching	O				Does not meet all geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
23	Wave diverting walls						
24	Graded beach	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
25	Advance the line with fill	O				Does not meet all Coastal Defence scheme objectives on its own but potential as part of a scheme with other identified options.	
26	Caissons to advance line			X		Would no be acceptable on amenity beach	X
27	Tyre reef	X		X		Short term design life; High damage potential under storm conditions; aesthetic and environmental concerns	X
28	Upgrade sea wall						
29	Early warning system for sea wall				X	Not a scheme option but may be part of the overall solution	C
30	Improve drainage in sea wall	O				Does not meet all Coastal Defence scheme objectives on its own but potential as part of a scheme with other identified options.	
31	Sink barges offshore	X				Not a long term solution in high wave energy environment	X
32	Asphalt revetmennt			X		Not environmentally or aesthetically acceptable	X
33	Contiguous bored piled wall behind sea wall	O				Does not meet all Coastal Defence scheme objectives on its own but potential as part of a scheme with other identified options.	
34	Big buttresses	O				Does not meet all Coastal Defence scheme objectives on its own but potential as part of a scheme with other identified options.	
35	Sheet piles behind sea wall	O				Does not meet all Coastal Defence scheme objectives on its own but potential as part of a scheme with other identified options.	
36	Grow kelp - bio engineering	X				Not proven in the UK as a suitable coast defence mechanism. Require large offshore area of kelp beds to begin to be effective	X
37	Rout out toe of sea wall and concrete						
38	Geobags	X		X		Short lifespan; not acceptable aesthetically or environmentally	X
39	Remove or realign rockery	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
40	New sea wall at Jane's Café to link with Cart Road	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
41	Dam underwater channel	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	

X: Does not meet requirements; O: May meet requirements in conjunction with other scheme options; C: Not an engineering solution but could be considered for incorporation within Coastal Defence System

Foreshore protection continued…

No.	Ideas and suggestions	NOT Technically viable	NOT Economically viable	NOT Environmentally / Aesthetically viable	Does not contribute to meeting objectives	Remarks	Definitely rejected
42	Extend Cobb	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options. Potentially expensive.	
43	Extend North Wall towards Lycy's Jetty and fill in			X		Significant loss of Town Beach sand beach area, therefore environmentally unacceptable	X
44	Large rock groyne at Broad Ledge and beach recharge			X		Would require major structure - not acceptable on SSSI	X
45	Pile within sea wall	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
46	Move North Wall seawards (E)		X			Too expensive with respect to benefits gained	X
47	Extend North Wall eastwards	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
48	Reopen sluices at Cobb and remove sandbar	X		X		Would cause loss of Monmouth Beach as only limited supply of shingle	X
49	Drain beach	X				Too high a tidal range, no beach, no evidence of system being effective in UK situation	X
50	Offshore breakwaters						
51	Nearshore bund	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
52	Coarsen beach	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
53	Geotubes	X		X		Short lifespan; not acceptable aesthetically or environmentally	X
54	Grout beach shingle	X				Variant of revetment options - not as technically satisfactory as other revetment options	X
55	Replicate existing system seaward		X			Replicating the entire Town Beach seawall seawards is too expensive within the coastal defence decision making process	X
56	Pressure relief drains	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
57	Recharge submarine channel with sediment	X				Unlikely to improve beach levels sufficiently; may result in greater siltation in the harbour; high maintenance commitment	X
58	Beach pumping/artificial sand recharge	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
59	Annual small-scale recharge	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
60	Shore parallel groynes						

X: Does not meet requirements; O: May meet requirements in conjunction with other scheme options; C: Not an engineering solution but could be considered for incorporation within Coastal Defence System

Foreshore protection continued…

No.	Ideas and suggestions	NOT Technically viable	NOT Economically viable	NOT Environmentally / Aesthetically viable	Does not contribute to meeting objectives	Remarks	Definitely rejected
61	Accelerate failure of western cliffs to provide sediment	X		X	X	Would not meet coastal defence or geotechnical scheme objectives; high environmental impact	X
62	Remove Humble Point	X		X	X	Would not meet coastal defence or geotechnical objectives; high environmental impact	X
63	Design the beach, grading permeability etc.	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options. Often expensive to achieve in practice.	
64	Pebbles like tertapods	X	X	X		Expensive to manufacture sufficient quantity; unsuitable for recreation beach; untested	X
65	Berosin geotextile in Town Beach Channel	X				Untested / effectiveness unquantifiable during design; potentiall short design life	X
66	Static Equilibrium Bay						
67	Surfing reefs	X				Effectiveness as Coastal Defence structure untested	X
68	Create new jetty about present end of Cart Road	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
69	Extension of Cart Road	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
70	Concrete armour unit revetment			X		Unacceptable on amentiy beach	X
71	Perched Beach (sand on rock)	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of a scheme with other identified options.	
72	Extend & raise existing jetties	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of scheme with other identified options.	
73	Rock revetment			X		Would not be acceptable on amenity beach	X
74	Submerged breakwaters	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of scheme with other identified options.	
75	Partly submerged breakwaters	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of scheme with other identified options.	
76	Offshore caisson breakwater	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of scheme with other identified options.	
77	Simple concrete apron	O				Does not meet all Coastal Defence or geotechnical scheme objectives on its own but potential as part of scheme with other identified options.	

X: Does not meet requirements; O: May meet requirements in conjunction with other scheme options; C: Not an engineering solution but could be considered for incorporation within Coastal Defence System

Slope stabilisation

Possible Scheme Element / Strategy	Reasons for rejection as principal stabilisation element
Slope reprofiling by cut and fill	Not appropiate due to lack of space and possible deleterious affect on stability of overall landslide complex, may be used locally only.
Excavate or recompact landslide material	Possibly use locally in shallow slips.
Vertical gravity drains	Not appropiate due to risk of adding water to potential deeper seated slip surface, possibly reducing stability.
Drainage adits	Not appropiate due to construction difficulties and high costs. Also collector drains vulnerable to post installation ground movement.
Ground anchors	Possibly required to secure existing retaining walls or used locally on shallow slips but bored piles more suitable as principal stabilisation element.
Diaphragm walls	Not appropiate due to high cost and possible adverse affect on groundwater regime.
Plant vegetation	Would not improve deep-seated landslides.
Gabions	Possibly use locally in shallow slips on lower slope, not appropriate as main element.
Crib Wall	Possibly use locally in shallow slips on lower slope, not appropriate as main element.
Soil Nailing	Possibly use locally in shallow slips on lower slope, not appropriate as main element.
Vertical pumped wells	Not appropriate due to high maintenance burden.
Vertical gravity drains	Not appropiate due to risk of adding water to potential deeper seated slip surface, possibly reducing stability.

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APPENDIX B1: DATA SOURCES FOR BENEFIT COST ANALYSIS: SUMMARY OF SOURCES

SHEET 1 OF 2

Scheme	Number of Properties	Market Value (MV) £M				TOTAL £M	Present Value (PV) Benefits £M				TOTAL £M
		Property	Services and infrastructure	Amenity	Harbour		Property	Services and infrastructure	Amenity	Harbour	
Phase II: Cobb Gate to Harbour	297	53.08 [1]	4.90 [4]			**57.98**	37.98 [8]	4.02 [11]	63.00 [14]		**105.00**
Phase IV: East Cliff	172	34.31 [2]	4.00 [5]			**38.31**	24.79 [9]	3.08 [12]	41.80 [14]		**69.67**
Phase V: The Cobb	63	7.06 [3]	1.00 [6]		7.84 [7]	**15.90**	2.51 [10]	0.36 [13]	10.09 [14]	3.86 [15]	**16.82**
TOTAL	532	**94.44**	**9.90**		**7.84**	**112.18**	**65.28**	**7.46**	**114.90**	**3.86**	**191.49**

Scheme	Design Preliminaries £M		Construction Contract £M		Maintenance per Annum £M		TOTAL PV Cost £M	BENEFIT/COST RATIO
	Cost	PV Cost	Cost	PV Cost	Cost	PV Cost		
Phase II: Cobb Gate to Harbour	1.35 [16]	1.32 [17]	16.70 [16]	15.20 [17]	0.01 [16]	0.24 [17]	**16.76**	**6.27**
Phase IV: East Cliff	0.95 [16]	0.88 [17]	13.00 [16]	11.04 [17]	0.01 [16]	0.22 [17]	**12.14**	**5.74**
Phase V: The Cobb	0.20 [16]	0.17 [17]	3.30 [16]	2.61 [17]	0.002 [16]	0.04 [17]	**2.82**	**5.96**
TOTAL	**2.50**	**2.37**	**33.00**	**28.85**	**0.02**	**0.50**	**31.72**	**6.04**

[1] The market value of properties in the areas indicated on the location plan for Phases II, III & V in Appendix C1 and calculated in Appendix D. It has been assumed that S9 will be affected by flooding and erosion resulting from a breach in the Cobb, but not landslipping, whereas in fact it could be affected by both.

[2] The market value of properties in all the zones indicated on the location plan for Phase IV in Appendix C2 and calculated in Appendix D.

[3] Present market value of properties in area S9 on the location plan for Phases II, III & V in Appendix C1, which would be affected by a breach in the Cobb as calculated in Appendix D.

[4] Assume failure of Cobb Road within zone S10, with repair of the road to reinstate access to the property in areas S10, S12 and S9, and restoration of services costing £2.9M. Assume also failure of the Marine Parade, with restoration of the highway and services costing £2M giving a total market value of £4.9M. See Appendix H

[5] Assume failure of Charmouth Road in zone E2, with repair and stabilisation of the road and rerouting of services costing £4M.

[6] Assume nominal value of £1M for the rerouting of services in Cobb Square.

[7] See Appendix E.

[8] The present value benefits of the areas indicated on the location plan for Phases II, III & V in Appendix C1 and calculated in Appendix D. It has been assumed that S9 will be affected by flooding and erosion resulting from a breach in the Cobb, but not landslipping, whereas in fact it could be affected by both.

[9] The present value benefits of all the zones indicated on the location plan for Phase IV in Appendix C2 and calculated in Appendix D.

[10] Present value benefit of area S9 on the location plan for Phases II, III & V in Appendix C1, which would be affected by a breach in the Cobb as calculated in Appendix D.

[11] Assume failure of Cobb Road within zone S10, with repair of the road to reinstate access to the property in areas S10, S12 and S9, associated land stabilisation and restoration of services costing £2.9M. This is then discounted by PVB/MV ratio of 0.78 as given in the summary table in Appendix D, giving a present value benefit of £2.26M. Assume also failure of the Marine Parade, with restoration of the highway and services costing £2M, discounted by 0.88 as per the PVB/MV ratio for zone S4, giving a present value benefit of £1.76. See Appendix H for definition of repair costs.

[12] Assume failure of Charmouth Road in zone E2, with repair and stabilisation of the road and rerouting of services costing £4M. This value is then discounted by the PVB/MV ratio of 0.77 for zone E2, as given in the summary table in Appendix D, giving a present value benefit of £3.08M

[13] Assume nominal value of £1M for the rerouting of services in Cobb Square, discounted by 0.36 as per the PVB/MV value for zone S9 on the location plan for Phases II, III & V in Appendix C, giving £0.36M

[14] Even on conservative estimates, amenity benefit will be very high and much greater than direct benefits. Assume, conservatively, that they are 1.5 times the direct benefits (see Appendix G).

[15] See Appendix E.

[16] See Appendix B2

[17] See Appendix B3. The maintenance costs are discounted each year over the following 50 years. The discounted maintenance costs beyond year 50 are assumed to be zero.

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APPENDIX B2: DATA SOURCES FOR BENEFIT COST ANALYSIS: ESTIMATED COST OF WORKS

Table A1: Estimated Costs for Coast Protection Works.

Scheme	Preliminaries	£k	Construction Contract	£M	Maintenance £k per annum
Phase II: Cobb Gate to Harbour	Design of slope works	700	Holmbush Car Park	0.3	
	Environmental Impact Assessment	50	Langmoor Gardens	1.1	
	Design of foreshore works	150	Lister Gardens	1.1	
	Preparation of Drawings and Contract Documents	250	Harbour Heights	1.0	
	WDDC staff costs & contingencies	200	Cobb Terrace	0.8	
			Marine Parade East	0.4	
			Shoreworks Structures	2.1	
			Shoreworks Beach	5.5	
			Supervision and WDDC staff costs	1.0	
			Contingency (25%)	3.4	
TOTAL		**1350**		**16.7**	**10**
Phase IV: East Cliff	Design of slopes	400	Slopes (assuming buttress solution)	7.5	
	EIA & Landscape design	200	Foreshore - included		
	Design of foreshore works	100	Increase in construction costs since 2000 estimate (20%)	1.5	
	Preparation of Drawings and Contract Documents	150	Supervision and WDDC staff costs	1.0	
	WDDC staff costs & contingencies	100	Contingency (30%)	3.0	
TOTAL		**950**		**13.0**	**10**
Phase V: The Cobb	Design, drawings and contract documents	200	Foundation	0.5	
			Cofferdam	0.5	
			Low Walkway	1.0	
			Supervision and WDDC staff costs	0.5	
			Contingency (30%)	0.8	
TOTAL		**200**		**3.3**	**2**

Note:- Source of Phase II construction costs - High Point Rendel 2003
Source of Phase IV construction costs - Lyme Regis Environmental Improvements Preliminary StudiesReport 10/2, Prepared by High Point Rendel

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APPENDIX B3: DATA SOURCES FOR BENEFIT COST ANALYSIS: CALCULATIONS FOR PRESENT VALUE DESIGN AND CONSTRUCTION COSTS

Calculations for Present Value Design and Construction Costs

Year	2002				2003				2004				2005				2006				2007				2008				2009				2010	
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Discount Factor	1.000000				0.966184				0.933511				0.901943				0.871442				0.841973				0.813501				0.785991				0.759412	
PHASE II: COBB GATE TO HARBOUR																																		
Preliminaries Total Cost £1M	44.5% * 1.00 * £1.35M = £0.6M				44.5% * 0.966184 * £1.35M = £0.58M					11% * 0.933511 * £1.35M = £0.14M			Total Present Value = £0.6M + £0.58M + £0.14 = £1.32M																					
Construction Total Cost £17.5M										37.5% * 0.933511 * £16.7M = £5.85M			50% * 0.901943 * £16.7M = £7.53M					12.5% * 0.871442 * £16.7M = £1.82M				Total Present Value = £5.85M + £7.53M + £1.82M = £15.2M										
PHASE IV: EAST CLIFF																																		
Preliminaries Total Cost £0.4M										37.5% * 0.933511 * £0.95M = £0.33M			50% * 0.901943 * £0.95M = £0.43M					12.5% * 0.871442 * £0.95M = £0.1M				Total Present Value = £0.33M + £0.43M + £0.1M = £0.88M										
Construction Total Cost £10.5M																		37.5% * 0.871442 * £13M = £4.25M			50% * 0.841973 * £13M = £5.47M				12.5% * 0.813501 * £13M = £1.32M				Total Present Value = £4.25M + £5.47M + £1.32M = £11.04M					
PHASE V: THE COBB																																		
Preliminaries Total Cost £0.1M																		37.5% * 0.871442 * £0.2M = £0.07M			50% * 0.841973 * £0.2M = £0.08M				12.5% * 0.813501 * £0.2M = £0.02M				Total Present Value = £0.07M + £0.08M + £0.02M = £0.17M					
Construction Total Cost £3.5M																									37.5% * 0.813501 * £3.3M = £1M				50% * 0.785991 * £3.3M = £1.3M					
																									Total Present Value = £1M + £1.3M + £0.31M = £2.61M								12.5% * 0.759412 * £3.3M = £0.31M	

Present value = percentage of activity in year x discount factor for year x total cost of activity

Total present value = sum of present values for each activity

Discount factor assumes 3.5% test rate for years 0 - 30 and 3.0% from year 31

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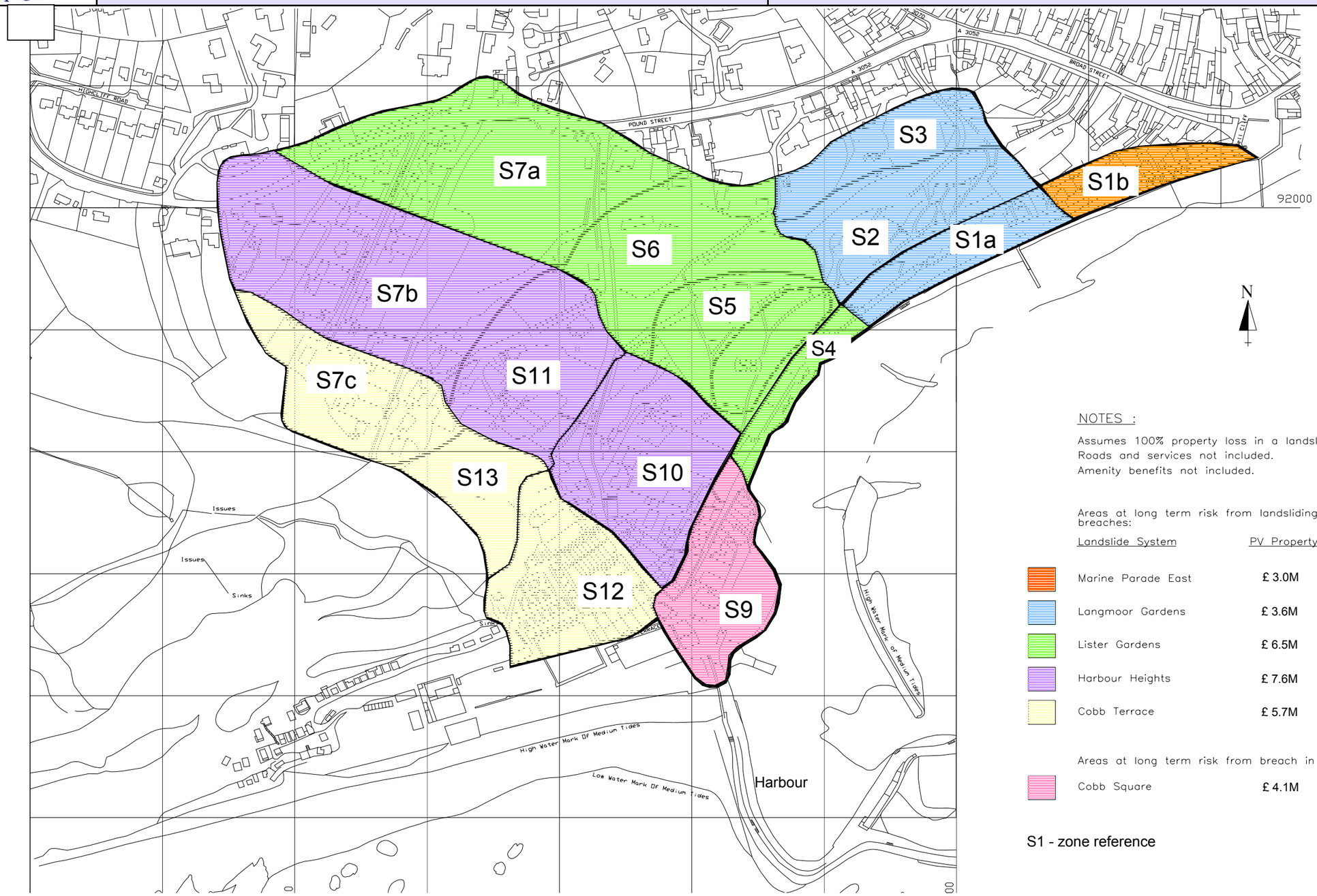
APPENDIX C1: PROPERTY BENEFIT LOCATION PLANS PHASES II & V



NOTES :

Assumes 100% property loss in a landslide event.
Roads and services not included.
Amenity benefits not included.

Areas at long term risk from landsliding/seawall breaches:

Landslide System	PV Property Benefit
Marine Parade East	£ 3.0M
Langmoor Gardens	£ 3.6M
Lister Gardens	£ 6.5M
Harbour Heights	£ 7.6M
Cobb Terrace	£ 5.7M

Areas at long term risk from breach in the Cobb:

Cobb Square	£ 4.1M

S1 - zone reference

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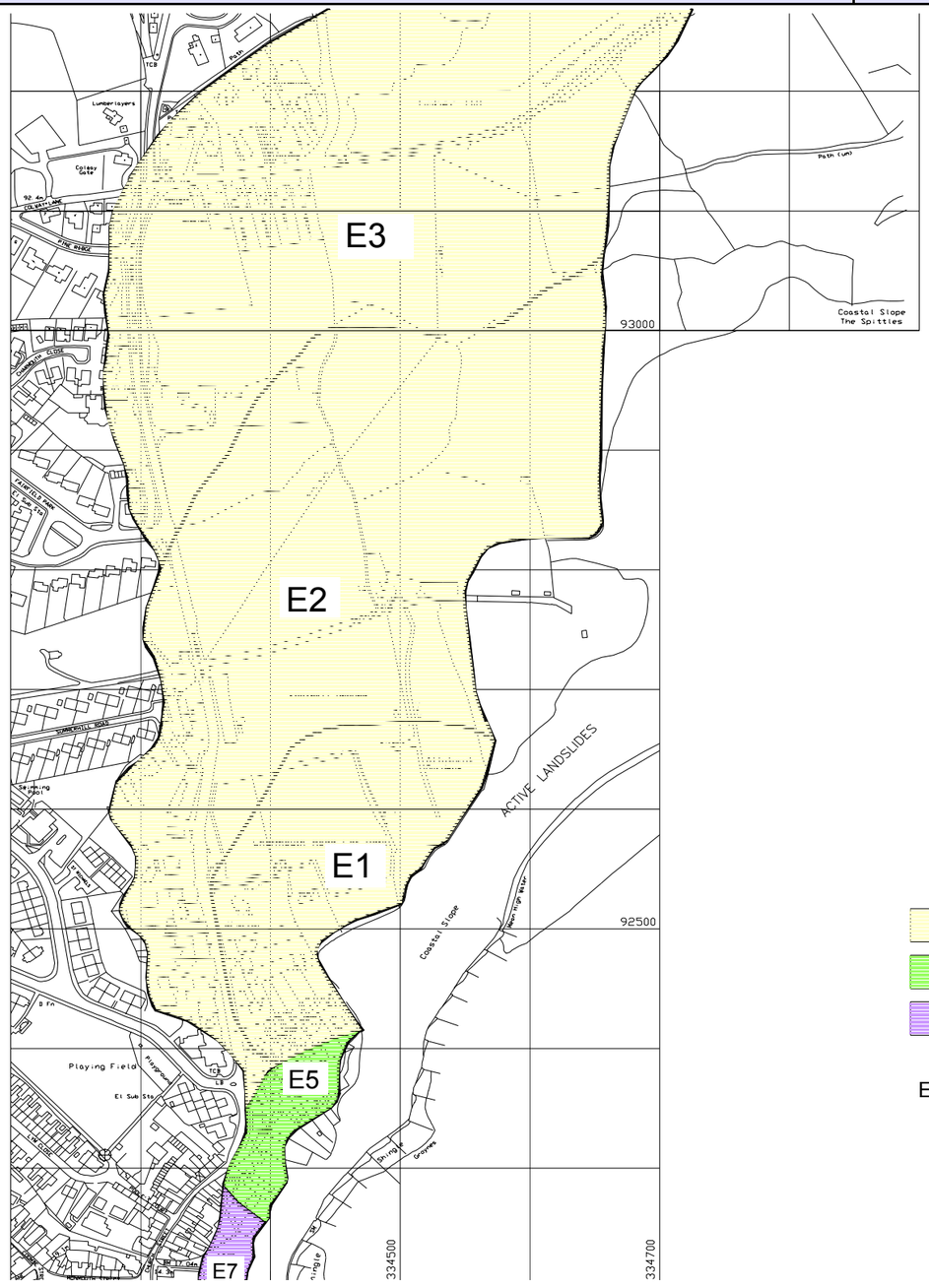
APPENDIX C2: PROPERTY BENEFIT LOCATION PLANS PHASE IV



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NOTES :

Assumes 100% property loss in a landslide event.
Roads and services not included.
Amenity benefits not included.

Areas at long term risk from landsliding/seawall breaches:

Landslide System	PV Property Benefit
East Cliff	£ 14.5M
Church Cliffs East	£ 1.7M
Church Cliffs West	£ 0.4M

E1 - zone reference

APPENDIX D1: PRESENT VALUE PROPERTY BENEFITS PHASE II

General

The tables in this appendix present the calculation of present value property benefits for the purposes of the benefit cost calculations.

Market Value of property

For Phases II and V, the market values of property are from valuation surveys carried out by a local estate agent (Martin Diplock property valuation survey, January 2002 and May 2003). For the residential properties, this was carried out by kerbside inspection backed up by actual comparable sales evidence. Commercial properties were valued on an investment basis by capitalising rental values, adopting current rent where known, and, if not known, an assessment of rental values based on estimated floor area. For non commercial properties where there is no evidence of market value, the estimated cost of capital replacement has been used. Assets such as beach huts and caravans are considered to be removable and have not been include in the tables. The value of the land on which they are located, however, has been included. Tenants interests such as the value of businesses have been excluded.

For Phase IV, the market values of property have been derived from a kerbside valuation survey carried out in 1998. These have been adjusted to take into account the average increase in local property prices since that time of 112%.

Probabilistic assessment of failure

For each zone of the study areas under consideration, a probability array is presented giving the probability of a particular disaster scenario taking pace in each year for the next 50 years. Each array has been derived using an event tree approach to calculate the chance of a sequence of events progressing from an initial trigger (such as a seawall failure) to progressive reactivation of successive parts of the landslide system. For each year, the probability of failure, P(S)n, is multiplied by the appropriate discount factor and the resulting products summed. This produces a factor which reduces the total market value of property within the zone to the discounted value. A description of the methodology is given in Preliminary Studies report 13/6 and full details of the calculations in Preliminary Studies reports 13/2, 13/3 and 13/4 (see References).

Adjustment of probability arrays

The probability series, representing the most likely 'do nothing' scenario for each property zone, were developed in 2000 using an 'event tree' approach and expert judgement. To update the probability series to 2003, a method has been adopted whereby the first two values in each series have been distributed over the remaining values in the series according to the following formula:

$$P_{an} = \left[\frac{(P_1 + P_2)}{1-(P_1 + P_2)} \times P_{n+2} \right] + P_{n+2}$$

where: P_n = probability at year n
P_{an} = adjusted probability at year n
P_1, P_2 = probability values at year 1 and 2 respectively

The adjusted probability series was then used to calculate the NPV's as shown in Appendices D1 to D10.

Timespan of Probability Arrays

The probability arrays have been calculated up to year 50 only. For most of the zones, the product of probabilities of failure and discount factor will have fallen to zero by this time (because the failure would have already taken place sometime in the preceding years). However, a few of the zones have a positive value of the product, albeit small a one, at year 50, which makes the method slightly conservative.

Discount Factor

A discount factor of 3.5% has been used for years 0 - 30 and 3.0% for years after year 30. The HM Treasury suggested rate of 2.5% for years beyond year 75 does not apply as this is beyond the design life of any of the proposed schemes.

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APPENDIX D3: PRESENT VALUE PROPERTY BENEFITS SUMMARY

Phase II

Zone	Description	MV £k	PVB £k	PVB/MV %
S1a	Bay Hotel area	2993	2535	85%
S1b	Marine Parade East	6660	4393	66%
S3	Alexandra Hotel area	3280	2699	82%
S4	Amusement Arcade	581	513	88%
S5	Gardens Area	176	156	88%
S6	Stile Lane area	2735	2365	86%
S7a	Sidmouth Road area	8647	6007	69%
S7b	Coram Avenue area	8139	5284	65%
S7c	Pine Walk	1940	568	29%
S10	Harbour Heights area	4628	3617	78%
S11	Shire End	2485	1909	77%
S12	Western Cobb Road	10815	7937	73%
TOTAL		**53078**	**37982**	

Phase IV

Zone	Description	MV £k	PVB £k	PVB/MV %
E1	Ferndown Road	3958	3120	79%
E2	Lower Charmouth Road	15351	11847	77%
E3	Timber Hill	8940	6461	72%
E5	East Cliff Lane	3388	2517	74%
E7	Church Cliffs	2671	842	32%
TOTAL		**34308**	**24788**	

Phase V

Zone	Description	MV £k	PVB £k	PVB/MV %
S9	Cobb Square area	7058	2512	36%
	The Harbour	7839	3856	49%
TOTAL		**14897**	**6368**	

APPENDIX F: SENSITIVITY ANALYSIS

Table Showing Effect of Varying Construction Costs on Benefit / Cost (B/C) Ratio

	B/C ratio assuming a 60% increase in construction costs
Phase II: Cobb Gate to Harbour	3.92
Phase IV: East Cliff	3.59
Phase V: The Cobb	3.73
Average B/C Ratio	3.74

1.0 Introduction

The precise mode, location and time of failure of the existing coastal defences at Lyme Regis, and the timescale and nature of subsequent deterioration under a 'do nothing' scenario is difficult enough to predict. Its effect on tourism and recreational activities is even more problematic. In the following analysis, therefore, a simplified scenario has been investigated to give some indicative, not definitive, ranges of likely amenity benefits that could be realised with the provision of a coastal defence scheme. There are an infinite number of variables that could be investigated, but for reasons of clarity these have been kept to a minimum, and sufficient only to provide a first order sensitivity analysis.

2.0 Estimate of visitor numbers

The first requirement in calculating amenity benefits is an estimate of annual visitor numbers, which forms the basis from which to consider likely losses without the provision of a future scheme. The figures available, specifically for Lyme Regis, are annual visitor numbers to the Tourist Information Centre (TIC) and a survey of users of the Cobb undertaken by WDDC between June and mid-September 1993.

The survey of Cobb users showed that at the peak of the holiday season, an average of 348 people per hour were walking out onto the Cobb. If this is translated to 7 hours per day and for 92 days (June, July and August) this predicts 224,112 visitors to the Cobb for the three months. If it is assumed that visitor numbers to the Cobb are a reflection of total visitor numbers to Lyme Regis, and that the factor is 2.0, then the total for June, July and August 1993 is 448,224.

To estimate the annual total, this figure for the three months in 1993 can be equated to TIC average visitor numbers for the same three months and this factor then used to scale up the figures to give a mean annual value. Using the TIC published data for the last four years, 98/99 to 01/02, this predicts approximately 0.9 million visitors per year, which for the sake of convenience could be rounded up to 1 million. This figure seems reasonable in the light of figures that have been published by the Dorset Tourism Data Project. For example, a built attraction such as Poole Pottery had 1 million visitors in 1996 and Moors Valley Country Park 673,873.

The question then remains as to how these annual visitor numbers are likely to be affected over time due to a deterioration in the coastal frontage under the ‘do nothing’ scenario. It could reasonably be expected that there would be a decline in the traditional ‘bucket and spade’ tourism. However, the Dorset and East Devon coast has been designated a ‘World Heritage Site’ for its geological interest and it is anticipated that the numbers of specialist visitors will increase

as a result; in particular during the out of season ‘shoulder’ months. It cannot be predicted at this time how this type of tourism is likely to develop, and for the purpose of calculating the amenity benefits it is assumed that the fall in the number of traditional visitors is balanced by a corresponding increase in the number of specialist visitors. A constant value of 1 million visitors per annum has thus been adopted for the benefit calculations.

3.0 Value of amenity assets

Research by the Flood Hazard Research Centre of Middlesex Polytechnic (‘The Economics of Coastal Management’ [The Yellow Manual], 1992, recently replaced by ‘The Benefits of Flood and Coastal Defence: Techniques and Data for 2003’ [The Multicoloured Manual]), has indicated that benefits, particularly the benefits of preventing the erosion of beaches, are likely to be among the most important benefits of coast protection, and in certain cases can be comparable to, or even higher than, those of protecting life and property. Among the other assets which are enjoyed for recreational use are promenades which, if a beach is lowered by erosion, can be threatened by undermining. At Lyme Regis the threat to both beach and promenade use is also threatened by landslipping.

There can be no doubt as to the importance of, and dependency on, the amenity benefits at Lyme Regis, both in terms of its economic revenue and employment. Furthermore, any losses that are sustained as a result of a 'do nothing' policy would be a loss to the national economy. Neighbouring resorts are already at capacity during the peak holiday season and it is doubtful if visitors displaced from Lyme Regis could be accommodated elsewhere in the immediate area.

There are a number of methods available for valuing recreational and amenity benefits that have no market price i.e. willingness to pay; willingness to accept; and enjoyment per visit. Such methods, however, rely on user surveys which assume that visitors can express a value of enjoyment or willingness to pay in money terms. Such surveys need to be conducted professionally and the results correctly interpreted if spurious and misleading conclusions are not to be reached. In the absence of survey data for Lyme Regis, some indicative values have thus been considered from sample user surveys presented in the Multicoloured Manual. A standard table of data on £ loss per adult visit with erosive changes at coastal sites has been compiled from a number of seafront user surveys, updated to 2001 (Table 8.3). From the 4 sites initially analysed in the Yellow Manual, where there was a deterioration in the beach and promenade, the mean £ loss for local, day and staying visitors equated to £5.36 per adult visit. For additional sites considered in the Multicoloured Manual, and one in particular (Herne Bay), where conditions are likely to be similar to that which would be experienced at Lyme Regis i.e. a deterioration in beach, seawall and promenade collapse in parts, a mean loss of £5.25 per adult per visit was predicted. If it is assumed for the present analysis that there will be no additional benefits of enhancement following sea defence works, then for the purpose of assessing the Net Present Value of a string of discounted annual amenity benefits, a value of £5 per head per adult visit would seem appropriate. In all likelihood this value could be higher for the special character of Lyme Regis and its international ‘World Heritage Site’ designation, and for a sensitivity analysis a value of £10 per head has also been included.

4.0 Net Present Value of Amenity Benefits

For this analysis, as described above, it has been assumed that total visitor numbers are 1 million per annum, and that £ loss per adult visit with erosive change is between £5 and £10 per head. For calculating the string of discounted benefits, with and without works, a scheme life of 50 years and an annual discount rate of 3.5% has been adopted. To look at the sensitivity of the net present value (NPV) with the time the string of discounted benefits might come into effect i.e. following the first failure of the seawall and continuing deterioration of the promenade and beach, times of failure have been varied from year 0 (failure now) to a failure in year 25.

The NPV of a string of discounted benefits is calculated using the following formula:

$$NPV = A \frac{(Ds - Dn+s)}{r}$$

where: A = present annual value
r = discount rate (3.5%)
Ds = Discount Factor at year benefit starts from base date
Ds+n = Discount Factor at year benefit ends from base date
(assume n = 50 year scheme life)

Applying this formula, the following table is obtained:

	Year of Loss / NPV (£M)							
£/head	0	2	4	6	8	10	15	25
5	117.28	109.48	102.2	95.41	89.06	83.14	70	49.63
10	234.56	218.96	204.4	190.82	178.12	166.28	140	99.26

The shows the considerable spread in NPV values that can be obtained, given the variation in year of loss and the £ value loss per adult visit i.e. from £50M at £5/head with a failure in year 25 to £235M at £10/head for a failure at the present time.

5.0 Conclusions

The foregoing investigation of likely amenity benefits has given a clear indication of the importance of recreation and tourism in the benefit cost analysis for a coastal defence scheme at Lyme Regis. Because of the many imponderables related to the likely effects of a 'do nothing' policy on visitor numbers, the values can be taken as indicative only. They do, however, give a potential range of values for a limited change in some of the more important variables i.e. year of failure of the seawall/promenade and the potential loss in the value of enjoyment for visitors.

The NPV of amenity benefits, even considering failure in 25 years for a value of £5/head, is around £50 million. This it is considered is a conservative lower estimate, and in all likelihood values would be in the much higher range. In particular, it would seem highly unlikely considering the ‘do nothing’ case that a major failure would not occur before year 25. The seawall is already showing signs of local distress in a number of areas and is currently being undermined during periods of beach drawdown.

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APPENDIX H: ESTIMATE OF SERVICE AND INFRASTRUCTURE BENEFITS FOR PHASE II

SHEET 1 OF 2

Assume 40m breach of seawalls and pavement, loosing all utilities, in winter, hence requiring double line sheetpiling temporary cofferdam to prevent further erosion effecting Marine Parade properties.

Marine Parade	**Quantity**	**Unit**	**Rate**	**Cost**	**Sub Totals**	**Details**
Mob/Demob Sheet pile equip	1	nr	70000	70,000		mob/demob twice @ £40000in, £30000 out
Supply temp sheet pile wall	160	t	250	40,000		50m lg x 10m wide, piles 7m lg @190kg/m = 160t @ £250/t inc buy back
Install temp sheet pile wall	160	t	350	56,000		160t @ £350/t
Walings	60	t	1100	66,000		60t say @£1100/t
Walings install	60	t	850	51,000		60t @ £850/t
					283,000	
Demolish existing concrete debris	1390	m3	25	34,750		40m lg, @ 8m highx 3.5m th+4.5m highx 1.5m th
Remove debris	1390	m3	10	13,900		
Excavate/Remove Breach material	3200	m3	12	38,400		40mx 8mx10m
					87,050	
Temporary diversion for Electricity	1	nr	30000	30,000		
Temporary diversion for Gas	1	nr	25000	25,000		
Temporary diversion for Water	1	nr	15000	15,000		
Temporary diversion Mob for Rising Main	1	nr	5000	5,000		
Temporary diversion for Rising Main pumps	26	wks	1250	32,500		2x6"pump, 1 on standby 6months @1100/wk +£150/wk
Temporary diversion for Rising Main hoses	26	wks	900	23,400		300mr hose @£3/m/wk
Temporary diversion for Drains	26	wks	585	15,210		2x4"pump, 1 on standby 6months @500/wk + £85/wk
	26	wks	200	5,200		100mr hose @£2/m/wk
					151,310	
Excavate footings for 2 walls	120	m3	6	720		exc 40x6x0.5rock
Remove mats.	120	m3	10	1,200		
Construct front wall: supply conc	270	m3	70	18,900		40x4.5x(2 - 1), 40x4.5x2 ms
place conc	270	m3	15	4,050		
	360	ms	40	14,400		
Construct rear wall; supply conc	960	m3	70	67,200		40x8x(4 - 2), 40x8x2ms
place conc	960	m3	15	14,400		
	640	ms	40	25,600		
Backfill to Marine Road level	3200	m3	30	96,000		Granular
					242,470	
Piling mob/demob	1	nr	20000	20,000		
Piling	34	nr	1850	62,900		600mm dia @2 6m c/c x 15m
Piling	34	nr	430	14,620		UC insert, 52kg/mr @ 15mlg @ £550/t
					97,520	
New Rising Main and Backfill	80	m3	16	1,280		Exc 40x1x2rock,
New Rising Main and Backfill	40	mr	32	1,280		supply and lay 300mm concrete pipe
New Rising Main and Backfill	60	m3	85	5,100		in conc
New Rising Main and Backfill	1	nr	15000	15,000		Chamber
Permanent diversion for Electricity	1	nr	25000	25,000		
Permanent diversion for Gas	1	nr	20000	20,000		
Permanent diversion for Water	1	nr	12500	12,500		
Permanent diversion for Drains	40	mr	55	2,200		150mm dia @1.5m depth, 2 manholes
					82,360	
Concrete Pavement: Supply	135	m3	70	9,450		40x10x0.3
Concrete Pavement: Place	135	m3	15	2,025		
Concrete Pavement: Mesh supply/fix	400	ms	10	4,000		
Handrailing	40	mr	115	4,600		
Street lighting	5	nr	2000	10,000		5 lamps + cabling
Facing Blocks to Walls	126	m3	750	94,500		40x9m high x0.35th in conc panel
					124,575	
Construction				**1,068,285**	**1,068,285**	
5% Allowance for 2002-2003 inflation				**53,414**		
On-Costs (35%)				**373,900**		
Profit/Ohds (10%)				**106,829**		
			sub total	**1,602,428**		
Contingency (25%)				**400,607**		
Total Estimate			**£**	**2,003,034**		***Prepared by High-Point Rendel May 2003***

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APPENDIX H: ESTIMATE OF SERVICE AND INFRASTRUCTURE BENEFITS FOR PHASE II

SHEET 2 OF 2

Assume 50m landslip of Cobb Road, losing pavement and all utilities, as well as up-slope landslip in winter. Landslip causes damage to next 30m of carriageway requiring removal of slip material, construction of piled retaining wall, reinstatement of granular fill and total pavement / utilities reinstatement. Works exclude any damage or refurbishment to properties.

Cobb Road	**Quantity**	**Unit**	**Rate**	**Cost**	**Sub Totals**	**Details**
Excavate/Profile Slip Material to stockpile	4300	m3	15	64,500		assume 50x10x4m dp +upslope of 50x20x1.5mdp + 30x15x1.5
Dispose of material	2500	m3	10	25,000		
Temporary Diversion : BT	1	nr		30000		
Temporary Diversion : Elec Cables	1	nr		20000		
Temporary Diversion : Water Supply	1	nr		15000		
Temporary Diversion : Sewers	26	wks	585	15,210		2x4"pump, 1 on standby 6months @500/wk + £85/wk
	26	wks	200	5,200		100mr hose @£2/m/wk
Temporary Diversion : Storm Water	26	wks	300	7,800		150mr hose @£2/m/wk
					182,710	
Piling mob/demob	1	nr	20000	20,000		
Piling	236	nr	700	165,200		50mr at 300mm dia @ 0.425m c/c x 10mlg @£70/m
Piling	236	nr	250	59,000		Reinforcement cage, allow 0.5t/pile= £250/pile
Excavate and Dispose arisings	500	m3	15	7,500		inc double handling mats using small plant
					251,700	
Capping Beam/Slab Supply Conc	125	m3	70	8,750		assume 55x3x0.75dp rc slab, 0.16t/mc rebar
Capping Beam/Slab Place Conc	125	m3	15	1,875		
Capping Beam/Slab Rebar	20	t	875	17,500		
Capping Beam/Slab Formwork	100	ms	50	5,000		
Retaining Wall : Supply Conc	110	m3	70	7,700		assume 55mx4x0.5mth, Rebar @0.16t/m3
Retaining Wall : Place Conc	110	m3	15	1,650		
Retaining Wall : Rebar	18	t	875	15,750		
Retaining Wall : Formwork	440	ms	60	26,400		
					84,625	
Place & Compact Excavated Suitable fill	1800	m3	7	12,600		return material from shore car park
Import, Place and Compact Granular Fill	2000	m3	35	70,000		500mm thick layers
Topsoiling	2000	ms	2	4,000		150mm layer to 2000ms
Permanent Diversion : BT				30,000		
Permanent Diversion : Elec Cables				20,000		
Permanent Diversion : Water Supply				15,000		
Permanent Diversion : Sewers				8,000		
Permanent Diversion : Storm Water				8,000		
					167,600	
Kerbing	80	mr	30	2,400		
Pavement :Type 1	336	m3	7	2,352		80x7x(2x0.15)dp @ £40/m3
Pavement :Roadbase	560	ms	25	14,000		80x7x0.15dp in two layers @ £25/ms
Pavement :Base Course	560	ms	12	6,720		60mm base course @ £12/ms
Pavement :Wearing Course	560	ms	10	5,600		40mm wearing course @ £10/ms
Footpaths :Type 1	24	m3	40	960		80x2m wide, 0.15 type 1 @£40/m3
Footpath :Base Course	160	ms	12	1,920		60mm base course @ £12/ms
Footpath :Wearing Course	160	ms	10	1,600		40mm wearing course @ £10/ms
Street lighting	8	nr	1000	8,000		8No posts@£1k each inc cabling, etc
					43,552	
Up-Slope Trench Drains Exc	200	mr	25	5,000		assume 10no drains @ 3m dp*20m lg*0.6 wide
Up-Slope Trench Drains Fill	720	m3	45	32,400		
Up-Slope Trench Drains Exc	70	mr	25	1,750		assume piped collector @ 3m dp*70m lg
Up-Slope Trench Drains Fill	135	m3	45	6,075		
Up-Slope Trench DrainsPipes	70	mr	20	1,400		
Up-Slope Soil Nails Drill/Grout	750	mr	40	30,000		60x25m area with soil nails at 1no(5m lg)/10m2
Up-Slope Soil Nails Rebar	150	nr	50	7,500		
Reinforced embankment	1800	ms	15	27,000		1800ms matting +
Down-slope Stabilisation Works				700,000		
					111,125	
Construction				**1,541,312**	**841,312**	
5% Allowance for 2002-2003 inflation				**77,066**		
On-Costs (35%)				**539,459**		
Profit/Ohds (10%)				**154,131**		
			sub total	**2,311,968**		
Contingency (25%)				**577,992**		
Total Estimate			**£**	**2,889,960**		***Prepared by High-Point Rendel May 2003***