URS

Southampton Coastal Flood and Erosion Risk Management Strategy

Main Document

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Prepared for:
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UNITED KINGDOM & IRELAND

REVISION SCHEDULE

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1 INTRODUCTION

1.1 Project Background

URS has been appointed by Southampton City Council to develop a long-term Coastal Flood and Erosion Risk Management Strategy (from here on known as 'The Strategy') for the City of Southampton. The 22km long study frontage spans from Woodmill at the tidal extent of the river Itchen around the main part of the City to Redbridge on the river Test (Figure 1-1).

Figure 1-1. Southampton Coastal Flood and Erosion Risk Management Strategy frontage.

Historically, large areas of the City have been reclaimed from the sea and the study area is comprised of varied, mainly urban land uses with a mixture of docks, industrial, commercial and residential development as well as important natural areas and historically significant assets. The frontage is dominated by marine and coastal industries, including a nationally significant port, which require access to the sea. The City has significant residential and commercial property and services, marinas, boat yards and wharfs, and critical infrastructure including railways, highways, electricity sub stations and wastewater treatment works.

Presently, there are no formal raised flood defences within the City of Southampton; however, quay and dock walls are present along a large proportion of Southampton frontage and these prevent the coastline eroding and currently offer some protection against tidal flooding. However, with sea levels expected to rise, the risk of tidal flooding will increase significantly in the future.

The primary aim of The Strategy is to develop a sustainable and robust coastal management strategy to implement the higher level Shoreline Management Plan policy of 'Hold the Line' over the coming Century. The Strategy will develop a route to deliver technically feasible, environmentally acceptable and economically viable solutions that ensure the protection of people and their property from coastal flooding and erosion within Southampton. The Strategy also needs to be compatible with the preferred management strategies of adjacent areas.

1.2 Purpose of this Document

This document presents 'The Strategy' and the preferred options for managing coastal flood and erosion risk within the study frontage for the next 100 years.

Specifically, this document includes:

- A summary of the background and context of the coastal strategy process;
- A summary of findings from the baseline studies and information on coastal processes;
- Development of a hypothetical 'Do Nothing' scenario which outlines the problem and forms the basis for economic analysis and comparison of identified management options;
- The specific objectives of The Strategy;
- The range of potential management options identified for assessment;
- Details of the options appraisal process and selection of the preferred options;
- Supporting economic and environmental assessments; and
- Presentation of the 'The Strategy' for public consultation; this includes detailed discussion of the preferred options, alignments and the required phasing of works;
- The implementation timeline for works including the priority works schedule; and
- The funding required to implement the preferred options.

This document should be viewed in conjunction with the Appendices which include:

Appendix A	Conceptual Understanding and Modelling Approach
Appendix B	Data Review and Model Calibration
Appendix C	Topographic Survey Report
Appendix D	Defence Condition Assessment
Appendix E	Desktop Contaminated Land Assessment
Appendix F	Strategic Environmental Assessment
Appendix G	Habitat Regulations Assessment
Appendix H	Water Framework Directive Assessment
Appendix I	Economic Assessment
Appendix J	Stakeholder Engagement

2 THE SOUTHAMPTON COASTAL FLOOD AND EROSION RISK MANAGEMENT STRATEGY

2.1 The Shoreline Management Planning Hierarchy

A coastal strategy forms an important part of the wider planning framework and it is important to consider the position of The Strategy in relation to other plans and programmes.

Shoreline Management Plans (SMPs) sit at the top of the hierarchy of plans for managing coastal flooding and erosion (Figure 2-1). A Shoreline Management Plan (SMP) is a high-level non-statutory planning document which provides a large-scale assessment of the risks associated with coastal processes and presents a long-term policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner. An SMP aims to manage risk by employing a range of methods which reflect both national and local priorities, to:

- Reduce the threat of coastal flooding and erosion to people and their property; and
- Benefit the environment, society and the economy as far as possible, in line with the Government's 'sustainable development principles '.

Coastal strategies sit at the next tier in the hierarchy and it is the role of strategies to identify the appropriate schemes to implement the SMP policies. The final element of work is undertaken at scheme level where different options are compared and a preferred option selected, designed and a business case developed to gain funding. On approval the detailed design of the scheme is let and the works carried out.

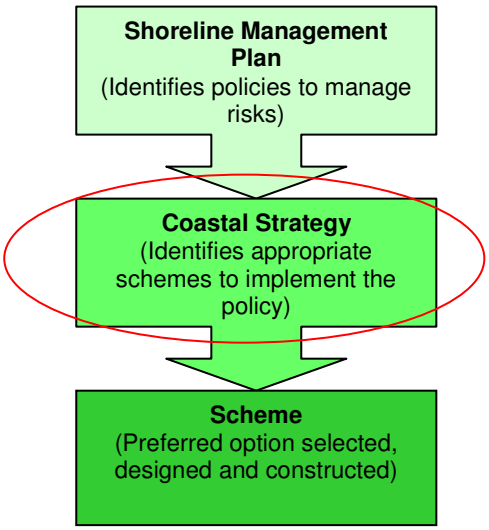


Figure 2-1. Hierarchy of coastal plans

2.2 The requirement for a strategic approach to managing risk

2.2.1 *Shoreline Management Plan for Southampton*

The Southampton Coastal Flood and Erosion Risk Management Strategy sits under the North Solent Shoreline Management Plan (New Forest District Council, 2011)[i] in the hierarchy. The publicly available final North Solent SMP (NFDC, 2011) has been used for the purposes of informing the development of the Southampton Coastal Flood and Erosion Risk Management Strategy. This SMP is the first review of the original SMP completed in 1998.

The North Solent SMP (NFDC, 2010) denotes the main Southampton City area as Policy Unit 5c12, however the relatively short section to the north of the bridges at Redbridge up to The Strategy boundary falls within Policy Unit 5c13 (Figure 2-2).

The preferred policy for the main City frontage (Policy Unit 5c12) is “Hold the Line” from the present day through to 2105. The preferred policy for the Test area around Redbridge (Policy Unit 5c13) is “No Active Intervention” from the present day until 2105.

Figure 2-2. North Solent SMP Policy Units relevant to The Strategy.

It is the role of The Strategy to review the high level coastal management policies recommended by the SMP for the study area and to develop options to facilitate the appropriate and sustainable coastal management of the frontage. In addition, The Strategy should identify the funding required for implementation and then make the business case to secure the required eligible public funding. Following adoption of The Strategy, detailed

[i] North Solent Shoreline Management Plan (New Forest District Council, 2010). Available from: http://www.northsolentsmp.co.uk/

scheme studies will be undertaken to implement the specific works required to carry out The Strategy recommendations.

2.2.2 *Current Management Practices*

It is known from previous strategic level assessments of the frontage that most of the existing defences have been constructed on an 'ad-hoc' basis, are in private ownership and the standard of protection provided by these defences varies greatly.

As part of this study, a defence condition assessment for the frontage was undertaken and the findings are briefly summarised in Section 5 and presented in full in Appendix D. The assessment shows that generally the frontage does not benefit from raised flood defences (e.g. flood walls). The defence structures present are generally in the form of quay and dock walls and prevent erosion of the coastline. These structures also provide some protection against flooding; the flood protection offered by the defences along the River Test is higher than the Itchen frontage where the defences are generally lower.

Currently, there is no specific budget allocated to maintaining defences across the city, and repairs are undertaken on a reactive basis. If defence structures were unmaintained in the future, failure would lead to the onset of slow erosion and an increased risk of tidal inundation.

Without undertaking The Strategy, flood and erosion risk management in Southampton would more than likely continue on a reactive basis rather than through scheduled maintenance or planned interventions. This would also lead to the risks not being managed cost effectively (a poor use of public and private funding) and could potentially lead to environmental degradation and loss of habitat. This in turn would mean increased flood and erosion risk over time, resulting in considerably more residents and properties in Southampton being at high tidal flood risk. Without a strategy, increased tidal flood risk could result in social and economic blight in parts of the city and severely constrain regeneration in the city centre. This demonstrates the benefits of a strategic study for Southampton to determine how the risk of erosion and tidal flooding should be managed, both now and in the future.

> *… A strategic approach is relevant to many aspects of the provision and management of flood and coastal defences. … Strategic planning is essentially a thought process and it is not possible to be prescriptive. Although not all flood and coastal defence problems will benefit from a strategic solution, application of these principles should be seen as part of a structured approach to flood and coastal management which facilitates the planning and management of future works …*
>
> All situations and locations are, to some extent, unique and may not be amenable to standard approaches. Where the study coastline is complex, in terms of coastal processes, natural assets, and the human and built environment, the framework on which coastal defence decision-making is based becomes complicated. In certain cases, strategic issues may be addressed adequately by appraisal of a single scheme; or may require several schemes, which require consideration of the cumulative impacts as few defence schemes along a coast can be regarded as truly 'stand alone'. Other cases may require a staged or adaptive approach to managing the coastline.

For the Southampton City frontage the Coastal Flood and Erosion Risk Management Strategy is **specifically required to**:

- address the potential future impacts of climate change on the local coastline;
- develop a sustainable method of managing and maintaining the largely urbanised frontage, whilst implementing the policy outlined in the Shoreline Management Plan and facilitating the City vision;
- assess the status of current defences and identify areas where works are required to maintain the functionality of the defences;
- propose and appraise options for coastal defence works;
- account for appropriate European and National environmental legislation.
- enable informed decisions on future infrastructure spending
- enable environmental and social considerations to be balanced against an economic appraisal where interventions are optimised in relation to time and scale.
- provide a robust route to secure funding from third parties (key landowners and developers) rather than rely solely on the public funds.

2.2.3 *Strategy Objectives*

With these requirements in mind, the following specific Strategy objectives were developed and agreed by the Client Steering Group and Key Stakeholders. The development of The Strategy objectives is covered in more detail in Section 7.1.

The **Strategy objectives** are to:

- provide appropriate sustainable coastal management mechanisms to manage coastal erosion and flooding of properties and the land around them;
- use sympathetic and robust solutions which wherever possible use existing defence corridors or features and are complimentary with the 'City Vision'
- increase the potential for recreation and tourism; without compromising or where possible, enhancing the natural environment, especially the environmentally significant area of the Test Valley;
- provide a blueprint for future monitoring and programming of maintenance works;
- increase the understanding of the shoreline and to focus consultations in a strategic manner; and
- consolidate and build upon information gathered within higher level plans to present a sustainable and holistic coastal management Strategy which dovetails with other relevant plans and programmes to deliver synergistic benefits to the City.

2.3 Overview of The Strategy Development Process

A Strategy should review the outcomes of the Shoreline Management Plan and investigate the application of the preferred Shoreline Management Plan policy at a local scale, over a 100 year timeframe. Crucially, a Strategy should identify areas where:

1. The policy is incompatible with the current management regime; and
2. Intervention is required to meet the objectives of the policy over the 100 years of The Strategy.

In both instances it is the role of The Strategy to assess a range of potential options for implementing the Shoreline Management Plan policy, in order to determine that an effective solution is both technically and economically feasible. The Strategy also needs to ensure that the preferred option meets the requirements of appropriate environmental legislation.

The Strategy should present the options investigated and should identify which options are most viable. The Strategy should also prioritise schemes if a number of schemes are required to meet the objectives of the Shoreline Management Plan policy.

The Local Authority (Southampton City Council in this instance) is then required to produce The Strategy Appraisal Report (StAR) to gain approval. The StAR should confirm that the proposed Strategy meets the thresholds for technical, economic, and environmental criteria.

Throughout the process, effective stakeholder engagement and liaison is required to ensure that those who may affect, or are influenced by the outcomes of The Strategy, shape and support the Plan. The consultation process is set out in a Stakeholder Engagement Strategy to ensure feedback is obtained from Key stakeholders throughout the process to facilitate a successful Strategy (see Appendix J - Stakeholder Engagement).

The key steps undertaken in the development of The Southampton Coastal Flood and Erosion Risk Management Strategy are summarised in Figure 2-4 and discussed in more detail in Sections 2.3.1 to 2.3.7.

2.3.1 *Data Collection and Review*

The initial stage in developing The Strategy involved the collection and review of a wide range of data from various data sources in order to gain a detailed appreciation and understanding of the study area and develop the baseline. For more detailed summary of data sources used see Section 3.

2.3.2 *Establish the baseline*

In order to develop 'The Strategy', it is imperative to understand the present situation, and then define a baseline against which management options can be compared. In order to achieve this, a hypothetical 'Do- Nothing' baseline situation was developed and the tidal flood modelling for this situation carried out.

The definition of a 'Do Nothing' scenario over the 100 Year Strategy assessment period enabled the calculation of the assets that are either are at risk or would be lost given this hypothetic walk-away scenario. Politically this is often seen as a non-viable option, especially for a large urban area such as Southampton, but it is an important comparison tool in benefit:cost analysis and is the option against which all other 'do-something' options are tested.

2.3.3 *Objective setting*

In addition to the requirement of The Strategy to review and facilitate the Shoreline Management Plan policy of 'hold the line' for almost the entire frontage, specific objectives and aspirations for The Strategy were developed and agreed in consultation with key stakeholders.

The objectives and aspirations then formed an integral consideration in the identification and development of strategy options.

2.3.4 *Option Development*

Development of options follows a multi-staged systematic process. Initially a wide range of possible options were identified (termed the long list options). These options were then conceptually appraised to screen out 'non viable' options. This process was informed by the supporting technical and environmental studies, site visits and key stakeholder liaison. A 'short list' of potentially viable options was then developed for detailed technical, environmental and economic appraisal.

Throughout this process, effective communication and engagement with key stakeholders was paramount to ensure local knowledge, needs, constraints and aspirations were adequately considered when developing feasible options, and exploring potential funding sources.

2.3.5 *Option Appraisal*

The short list of options then required detailed appraisal on a number of key issues. Firstly, the options were appraised to ensure technically feasibility. Economic viability was also tested to demonstrate feasibility in relation to the baseline; however this did not necessarily justify selection of one option over another. Environmental appraisal of the options assessing the environmental impacts of the proposed options was also undertaken to ensure any impacts were acceptable. Following the detailed assessments and testing, the draft preferred options, alignments and phasing were recommended and The Strategy drafted.

2.3.6 *The Draft Strategy and Confirmation of the Preferred Options*

Following the detailed appraisals and development of the draft preferred options, 'The Strategy' was issued for public consultation. A three month consultation period was held providing all stakeholders and the public the opportunity to review The Strategy recommendations and provide feedback (Figure 2-3).

All Stakeholder feedback and comments received were collated in a database and were addressed and incorporated during the confirmation of the preferred options and a revision of the final Strategy. For full details of the Stakeholder engagement activities and the feedback received see Appendix J (Stakeholder Engagement).

Figure 2-3. One of the public exhibitions held during the consultation period for The Strategy.

2.3.7 *Strategy Approval*

All coastal strategies are now considered and approved by the Environment Agency's Large Project Review Group (LPRG).

A coastal strategy submission requires the completion of a Strategy Appraisal Report (StAR) along with other documentation generated in support of The Strategy. The StAR format provides a consistent reporting format for the Large Project Review Group to appraise, and prescribes the level of detail required. The StAR is supported by The Strategy and technical appendices.

Following public consultation and completion of the final revision of The Strategy, the StAR document was produced with The Strategy for submission to the Large Project Review Group for consideration and approval.

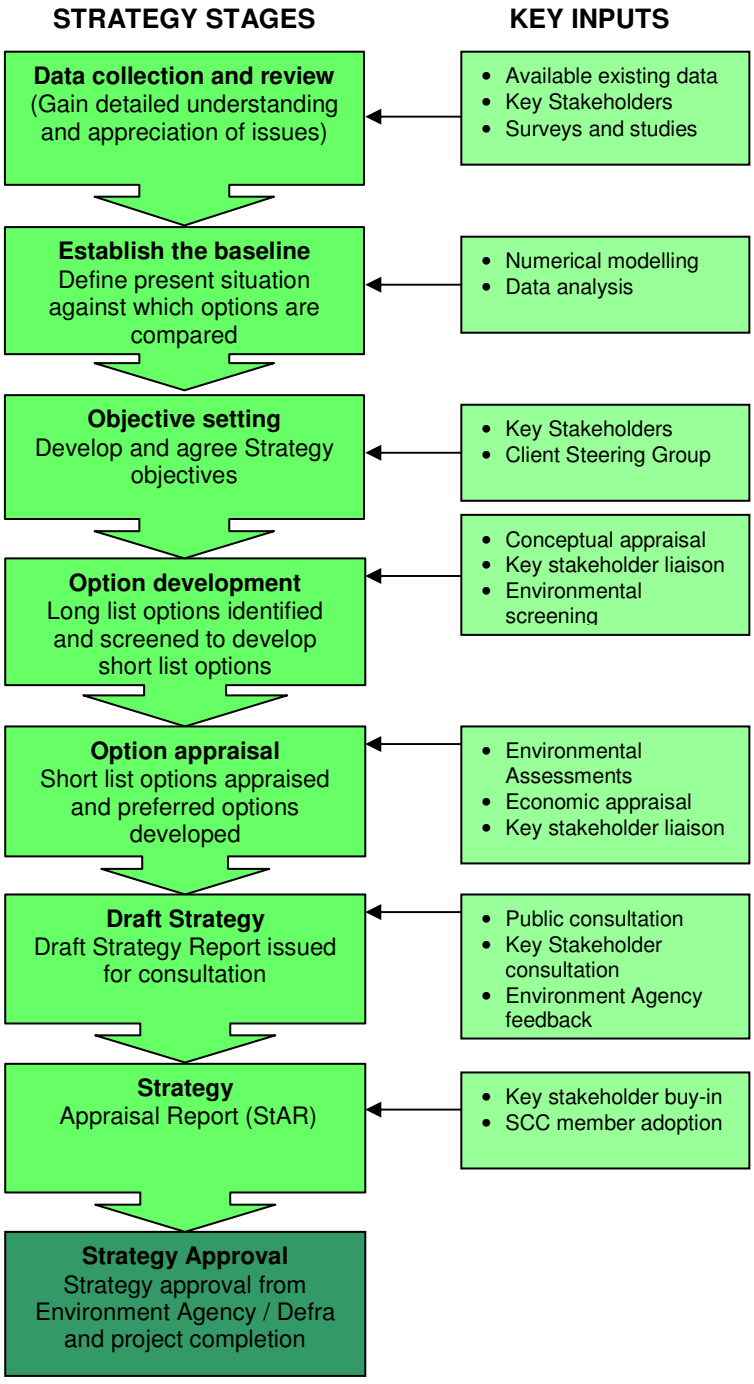


Figure 2-4. Overview of The Strategy development process.

3 KEY DATA SOURCES

The initial stage of the Southampton Coastal Flood and Erosion Risk Management Strategy was to collect a wide range of data types from various data sources in order to inform the conceptual understanding of the site and undertake the required detailed studies. Survey reports with full details and findings of the studies undertaken are provided within the Appendices to this report; however this section summarises some of the key data collected as part of the study.

3.1 Survey and Monitoring Data

3.1.1 *Topographic Data*

URS undertook a topographical survey to verify the ground levels derived from the 2007 LiDAR data provided by Southampton City Council (Figure 3-1).

Areas topographically surveyed included potential flood flow paths, accessible parts of the frontage, and redevelopment sites across the City. Surveys were undertaken at St Denys, Northam, the City Centre, the Docks and Redbridge between the 5th and 11th January 2011.

This survey data showed that the LiDAR levels were, on average, accurate to within +/- 3cm, thus providing a high degree confidence in the topographical representation of the floodplain used in the flood modelling.

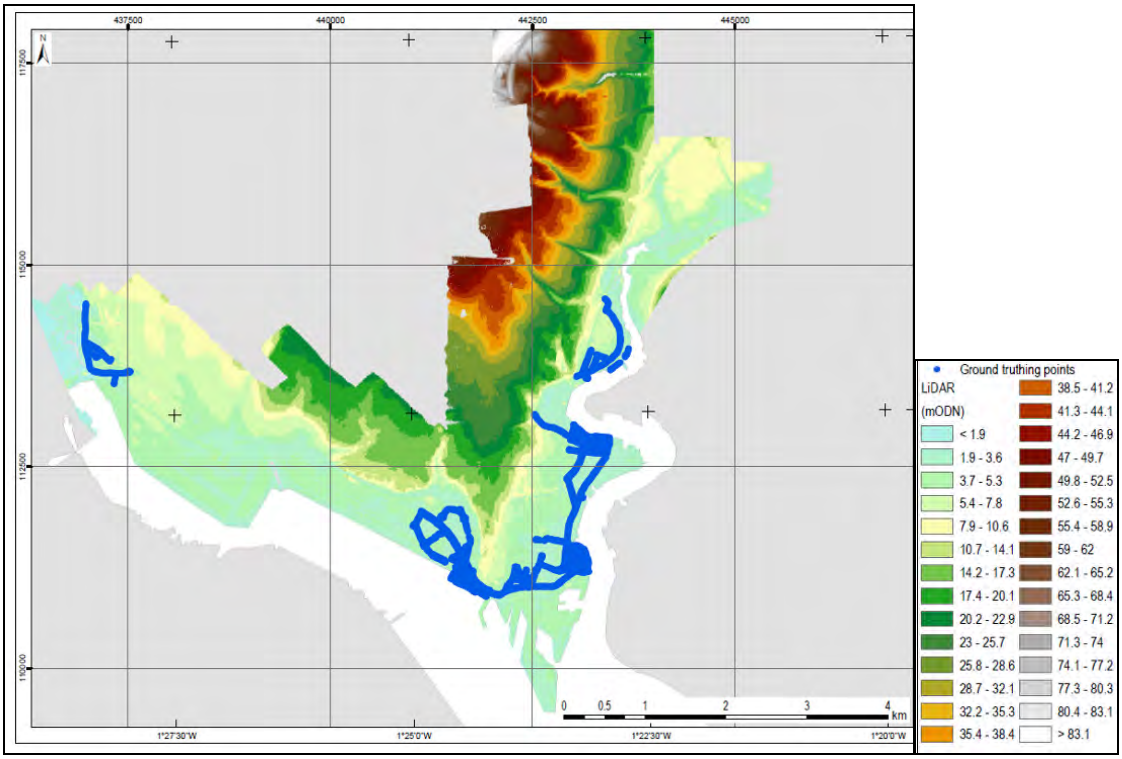


Figure 3-1. Topographic data used including LiDAR and topographic survey data.

3.1.2 *Bathymetric Data*

ABPmer hold detailed bathymetric data covering much of the Southampton Water area, however further bathymetry data was required upstream of Redbridge to create a complete Digital Terrain Model of the study area. ABPmer undertook a bathymetric survey on the 28th September 2010 covering the main channels of the River Test and upstream of Redbridge.

3.1.3 *Ordnance Survey Mapping*

Ordnance Survey Mapping for the present day (2010) was supplied under licence by Southampton City Council for use in the study. This was applied to define property boundaries, place names and key infrastructure to be identified and considered with the option development.

3.1.4 *Aerial Imagery*

Publically available aerial imagery from 2008 covering the majority of The Strategy area was obtained from the Channel Coastal Observatory. In addition City Wide aerial imagery was commissioned by Southampton City Council in 2011 and was made available for use in this study.

The imagery provided a detailed background to the GIS mapping of the area, allowing stakeholders and specialist alike to quickly interpret the ground conditions and potential flood pathways. This imagery was used extensively as part of the option development process.

3.2 Coastal Processes

3.2.1 *Water Levels*

Although water level data was available from the Dock Head tide gauge, supplementary data was required to ensure a high level of model calibration could be achieved in the upper reaches of the study area. ABPmer carried out a specific hydrographic survey programme from September to December 2010 to provide calibration data for the hydrodynamic model. Instruments were set up to record water levels at 10 minute intervals over four weeks at six different locations along the study frontage; these were Itchen Bridge, Northam Bridge, Cobden Bridge, Woodmill, Berth 207 and Redbridge. Full details of the water level survey and data collected are given in Appendix B.

3.2.2 *Wave Data*

The influence of waves on the Southampton frontage is limited due to the relatively sheltered estuarine environment and limited fetches; therefore waves were not considered a significant factor in this study and no wave data was collected. However, to account for the potential for small waves and uncertainties, a freeboard allowance of 300mm is included in the design of defence options (See Section 9.2.3).

3.3 Bore Hole Records

Borehole records for the Southampton area were obtained from the British Geological Survey website. Records were downloaded for the following boreholes:

- SU41NW454
- SU41NW466

- SU41NW467
- SU41SW162
- SU41SW167
- SU41SW168
- SU41SW159
- SU41SW164
- SU41SW900
- SU41SW16X

Borehole records provided strata descriptions for up to 30m in depth in the areas around the Itchen and Upper Itchen.

3.4 River flow data

Freshwater discharge from the three main rivers flowing into Southampton Water are recorded by the Environment Agency and stored within the National River Flow Archive database[ii] at a number of gauging stations within the UK.

The three stations which are closest to the tidal limit are on the River Test at Broadlands (Station Number 151816001), River Itchen at Woodmill (Station Number 152208001) and on the River Hamble at Frogmill (Station Number 152502001).

The daily gauged flow data recorded during the survey period (September to November, 2010) was downloaded and used to determine the input flow conditions for the hydrodynamic model. Full details of the river flow data are given in Appendix B.

3.5 Contaminated Land

A Desktop Contamination Land Assessment was undertaken by URS. A review and synthesis of contaminated land records held by Southampton City Council was undertaken and the assessment focused on the identification of significant historic contamination issues and the locations of any potential key contaminants.

The Contaminated Land Assessment Report (Appendix E) summarises the findings from the available land quality records for The Strategy area and identifies the potential contamination areas (Figure 3-2) to feed into the baseline understanding.

[ii] http://www.ceh.ac.uk/data/nrfa/data/search.html

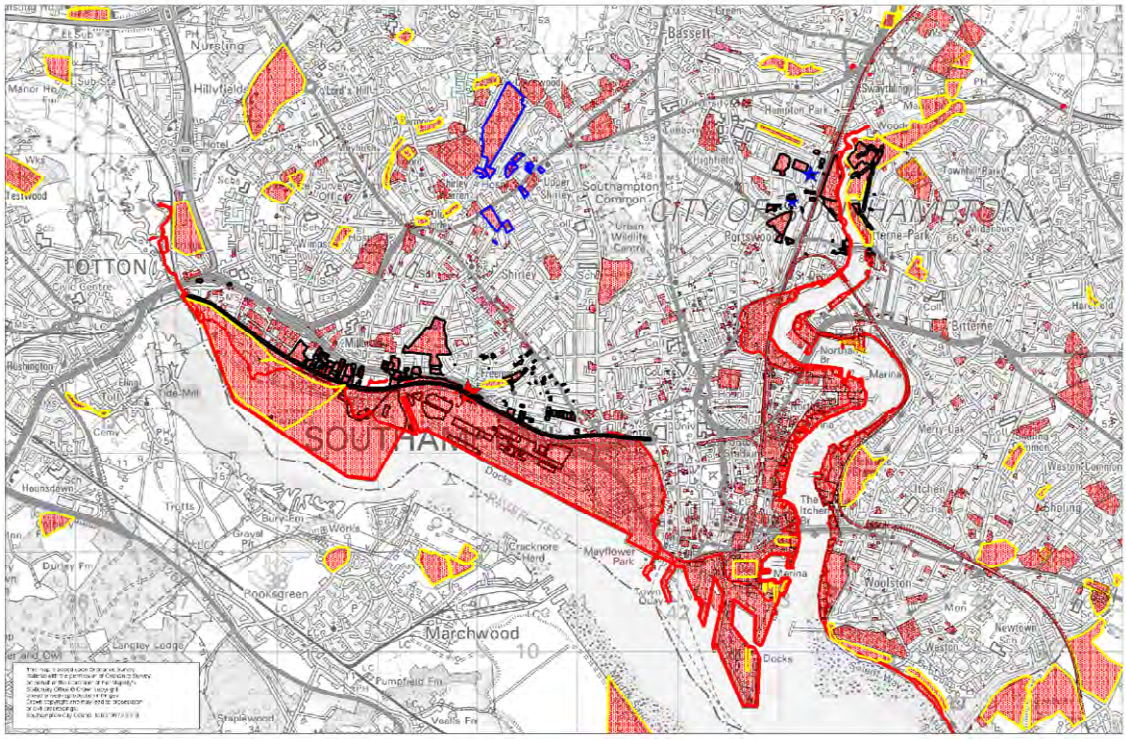


Figure 3-2. Map showing where potentially contaminating land uses have once existed for the City of Southampton (obtained from historical mapping) Source: Southampton City Council, 2011.

3.6 Property data

An important part of developing The Strategy was to identify and categorise individual properties within the flood plain. Southampton City Council provided an address point dataset which included the property address, post code, type (e.g. Residential – Detached, Commercial - Office) and property coordinates for all residential and commercial assets within the Southampton City Council area. Flood depths for each individual property were obtained by conducting point inspections using the property location and the flood modelling for each water level modelled.

House sale data over the past 5 years was obtained from the Land Registry. The data was averaged by post code region for each property type (detached, semi, terrace, bungalow and flat) and then applied to each property in the flood plain. Commercial properties were valued on a square metre rate dependant on their use category. The area of commercial properties was taken by matching the address point database with OS Mastermap. Some commercial properties were significant enough that they required individual valuation based on construction costs of similar properties or developments. The rateable value for a range of commercial property types and locations was obtained from the UK Valuation Office to consider potential flood write-off losses.

3.7 Socio-economic data

The 2007 Comprehensive Spending Review 2007 set out a series of Outcome Measures to measure progress towards flood and coastal risk management targets. Outcome Measure 3 considers the number of households in the 20% most deprived areas moved out of the

significant or very significant flood risk probability category. To determine properties falling into this category 'Super Output Areas and Deprivation' datasets were obtained from the Office of National Statistics in the Department for Communities and Local Government (DCLG). The 'Indices of Deprivation 2010 for Super Output Areas (2010)'[iii] were extracted for each property in the flood plain and applied in the economic appraisal of The Strategy options.

3.8 Other Key Plans and Programmes

In addition to the North Solent Shoreline Management Plan (See Section 2.2.1), a number of other key plans and programmes were identified as being relevant for consideration in the development of The Strategy. These plans include flood risk management documents and spatial planning documents and cover a range of strategic issues with the findings and recommendations of each contributing to shaping the future vision for Southampton City. The following key documents, which have either been published, or are currently being developed, have been reviewed and the outcomes have fed into the development of The Strategy:

- River Itchen to Hamble Coastal Technical Study
- Southampton Level 2 Strategic Flood Risk Assessment (SFRA2);
- Partnership for Urban South Hampshire (PUSH) SFRA;
- Making Space for Water;
- South East Plan;
- Test and Itchen Catchment Flood Risk Management Plan;
- Southampton Surface Water Management Plan;
- Masterplan for Southampton City Centre;
- Southampton ABP Port Masterplan;
- Royal Pier Development; and
- Hampshire Minerals and Waste Plan.

The recommendations of these documents have influenced, and/or will be influenced by, The Strategy. An integral and important part of The Strategy development has been the ongoing liaison and dialogue with the authors and key stakeholders of these relevant plans to ensure that The Strategy is complimentary with their recommendations and, where possible, capitalises on opportunities to support them in facilitating the overall City vision and aims.

Associated British Ports (ABP) own a significant proportion of The Strategy frontage and consequently consultation with the Port has been an essential part of developing The Strategy (See Section 9.1.4).

Also, the City Masterplanners and Royal Pier Masterplanners have been closely involved and engaged with The Strategy development process to ensure development plans and opportunities are captured, incorporated and supported by The Strategy to deliver synergistic benefits to the City.

[iii] http://www.imd.communities.gov.uk/

4 COASTAL PROCESSES

Understanding the coastal processes occurring in an area is crucial to establishing the baseline of any coastal management strategy. This section provides a brief summary of the coastal processes occurring along the Southampton frontage and in adjacent areas. This information was obtained from previous work undertaken on the Southampton frontage and was supplemented with survey data obtained specifically for this study.

4.1 Water Levels

4.1.1 *Tidal Regime*

The tidal regime for Southampton Water is unique (Figure 4-1), with a double high water and a young flood stand (this is where the water level slowly increases for up to 2 hours during the early to mid part of the flood tide phase).

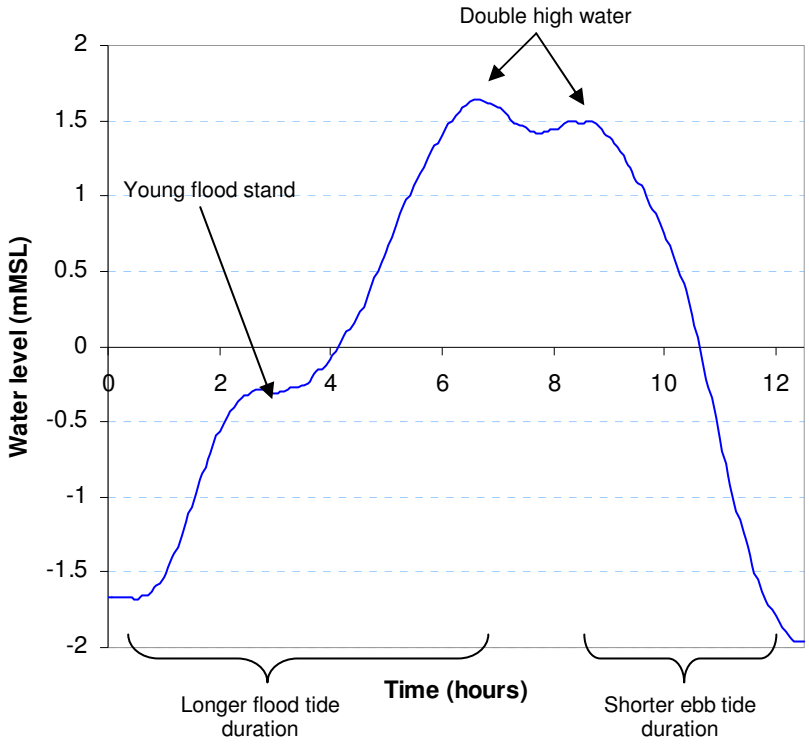


Figure 4-1. Graphical representation of the typical tidal characteristics in Southampton.

There is a strong asymmetry in tidal movement in and out of the estuary and the ebb tide phase typically takes less than 5 hours and the flood takes nearly 8 hours; hence Southampton Water is an ebb dominated system. This means that stronger tidal currents occur on the ebb tide compared to the flood.

Three main rivers, the Test, Itchen and Hamble, flow into Southampton Water; all of these have an influence on tidal propagation around the Southampton City area.

4.1.2 *Storm surges and extreme water levels*

In addition to the regular tides caused by astronomical forcing, water level variations can occur due to a combination of a number of climatic factors. Changes in air pressure and strong winds can combine to produce water levels different to those predicted by tidal forcings; these variations are known as 'Storm Surges'.

Combinations of 'Storm Surge' and high tidal levels can cause extreme water levels (Figure 4-2). The magnitude of extreme water level events is described by a 'Return Period'. Return Periods relate the annual probability of occurrence to a frequency; e.g. 1 in 100 years, the level which will occur, on average, once per one hundred years. It should be noted that the definition 'Storm Surge' is often interpreted as having a sudden occurrence; however 'Storm Surges' generally exhibit a progressive increase to their peak level over several hours, and then a steady decrease after the peak.

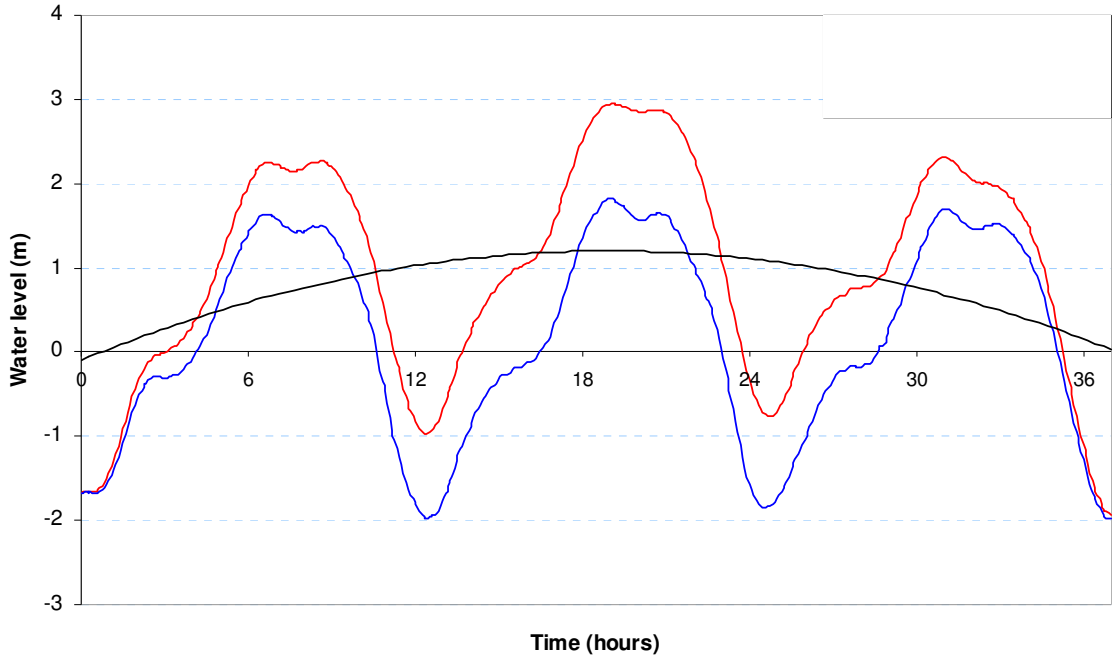


Figure 4-2. Graphical representation of how a 'storm surge' combines with tide levels to cause an extreme water level at Southampton.

Storm surges in the Solent have been the subject of much study and research. The most significant surges typically result from deep atmospheric depressions and strong winds that generally occur in the winter months. Investigations revealed that the highest surge events generally occur at low water, therefore the more extreme water levels in Southampton are likely to result from moderate surge events in association with High Water (Figure 4-2).

The predicted water level can be increased or decreased depending on interaction of the Storm Surge and the tidal level at any given instance or location. At Southampton the 1 in 50 year Storm Surge component can contribute up to 1m of observed extreme water levels.

4.2 Climate change and sea level rise

As a consequence of climatic changes and continued warming of the global oceans, sea levels are expected to increase over the coming century. The baseline Strategy studies and draft

Strategy options were developed in accordance with the relevant Defra 2006 guidance at the time. However, in September 2011 the Environment Agency issued updated sea level rise and climate change adaptation guidance for FCERM[iv] (from here on referred to as "EA 2011"). In accordance with advice, and in agreement with the Environment Agency, a review of the impacts of the updated guidance on the draft Strategy was undertaken and the EA 2011 sea level rise and storm surge change allowances were adopted in The Strategy.

This EA 2011 guidance includes updated sea level rise allowances based on the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report. A range of scenarios are provided including; lower end estimates, a central change factor, an upper end estimate and an H++ scenario. The allowances are presented as central estimates of change for each emissions scenario with upper and lower confidence bounds. The range of projections set the context of future uncertainty and this was appropriately considered in the development of Strategy options.

The EA 2011 sea level rise and storm surge projections were downloaded from the user interface[v] for Southampton; these are provided as change values relative to 1990 and for any year upto 2100. In accordance with the EA 2011 guidance, values beyond this time period have been extrapolated. Table 4-1 gives the future range of relative sea level rise for Southampton under different climate change scenarios, and is shown graphically in Figure 4-3. Based on the EA 2011 guidance the upper confidence bound (95 percentile) medium emissions scenario has been adopted as the 'change factor'.

Table 4-1. Cumulative relative sea level rise changes under different UKCP09 climate change scenarios.

Scenario (total sea level rise in cm)	2015	2030	2060	2110
UKCP 09 Medium (95%tile) – Change Factor*	**2.6**	**11.1**	**31**	**72.6**
Lower end estimate (UKCP09 low emissions 50%tile)	1.4	5.8	16	37.4
UKCP09 Upper end estimate	2	9.5	34.5	101.5
H++ Scenario	3	15	64	211

*Changes to relative mean sea level adopted in The Strategy.

[iv] EA 2011, Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities
[v] http://ukclimateprojections-ui.defra.gov.uk

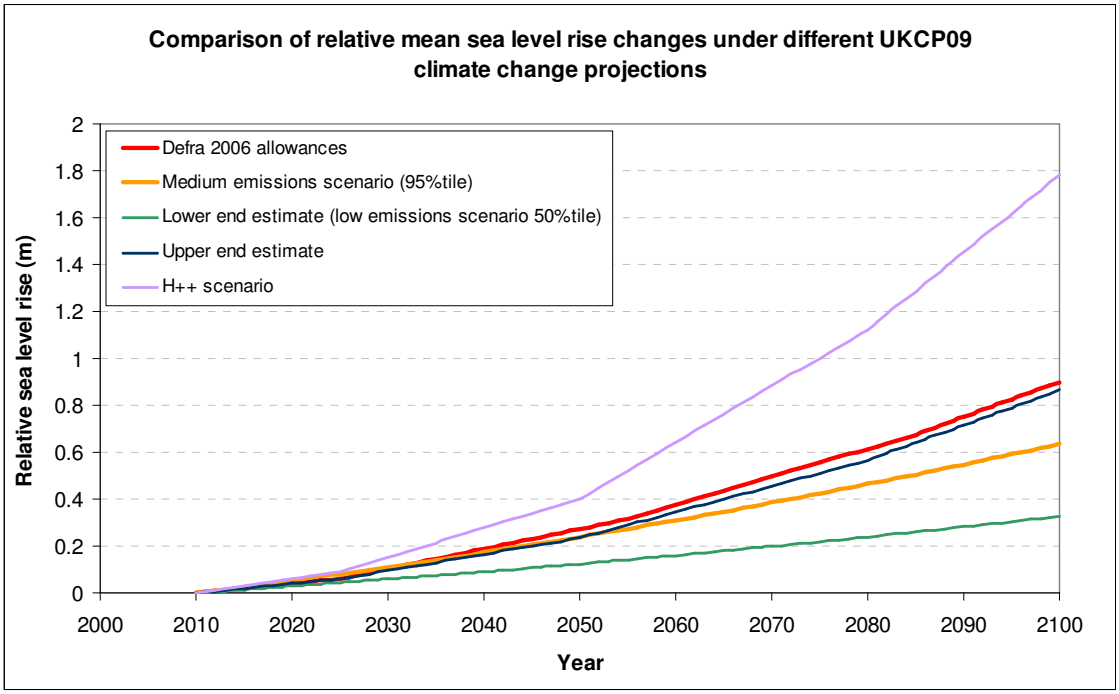


Figure 4-3. Comparison of range of UKCP09 estimates (EA 2011 guidance) against the Defra 2006 allowances for Southampton

4.2.1

4.2.2 *Future Extreme water levels*

As described in Section 4.1.2, extreme water levels occur as a resultant combination of Mean Sea Level, astronomical tide levels and the non tidal components (such as storm surge). For The Strategy, extreme water levels have been determined at Dock Head (Southampton) using 75 years of measured water level data. The extreme water levels estimated are based on a long term record of measured total absolute water levels, and therefore include the non tidal surge component.

As a result of potential future sea level rise, extreme water levels are predicted to increase. In addition, EA 2011 provides advice and change factors for potential increases in storm surge. The changes in relative mean sea level, as well as the changes in the storm surge component have been added to the present day extreme water levels to predict future extreme water levels (See Appendix A – Addendum). An example of how storm surge allowance and changes in mean sea level combine to estimate how the 1:200 year extreme water level increases over time is shown in Figure 4-4.

The extreme water levels (accounting for relative sea level rise and storm surge increase allowances) were calculated for the present day (2010) and for 2030, 2060 and 2110, and were agreed by the Environment Agency for use in the study. A summary of the extreme water levels used to develop The Strategy are presented in Table 4-2.

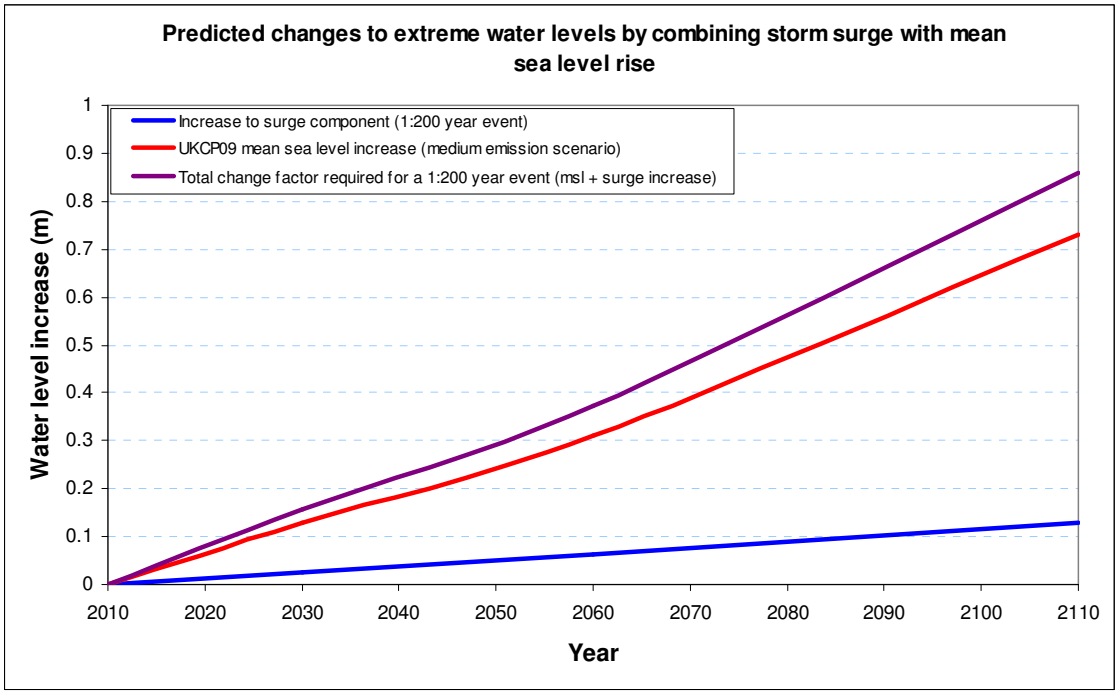


Figure 4-4. Graphical example of how the predicted surge increase is combined with the medium emissions mean sea level changes to produce the overall increases to the present day 1:200 year extreme water level.

Table 4-2. Predicted future extreme water levels (mODN) for Southampton based on EA 2011 guidance (95 percentile medium emission scenario for relative sea level rise coupled with recommended storm surge changes).

Return Period (years)	2010	2030	2060	2110
1	2.45	2.60	2.79	3.21
2	2.55	2.69	2.88	3.33
5	2.67	2.81	3.01	3.46
10	2.76	2.90	3.11	3.56
20	2.84	2.99	3.19	3.66
50	2.94	3.10	3.31	3.77
100	3.02	3.17	3.39	3.87
200	3.09	3.25	3.46	3.95
500	3.18	3.35	3.57	4.05
1000	3.25	3.41	3.64	4.14

N.B The extreme water levels are given to two decimal places (mODN) to show relative differences between return periods but are only considered accurate to one decimal place.

4.3 Numerical modelling of extreme water levels and tidal flooding

Numerical modelling is a tool that, with careful interpretation, can provide a better insight into the physical processes functioning within an area and, in this case, the complex interactions between the fluvial and coastal processes. This improved understanding from modelling provides a good basis to assess the potential impacts from a range of extreme water levels and future potential sea level rise conditions and helps to quantify the degree of impact and significance of any changes.

For this study ABPmer were commissioned to develop a purpose built numerical model to simulate extreme water levels and simulate tidal flows and tidal flooding over the 100 year Strategy period.

The modelling of flooding was undertaken by dynamically linking a modified existing 1D hydrodynamic model of Southampton Water (estuary and river model – see Figure 4-5), configured using the MIKE11 software through the MIKEFLOOD model system, and coupled with a 2D model of the surrounding floodplain (Figure 4-6) which allows a 2D description of the floodplain using a Flexible Mesh (FM) to represent the topography.

This model enables the simulation of inland flooding (inundation) when water levels exceed the height of the shoreline frontage and existing defences. This approach provides a feedback mechanism between the flood waters and the surrounding estuarine environment by allowing modification of the water levels, and discharges up estuary of the area of overtopping as a result of the flooding process. This will affect the timing and duration of flooding at different locations which can influence the overall flood extents and depths.

This model was calibrated against the available data (Section 3) to ensure that an accurate representation of flows and water levels was achieved. This model was then used to simulate flood events under a 'Do Nothing' scenario to generate baseline flood maps (Section 6.2.1) and then later in the process to assess and evaluate the performance and economic benefits of implementing the preferred options of The Strategy.

For full details of the model setup, calibration and the methodology see Appendix A and B.

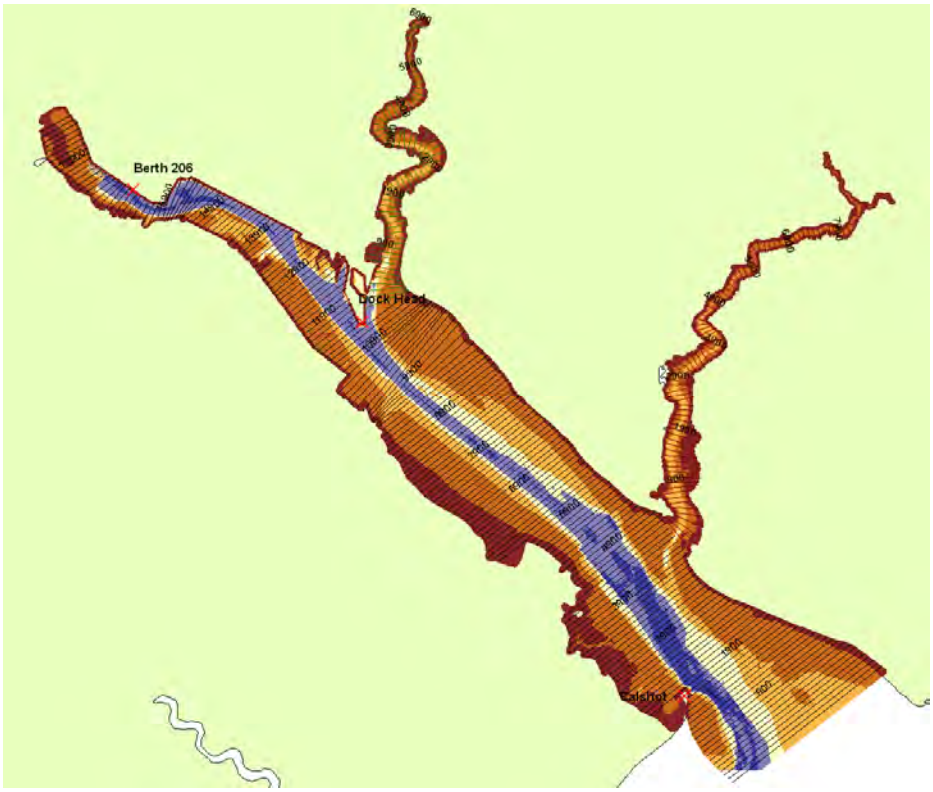


Figure 4-5. Overview of the 1D Mike 11 hydrodynamic model which was used to simulate the extreme water level events and is linked to the 2D floodplain model (Figure 4-6).

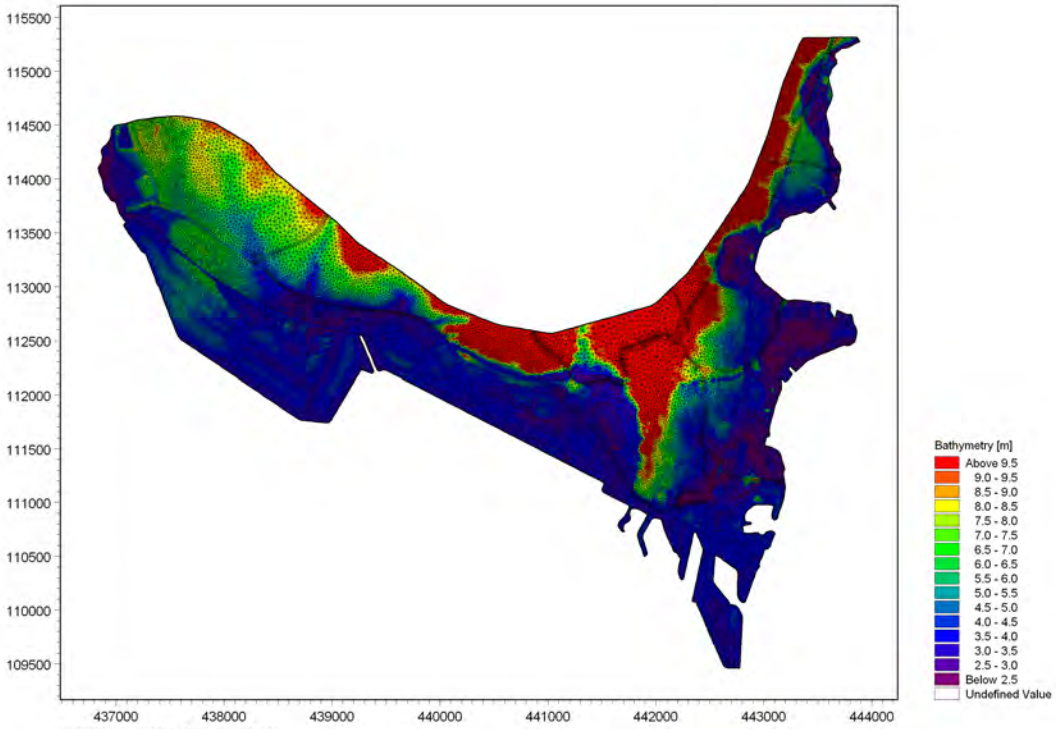


Figure 4-6. 2D Mike 21 floodplain model linked to the hydrodynamic model (Figure 4-5) which was used to simulate tidal inundation for the Southampton Strategy area.

5 EXISTING DEFENCES

A defence condition assessment was carried out for the purpose of informing the decision making process within The Strategy (Appendix D). The defence condition assessment was based upon a visual survey of defences and was undertaken in October 2010. This survey showed that there is a significant variation in defence type, condition, standard of protection and residual life along the frontage. For full area by area defence condition details see Appendix D.

5.1 Summary of Defences

Many of the defences along the study frontage are of fair or good condition, with some poorer sections and some areas with no formal defences.

The defence condition surveys showed that the Itchen frontage is comprised of highly varied defence types of varying condition. Along the Upper Itchen there is a complex mix of informal private defences and formal defences to prevent erosion (Figure 5-1).

Figure 5-1. Informal private defences on the Upper Itchen (left) and formal steel sheet pile erosion defences (right).

Around Northam, St Mary's and fronting Town Depot there is a mixture of mainly industrial and commercial land uses including marinas and operational wharves and quays with structures mainly in fair to good condition however, there are sections in poorer condition (Figure 5-2).

Figure 5-2. Wharfs and quay walls around Northam and St Mary's.

The lower Itchen frontage is comprised of a mix of mass concrete quay walls and steel sheet pile erosion defences mainly in fair to good condition. However there is a localised poor area with loose / missing blocks and spalling (Figure 5-3).

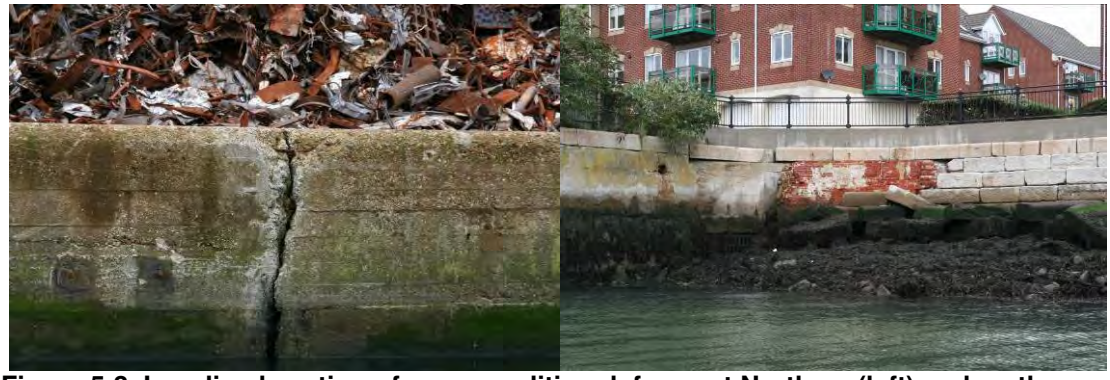


Figure 5-3. Localised section of poor condition defence at Northam (left) and on the lower Itchen (right).

The Eastern Docks of the Port of Southampton extends from the southern extent of Ocean village around Dock Head at the confluence of the tidal river Test and Itchen, to Town Quay. The Eastern Docks frontage is comprised of mass concrete quay walls and steel sheet pile walls in fair to good condition (Figure 5-4).

Figure 5-4. Quay walls along the Eastern Docks frontage

The quay walls of the Western Docks cover much of the Test frontage; these are generally in fair to good condition (Figure 5-5). However there are two sections of mass concrete sea wall on the lower Test frontage that are also identified as having some poor areas with significant cracking and spalling.

Figure 5-5. Western Docks quay walls.

To the north of the Redbridge road bridge the lower Test Valley is comprised of natural reed beds, saltmarshes and a tidal floodplain backed by a railway embankment, railway line and road (Figure 5-6).

Figure 5-6. Lower test valley frontage (left) backed by the railway embankment (right).

6 BASELINE 'DO NOTHING' SCENARIO

As discussed in Section 2.3.2, in order to develop 'The Strategy', it is imperative to understand the present situation, and then define a baseline against which options can be compared. In order to achieve this, a hypothetical 'Do Nothing' baseline situation is defined; this is critical to the analysis and needs careful consideration.

6.1 Definition of the 'Do Nothing' Scenario

FCERM-AG[vi] defines the 'Do Nothing' or 'No Active Intervention' baseline as an option:

> "Where there is no further intervention of any kind, including no emergency response or warning system. Where there are assets at present or where maintenance activities or other interventions are carried out, the option will be to withdraw all activities, allowing nature to take its course".

The 'Do Nothing' scenario represents a hypothetical situation where all existing coastal defences are abandoned in terms of maintenance and repair, and no remedial or additional protection works are carried out. Adaptation to sea level rise or other climate change responses are also not addressed.

The 'Do Nothing' baseline is critical to the analysis of the options and needs careful consideration. Politically this is often seen as a non-viable option, especially for a large urban area such as Southampton, but it is an important comparison tool for the benefit cost analysis and is the option against which all other 'Do Something' options are tested.

Under the baseline 'Do nothing' scenario defence failure would occur depending on the residual life of the structure and the occurrence of storms. Any failure that occurred would not be repaired. Additional failures, adjacent to the failure, or of defences' dependant on the functionality of the failed defence, would also be likely.

The definition of a 'Do Nothing' scenario over the 100 year strategy assessment period enables the calculation of the assets that either are at risk or would be lost given this hypothetic walk-away scenario.

Options for continuing the protection of the coastline (i.e. maintenance or provision of additional defences), would prevent the loss of all, or a portion of, the assets that would be lost under the 'Do Nothing' option. This portion of, or all, the assets that are prevented from being lost by implementation of the 'Do Something' option then become the benefits of that option. Knowing the cost of the option can then provide a Benefit:Cost ratio which can then be used to determine which options are economically viable.

[vi] Flood and Coastal Erosion Risk Management appraisal guidance (Environment Agency, March 2010)

6.2 Southampton 'Do Nothing' Scenario

*For Southampton the **'Do Nothing'** scenario would mean that the current coastal structures and erosion defences would be left in the condition as reported in the Defence Condition Assessment Report (Appendix D).*

No further maintenance, crest raising, or repairs of defence structures would be undertaken. This situation was modelled to calculate the 'Do Nothing' losses which formed the baseline against which future options were tested.

6.2.1 *Baseline flood modelling*

The flood modelling for the baseline 'Do Nothing' situation shows a significant increase in flood risk across the City in the future due to sea level rise.

The baseline flood maps (Figure 6-1 to Figure 6-4) demonstrate that initially (2015 to 2060) the significant flood risk is mainly along the Itchen frontages, particularly around Northam, St Mary's and Town Depot.

With rising sea levels the flood envelopes and depths increase and, by 2110, the flood risk is very extensive with a continuous flood cell under a 1:200 year event covering much of The Strategy frontage with depths of over 2 metres in parts of Northam, Bevois Valley, and the City Centre.

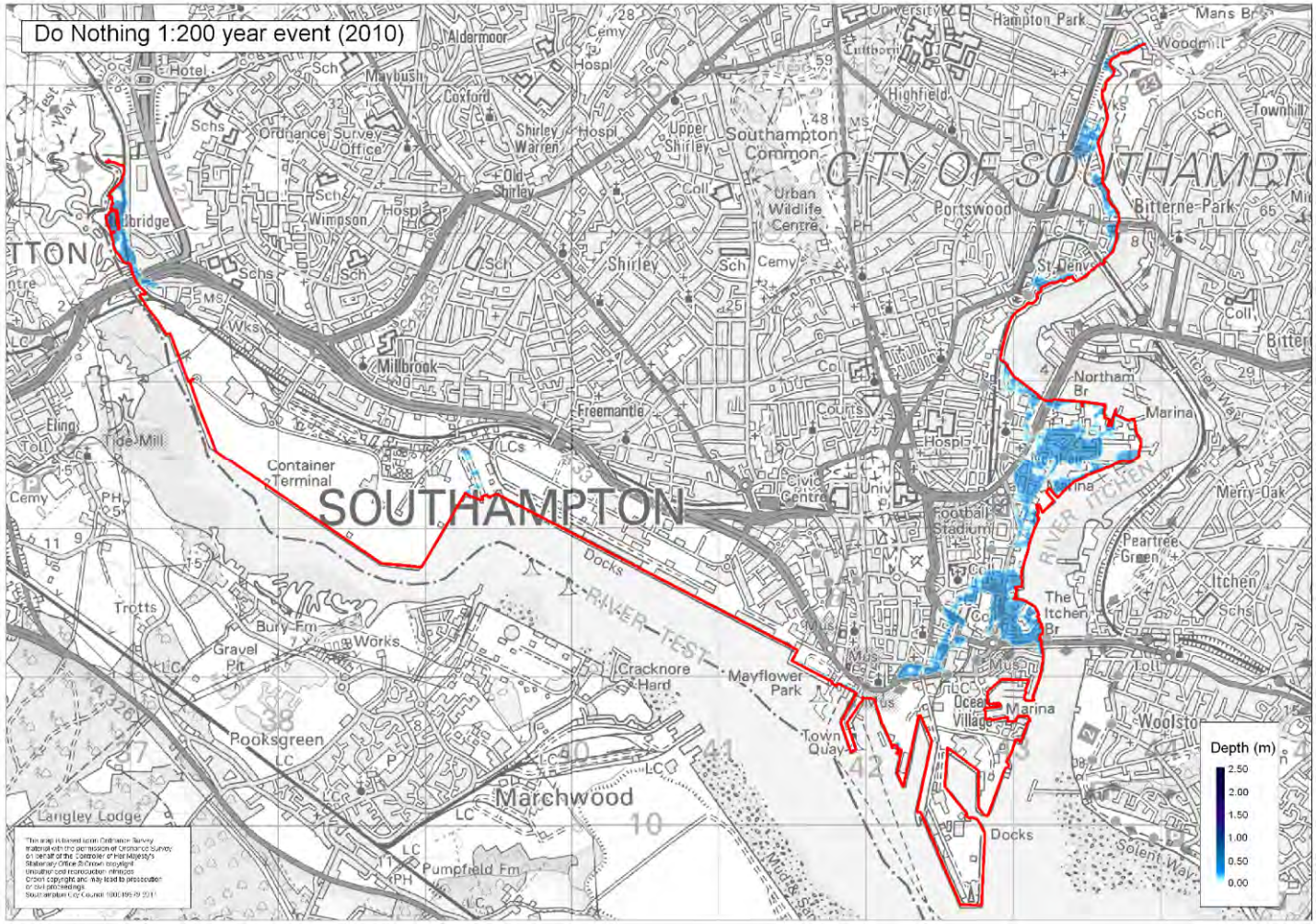


Figure 6-1. Present day 1:200 year event flood map for a 'Do Nothing' baseline scenario

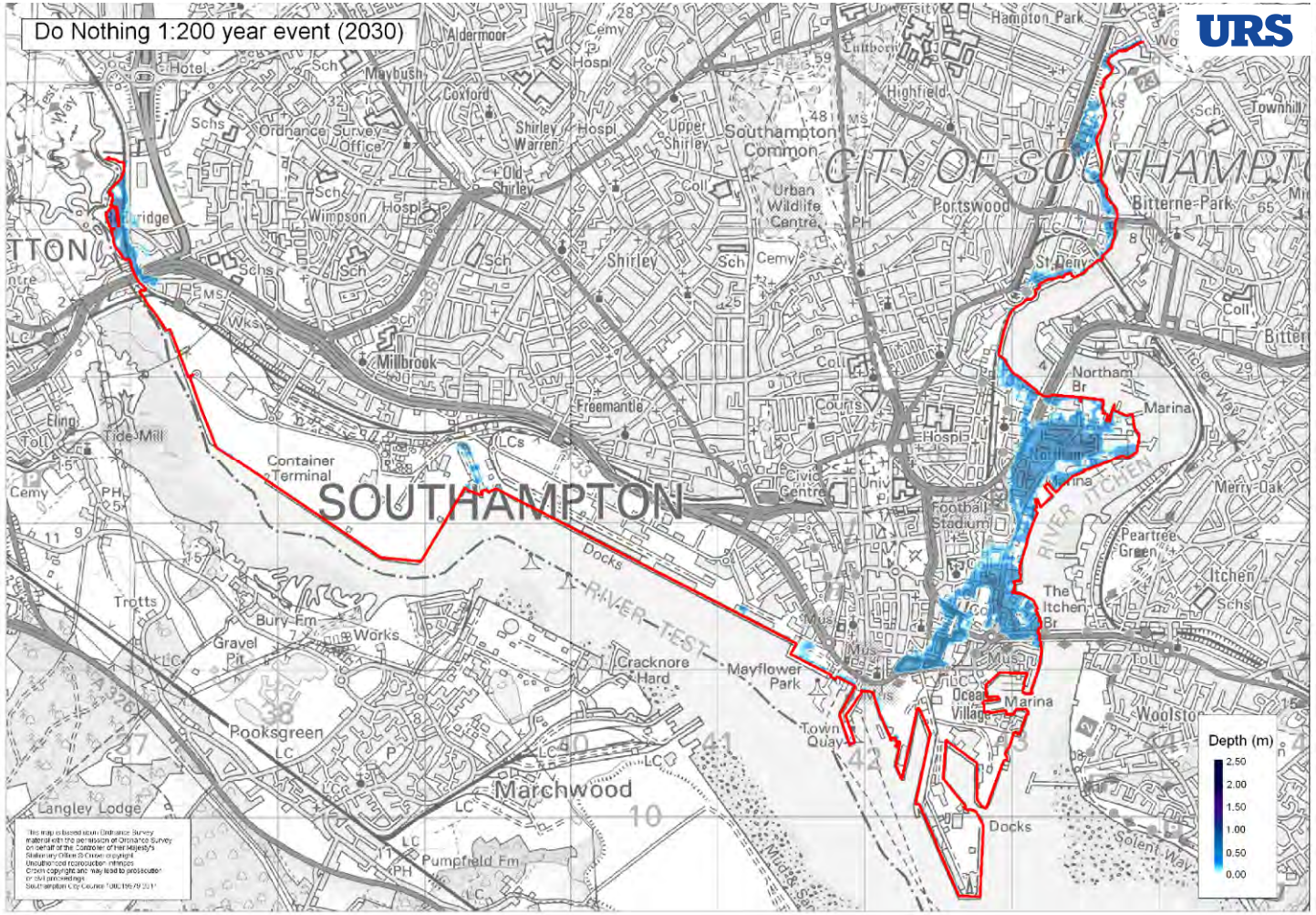


Figure 6-2. Year 2030 1:200 year event flood map for a 'Do Nothing' baseline scenario

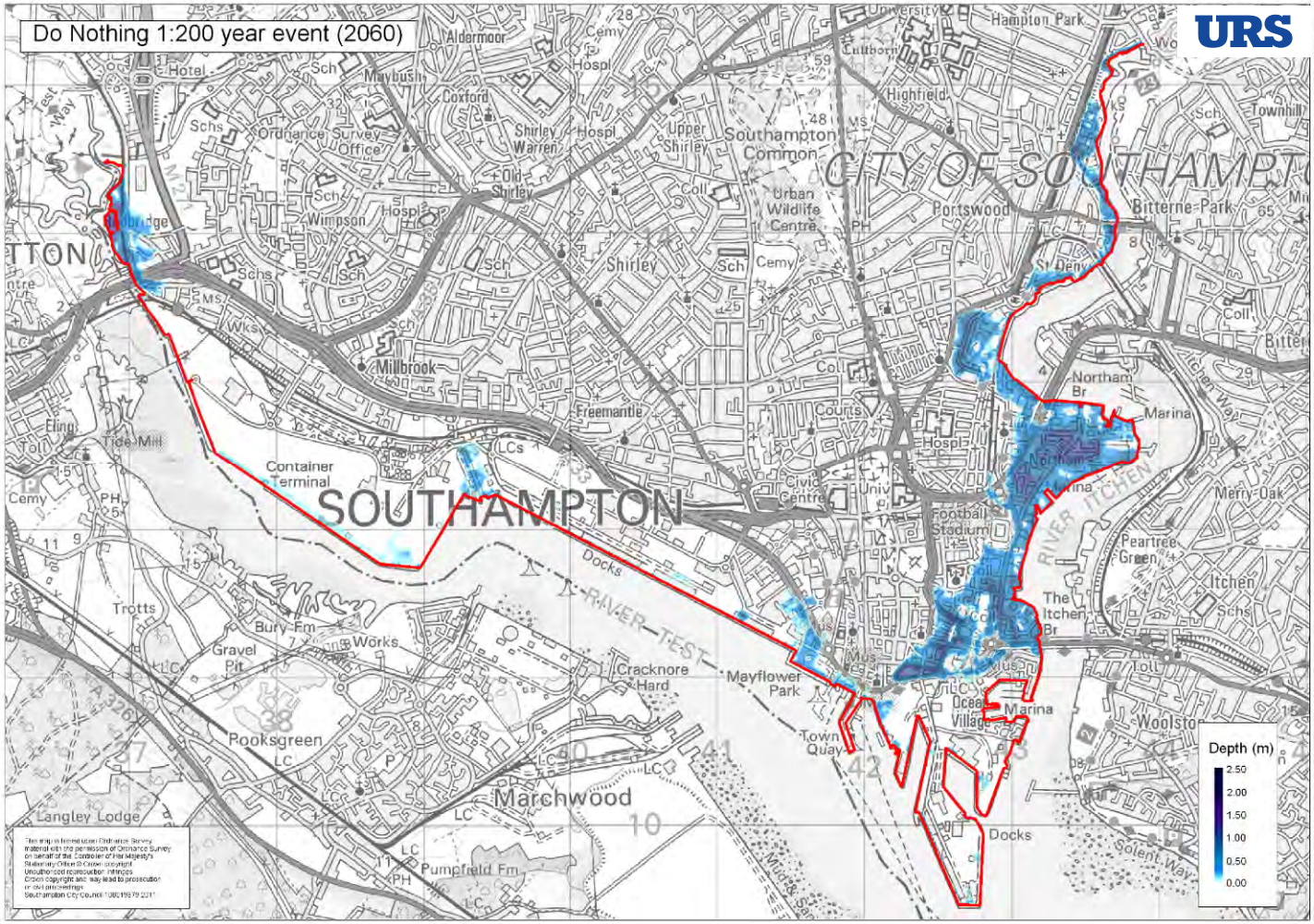


Figure 6-3. Year 2060 1:200 year event flood map for a 'Do Nothing' baseline scenario

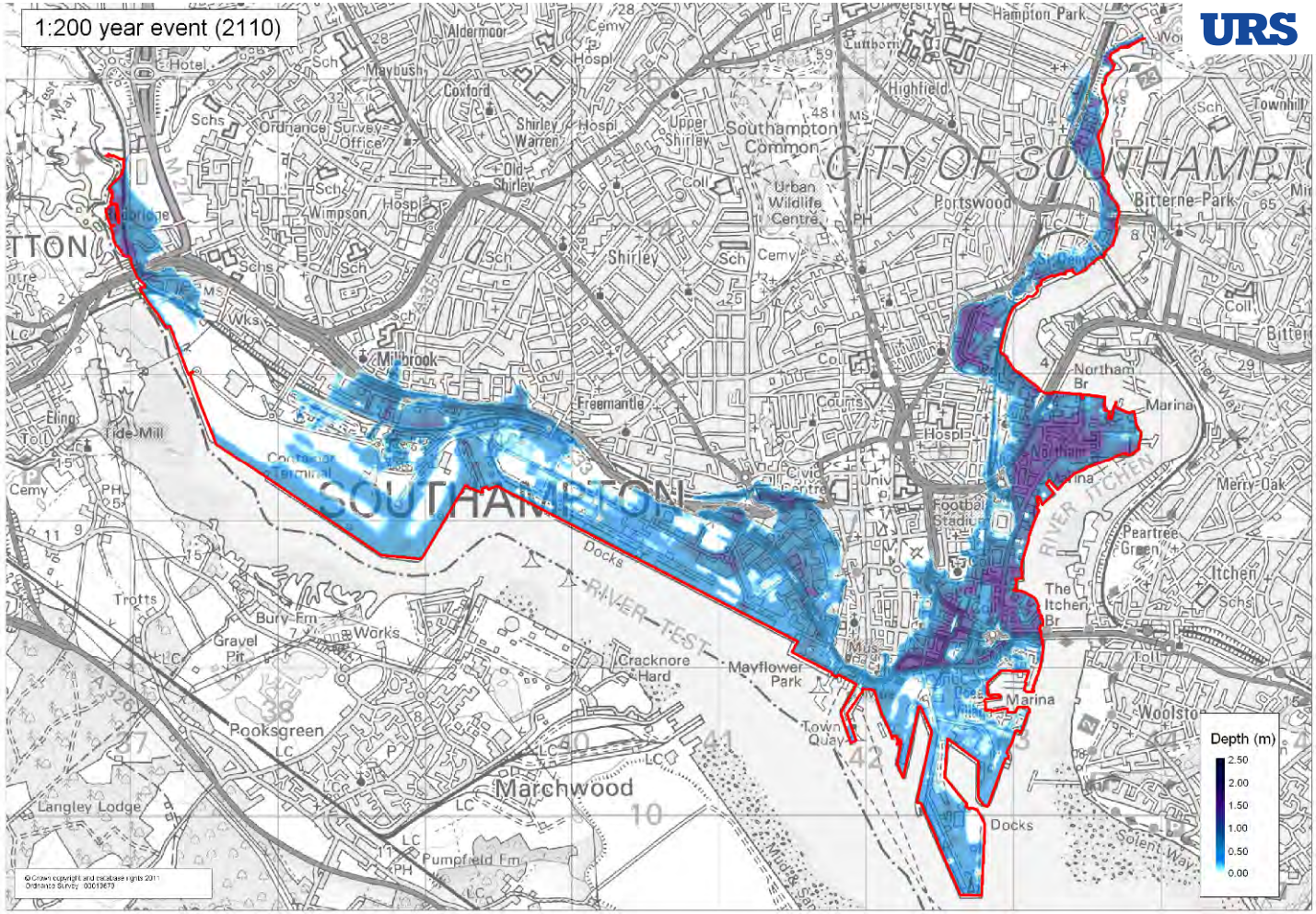


Figure 6-4. Year 2110 1:200 year event flood map for a 'Do Nothing' baseline scenario.

6.3 Current Baseline and Future 'Do Nothing' Scenario – Area by Area Assessment

Following the baseline modelling, the impacts and changes under a hypothetical 'Do Nothing' scenario have been summarised for each area of the frontage. Figure 8-1 shows the locations of the sub areas of the frontage discussed below:

6.3.1 *Upper Itchen / St Denys*

In this area the land is low lying land and gently slopes upwards away from the waterfront. Land use is predominantly private residential houses and gardens along much of frontage, all with land owners with varying interests and demands. There is also critical infrastructure in the form of Portswood Waste Water Treatment Works and the railway line and roads.

The frontage comprises a mixture of informal 'ad-hoc' private defences with varying type, condition and standards interspersed with more formal erosion defences which also serve to protect against regular present day astronomical tidal high water events. Some properties have no structures to protect against flooding or erosion.

Figure 6-5. Photographs of the Upper Itchen and St Denys area at high water on a spring tide.

Parts of this frontage are vulnerable to tidal flooding from the present day. There are approximately 70 residential properties and assets at risk of less than a present day 1 in 50 year event (2% chance of flooding in any year). The majority of these most vulnerable properties are located in the area around Priory Hard and there is considerable anecdotal and photographic evidence of flooding along this frontage; most recently properties around Priory Hard were flooded to a depth of 15cm in 2008 from approximately a 1:20 year tidal flood event (Figure 6-6). In addition to the risk of tidal flooding, there is also significant potential for surface water flooding associated with tide locking of surface water drains; anecdotal evidence has shown that tide locking events causing surface water flooding have occurred in recent years.

Under a baseline 'Do Nothing' scenario the frequency and extent of flooding would increase significantly with sea level rise. Initially, gardens and frontline properties would predominantly be at risk of flooding, however over time if sea levels rise as expected widespread and significant flooding would occur as structures become more regularly overtopped, outflanked and breached as defences fail. The present day 1 in 50 year event flood envelope becomes approximately a 1 in 10 year event (10%) chance of flooding in any year by 2030, and a 1 in 2 year event (50%) chance of flooding in any given year by 2060. As defences fail and breaches occur, the risk of significant flooding will accelerate further.

There is low erosion potential in this area due to low energy wave climate and the sheltered location; however, if private structures were allowed to fail under a 'Do Nothing' scenario, some erosion of gardens would occur as sea levels rise.

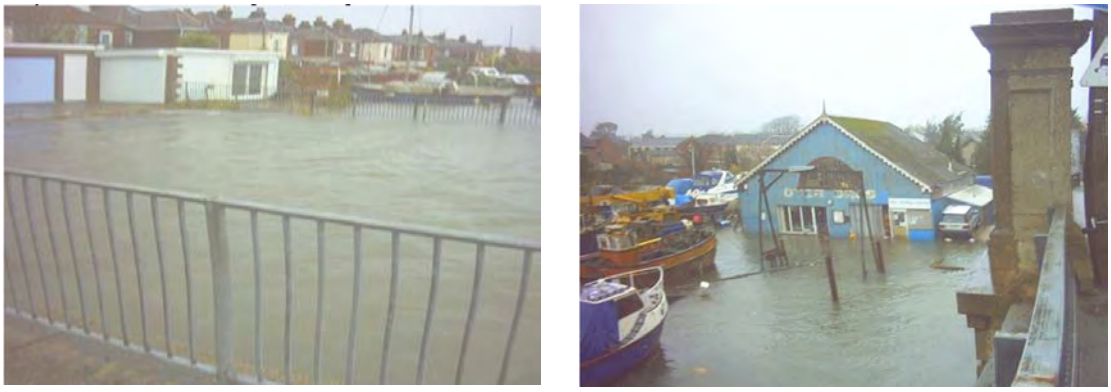


Figure 6-6. Photos of tidal flooding along the Upper Itchen – 10th March 2008. Priory Hard (left) and from Cobden bridge (Right). Photos courtesy of http://www.divdev.fsnet.co.uk/graff.htm

6.3.2 *Bevois Valley*

This area is currently fronted by a railway line with a new boardwalk. Current land uses include residential housing, commercial properties and a Rail Depot. The land levels slope down away from the frontline into a basin of low lying land behind.

Figure 6-7. Photographs of the Bevois Valley frontage.

The new boardwalk, embankment behind and the railway infrastructure currently offer protection against erosion and provide a present day standard of protection against flooding against a 1 in 200 year event (Figure 6-7). However, by 2060, the area becomes at significant risk of flooding from a 1:200 year event, and the standard of protection falls to less than a 1 in 1 year event by 2110. Due to the topographic depression behind the front line, flood depths become very significant (up to 2m) once the front line defences are breached or overtopped.

Due to the location of this area on the outside of a large bend of the Itchen, and some limited wave exposure, there is potential for erosion if defences fail at the end of their residual life. This could bring forward the flood risk in this area as tidal inundation could occur through and over the railway embankment.

6.3.3 *Former Meridian Studios (Railway line to Northam Bridge)*

This area includes the site of the former Meridian TV studios which is awaiting redevelopment and the site has been cleared except for piles of rubble and fill material. Ground levels at this site at present are generally 2.9 – 3.5 m ODN. Beside the redevelopment area are industrial units. In this area the frontline defences typically have crest levels of around 2.7-2.8m ODN and are generally of fair condition (Figure 6-8).

Figure 6-8. Photographs of the former Meridian Studios site frontage.

The area is at risk of some flooding under a present day 1:200 year event and as sea levels rise the flood risk increases significantly. Lower ground levels towards Northam Bridge provide a flow path for tidal flooding towards Northam for a 1:200 year event by 2030 under a 'Do Nothing' scenario. As defences fail and breaches occur, the risk of significant flooding will accelerate further. Beyond 2060 the area would be at very significant risk of regular tidal inundation due to sea level rise.

6.3.4 *Northam (Northam Bridge to Belvedere Wharf)*

This area is comprised of low lying land gently sloping towards a low point in the centre of the area. The frontline generally consists of steel sheet pile or concrete quay wall defences in fair to good condition with some poorer areas. There is also an area with no formal defences at Shamrock Quay.

Northam is a highly urbanised frontage and includes a potential redevelopment area, residential housing, commercial properties, industrial units, marinas and wharves (Figure 6-9).

Figure 6-9. Photographs of the Northam frontage.

Many of these assets are at risk of tidal flooding from the present day with a significant area at risk of flooding of up to 0.5m depth from a present day 1:200 year event. However, under the 'Do Nothing' scenario this risk increases significantly due to sea level rise. Pooling of flood waters would also occur behind the front line if tidal inundation occurs due to the slight natural topographic depression.

As front line defences fail under this scenario, some slow erosion of the frontage would also occur thereby accelerating the flood risk further and flooding would occur more frequently under astronomical tide levels rather than just extreme water levels.

6.3.5 *St Mary's Wharves*

This area is currently fronted by operational aggregate wharves (Figure 6-10). Behind the wharves there are many industrial units, St Mary's Football Stadium, commercial properties and residential properties, some of which are at risk of flooding under a present day 1:200 year event.

Figure 6-10. Photographs of the St Mary's Wharves frontage.

Under a 'Do Nothing' scenario, flood risk would increase significantly with sea level rise and the present day 1:200 year flood envelope would become equivalent to less than a 1:10 year event by 2060 and to less than a 1:1 year event by 2110. There are also flood flow paths from this area towards adjacent areas including Northam to the north and the City Centre to the south west.

As front line defences fail under this scenario, some slow erosion of the frontage would also occur thereby accelerating the flood risk further and flooding would occur more frequently under astronomical tide levels rather than just extreme water levels.

6.3.6 *Town Depot*

This area is low lying and is where the Council's former waste recycling depot was located. Currently, part of this area is earmarked for redevelopment. There are also industrial units present with residential housing behind (Figure 6-11).

Figure 6-11. Photographs of the Town Depot frontage.

There is a present day flood risk from a 1:50 year event and the flood envelope for a present day 1:200 year event is significant with flow paths extending through towards the City centre.

Flood risk increases significantly with sea level rise and the present day 1:200 year flood envelope would become equivalent to less than a 1:10 year event by 2060 and less than a 1:1 year event by 2110.

As front line defences fail under this scenario, some slow erosion of the frontage would also occur thereby accelerating the flood risk further and flooding would occur more frequently under astronomical tide levels rather than just extreme water levels.

6.3.7 *Ocean Village*

This area has relatively higher land levels than the adjacent Itchen frontages to the north. Ocean village is comprised of residential properties, hotels, restaurants and commercial properties based around a large marina with mass concrete and steel sheet pile quay walls in good or fair condition with typical crest levels of 3.7 – 3.8m ODN (Figure 6-12). Land levels gently slope downwards towards a typical level of 3.4mODN along Canute Road at the rear of Ocean Village.

Figure 6-12. Photographs of the Ocean Village frontage.

There is no significant flood risk in this area until beyond 2060. There is a risk of flooding from a 1:10 year event by 2110, with significant flood risk from a 1:200 year event in 2110. Flooding would occur from inundation over quay walls and indirectly via a flow path from the Town Depot frontage to the north.

Due to the very low wave energy and sheltered location, there is a low risk of erosion, although structures would start to fail at the end of their residual life under a 'Do Nothing' scenario.

6.3.8 *Eastern Docks / Dock Gate 4*

The frontage is comprised of ABP docks and associated infrastructure and assets and also the National Oceanography Centre of Southampton. The front line defence consist of quay walls with a design crest level of 3.5m ODN (Figure 6-13).

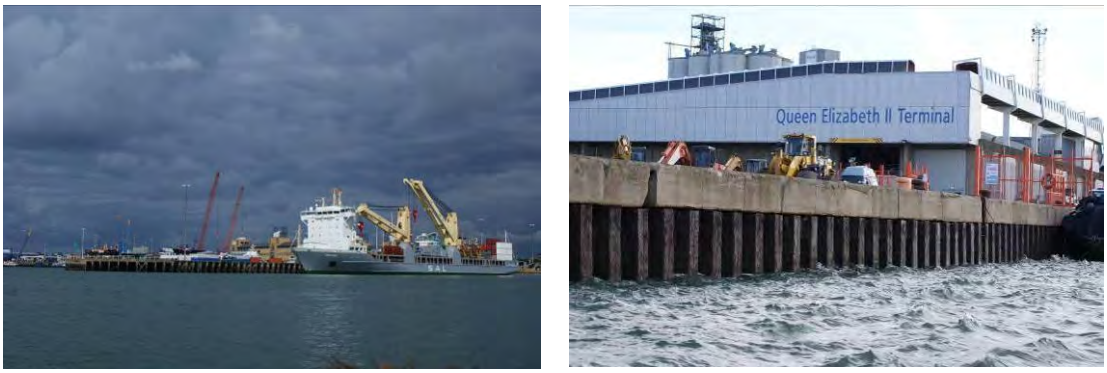


Figure 6-13. Photographs of the Eastern Docks / Dock Gate 4 frontage.

There is no significant risk of flooding in this area until beyond 2060 when flooding from inundation over the front line may occur. However, there is a risk of flooding 'via the back door' from the Itchen frontages around Town Depot and St Mary's Wharves under a 1:200 year present day event, and this risk increases over time.

The risk of flooding over the front line defences in this area begins after 2060 with flood risk from a 1:10 year event by 2110 and significant flood risk from a 1:200 year event as water levels exceed the quay wall crest levels and the flood envelope joins with that of adjacent frontages.

Although a generally low wave energy environment, structures would start to fail under a 'Do Nothing' scenario and the erosion risk would increase over time.

6.3.9 *Mayflower Park / Major Development Quarter*

This area is fronted by a public amenity park (Mayflower Park) with commercial properties behind in the Central Business District (Figure 6-14). Adjacent to Mayflower Park is the Isle of Wight ferry terminal and car parking. The area in front of the park contains the Royal Pier which is due for imminent redevelopment. The large area behind Mayflower Park is also earmarked for redevelopment.

Figure 6-14. Photographs of the Mayflower Park / Major Development Quarter frontage.

There is presently a low risk of flooding with only minor flooding from a present 1:200 year event. Under a 'Do Nothing' Scenario there would be a significant increase in flood risk after 2060 with a significant flow path for flooding northwards towards West Quay and Southampton Central Railway station with flood risk from a 1:10 year event in 2110.

As frontline structures fail under a 'Do Nothing' scenario, there is a risk of slow erosion of this frontage.

6.3.10 *Western Docks*

This long section of the frontage is generally flat and comprises of ABP docks and the Port of Southampton associated infrastructure and assets (Figure 6-15). This area also contains the cruise liner terminals and Millbrook Waste Water Treatment Works lies behind the Port area.

The front line generally consists of steel sheet pile and concrete quay walls with a design crest level of 3.5m ODN. Generally these defences are in fair to good condition; however the area fronting the car storage area to the far west of the frontage has no formal defences.

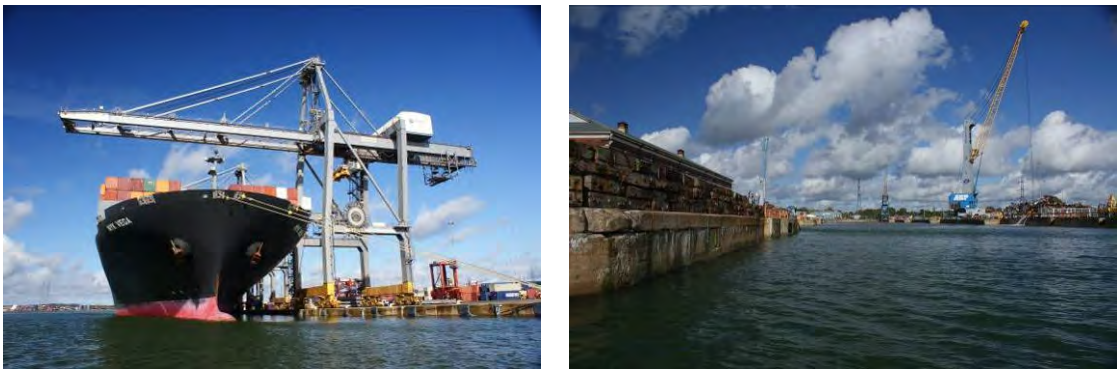


Figure 6-15. Photographs of the Western Docks frontage.

There is no significant flood risk in this area until beyond 2060 however the area would be at risk of flooding from a 1:10 year event by 2110, with significant flood risk from a 1:200 year event by this time as water levels would significantly exceed the quay wall crest levels. Flooding from such an event would inundate almost the entire Port area and significant flooding would also occur to areas behind the Port.

Although a generally low wave energy environment, structures would start to fail under a 'Do Nothing' scenario and the erosion risk would increase over time.

6.3.11 *Redbridge*

This area comprises of the Redbridge road and rail bridges towards the southern end of the unit with a railway and road backing a tidal floodplain of high environmental importance to the north of the bridges (Figure 6-16). Behind the railway line is residential housing and a business / industrial park at the north of the unit.

Figure 6-16. Photographs of the Redbridge frontage.

Figure 6-17. Photographs of the gap in the wall near the Redbridge road bridge.

Although tidal flood risk is currently not significant, there is a notable gap in the wall near the road bridge which acts as a low point for potential tidal inundation (Figure 6-17).

Under a 'Do Nothing' scenario tidal flood risk is set to increase due to sea level rise and by 2030 there would be approximately 30 properties and rail infrastructure at risk from less than a 1:50 year tidal event. Beyond 2060 the flood risk would increase further with flood depths of up to 1.5m from a 1:200 year event in 2110. In addition to the risk of tidal flooding, there is also significant potential for surface water flooding associated with tide locking of surface water drains; anecdotal evidence shows that tide locking events causing local surface water flooding have occurred in recent years.

Although a very low wave energy environment, structures would start to fail under a 'Do Nothing' scenario and the erosion risk would increase over time and this could also exacerbate the flood risk.

6.4 Southampton "Do Nothing" Damages

The overall 'Do Nothing' damages associated with each frontage outlined above were quantified in accordance with the Environment Agency Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) 2010[vii]. These potential damages were derived from modelling of flood depths for different return period events over the next 100 years and estimation of the resulting flood damages based on a flood damage database. Further details of the economic assessment of the 'Do Nothing' case is provided in Section 11.2.

[vii] Flood and Coastal Erosion Risk Management appraisal guidance (Environment Agency, March 2010)

7 DEVELOPMENT OF 'THE STRATEGY'

Following the definition and establishment of the baseline scenario, The Strategy can be developed. The objectives must first be established before options can be identified and appraised. This Section defines The Strategy objectives and provides an overview of the subsequent steps undertaken to develop the preferred options.

7.1 Context and Strategy Objectives

The major issue facing Southampton is the increasing risk of tidal flooding over time. As described in the previous sections, Southampton is a generally low-lying urban area and currently has no formal flood defences and although tidal flood risk is currently not a significant problem, the risk increases substantially in the future due to sea level rise.

The North Solent SMP policy from Woodmill to Redbridge, which encompasses the main part of the City of Southampton frontage, is to 'Hold the Line'. The baseline studies and economic assessments of a hypothetical 'do-nothing' scenario undertaken for this Strategy also strongly supports this policy. Therefore strategy options must be identified to facilitate this overarching SMP policy of holding the existing defence line. North of the Redbridge road bridge, the SMP policy is for 'No Active Intervention', however due to demonstrated flood risk to residential assets, it was imperative that 'Do Something' management options were explored in more detail in this area.

In addition to the requirement of The Strategy to facilitate the SMP policy of 'Hold the Line' for almost the entire frontage, the City Council's aspirations and long term strategic vision for redevelopment, regeneration and improved connectivity between the City and the Water were integral in the development of specific objectives for The Strategy. The Strategy objectives were developed and agreed by the Client Steering Group and Key Stakeholders.

The Strategy **objectives** are to:

- provide appropriate sustainable coastal management mechanisms to prevent coastal erosion and reduce tidal flood risk to people and their properties,
- to seek approval to deliver priority schemes for vulnerable areas;
- use sympathetic and robust solutions which wherever possible use existing defence corridors or features and are complimentary with the 'City Vision';
- capitalise on opportunities to support regeneration and incorporate strategic flood defence within future redevelopments;
- avoid impedance of economic activities;
- increase the potential for recreation and tourism; without compromising or where possible, enhancing the natural environment, especially the environmentally designated Lower Test Valley;
- ensure the requirements of the Water Framework Directive (WFD) are met and mitigation measures proposed by the WFD are included where appropriate;
- provide a blueprint for future monitoring and programming of maintenance works; and
- consolidate and build upon information gathered within higher level plans to present a sustainable and holistic coastal management Strategy which dovetails with other relevant plans and programmes to deliver synergistic benefits to the City.

The requirements and aspirations of these specific objectives were therefore an integral consideration in the identification of The Strategy options and the development of the preferred option.

7.2 Developing the Preferred Options

As outlined in the FCERM-AG (2010)[viii] guidance, the option development process is necessarily an iterative and multi-faceted process. Development of options followed the systematic process as laid out in Figure 7-1.

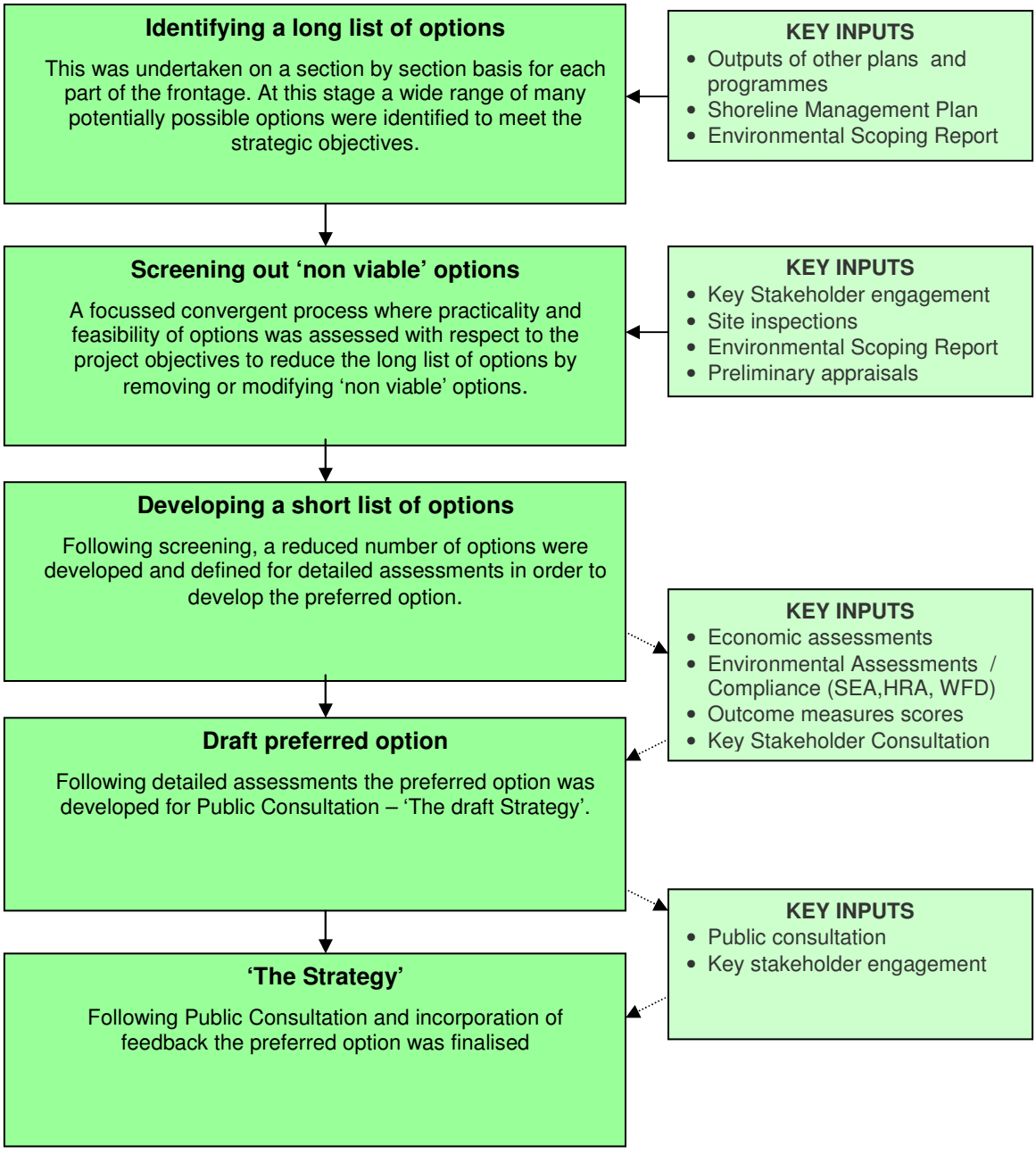


Figure 7-1. Option development process.

This multi-staged approach required a number of inputs to inform the development of the short list options. A conceptual appraisal and evaluation of identified long list options was undertaken to assess the positive and negative impacts of the various long list options relative to the

[viii] Flood and Coastal Erosion Risk Management appraisal guidance (Environment Agency, March 2010)

baseline scenario. Outputs from the Strategic Environmental Assessment (Appendix F) were also used during the screening process to ensure shortlist options were environmentally acceptable and that any opportunities were captured.

Throughout this process, effective communication and engagement with key stakeholders was paramount to ensure local knowledge, needs, constraints and aspirations were considered in order to develop feasible options, and explore potential funding sources. Full details of Stakeholder Engagement Strategy and the activities undertaken to date are included in the Stakeholder Engagement Report (Appendix J).

8 IDENTIFYING THE LONG LIST OF OPTIONS

8.1 Option Development Units

Present day land uses, future land uses (redevelopment areas), ownership, defence types, and flood risk vary significantly along The Strategy frontage. These factors combine to provide constraints and opportunities when identifying and developing options for coastal management along the frontage.

On this basis, the frontage was divided into sub-areas in order to consider different options; these were termed Option Development Units (ODUs). The creation of ODUs was necessary as the technical and practical feasibility of different defence options depends on the various constraints of different areas (for example, the operational requirements of the Port area would mean a raised up stand wall at the front line would not be feasible, whereas it may be feasible in another area where no quay access is required).

Option Development Units provide the required flexibility to develop suitable options on an area by area basis so that options identified are appropriate for the area.

Figure 8-1 shows the 11 Option Development Units for The Strategy frontage.

8.2 Flood risk and flood cells

The outputs of the baseline flood modelling for a hypothetical 'Do Nothing' scenario show that by 2110 almost the entire Strategy frontage is at significant risk of flooding from a 1:200 year event (Figure 6-4). This demonstrates that in all ODUs 'Do Something' options to manage or protect against the flood risk should be identified for detailed appraisal.

It is also apparent from the baseline flood modelling that the areas at risk of flooding change over time and increase in extent and depth due to sea level rise; consequently this provides a risk based guide as to the required phasing of when options would need to be implemented in different areas to prevent flooding. For example, if an area is shown to flood in the present day, logic would follow that this area should be defended first over an area which has no flood risk until 2060. In reality, funding constraints for 'acting now' could influence the precise phasing of the preferred option, and such optimisation of the preferred option to account for aspects such as financial constraints is undertaken later in the option development process following detailed economic assessments.

The interdependencies between various Units was considered through the use of flood cells. For example, it would make no logical sense to defend an area which could be flooded via the backdoor from an undefended adjacent area, so phasing the options of dependent units is an important consideration.

Figure 8-1 shows that by 2110 there are 3 main independent flood cell areas for a 1:200 year event. For option development purposes and economic testing of scheme phasing these three main flood cells were sub-divided further based on the changing flood risk areas over time (See Appendix I).

Flood Cell A is the largest encompassing ODUs 2 to 10 (Bevois Valley to the western extent of the Docks). Flood Cell B covers the Upper Itchen / St Denys area and Cell C encompasses the Redbridge area. The division between Flood Cell A and C is created by naturally elevated topography just south of Redbridge. Up to a 1:200 year event in 2110 (when the railway

creates a shallow link between the two cells), the division between Cell A and B is created by naturally elevated land levels. For the purposes of option development at The Strategy level, Cells A and B are assumed to be independent as a scheme to cut off the linking flow path could be undertaken. This detail is included and costed as part of the options considered to ensure interdependency between the flood cell areas.

Before 2110 the flood cells are smaller in extent due to lower sea levels. Table 8-2 summarises the changing flood risk over time by area. This table uses a 'traffic light' approach to indicate the level of flood risk from a 1:200 year event at the present day (2010), 2030, 2060 and 2110. Indicative typical depths (average depth that properties within the flood envelope are flooded to) and maximum depths (greatest flood depth of a property in a flood envelope) are also given along with the flood cell reference. Table 8-1 provides an annotated sub-section from Table 8-2 to explain what is shown.

Table 8-1. Annotated sub section of Table 8-2 indicating flood risk by ODU.

Area	Upper Itchen / St Denys	Bevois Valley
Option Development Unit	1	2
Present Day Flood Risk 1:200year typical depth (max) metres	0.25(0.75)	0
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(1)	0
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75 (1.25)	0.5(0.75)
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.75(2.25)	1.5(2.25)
Present Day Flood cell	B	
2030 Flood cell	B	
2060 Flood cell	B	A
2110 Flood cell	B	A

Geographical location

Option Development Unit number (see Figure 8-1 for map)

Amber indicates moderate flood risk at 2010 from 1:200 year event with typical flood depths of 0.25m but up to 0.75m

Green indicates low flood risk from 1:200 year event at 2030 under a hypothetical 'Do nothing' scenario.

Red indicates high flood risk from 1:200 year event at 2110 under hypothetical 'Do nothing' scenario with typical depths 1.5m but up to 2.25m

Denotes that this area (Bevois Valley) has no flooding from a 1:200 year event until after 2030 then it joins flood cell A after 2060 (see map in Figure 8-1).

Denotes that this area (Upper Itchen / St Denys) is in flood cell B, separate from the flood cell in the adjacent area (Bevois valley). See map in Figure 8-1)

In flood Cell A It is evident that the Itchen frontages (ODUs 3-6) are most vulnerable to flooding in the short to medium term (up to 2060) and there is also a flow path through to Eastern Docks / Dock Gate 4 from these Itchen frontages by 2030. From 2060, Flood Cell A covers the entire area from Bevois valley to the Docks with depths of up to 2.25m under a 1:200 year event by 2110.

The Upper Itchen / St Denys (ODU 1) has some flood risk from a present day 1:200 year event and the flood cell extent increases significantly in the future.

Redbridge has low flood risk until beyond 2030 when Flood Cell C increases in extent significantly.

This identification of flood cells and the interdependencies of ODUs over time thus provide an important input to inform the option development process and to guide potential phasing of options for interdependent Units.

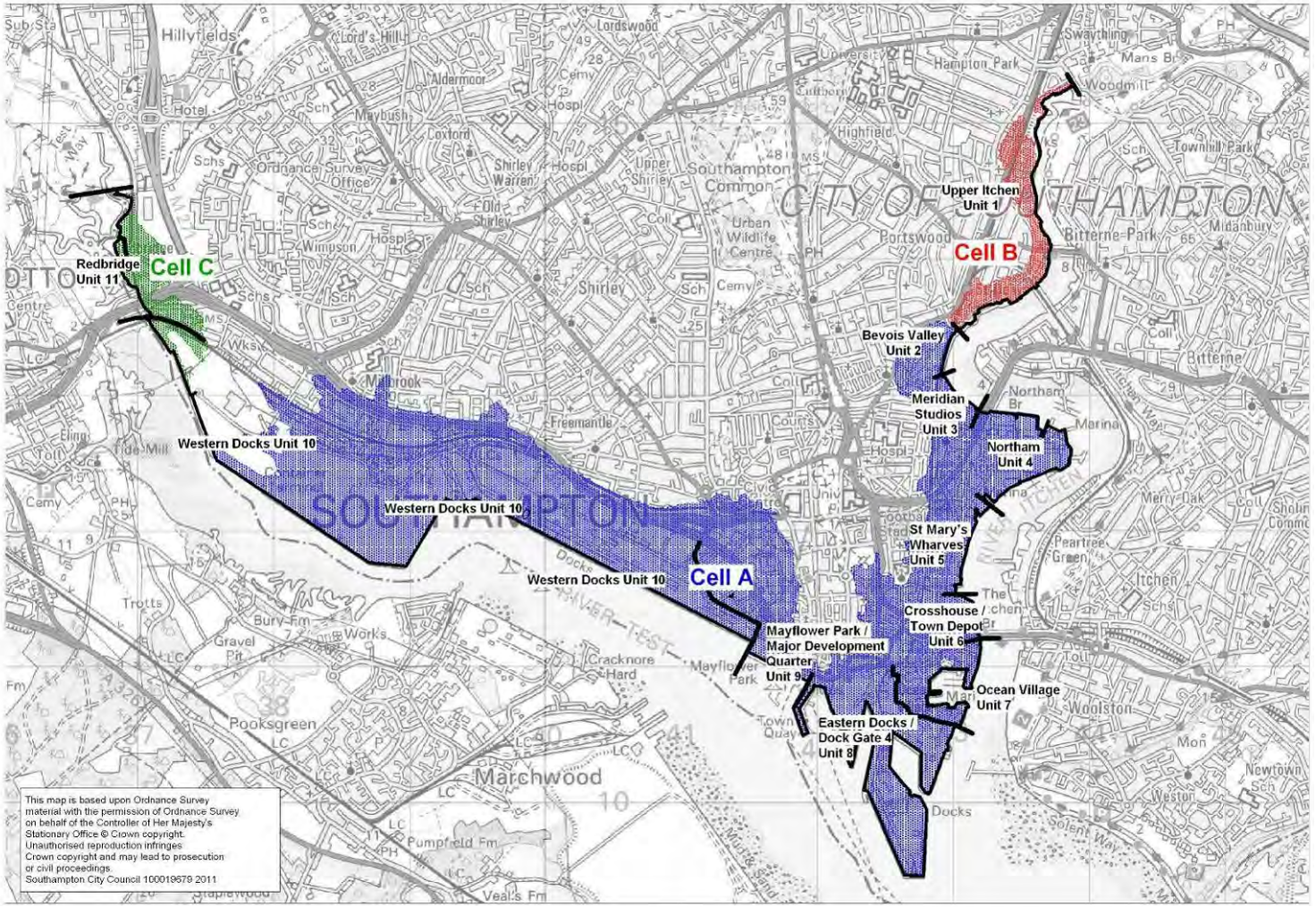


Figure 8-1. Map showing flood cells A, B and C (1:200 year event 2110 flood envelopes) and Option Development Units.

Table 8-2. Summary of flood risk, depth and cells over time by Option Development Unit. Refer to Figure 8-1 for flood cell map.

Area	Upper Itchen / St Denys	Bevois Valley	Former Meridian Studios site	Northam	St Mary's Wharves	Crosshouse / Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge
Option Development Unit	1	2	3	4	5	6	7	8	9	10	11
Present Day Flood Risk 1:200year typical depth (max) metres	0.25(0.75)	0	0.25(0.5)	0.25(0.75)	0.25(0.5)	0.25(0.75)	0	0	0	0	0
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(1)	0	0.5(0.75)	0.75(1)	0.25(0.75)	0.75(1)	0	0.5(0.75) via the 'back door'	0	0	0.25
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75 (1.25)	0.5(0.75)	0.75(1)	1(1.25)	0.5(1)	0.75(1.25)	0	1(1.75) via the 'back door'	0.25(0.5)	0	0.25(0.75)
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.75(2)	1.5(2)	1.5(1.75)	1.75(2.2)	1.5(2)	1.75(2)	0.5(1)	1.5(2)	1(1.5)	1(1.75)	1(1.75)
Present Day Flood cell	B		A	A	A	A					
2030 Flood cell	B		A	A	A	A		A			C
2060 Flood cell	B	A	A	A	A	A		A	A		C
2110 Flood cell	B	A	A	A	A	A	A	A	A	A	C

8.3 Suite of long list options

A range of strategic options were initially identified as possible solutions to carry out a policy of 'hold the line' and to protect against or manage tidal flooding. The following options formed a generic menu from which to select long list options for the individual ODUs:

8.3.1 *Steel sheet pile front line defences*

Steel sheet pile is a form of continuous interlocking steel plate driven into the ground. Driving through obstructions or dense gravels may require a much heavier duty pile.

Corrosion is the key issue of steel sheet pile defences and it must be allowed for in the design. Apart from that, sheet pile defences can be unattractive, although often suitable for working quaysides. The steel sheet pilling option can be economical compared to a reinforced mass concrete sea wall. Typical steel sheet pile defences are pictured in Figure 8-2.

Figure 8-2. Steel sheet pile defences

8.3.2 *Floodwalls*

A floodwall can be constructed from brick, masonry, concrete, sheet piling or a combination of these materials. It is fundamental that a flood defence structure remains stable under hydraulic loading, even if the loading is prolonged or if the defence is overtopped. Although some damage to a flood defence may be expected in an extreme flood, this should not impair the serviceability of the structure and under no circumstances should the defence collapse during a flood.

Should the existing front line defences not be suitable for upgrading or rehabilitation (having reached the end of their service life), the option of setting the floodwall back from the front line could be considered. This has implications for the flood defence of the land between the river and the floodwall, but may be the only acceptable option if the flood defence is to remain independent of the front line defences and thereby not dependent on their stability. Such a situation is likely to arise when the party responsible for constructing and maintaining the flood defence does not have (and does not want to take on) any responsibility for the existing river frontage structures.

For defences remote from the river, construction tends to be more straightforward. Concrete (both precast and insitu) is the most common form of construction, often with some form of cladding or decorative finish. Brick and masonry can be used, but these either have to be massive structures (unless very low in height) or be reinforced with steel bars. Low brick walls can be formed by constructing a tied cavity wall on a concrete foundation, with reinforcing bars extending from the foundation up through the cavity. The cavity can then be filled with concrete, during which time the brick skins may need external support while the concrete in the cavity hardens. Two different floodwall designs are shown in Figure 8-3.

Standard precast wall concrete units offer the advantage of speed of construction, but may lead to wastage if the ground level along the wall alignment is very variable, requiring the wall height to vary. (The advantage of using precast units is reduced if many different sizes are needed or if the largest size required is used throughout.) Cast insitu walling is more often used where there are frequent changes of direction or wall height.

Where a floodwall passes through private land, there may be a need for an easement to ensure the right of access for inspection and maintenance is provided for ever.

Figure 8-3. Differing floodwall designs (Source: EA FCERM Libraries, 2011)[ix]

8.3.3 *Earth embankments*

Earth embankments are earth structures covered by grass and are designed to hydrological specifications (i.e. based on design height, flood return period) to ensure they perform their primary function of preventing inundation of land by water.

The slope of the flood embankment has to be reinforced to avoid failure by classical failure mechanisms (i.e. wave overtopping, piping, micro-instability and settlement to name a few). The embankment can be constructed from a variety of local earth materials. Therefore, the cost of construction can be markedly reduced and environmental impact can be reduced as this is more sympathetic compared to harder engineering options. The footprint width of such a defence is proportional to the required design height and significant land take may be required to implement such an option. A photograph of an earth embankment flood defence and a typical cross section are shown in Figure 8-4.

[ix] http://evidence.environment-agency.gov.uk/FCERM/

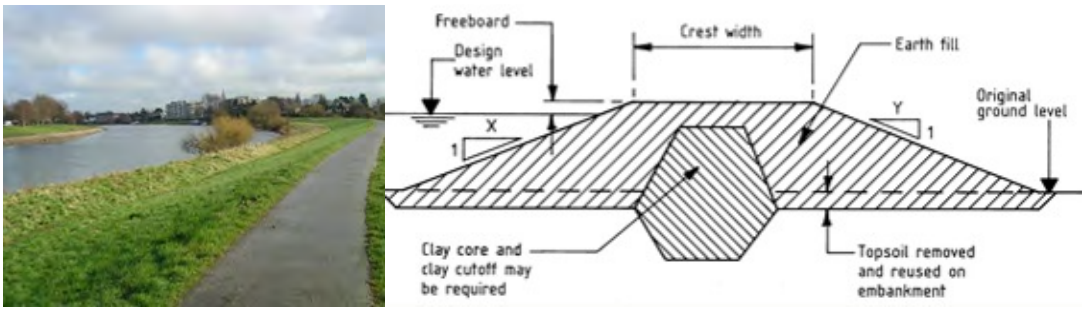


Figure 8-4. Photo (left) and an indicative design cross section of an earth embankment flood defence (right) (Source: EA FCERM Libraries, 2011)[x].

8.3.4 *Road raising*

Similar to earth embankments, road raising can be constructed with low-cost fill material that is locally available. Commonly used fill materials include native shale, rock or mining spoil, gravel, concrete or demolition waste. The crest level is designed in accordance with design height and flood return period. Fill material to be placed and shaped with a grader or bulldozer. Geo-textile sometimes is used to reinforce the road base. If the design height is significant, access requirements and practical suitability may be an issue, especially in the tight urban fabric of a city.

8.3.5 *Land raising / redevelopment*

Raising land to create high ground is the most robust form of defence with very little potential for failure. This option also has the advantage of no defence maintenance or repair costs. Such an option would be most appropriately and effectively carried out during the re-development of sites, as demolition of existing buildings may otherwise be required. However, if opportunities to redevelop do not arise, and sufficient time is available until the defence is required, with careful co-ordination and planning, such an option could be achieved through joining up incrementally raised areas overtime, aligned with renovation or building replacements therefore allowing existing land uses to remain.

To form a robust defence without risk of breaching, a minimum width raised strip of 40m should be aimed for, with wider raised areas preferable. With this option raised defences can be sympathetically landscaped into the urban environment. As well as providing a robust flood defence, raised land can improve connectivity with the waterfront and avoids many of the drawbacks of floodwalls and hard structures (e.g. detrimental visual impacts and restricted access). Such an option also reduces the risk of other forms of flooding such as surface water.

The following issues should be considered when implementing land raising:

- top soil stripping, storage and reinstatement
- existing ground conditions (e.g. under laying soft or highly permeable ground)
- type of material (inert, granular/cohesive e.g. clay)
- slope or embankment stability
- compaction and settlement of infill material

[x] ttp://evidence.environment-agency.gov.uk/FCERM/

- possibility of mobilising contaminants
- impact on existing hydrology

Preparation of a detailed flood risk assessment is essential to support a planning application which would be assessed by the local planning authority. This option minimises the need for resistance and resilience measures. However this option should ensure safe movement of people in or out of the area (i.e. an island effect with surrounding areas inundated by floodwater is not acceptable).

8.3.6 *Ramps, demountable defences and flood gates for access*

It is often necessary to provide access over or through a flood defence to allow people and, in some cases, vehicles to pass through. There are several ways of ensuring access can be maintained or so that gaps can be closed when flood conditions are developing.

The preferable and most technically robust solution to allow access is to ramp access roads over defences. Where heavy plant or abnormal loads require access this may require considerable ramp lengths in order to allow for the sufficiently shallow gradients needed.

Alternative solutions where ramping is not practical, include the use of floodgates (Figure 8-5). An important factor is the need to establish responsibility for timely closure of the gap so that the proper functioning of the flood defence is not compromised.

Demountable systems offer an alternative solution to protect against flooding through access points in flood walls, or to defend individual properties.

Figure 8-5 shows how demountable panels may be custom designed to suits certain locations (railway track, road, etc). The defences are stored nearby to ensure efficient installation and to be erected when necessary. They rely on sturdy built-in foundations for stability and ease of installation. When not in use, demountables can be almost completely invisible, avoiding the unsightliness of large flood walls. This sustainable option is ideal for places where visual impact or access is a key issue. However, assembling the demountables in time before the flood occurs can be a problem and the risk of failure is therefore greater with this option.

Figure 8-5. Demountable flood defence over a railway (left) – *Courtesy of Bauer Demflood*[xi] and (right) swinging flood gate across a road –*Source: Environment Agency FCERM Fluvial Design Guide*[xii].

[xi] http://www.demflood.com/

8.3.7 *Community and property level flood resistance, resilience and adaptation*

Flood resistance (stopping water entering property) and resilience (reducing damages from flood water when it enters a property) is a property level approach towards managing flooding.

Flood resistance is achieved by fitting or modifying properties with commercially available and industry accredited property level flood defences. Property level flood resistance measures include flood gates, non return valves, sealing and air brick covers and can also be added to existing properties to manage the flood risk and help reduce the impacts of flooding (Figure 8-6).

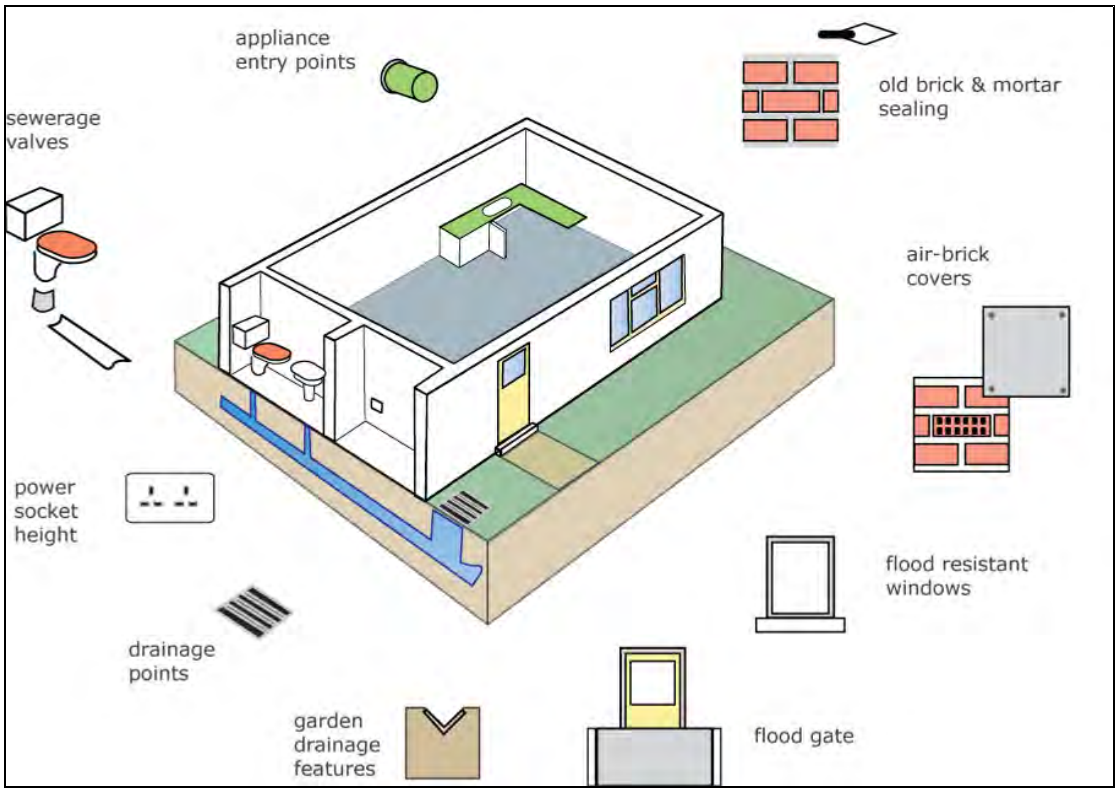


Figure 8-6. Some examples of flood resistance and resilience measures for properties (Source: Flood Sense[xiii]).

Flood resilience allows for flooding by incorporating building fabric, fixtures and fittings to reduce the impact of floodwater. This approach reduces the drying and cleaning process and cost and considerably reduces the amount of time until the building can re-occupied. Despite being a sustainable approach, the cost of materials and construction can be high due to the effect of the ageing of materials with time. Flood resilience is built into new properties through being designed in accordance with resilient construction guidance. Existing properties may also be retrofitted with resilience measures during renovation.

The option can implemented for properties within a flood cell which do not benefit from raised flood defences or where there is not a strong economic case to attract enough public funding

[xii] http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide
[xiii] http://www.floodsense.co.uk/

for a front line raised defence. The option requires educating and advising the community of the risks and the benefits that can be gained from flood resistance and resilience measures. Before implementing such an option, a period of consultation and community engagement should be held outlining the risks and providing advice on 'best practices'. This could be undertaken using 'Flood Fairs' to ensure the most effective implementation of this option.

Although optional, the uptake of publically funded resistance measures would be strongly encouraged. The resistance measures can also be supplemented by resilience measures implemented by the homeowner through renovation which could have additional benefits of reducing insurance premiums.

Defra have undertaken a number of grant aid flood resistance and resilience pilot studies; the uptake of publically funded property defences was very positive (89%). If kite marked products are used, adequate protection against relatively shallow flooding (up to 0.6m) can be achieved although other assets such as gardens and vehicles would be subject to flood damages. In an Aviva sponsored study (Flood Resilient Project) on a house in Lowestoft, the insurance company demonstrated how making a property flood resistant and resilient, post flood damages can be reduced by up to 80% compared to without implementing the measures[xiv].

8.3.8 *Do minimum*

The FCERM-AG[xv] defines the 'Do minimum' approach is one which requires the minimal amount of action to achieve necessary legal requirements (in terms of maintaining assets). This option is useful to help set the expenditure and benefits of the preferred defence scheme option in context and to test the incremental benefit: cost ratio.

This option usually comprises maintenance of defences or continuing current management practices and this minimal option is a useful comparator against larger schemes. A 'Do Minimum' approach is however more well suited to studies considering erosion risk or the maintenance of raised flood defences.

However, in Southampton, the main risk is from tidal flooding and there are no formal raised flood defences. The majority of existing defence structures along the frontage are privately owned. There is also currently no defence maintenance budget or formalised approach to managing flooding and erosion in Southampton.

'Continuing current practices' or a 'scheduled maintenance' based scenario would not meet the 'Do Minimum' requirements as flooding would occur with the same consequences as the 'Do Nothing' case. Large areas of the City would be at significant tidal flood risk over time and a 'Do Minimum' option would not maintain Southampton as a viable City; to do so requires the implementation of a flood and erosion risk management scheme (such as one or more of the alternative options discussed above). Consequently 'Do Minimum' was not considered an applicable option for this Strategy.

8.3.9 *Reactive maintenance and repairs*

Until 'Do something' options are implemented in The Strategy it has been assumed that the current approach of reactive maintenance and repair will continue unless otherwise stated, and this has been considered in the assessments. For example if raised defences are not required until 2030 it has been assumed that until that time, the current front line structures, including

[xiv] www.floodresilienthome.com
[xv] Coastal Flood and Erosion Risk Management appraisal guidance (Environment Agency, 2010)

those which are privately owned (such as along the ABP Port frontage), will be maintained by the operators and owners in a similar condition to that of the present day with no raising of the defence crests.

8.4 Long list options by Option Development Unit

The initial phase of option development involved the identification of a range of possible options to be investigated for each Option Development Unit to manage or protect against flooding and erosion.

At this early stage the 'net was cast wide' to include as many potential options as possible. This option identification was undertaken in liaison with key stakeholders and by picking up on the recommendations and the outputs of other relevant plans and programmes for the frontage (Section 3.8).

In addition to the range of generic long list options for consideration as described in Section 8.3, a 'Do Nothing' option was also included for each ODU as this had already been assessed as part of developing the baseline, and this option provides the basis for comparison of the impacts of other options. At this stage in the process, consideration of phasing or specific detailed alignments was not required; this would be undertaken during the appraisal of short list of options and the development of the preferred option.

The long list of options identified for each ODU are detailed in Table 8-3.

Table 8-3. Table summarising the long list of potential Strategy options identified for each Option Development Unit.

Area	Upper Itchen / St Denys	Bevois Valley	Meridian Studios	Northam	St Mary's Wharves	Crosshouse / Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge
Option Development Unit	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Long list options identified	1. Do Nothing 2. Steel sheet pile front line defences 3. Floodwall frontline defence 4. Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice 5. Raise Priory Road 6. Wholesale re-development / land raising	1. Do Nothing 2. Steel sheet pile front line defences 3. Community and property level flood resistance / resilience / adaptation 4. Land raising through redevelopment	1. Do Nothing 2. Land raising through redevleopment 3. Earth Embankment defences	1. Do Nothing 2. Sheet pile front line defences 3. Floodwall frontline defences 4. Land raising 5. Community and property level flood resistance / resilience / adaptation 6. Earth Embankment defences	1. Do Nothing 2. Sheet pile front line defences 3. Floodwall front line defences 4. Land raising 5. Earth Embankment defences 6. Community and property level flood resistance / resilience / adaptation 7. Road raising at the rear of the Wharves	1. Do Nothing 2. Floodwall front line defences 3. Steel Sheet pile front line defences 4. Land raising through redevelopment	1. Do Nothing 2. Raise quay walls with defences along perimeter of ABP land and demountable defences / ramps on access points 3. Defend frontline with tide gate / lock across entrance to marina and defences along perimeter of ABP land and demountable defences / ramps on access points 4. Road raising 5. Steel Sheet pile front line defences	1. Do Nothing 2. Frontline floodwall 3. Raise Canute / Platform Road 4. ABP boundary floodwall with demountables / ramps across access points 5. Steel sheet pile wall	1. Do Nothing 2. Defend frontline 3. Land Raising through redevelopment 4. Earth Embankment defences 5. Floodwall at rear of park and along the port boundary with demountable defences / ramps on access points 6. Existing Road raising 7. Construct elevated service road as flood defence	1. Do Nothing 2. Defend frontline 3. Floodwall along ABP boundary with ramps / demountables on access points 4. Raise the service road through the Port 5. Raise entire Port area 6. Raise road at rear of the Port 7. Upgrade railway line at rear to act as a defence	1. Do Nothing 2. Defend frontline 3. Earth embankment defences alongside railway 4. Sheet pile defences along railway line 5. Steel sheet pile defences along the river channel. 6. Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice

9 DEVELOPMENT OF THE SHORT LIST OPTIONS

9.1 Screening out 'Non Viable' Options from the Long List

The long list options for each area included a wide range of potentially possible strategic options. Some of these options were chosen for completeness and to ensure that no possible options were missed. However, in reality, it is unnecessary and impractical to investigate and appraise all of these options in detail, as given closer inspection and preliminary appraisal, it is apparent that some of the options would clearly not be feasible or practical solutions. A number of steps were undertaken in the screening process which was informed by detailed site investigations and key stakeholder engagement. The activities undertaken during this process are summarised in the following sections.

9.1.1 *Supporting data and assessments*

The review of a wide range of relevant data and the completion of the baseline studies and supporting assessments (See Sections 3,4, 5 & 6) allowed a detailed understanding of the frontage and the issues, constraints and opportunities to be gained. This information provided a sound basis from which to undertake the conceptual appraisal of options to screen out non viable options, and to develop potentially viable options in order to meet The Strategy objectives.

9.1.2 *Visual site inspections*

A number of site walkovers were undertaken covering the accessible areas of the frontage. Boat surveys covering the entire frontage were also carried out in order to fully understand and appreciate the issues, constraints and opportunities for the different strategic defence options along the different areas of the frontage. This informed the screening out of 'non viable' options and helped identify the practical options 'on the ground' for inclusion in the detailed appraisal stage.

9.1.3 *Key Stakeholder Engagement*

Engagement and liaison with key stakeholders formed an important part of the screening of the long list options. Dedicated meetings to discuss options were held with the Key Stakeholder Group and also the project Client Steering Group and individual meetings were also held with the following organisations:

- Network Rail – to discuss rail infrastructure and assets and the possible defence options.
- Scottish and Southern Energy
- Southern Water
- City Centre Master planners – to discuss The Masterplan outcomes, redevelopment areas, City vision and potential options.
- Royal Pier site developers (Urban initiatives)
- Associated British Ports (ABP) – to discuss potential viable options for the Port area.
- St Mary's Wharf operators (Hanson, Tarmac and CEMEX)

9.1.4 *ABP Liaison and current approach to flood defence*

As landowners of significant areas of study frontage, Associated British Ports (ABP) who own the Port of Southampton has been integrally involved and engaged, with as members of the Client Steering Group during the development of The Strategy.

As a result of a presentation of the baseline flood modelling, and discussions regarding potential defence options for the future, a formal letter was sent by ABP to Southampton City Council (dated 11th May 2011) outlining their corporate position in relation to The Strategy. The Strategy has accounted for this feedback in the screening of the long list options and the development of the preferred options.

ABP recognises that their "approach to port land use in the future is inherently linked with the City Council's considerations to prevent incidences of coastal flooding". ABP acknowledge that the "outputs from the baseline flood modelling undertaken in this study will be fundamental to developing the Port's strategy to managing climate change over the coming decades." Importantly ABP noted that "no flooding incidents are predicted to occur on ABP owned land for the next 50 years assuming a 1:200 year scenario" and ABP "feel this timeframe allows for coherent, targeted and integrated planning with all stakeholders."

Whilst ABP "recognises that there are undoubtedly benefits to both the City and ABP by placing a defence at the closest proximity possible to the quay edge, such that port operational land is afforded the maximum amount of protection it is felt that the Port's sensitivity to flooding is not necessarily the same as that of the City Council." As a "water compatible industry" ABP stated that they may be "able to tolerate some degree of flooding within the port estate. Nevertheless given the predicted timeframe involved ABP has the ability to develop a long term strategy which may be to the benefit of the Port and the City."

ABP stated that the "Port of Southampton Master Plan 2009- 2030 only considers a 20 year horizon – a considerable time in assessing cargo handling activity, capacity and requirements – and yet the Coastal Strategy projects a further 80 years into the future." ABP also recognise that "any approach ABP or successor organisations may pursue must not only consider measures to manage the risk of coastal flooding but also assess port operations/capabilities, funding and inherent liabilities. The measures which ABP will undoubtedly consider to be incorporated into port strategic planning include a range of options such as land raising, cope flood barriers and location or facility specific resilience measures." ABP also stated that equally they may "conclude that it is not considered feasible, practical or viable to incorporate measures on the port estate to the extent that they also meet the City Council's requirements for flood defence."

ABP has also informed The Strategy that "there will be in excess of one million cubic metres of aggregate is likely to be realised from the next capital dredging proposal of the main navigation channel to the Port" and proposed that this "could be used for the beneficial use of providing additional fill material for land raising to provide flood defences. The likely timeframe for removal of this material is 2012 – 2013, although ABP propose that a processing and storage area for this quantity of material would need to be independently sourced as there is currently insufficient area within the Port estate to handle this quantity material over a relatively short arrival window."

Therefore, at this time it is imperative that The Strategy accounts for this feedback and the possibility that no port land should form part of this particular management strategy, and that

"ABP is unable to commit to any specific concepts at this early stage without consideration of a detailed risk assessment and more detailed investigations."

9.2 Target Minimum Standard of Protection against Flooding

9.2.1 *Standard of Protection*

> ***Standard of Protection*** *can be defined as…*
>
> *"The flood event return period above which significant damage and possible failure of the flood defences could occur."*

An additional key consideration in screening the long list of options and developing the short list of viable options for each ODU, is the target minimum standard of flood protection which should be achieved by the options.

Such a decision on target minimum standard determines the required defence heights and therefore the relative heights of structures above existing ground levels. Consequently, this has implications for the type of defence which may be practical or achievable within the different ODUs, the design specifications and ultimately the cost. On deciding the minimum target standard of protection, the extreme water levels can be used to establish the required design crest height of defences, and therefore their relative height above existing ground levels, for any given reference time.

Due to the significant urban area and associated assets including critical infrastructure at risk of flooding over The Strategy timescale, and to facilitate The Strategy objectives, a suitably high standard of protection is desirable.

> *The aim of the Strategy to provide a* ***Standard of Protection*** *to prevent significant flooding up to* ***at least a 1:200 year*** *extreme flood event.*

This target minimum standard is also consistent with the recommendations of the Environment Agency for coastal flood defence strategies in other urban areas. It should also be recognised that for most of the intended design life of defences, the standard of protection provided will be far greater than the design standard (i.e. greater than 1:1000 years) with convergence towards the design standard only in the later years (Figure 9-1).

As part of the economic assessment of options, the case for providing a greater minimum standard of protection (1:500 year) was investigated (See Section 12).

9.2.2 *Determining design crest levels and defence phasing to achieve required standard of protection*

To achieve a target standard of protection for any given period in time, the design crest levels of defences have been determined using the predicted extreme water levels (Table 9-1). In addition, a multi-staged or 'phased' approach to implementing defences has been considered in the development of the preferred option. This concept is presented graphically through a worked example in Figure 9-1 and is explained in the following paragraphs below:

In an area where defences are required now to protect against flooding for the next 100 years, one approach to protecting against flooding could be to implement a large raised defence (e.g. a floodwall) in 2015 with a design crest level based on the 2110 1:200 year still water level. This approach would provide an exceptionally high standard of protection (unnecessarily so) during the first 50 years of The Strategy time period. This approach would also require a large up front capital investment due to the significant structure required. If such an approach was implemented through using a floodwall, significant issues such as hindered waterfront connection, access and operational requirements would result. Significant maintenance costs would also be required to achieve a 100 year service life of such a structure, possibly including a complete rebuild after 50 years. However, if this option was implemented through land raising many of these limitations and problems would be avoided or overcome.

An alternative approach could be to consider a hybrid of defence options with phased implementation to provide flood protection over the period. For example, Figure 9-1 shows how, over time, the water levels relating same frequency events (1:1, 1:200 and 1:500 year events) increase due to sea level rise. Therefore to achieve the target minimum standard of protection of 1:200 years, Defence A (e.g. an intermediate height floodwall) could be implemented to provide this standard of protection until 2060. This structure would initially (until 2045) have a crest level which would provide a standard of protection in excess of a 1:500 year event; this is necessary in order to account for the sea level rise over the design time period.

After 2060, if Defence A was not raised or superseded, the standard of protection from this defence would fall to less than 1:1 year by 2110. Therefore, in order to maintain a minimum 1:200 year standard of protection for the following 50 years, Defence B (e.g. a continuous strip of raised land) could be implemented at 2060 to supersede Defence A; this second phase defence would have a design height based on the 2110 1:200 year water level.

Through either the 'two phased' implementation approach (Defence A then Defence B), or an single phase initial implementation of a defence, it should be noted that for the majority of The Strategy period the standard of protection provided by the defences will be far in excess of the minimum target standard, and only the few years prior to the end of their design life does the defence fail to protect to at least a 1:500 year standard.

The consideration and evaluation of these concepts and issues was an integral part of the assessment of various options for each ODU and in the development of The Strategy. At the more detailed scheme stage, further refinement of phasing should be considered to determine the most efficient economic model.

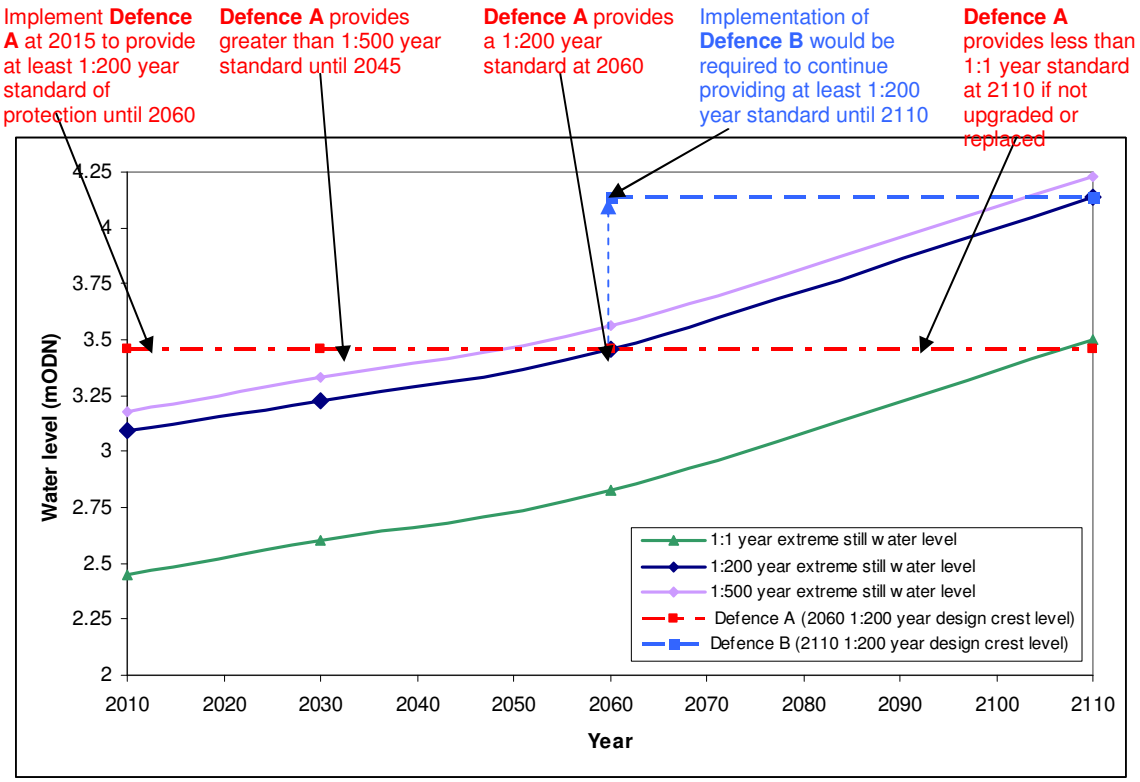


Figure 9-1. Graphical representation of how design crest levels are calculated from the extreme water levels (Table 4-2 and Table 9-1) to provide the target standard of protection, and how a phased approach can be used to provide flood protection over the period.

9.2.3 *Freeboard*

> ***Freeboard*** *refers to…*
> *"The height of the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action)*
>
> *Freeboard can be seen as a safety margin that makes allowance for uncertainties."*

Wave energy in The Strategy area is relatively low. For the purposes of the baseline flood modelling and determining flood risk, the influence of wave energy was ignored and only still water levels were simulated.

However, to allow for the potential for small waves in combination with the extreme water level events, and to allow for any other uncertainties, **a freeboard allowance of 300mm has been applied to the design of the short list of options investigated in this Strategy (Figure 9-2)** and the options have been assessed and costed on this basis.

By combining the design water levels (Table 9-1) with the freeboard allowance (300mm) the design crest levels for defences (in metres above Ordnance Datum Newlyn – mODN) have been generated (Figure 9-2) for 2010, 2030, 2060 and 2110 and are presented in Table 9-1).

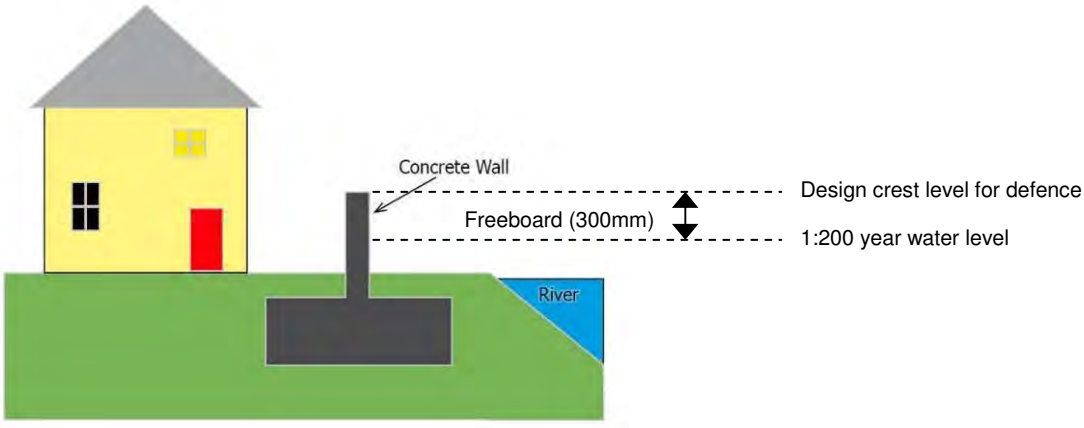


Figure 9-2. Schematic diagram showing how defence crest levels are established to achieve a minimum target standard of protection (1:200 year event).

Table 9-1. Design crest levels required to implement a 1:200 and 1:500 year standard of protection for Southampton with a 300mm freeboard allowance included.

	2010	2030	2060	2110
Design water level - 1:200 year event (mODN)	3.09	3.25	3.46	3.95
Design water level – 1:500 year event (mODN)	3.18	3.35	3.57	4.14
Freeboard allowance (m)	0.3	0.3	0.3	0.3
Design crest level used for costing defences 1:200 year event (mODN)	3.4	3.55	3.75	4.25
Design crest level used for costing defences 1:500 year event (mODN)	3.5	3.65	3.85	4.45

9.3 Short list options

On the basis of discussions with key stakeholders, site visits and the appreciation of issues, constraints and opportunities, and a consideration of required design heights to meet the target minimum standard of protection, a conceptual appraisal of the impacts and viability of the long list options was undertaken. This identified the options worthy of detailed appraisal for each ODU and screened out any 'non viable' options. 'Non viable' options refer to those options which following an initial appraisal were found to be unfeasible or unsuitable solutions, either on technical, practical, environmental or social acceptability grounds. These options were then excluded from any further detailed appraisal, with an explanation, and the remaining options then formed the short list of viable options for each ODU which were then costed.

10 IDENTIFYING THE PREFERRED OPTIONS FROM THE SHORTLIST

10.1 Methodology

In order to ensure that the options developed as part of The Strategy are realistic and acceptable practical solutions, and not just the most cost effective theoretical options which may not be achievable in reality, preferred options were identified for each area based on an appraisal of technical, practical, environmental, economic and social feasibility.

The Strategy objectives (Section 7.1) and the aspirations of the 'City vision' formed an integral consideration in the identification of preferred options. The shortlist options were also appraised in terms of their potential environmental impacts; this process was undertaken through the formal assessment frameworks set out in the Environmental Report (Appendix F), Habitats Regulations Assessment (Appendix G) and the Water Framework Directive Assessment (Appendix H). These environmental assessments were parallel and integral processes in the development of The Strategy and the key findings of these assessments have been summarised within the appraisal matrices in Section 10.2 for the shortlist options of each area. These processes and supporting assessments rationalised the potentially large number of possible option combinations for detailed testing (many of which would be non-sensical) and have also helped ensure that the options forming the final Strategy are practical and can be delivered 'on the ground'.

In addition to the identification of preferred options for each Unit, a flood risk based approach was used to identify the preferred phasing of works for the various areas of the frontage. The concept of identifying the 'phasing of works' is based on the assumption that in a ideal world it is optimal to implement defences in advance of the flood risk for a given area (for example, if there is no flood risk at 2030 but is a significant risk by 2060 it follows that the risk would begin to arise sometime within this time period, so defences would be required to be implemented at 2030 to protect against significant flooding). Therefore the flood risk based phasing of works was identified and informed by the timing of significant flood risk summarised in Table 8-2.

Following the identification of the preferred options and the required phasing of works for each area, the 'package' of preferred options was assembled as a focus for further detailed testing and full economic and environmental assessments. During the detailed assessments, alternative phasing approaches for implementing the options were explored and tested to optimise the timing of works and further refine the options.

10.1.1 *Accommodating future uncertainty*

The range of climate change projections (EA 2011)[xvi] sets the context of future uncertainty (see 4.2) and this needed to be appropriately considered in the development of Strategy preferred options. An imperative part of this process was the sensitivity testing of preferred options against the range of scenarios presented to ensure that the options being put forward are still appropriate, not only for the recommended change factor, but also that there is sufficient inbuilt flexibility within The Strategy to account for the range of risks.

EA 2011 recommends that for high level plans the upper and lower estimates should be used to give an indication of the range that might occur over the lifetime of the plan and be used in

[xvi] EA 2011, Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities

the primary consideration of different options. Projections based on the central change factor are largely of secondary use as a planning guide.

For investment appraisals, such as a coastal strategy, EA 2011 advises that the central change factor will provide a focus for options consideration, with the upper and lower estimates providing a range to test the extent to which options can adapt and, if need be, refined to better reflect the wider range of potential future mean sea level changes.

In order to test the robustness and applicability of options to the range of scenarios a sensitivity analysis across the range of plausible sea level rise changes was undertaken (Figure 10-1). By carrying out such an assessment it ensured that the adaptation options taken forward are not tied to a single assumption of what may happen in the future and are therefore more able to cope with a wider range of possible future scenarios. This helped accommodate the significant uncertainty in current climate projections, both at the scale and the timeframe of typical FCERM decisions. An economic sensitivity test was also undertaken to confirm applicability and robustness of the preferred options to the range of sea level rise projections (See Section 12.6).

Therefore flexibility and robustness were key considerations in the selection and refinement of preferred options and the following three main considerations underpinned the philosophy adopted in the selection of the preferred options:

- **Identifying options that could deal with a range of potential sea level rise changes**

  One approach is to develop options that reduce risk over the range of potential change or could be designed from the outset to cope with upper end estimate of climate change.

- **Build in flexibility**

  Another approach is to build in the ability to adjust an option should it be required; i.e. build in flexibility. Examples include purchasing an area behind a floodwall to enable it to be raised if necessary.

- **Delaying decisions that would be difficult to change – adaptive management**

  A complementary approach is to build in flexibility into the decision process itself over time through waiting and learning. For example, sequencing options so that no or low regret options are taken earlier and more inflexible measures are delayed in anticipation of better information.

EA 2011 advises that where possible opportunities are sought to sequence the investment over time, rather than implement a robust (precautionary) design from the outset. A phased approach to implementing preferred options, underpinned by flood risk, has therefore been recommended by The Strategy in order to provide the required flexibility to accommodate potential future change cost-effectively.

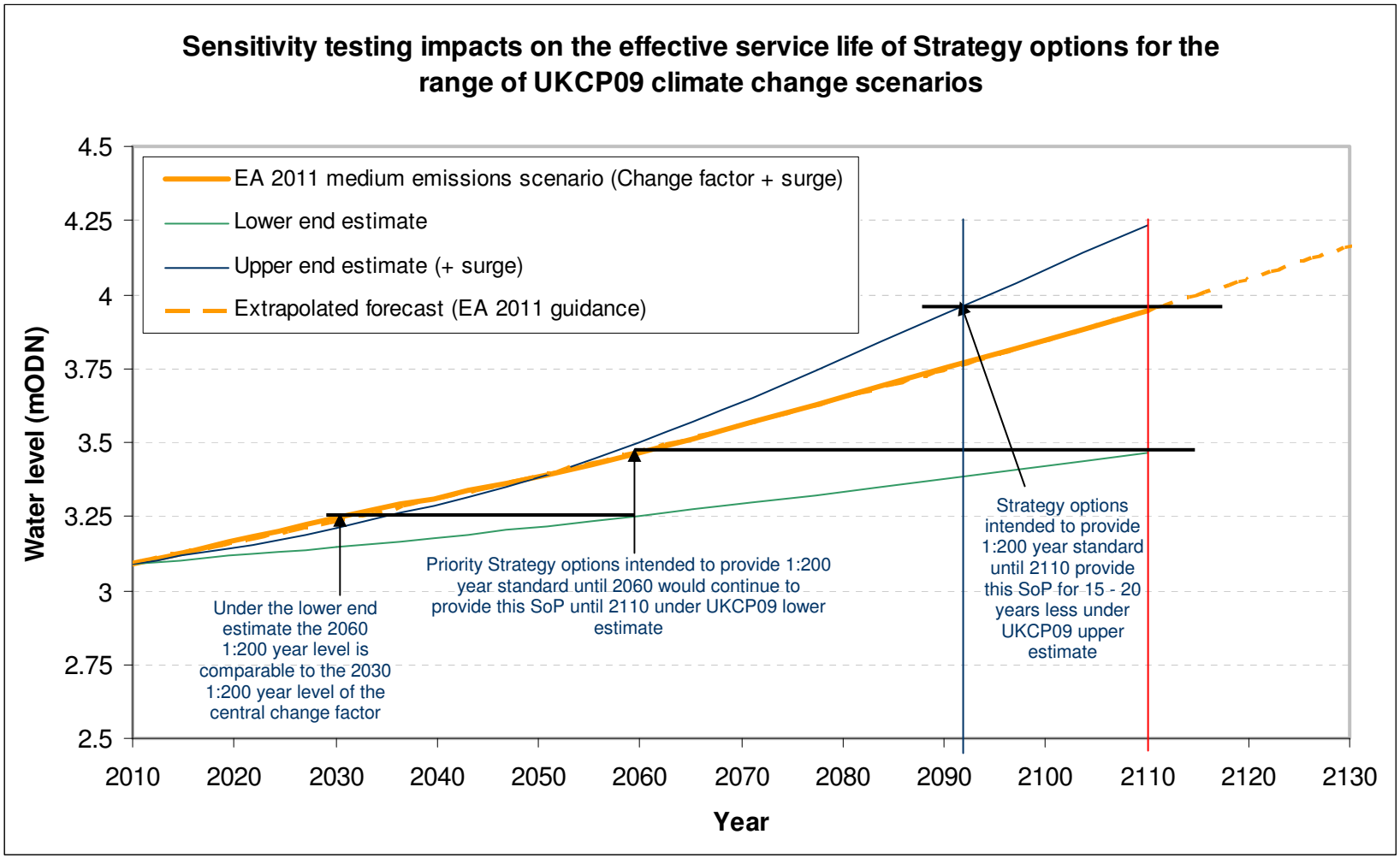


Figure 10-1. Sensitivity of effective service life of preferred options to the range of future climate change scenarios.

10.1.2 *Confirmation of the preferred options*

Following option appraisal and selection of the preferred options, the draft Strategy was put forward for public consultation. This consultation period spanned 3 months (November 2011 - January 2012). During this period four manned exhibitions were held at venues along The Strategy frontage to present the draft proposals to the public (Figure 10-2). The exhibitions were hosted by Southampton City Council with support from URS.

In addition an unmanned exhibition was held in the City Library for a 2 week period. This provided all stakeholders and the public with an opportunity to understand the plan and the implications of the preferred strategy as well as to ask any questions. Feedback and comments from the consultation activities were gained through the use of printed and online questionnaires. During this period the project website and the Southampton City Council website also hosted the consultation documents and materials.

Additional engagement with key stakeholders and landowners was undertaken through e-mail shots, letters, press releases and meetings.

Figure 10-2. Photos from the public exhibitions.

The exhibitions and engagement activities were integral in gaining support for the proposals and in building commitment towards its implementation. A very positive response was received with 99% agreement from the public to the proposals put forward (Figure 10-3). In addition feedback from key stakeholders landowners, Natural England and the Environment Agency was received.

Following consultation, The Strategy was finalised and the preferred options confirmed, accounting for stakeholder feedback received. Full details of the consultation process and feedback received are given in Appendix J – Stakeholder Engagement.

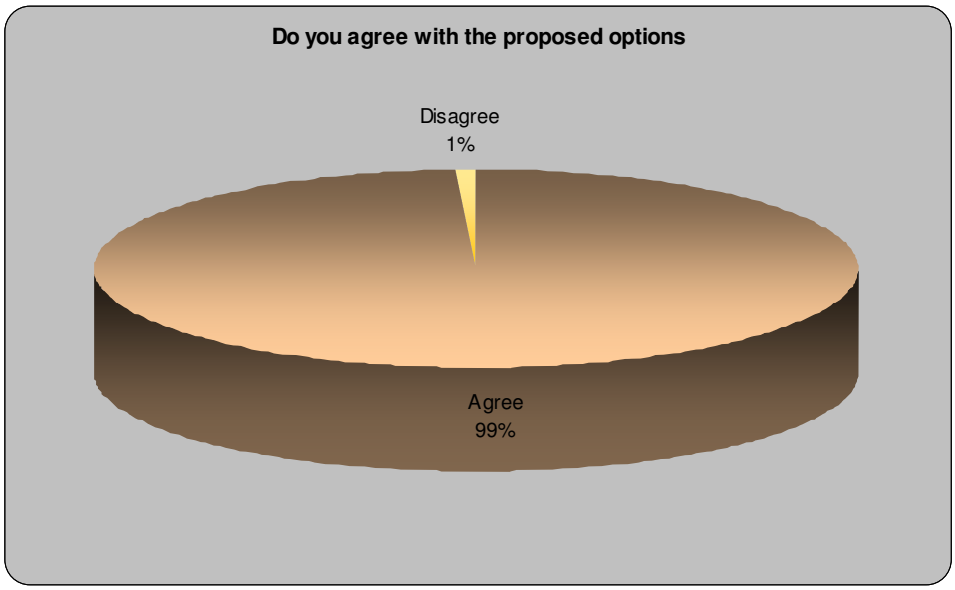


Figure 10-3. Respondent agreement of preferred Strategy options.

10.2 Summary of option appraisal and preferred option for each ODU

The following sub-sections provide a summary of the option appraisal processes undertaken for each Option Development Unit and also the preferred options identified along the frontage.

For each ODU the 'Do Nothing' flood risk is summarised and the flood risk based phasing is identified.

To achieve the target standard of protection the topographic surface described by the LiDAR data was inspected to determine the required defence height. This was undertaken using 100m defence sections. The typical, maximum and minimum defence heights (including 0.3m freeboard) to achieve a minimum 1:200 year Standard of Protection for each Unit are also included.

The summary of the initial assessment of the long list of options for each Unit is provided and the non viable options discarded for further appraisal and the potentially viable short list options selected for detailed evaluation.

Summaries of the detailed studies and assessment of options are provided in tables using Red, Amber, Green indicators to provide an illustration of the relative merits of options against a number of receptors and indicators in a simplified way. These receptors cover a range of aspects which could potentially be impacted by the implementation of the option. These tables are underpinned by the detailed environmental and technical assessments undertaken for this study which have guided the selection of the preferred option; simplified supporting commentaries summarising the detailed findings are provided as a guide in the following tables. Note that box outs in the 'viable options' assessment tables of each Unit indicate those options which either form elements of the preferred option, or are the preferred option. For each Unit a detailed discussion of the preferred option is provided.

For full information and the detailed assessments of the environmental impacts of each option which have underpinned the preferred option selection please view the Strategic Environmental

Report, Habitats Regulations Assessment and Water Framework Directive Assessment provided in Appendices F, G and H respectively.

The long listed and short listed options assessed in the area by area option appraisal are summarised in Table 10-55 and a summary of the preferred options for each ODU is provided in Table 10-56.

10.3 Unit 1 - Upper Itchen / St Denys

10.3.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-1.

Table 10-1. 'Do Nothing' scenario flood risk summary for Option Development Unit 1

Area	Upper Itchen / St Denys	'Do nothing' tidal flood risk summary
Option Development Unit	1	
Present Day Flood Risk 1:200year typical depth (max) metres	0.25 (0.75)	There is a present day tidal flood risk for around 130 properties from a 1:200 year event. Under such an event flood depths would be typically 0.25m and up to 0.75m. Approximately 70 properties are at more significant immediate risk lying within the present day 1:50 year flood envelope. By 2030 the flood risk will increase further and the present day 1 in 50 year flood envelope will become approximately a 1 in 20 year event (5% chance) by 2030, and a 1 in 2 year event (50% chance of flooding in any given year) by 2060. Beyond 2060 the flood envelope and flood depths will continue to increase significantly.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5 (1)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75 (1.25)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.75 (2)	
Present Day Flood cell	B	
2030 Flood cell	B	
2060 Flood cell	B	
2110 Flood cell	B	
Required implementation of 'Do something' option based on flood risk		2015
SMP policy		Hold the Line till 2110

10.3.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative minimum, maximum and typical defence heights required are summarised in Table 10-2.

Table 10-2. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 1.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	1.5	0.5
2030	-	1.6	0.6
2060	-	1.8	0.8
2110	-	2.3	1.2

The initial appraisal of the long list options for this Unit is presented in Table 10-3. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-3. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Raise Priory Road	No	Due to the low number of properties at risk (and therefore low economic benefits generated) behind this road, and the technical, access and groundwater drainage issues associated with road raising, this option was rejected for detailed appraisal.
	Wholesale re-development / land raising -	No	Due to the significant lengths of private residential ownership of much of this frontage, and the relatively low economic benefits generated behind the frontline of properties, this option was rejected for detailed appraisal.
Potentially viable short list options	Steel sheet pile front line defences.	Yes	Many residential properties and commercial assets along the frontage are at high risk of flooding over The Strategy period so a detailed appraisal of a frontline defence option was undertaken.
	Floodwall front line defence.	Yes	Many residential properties and commercial assets along the frontage are at high risk of flooding over The Strategy period so a detailed appraisal of a frontline defence option was undertaken.
	Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice.	Yes	The flood envelope is relatively narrow and it is mainly waterfront properties at risk of flooding. Due to long stretches of private frontages where waterfront access and riverside views are an important factor for many residents this option (where the risks are managed and adapted to) was appraised in detail.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-4 and for the potentially viable short list options in Table 10-5.

The box out in Table 10-5 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.3.3.

Table 10-4. Appraisal of non viable options screened out for ODU 1 (Upper Itchen / St Denys).

Options	Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Raise Priory Road	None	Minimal	Poor – no flood protection to properties in front of road, access issues, land take etc.	Altered – raised road of significant height	Unaffected	Some likely	Minimal	Front line properties still have no flood protection	High cost option Low benefits generated as many assets in front of Priory Road	High – properties in front of road still at risk of significant flooding
Wholesale redevelopment / land raising	Potential for some detrimental impacts	Potential for compression impacts on assets	Poor – private land owners at present, would totally alter the area	Significantly altered	Unaffected	This option would require significant areas of privately owned land to implement	None	Good – if continuous strip of raised land achieved	High cost option Poor economic case to attract public funding	Low if continuous raised strip achieved.

Table 10-5. Summary of short list option appraisal for ODU 1 (Upper Itchen / St Denys). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Steel sheet pile defences	Potential detrimental impacts for adjacent designated sites (vibration, noise etc).	Potential for impacts to buried assets.	Mixed – increased flood protection but character of waterfront significantly altered	Significantly altered	Significantly restricted due to height required	Minimal	Minimal and infrequent	Good – low risk of failure	High cost option Poor economic case to attract public funding in short term	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Concrete flood wall	Potential impacts on BAP mudflats but mainly temporary during construction.	Minimal	Mixed – flood protection but views hindered, access issues and land take	Some detrimental impacts and views hindered	Significantly restricted due to height required	Some loss of gardens / land take	Minimal and infrequent	Good – low risk of failure	Medium cost option Poor economic case to attract public funding in short term but better in the future.	Potential for significant flood event if defence overtopped or breach failure occurs

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Community and property level resistance / resilience / adaptation	Minor	Minimal	Mixed – increased protection but some aesthetic impacts. Concerns of defence failure / flooding	Loss of gardens over time as sea levels rise. Some aesthetic impacts	Access maintained	Minimal	Some maintenance required	Good short to medium term, not good long term as flood risk increases. Risk of failure.	Low cost	Greatly reduces consequences of flooding especially in the short to medium term. Potential for residual damage if defences are not implemented in advance of flood event or under extreme events in the longer term.

10.3.3 *Preferred option*

A range of potentially viable short list options were identified for this Unit including a

- front line steel sheet pile wall,
- a concrete flood wall near the front line; or
- Community and property level flood resistance / resilience

For the short to medium term (up to 2060), the flood risk envelope from a 1:200 year event is relatively narrow and the flood depths of the assets affected are typically 0.25m. Consequently, the economic case to attract public funding for costly front line defences until this time is not strong.

In addition, a major drawback of implementing raised flood defences along the frontage to provide a 1:200 year standard of protection up to 2110 is that it would form a significant barrier between the land and the river and may fundamentally alter the character of the frontage. River views would be significantly hindered along with access to the river from many properties and gardens and this option would be aesthetically undesirable. Front line defences may also increase the risk from surface water flooding as the defences would prevent surface water running off into the river as the land slopes upwards away from the river.

Therefore the preferred option to manage flood risk and reduce the consequences of flooding in this unit until 2060 is property level flood resistance (stop water entering) and resilience (reduce damages / clear up when water enters). Under this option the most vulnerable 70 properties currently at risk from less than a 1:50 year tidal flood event could be eligible to receive Flood Defence Grant in Aid (FDGiA) funding for property level defences from 2015 (Figure 10-4 & Figure 10-5). The property level resistance and resilience would rely on property owners taking responsibility for the operation of the defences ensuring that flood gates are closed in advance of impending flood events. This option would also provide additional benefits reducing the consequences of any surface water flood events that would occur. This preferred approach will also include setting up a flood warning system to provide advanced notice of flood events and also the establishment of a community flood group. For a full description of this option and the types of measures involved see Section 8.3.7.

There are a further 130 properties at lower risk of present day tidal flood flooding (greater than a 1:50 year event envelope but within the 1:200 year flood envelope). These properties are not currently eligible for FDGiA funding for property level protection under the current criteria; however engagement and liaison with these properties will be undertaken to raise awareness of tidal flood risk and the potential increase in risk in the future due to sea level rise. Privately funded property measures would also be encouraged for these properties to reduce the consequences of an extreme event. By 2030, if the tidal flood risk increases as expected, these properties may then become eligible for FDGiA funding for property level flood resistance measures, assuming the current FDGiA funding criteria for this option still apply.

From 2030 further engagement and awareness raising to facilitate community adaptation to sea level rise will be undertaken for those properties which become at risk of tidal flooding due to sea level rise but have not benefited from FDGiA funding to implement property level protection.

The option of resistance and resilience until 2060 could be considered to be at odds to the SMP policy of Hold the Line; however, it should be noted that currently there is no formal defence alignment to 'hold' and many of the structures present are privately owned. It is recognised that in addition to the implementation of resistance and resilience measures to reduce the consequences of tidal flooding, the continued maintenance and repair of privately owned structures would also be beneficial to prevent tidal inundation from the lower return period events and to prevent erosion of the gardens in the short to medium term.

By 2060, the flood risk is set to increase significantly and the case for a front line flood defence would be much stronger by this time. Technically, defending the frontage using steel sheet pile defences is challenging in this area due the required defence heights and because of the soft estuarine mud and ground conditions; this would consequently be a high cost option. Environmental constraints of accessing and constructing steel sheet pile defences on the Biodiversity Action Plan mudflats would also need to be addressed along with any archaeological considerations.

Therefore for longer term flood protection, the preferred option would be to implement a concrete floodwall (in 2060) to provide protection against tidal flooding up to a 1:200 year event at 2110. This would require a wall of typically 1.2 metres in height above existing ground levels. The wall would ideally run close to the front line and would need community support to ensure a continuous defence is achieved so that there are no weak points where breaching of the defence could occur. A wall could also be more sympathetically landscaped compared to a 'stark' steel sheet pile front line defence. However, the construction footprint for the wall foundations and the land take (gardens) involved with this option would need to be considered and accepted by land owners.

If the benefits to the community of raised flood defences are perceived to overwhelm the drawbacks, and the necessary non-public funding contributions could be obtained, a concrete flood wall defence could be delivered for this Unit before 2060.

Summary of preferred option for ODU 1

2015 to 2060 – Community and property level flood resistance and resilience and adaptation

2060 to 2110 – Floodwall near the front line

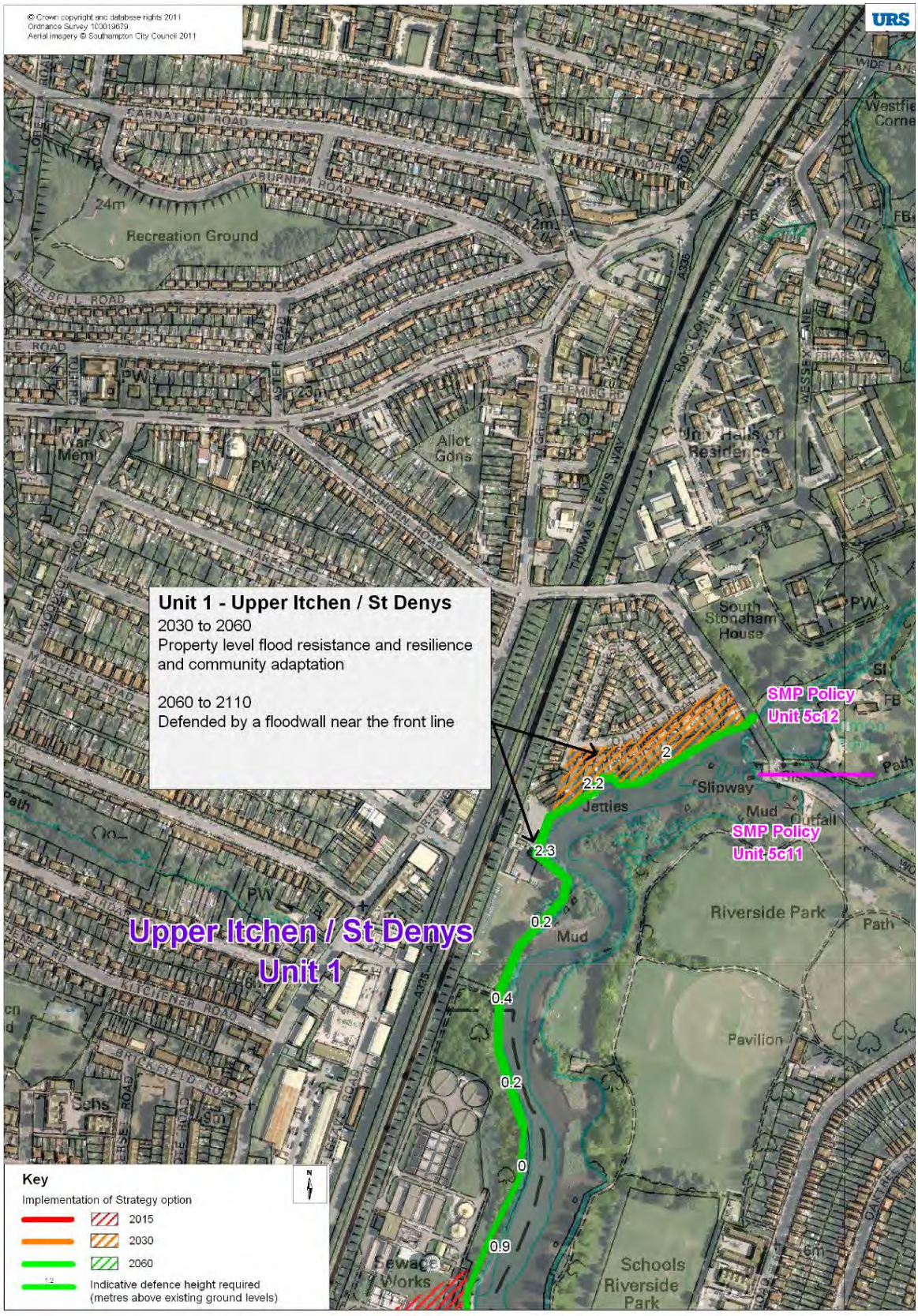


Figure 10-4. Mapping of the preferred option for northern part of ODU 1 (Upper Itchen / St Denys).

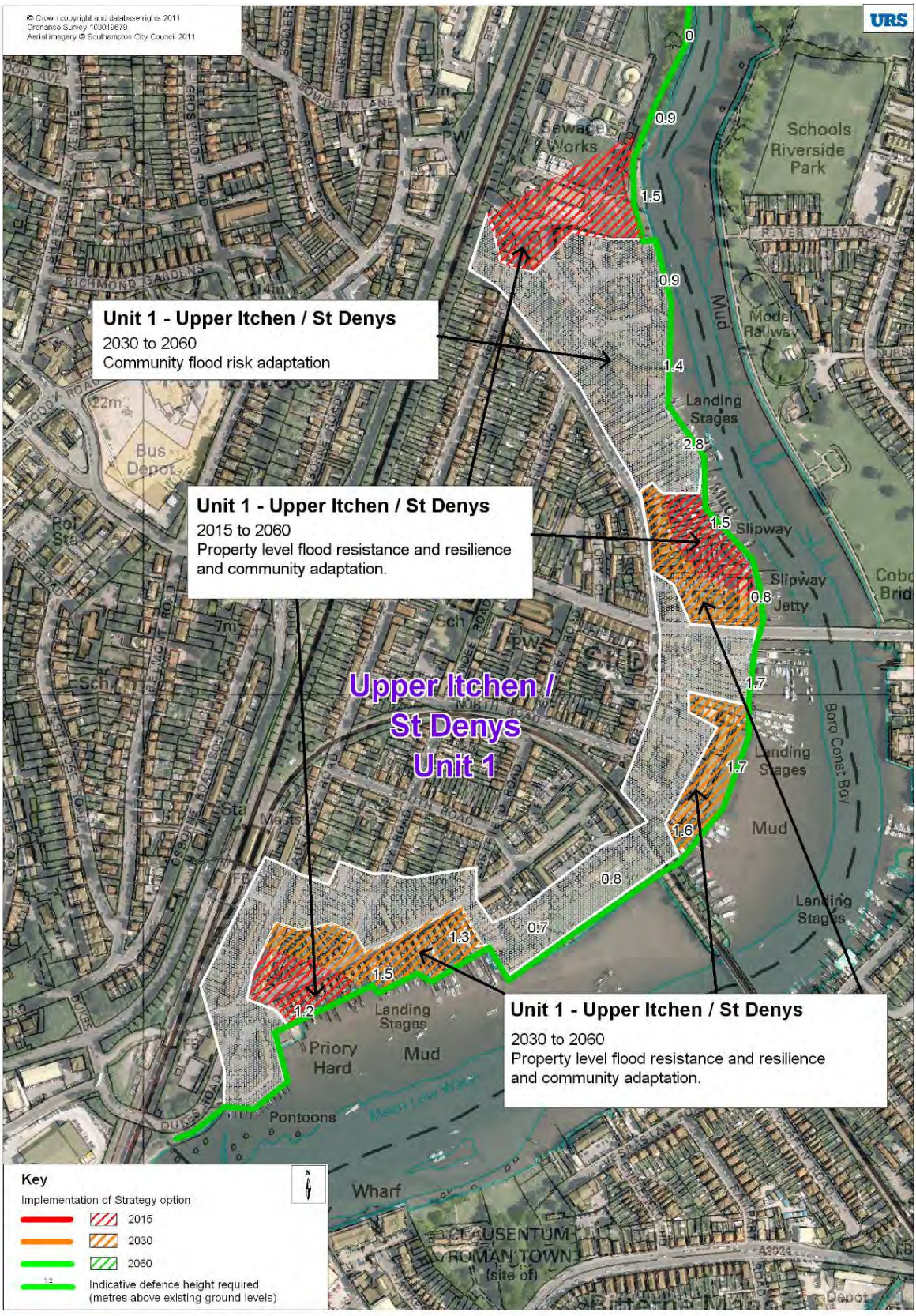


Figure 10-5. Mapping of the preferred option for southern part of ODU 1 (Upper Itchen / St Denys).

10.4 Unit 2 - Bevois Valley

10.4.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-6.

Table 10-6. 'Do Nothing' scenario flood risk summary for Option Development Unit 2.

Area	Bevois Valley	'Do nothing' tidal flood risk summary
Option Development Unit	2	
Present Day Flood Risk 1:200year typical depth (max) metres	0	The new boardwalk and defences and railway infrastructure currently offer protection against erosion and offer a present day standard of protection against flooding to greater than a 1 in 200 year event. However, by 2060, the area becomes at significant risk of flooding from a 1:200 year event, and the risk of flooding falls to less than a 1 in 1 year event by 2110.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5 (0.75)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.5(2)	
Present Day Flood cell		
2030 Flood cell		
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2030
SMP policy		Hold the Line till 2110

10.4.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-7.

Table 10-7. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 2.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	-	-	-
2060	-	0.4	0.3
2110	-	0.9	0.8

The initial appraisal of the long list options for this Unit is presented in Table 10-3. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-8. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Community and property level flood resistance / resilience / adaptation.	No	This unit is part of a continuous flood cell and the depths associated with future flood events are significant by 2060 due to the topographic depression behind the front line, so this option was rejected for detailed appraisal.
	Land raising through redevelopment	No	Due to the presence of the railway line at the frontline, and the operational / technical issues of land raising along a railway line this option was rejected for detailed appraisal.
Potentially viable short list options	Steel sheet pile front line defences.	Yes	A number of receptors and assets are at high risk of flooding by the end of The Strategy period. This area is also part of a larger continuous flood cell so this was appraised in detail.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-9 and for the potentially viable short list options in Table 10-10.

The box out in Table 10-10 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.4.3.

Table 10-9. Appraisal of non viable options screened out for ODU 2 (Bevois Valley).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Community and property level flood resistance / resilience / adaptation	Minor	None	Potential for significant flood depths and concerns over flood risk.	Minor	Unaffected	None	Some maintenance required	Risk of failure as flood depths significant	Low cost option.	Potential for significant damage due to flood depths in this area if defences overtopped.
Wholesale redevelopment / land raising	Minimal	Potential impacts for assets	Significant costs and disruption. Interruption to critical infrastructure	Significantly altered but also with opportunities for improvement	Unaffected	This option would require significant areas of land take to implement but once undertaken would be redeveloped	None	Good – if continuous strip of raised land achieved	High cost option Poor economic case to attract public funding	Low chance of breach failure however should overtopping occur significant and extensive flood event would occur

Table 10-10. Summary of short list option appraisal for ODU 2 (Bevois Valley). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Steel sheet pile defence	Minimal – possible construction impacts	Potential benefits for listed buildings and scheduled monuments as they are protected	Good – increased flood protection using similar defences to present	Minimal effects as currently defended by sheet pile defences	Not affected	Minimal	Minimal	Good	Medium cost option	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

10.4.3 *Preferred option*

The frontage will continue to be protected to a 1:200 year standard of protection until 2030 by the existing defence structures as their crest heights are sufficiently high. After 2030 the flood risk increases significantly as the existing structures crest heights are exceeded.

Under a "Do Nothing" scenario, Critical infrastructure of the railway and other industrial assets would be at significant risk of flooding by 2060. Due to the topographic basin behind the front line there is the potential for significant pooling of flood water here. By 2060 if no additional defences were implemented, flooding in this unit would also rapidly inundate the adjacent areas.

The intertidal area is immediately in front of the railway line and there is little room for defences. Therefore the implementation of a steel sheet pile at 2030 is the preferred option. To provide at least a 1:200 year standard of protection until 2110, this defence would require a crest level of 4.25m ODN which would need to be typically 0.8m above existing levels. This defence would need to tie into the higher ground at the north of the unit and to the defence scheme in ODU 3 to the south (Figure 10-6). There is potential to involve Network Rail in the implementation of this option and dialogue with them should continue. Works could be incorporated or timed to coincide with railway upgrades as this defence will provide necessary protection to their assets and key infrastructure.

Summary of preferred option for ODU 2

2015 to 2030 – Defended by existing structures

2030 to 2110 – Defended by steel sheet pile wall at the front line implemented at 2030

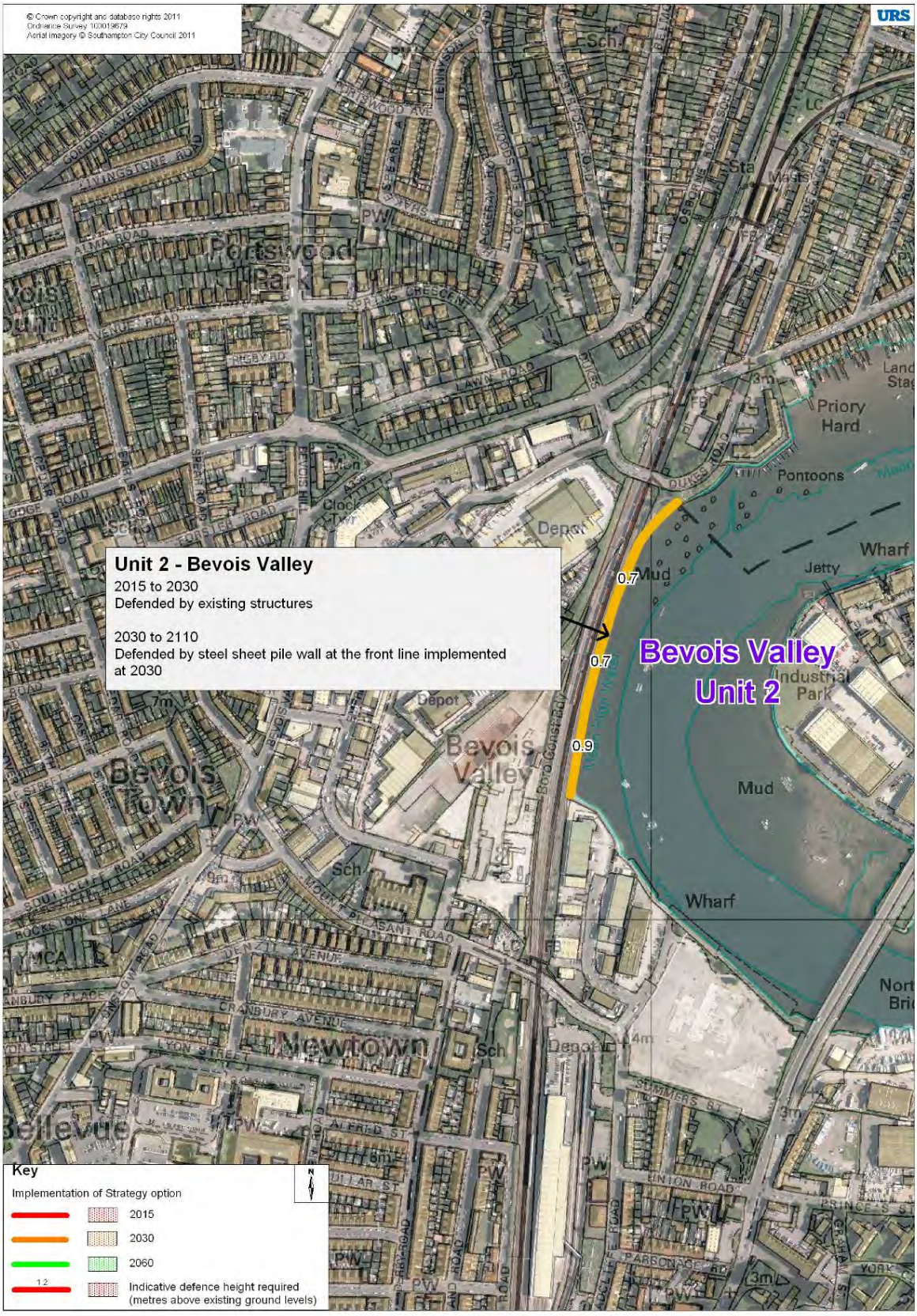


Figure 10-6. Mapping of the preferred option for ODU 2 (Bevois Valley).

10.5 Unit 3 – Former Meridian Studios site (Railway line to Northam Bridge)

10.5.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-11.

Table 10-11 'Do Nothing' scenario flood risk summary for Option Development Unit 3

Area	Former Meridian Studios site	'Do nothing' tidal flood risk summary
Option Development Unit	3	
Present Day Flood Risk 1:200year typical depth (max) metres	0.25 (0.5)	This area comprises industrial units and the former Meridian Studios site. The area is at risk of some flooding under a present day 1:200 year event and as sea levels rise the flood risk increases significantly. Lower ground levels towards Northam Bridge provide a flow path for tidal flooding towards Northam for a 1:200 year event at 2030.The flood risk would continue to increase significantly into the future without implementing new raised flood defences.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5 (0.75)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75 (1)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.25 (1.5)	
Present Day Flood cell	A	
2030 Flood cell	A	
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2015
SMP policy		Hold the Line till 2110

10.5.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-12.

Table 10-12. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 3.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	0.5	0.6	0.6
2030	0.6	0.7	0.7
2060	0.8	0.9	0.9
2110	1.3	1.7	1.4

The initial appraisal of the long list options for this Unit is presented in Table 10-13. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-13. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Earth Embankment defences	No	The implementation of this option would be impractical due to current land use requirements and the significant land take required so was rejected for detailed appraisal.
Potentially viable short list options	Floodwall front line defences	Yes	This option was appraised in detail as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell with flow paths through to adjacent areas.
	Land raising through redevelopment	Yes	Part of the site is currently awaiting re-development and there is a strong potential for land raising to form a flood defence so this option was appraised in detail

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-14 and for the potentially viable short list options in Table 10-15.

The box out in Table 10-15 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.5.3.

Table 10-14. Appraisal of non viable options screened out for ODU 3 (Former Meridian Studios Site).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing tidal flood risk	Maintenance	Relative Cost	Residual risk
Earth embankment defences	Minimal	Some possible - potential for compression damage	Mixed – improved flood protection but also land take issues	Impacts on the landscape but also with potential for improvement	Some impacts – potential for improvement	Significant land take for earth embankment of sufficient height.	Depends on the width of the embankment but risk of breach exists especially with narrow bank	Some maintenance required	Low cost option	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

Table 10-15. Summary of short list option appraisal for ODU 3 (Meridian Studios). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual risk
Flood wall front line defences	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	Unlikely to be any effects	Mixed – improved flood protection but access and land take issues	Some impacts due to required crest height above existing defences	Some restriction, but minor if built to intermediate standard	Minor once implemented	Some failure risk, especially at access points	Some	Low	Some residual risk from overtopping under extreme events with high consequence
Land raising	Minimal	Minor	Mixed – existing landscape altered but robust flood defence and maintained access / water views	Altered – mixed opinions.	Access maintained	None if undertaken through re-development	Excellent – very low risk of failure	None	High, but potential to reduce costs if undertaken through re-development and utilising ABP dredge material and on site demolition material.	None

10.5.3 *Preferred option*

The flood mapping demonstrates the need to 'do something' in the short term to protect against flooding in this unit. Land raising is the most robust defence solution and therefore an aspirational preference which best achieves the objectives of The Strategy; however, due to the current industrial land use in parts of this Unit adjacent to the railway, the land raising and redevelopment is not appropriate in these areas until the current properties reach the end of their service life.

However, part of this area is currently cleared awaiting redevelopment (former Meridian Studios site). There is an opportunity for some of this site to be raised during redevelopment in the near future and this should form part of the flood defence in this Unit. This land raising at this site would need to achieve a strip of raised land of at least 50m width with a height of 4.25m ODN to provide at least a 1:200 year standard of protection until 2110. This land raising would also need to tie into Northam Bridge and the defences to the east to ensure a robust defence is achieved.

To provide flood protection within the unit until land in other areas can be raised in the future, a relatively low flood wall (typically 0.9m above existing ground levels) would be required near the front line to provide a 1:200 year standard of protection till 2060 (Figure 10-7). This wall would need to tie into the land raising undertaken previously at the former Meridian Studios site.

As flood risk increases in the longer term (by 2060), and buildings in the area to the west of the Meridian Studios reach the end of their current service life, land should be raised during redevelopment to supersede the flood wall as the defence. This land raising would need to achieve a continuous strip of raised land of at least 50m width with a height of 4.25m ODN to provide at least a 1:200 year standard of protection until 2110. This land raising would also need to tie into land previously raised at the Meridian Studios site in order to form a robust defence.

Summary of preferred option for ODU 3

2015 to 2060 – Intermediate height floodwall forming the spine of the flood defence until raised land undertaken through redevelopment supersedes the wall as the main defence by 2060.

2060 to 2110 – Defended by a continuous strip of raised land achieved through redevelopment to form a robust flood defence.

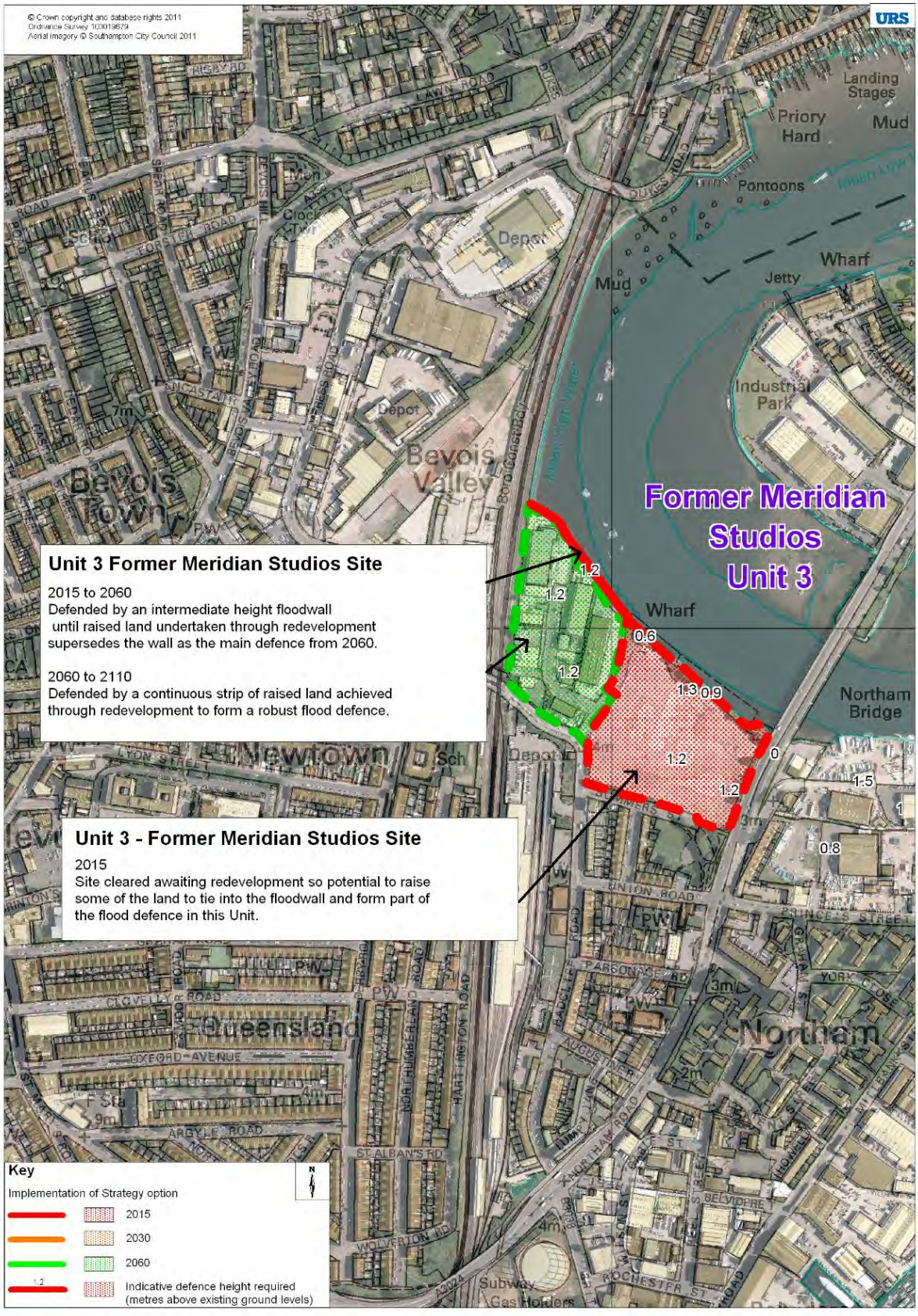


Figure 10-7. Mapping of the preferred option for ODU 3 (Former Meridian Studios Site).

10.6 Unit 4 - Northam (Northam Bridge to Belvedere Wharf)

10.6.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-16.

Table 10-16 'Do Nothing' scenario flood risk summary for Option Development Unit 4

Area	Northam	'Do nothing' tidal flood risk summary
Option Development Unit	4	
Present Day Flood Risk 1:200year typical depth (max) metres	0.25(0.75)	Many assets are at risk of tidal flooding from the present day with a significant area at risk of flooding of up to 0.75m depth from a present day 1:200 year event. However, if raised flood defences were not implemented, the flood risk would continue to increase significantly into the future. Pooling of flood waters would occur under tidal inundation due to the slight natural topographic depression behind the front line. The flood risk would continue to increase significantly into the future without implementing new raised flood defences.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1(1.25)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.75(2)	
Present Day Flood cell	A	
2030 Flood cell	A	
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2015
SMP policy		Hold the Line till 2110

10.6.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-12.

Table 10-17. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 4.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	0.9	0.4
2030	-	1.0	0.5
2060	-	1.2	0.7
2110	0.7	2.4	1.2

The initial appraisal of the long list options for this Unit is presented in Table 10-18. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-18. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Community and property level flood resistance / resilience / adaptation	No	Flood risk becomes significant by 2030. Within this unit flood depths become large and the flood extent significant so resistance, resilience and adaptation would not be sufficient to mitigate the risks. The economic benefits of defending this frontage are also large. This area is also part of a larger continuous flood cell so this option was rejected for detailed appraisal.
	Earth Embankment defences.	No	Due to the highly developed, industrial and residential land uses and the operational requirements of the quays, the practicality and acceptability of this option render this a non starter in this area so was rejected for detailed appraisal.
Potentially viable short list options	Steel sheet pile front line defences.	Yes	This option is worthy of detailed appraisal as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell.
	Floodwall front line defences	Yes	A detailed appraisal of this option was undertaken as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell and this is cheaper option than steel sheet pile defences.
	Land raising through redevelopment.	Yes	Due to potential operational difficulties of implementing a front line defence option, and the potential for re-development, the land raising option was considered worthy of detailed appraisal.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-19 and for the potentially viable short list options in Table 10-20.

The box out in Table 10-20 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.6.3.

Table 10-19. Appraisal of non viable options screened out for ODU 4 (Northam).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Flood resistance / resilience	Minor	Minor	Potential for significant flood depths and concerns over flood risk.	Some impacts on property aesthetics	Unaffected	None	Some maintenance required	Risk of failure as flood depths significant	Medium cost option	Potential for significant damage due to flood depths in this area if defences overtopped.
Earth embankment defences	Minimal	Some possible impacts - potential for compression damage	Significant land take concerns and opposition to short term implementation	Impacts on the landscape but with potential for improvement	Some impacts – potential for improvement	Significant land take for earth embankment of sufficient height.	Some	Depends on the width of the embankment but risk of breach exists	Low cost option	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

Table 10-20. Summary of short list option appraisal for ODU 4 (Northam). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Steel sheet pile wall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	Unlikely to be any effects	Mixed – improved flood protection but operational concerns, views hindered, and access affected.	Some impacts due to required crest height above existing defences	Hindered due to required height	None	Good	Minimal	High	Some residual risk from overtopping under extreme events with high consequence
Front line floodwall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	Unlikely to be any effects	Mixed – improved flood protection but views hindered, access issues and land take	Some impacts due to required crest height above existing defences	Some restriction, but minor if built to intermediate height	Minor once constructed	Good	Some possible	Medium	Some residual risk from overtopping under extreme events with high consequence
Land raising	Minimal	Unlikely to be any effects	Mixed – existing landscape altered but robust flood defence and maintained access / water views	Altered – mixed opinions.	Access maintained	None if undertaken through re-development	Excellent – very low risk of failure	None	High, but potential to reduce costs if undertaken through re-development and utilising ABP dredge material	Low if continuous raised strip achieved.

10.6.3 *Preferred option*

The flood mapping demonstrates the need to 'do something' in the short term to protect against flooding in this unit. Providing at least 1:200 year standard of protection until 2110 using a flood wall would require a structure of considerable height (typically 1.2m above existing levels) which would require significant construction land take for foundations, and would have significant operational constraints and impacts on access to the waterfront.

Land raising is the most robust defence solution and therefore an aspirational preference which best achieves the objectives of The Strategy; however, due to the current commercial, industrial and residential land uses in this Unit, land raising and redevelopment may not be appropriate in these areas until the current properties reach the end of their service life.

Therefore to provide flood protection within the Unit until land in other areas can be raised in the future, an intermediate height flood wall (typically 0.7m above existing ground levels) is required near the front line to provide a 1:200 year standard of protection till 2060 (Figure 10-8). This wall would need to tie into Northam Bridge and the defences in Unit 5 to the south to ensure a robust defence is achieved as this area is part of a continuous flood cell. By using a wall of this height many of the operational constraints and access issues that would occur from a full height 1.2m high wall would be avoided.

As flood risk increases in the longer term (by 2060), and areas of this Unit become available for redevelopment, land should be raised as part of the redevelopment process so that a continuous raised strip of land is achieved which will supersede the flood wall as the main flood defence.

It is apparent that there is an opportunity for the land raising part of this area to occur sooner, as the area to the east of Northam Bridge is already earmarked for redevelopment in the future. Land raising would need to achieve a strip of raised land of at least 50m width with a height of 4.25m ODN to provide at least a 1:200 year standard of protection until 2110. To achieve this it would typically require land to be raised by 1.2m. The raised land would also need to tie into Northam Bridge to ensure a robust defence is achieved.

By 2060 land raising would need to achieve a continuous strip of at least 50m width with a height of 4.25m ODN throughout the Unit to provide at least a 1:200 year standard of protection until 2110. This land raising would need to tie into land previously raised at the Meridian Studios site and the defences of Unit 5 to the south in order to form a robust defence.

However, if opportunities to redevelop some areas of the frontage do not arise, with careful co-ordination and planning to ensure a continuous defence occurs by 2060, the preferred option could potentially still be achieved through incrementally raising areas over time, whilst existing land uses remain. Should land raising of some areas of the frontage not be achieved by 2060, the floodwall could be further raised or replaced with a full height structure in these areas, if required, to ensure a robust continuous flood defence is provided until 2110.

Summary of preferred option for ODU 4

2015 to 2060 –	**Intermediate height floodwall forming the spine of flood defence until raised land, preferably achieved through redevelopment, supersedes the floodwall as the main defence by 2060.**
2060 to 2110 –	**Defended by a continuous strip of raised land.**

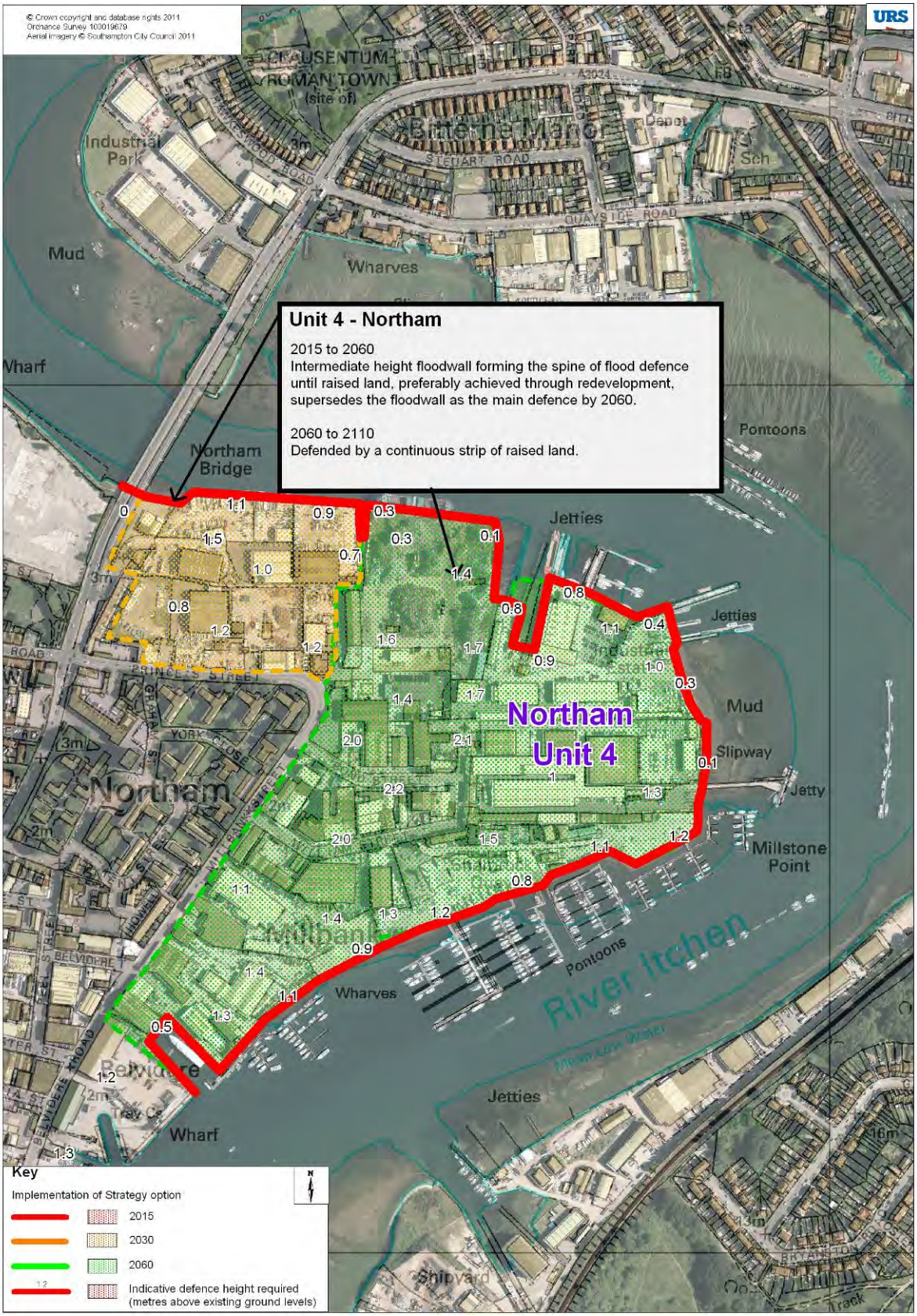


Figure 10-8. Mapping of the preferred option for ODU 4 (Northam).

10.7 Unit 5 - St Mary's Wharves

10.7.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-21.

Table 10-21. Do Nothing' scenario flood risk summary for Option Development Unit 5

Area	St Mary's Wharves	'Do nothing' tidal flood risk summary
Option Development Unit	5	
Present Day Flood Risk 1:200year typical depth (max) metres	0.25(0.5)	There is a present day flood risk from a 1:200 year event with typical flood depths of 0.25m for the Wharves and assets behind. Without implementing raised flood defences the flood risk would increase significantly with sea level rise and the present day 1:200 year flood envelope would become equivalent to less than 1:10 year event by 2060 and less than a 1:1 year event by 2110. There are also flood flow paths from this area towards adjacent areas including Northam to the north and towards the City Centre to the south west.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(0.75)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(1)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.25(1.75)	
Present Day Flood cell	A	
2030 Flood cell	A	
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2015
SMP policy		Hold the Line till 2110

10.7.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-22.

Table 10-22. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 5.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	0.6	0.5
2030	0.4	0.7	0.6
2060	0.6	0.9	0.8
2110	1.1	1.4	1.3

The initial appraisal of the long list options for this Unit is presented in Table 10-23. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-23. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Community and property level flood resistance / resilience / adaptation	No	Flood risk becomes high by 2030. Flood depths become large and the flood extent significant and resistance, resilience and adaptation cannot adequately mitigate the risks. The economic benefits of defending are also large. The unit is also part of a larger continuous flood cell and this option was rejected for detailed appraisal.
	Earth Embankment defences	No	Due to the highly developed, industrial and residential land uses and the operational requirements of the quays, the practicality and acceptability of this option render this a non starter in this area so was rejected for detailed appraisal.
	Road raising at the rear of the Wharves	No	Due to the levels required to provide protection, the limited space due to dense industrial land use and the access requirements for large plant to the wharves this option is a 'non starter' and was rejected for detailed appraisal.
Potentially viable short list options	Steel sheet pile front line defences.	Yes	This option was appraised in detail as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This unit is also part of a larger continuous flood cell.
	Floodwall front line defences	Yes	This option was considered worthy of detailed appraisal due to the high number of receptors and assets at high risk of flooding, over The Strategy period. This option is also a lower cost option than the sheet pile option. Also part of a larger continuous flood cell.
	Land raising	Yes	Due to potential operational difficulties of implementing a front line defence option the land raising option was considered worthy of detailed appraisal. This is also the most technically robust defence type to protect against flooding.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-24 and for the potentially viable short list options in Table 10-25.

The box out in Table 10-25 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.7.3.

Table 10-24. Appraisal of non viable options screened out for ODU 5 (St Mary's Wharves).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Maintenance	Technical robustness managing tidal flood risk	Relative Cost	Residual risk
Community and property level flood resistance / resilience / adaptation	None	None	Potential for significant flood depths and concerns over flood risk and backdoor flooding to City Centre	Some impacts on property aesthetics	Unaffected	None	Some maintenance required	Risk of failure as flood depths significant and flood envelope extensive	High cost option due to the large number of properties at risk	Potential for significant damage due to flood depths in this area
Earth embankment defences	Minimal	Some possible impacts - potential for compression damage	Significant land take concerns and opposition to short term implementation	Impacts on the landscape but with potential for improvement	Some impacts – potential for improvement	Significant land take for earth embankment of sufficient height. Potential to utilise the embankment one in place	Some	Depends on the width of the embankment but risk of breach exists	Low cost option	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Raise Road at rear of the Wharves	None	Minimal	Poor – poor flood protection to wharves, access issues due to required height	Altered – raised road of significant height	Unaffected	Some possible land take required	None	Robust defence but front line assets have no flood protection	High cost option due to height required and technical challenges of implementation	Low but properties in front of road still at risk of significant flooding

Table 10-25. Summary of short list option appraisal for ODU 5 (St Mary's Wharves). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics Impacts	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual risk
Steel sheet pile wall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	Potential for adverse impacts on archaeological assets during construction	Mixed – improved flood protection but operational concerns, and access potentially affected	Some impacts due to required crest height above existing defences	Hindered due to required height	None	Good	Minimal	High	Some residual risk from overtopping under extreme events with high consequence
Front line flood wall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	No significant adverse impacts expected as this area has been previously reclaimed	Mixed – improved flood protection but potential land take / access issues	Some impacts due to required crest height above existing defences	Some restriction, but minor if built to intermediate standard	Minor once constructed	Some failure risk, especially at access points	Some	Medium	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Land raising	Minor	No significant adverse impacts expected as this area has been previously reclaimed	Mixed – existing landscape altered but robust flood defence and maintained access / water views	Altered – mixed opinions	Access maintained	None once re-development undertaken.	Excellent – very low risk of failure	None	High, but potential to reduce costs if undertaken using demolition material or dredge material	Low if continuous raised strip achieved.

10.7.3 *Preferred option*

The flood mapping demonstrates the eminent need to 'do something' in the short term to protect against flooding in this Unit, especially as this area provides a flow path for flooding through towards the City Centre. Land raising is the most robust defence solution and therefore an aspirational preference which best achieves the objectives of The Strategy.

The wharves are a key strategic location for minerals and aggregate handling and their operations are safeguarded under the Hampshire minerals and waste plan[xvii]. Therefore land raising may not be achievable until the current operations cease or the owners look to replace buildings or upgrade their sites, whereby land raising could be undertaken incrementally over time as opportunities arise to raise parts of the wharves.

An alternative option to provide robust flood protection could be to implement a floodwall along the frontage to provide at least a 1:200 year standard of protection until 2110. However, this would require a structure of considerable height (typically 1.3m above existing levels). This option would therefore have significant constraints for the wharf operations and impacts for access to the waterfront.

With this consideration, the preferred approach to providing flood protection in the Unit is comprised of a combination of options. Until land raising can be achieved in the future, an intermediate height flood wall (typically 0.8m above existing ground levels) is required along the frontage to provide a 1:200 year standard of protection till 2060 (Figure 10-9). As this area is part of a continuous flood cell, the floodwall would need to tie into the defences in Unit 4 to the north, and Unit 6 to the south to ensure a robust defence is achieved. By using an intermediate height wall many of the operational constraints and access issues that would occur from a 1.3m high wall required to provide protection until 2110 would be avoided.

As flood risk increases in the longer term, a continuous strip of raised land (at least 50m wide with a level of 4.25m ODN) should be achieved to supersede the floodwall as the main flood defence by 2060 to provide at least a 1:200 year standard of protection until 2110. The raised land should be achieved through a co-ordinated approach looking to capitalise on opportunities as they arise which may be aligned with renovation projects or building replacement by existing operators, or through redevelopment of the sites if the existing operations cease along this frontage. The defence would also need to tie into the raised land of adjacent units to ensure a robust defence is achieved.

Should land raising of some areas of the frontage not be achieved by 2060, the intermediate height floodwall will be further raised or replaced with a full height structure in these areas, if required, to ensure a robust continuous flood defence is provided until 2110.

Summary of preferred option for ODU 5

2015 to 2060 – Intermediate height floodwall forming the spine of flood defence until raised land supersedes the floodwall as the main defence by 2060.

2060 to 2110 – Defended by a continuous strip of raised land.

[xvii] Hampshire Minerals and Waste plan, 2011 Available from: http://consult.hants.gov.uk/portal/pdpp/publication_of_the_draft_hampshire_minerals_and_waste_plan

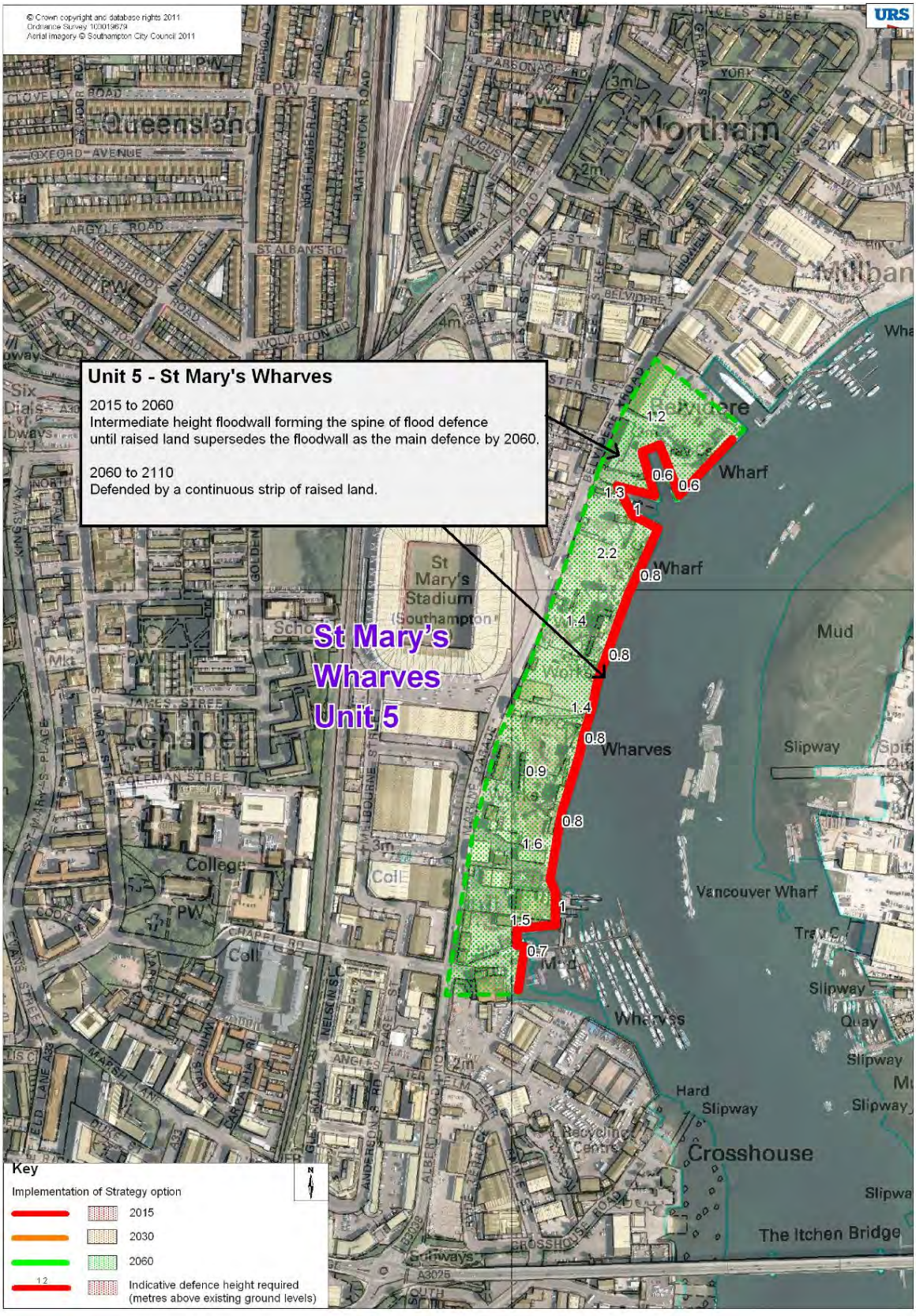


Figure 10-9. Mapping of the preferred option for ODU 5 (St Mary's Wharves).

10.8 Unit 6 - Crosshouse / Town Depot

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-26.

Table 10-26. Do Nothing' scenario flood risk summary for Option Development Unit 6

Area	Crosshouse/Town Depot	'Do nothing' tidal flood risk summary
Option Development Unit	6	
Present Day Flood Risk 1:200year typical depth (max) metres	0.25(0.75)	There is a present day flood risk from a 1:50 year event and the flood envelope from a present day 1:200 year event is significant with flow paths extending through towards the City centre. If raised flood defences were not implemented, flood risk would increase significantly with sea level rise in the future and the present day 1:200 year flood envelope would become equivalent to less than a 1:10 year event by 2060 and less than a 1:1 year event by 2110.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1.25)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.75(2)	
Present Day Flood cell	A	
2030 Flood cell	A	
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2015
SMP policy		Hold the Line till 2110

10.8.1 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-27.

Table 10-27. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 6.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	0.9	0.7
2030	-	1.0	0.8
2060	0.4	1.2	1.0
2110	0.9	1.7	1.5

The initial appraisal of the long list options for this Unit is presented in Table 10-28. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-28. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	None	-	
Potentially viable short list options	Steel sheet pile front line defences.	Yes	This option was considered worthy of detailed appraisal as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This unit is also part of a larger continuous flood cell.
	Floodwall front line defences	Yes	This option was appraised in detail as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This is also a lower cost option than the sheet pile option. This unit is also part of a larger continuous flood cell.
	Land raising through redevelopment	Yes	This site is earmarked for redevelopment and due to potential operational difficulties of implementing a front line defence option, the land raising option was considered worthy of detailed appraisal. This is also the most technically robust defence type to protect against flooding and requires no maintenance unlike other raised flood defences.

An indicative summary of the relative impacts, merits and drawbacks of the potentially viable short list options is provided in Table 10-29.

The box out in Table 10-29 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.8.2.

Table 10-29. Summary of short list option appraisal for ODU 6 (Crosshouse / Town Depot). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics Impacts	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual risk
Steel sheet pile wall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	There is the potential for adverse effects in relation to archaeological remains.	Mixed – flood protection but operational concerns, views hindered, and access affected.	Some impacts due to required crest height above existing land levels	Hindered due to required height	None	Good	Minimal	High	Some residual risk from overtopping under extreme events with high consequence
Front line floodwall	There is the potential for temporary disturbance to the Solent and Southampton Water SPA / Ramsar during construction	There is the potential for adverse effects in relation to archaeological remains	Mixed – flood protection but views hindered, access issues and land take	Some impacts due to required crest height above existing land levels	Restricted due to height required	Some	Some failure risk, especially at access points	Some	Medium	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Land raising	There is unlikely to be any effect in relation to biodiversity / designated habitats.	Potential for compression damage to assets if present	Mixed – existing landscape altered but robust flood defence and maintained access / water views	Altered – mixed opinions	Access maintained	None once re-development undertaken.	Excellent – very low risk of failure	None	High, but potential to reduce costs if undertaken through re-development and utilise ABP dredge material	Low if continuous raised strip achieved.

10.8.2 *Preferred option*

The flood mapping demonstrates the eminent need to 'do something' in the short term to protect against tidal flooding in this Unit, especially as this area provides a flow path for flooding through towards the City Centre. Land raising is the most robust defence solution and therefore an aspirational preference which best achieves the objectives of The Strategy.

The majority of this area is currently comprised of the City Council's former waste collection and recycling depot. The area is earmarked for redevelopment and consequently the preferred approach to providing flood protection in the Unit is land raising through redevelopment. To achieve a robust flood defence a continuous strip of raised land (at least 50m wide with a level of 4.25m ODN) should be implemented to provide at least a 1:200 year standard of protection until 2110 (

Figure 10-10). Typically land levels would need to be raised by 0.9 to 1.7m above existing ground levels to achieve this. As this area is part of a continuous flood cell, the raised land would need to tie into the defences in Unit 5 to the north.

A key advantage of land raising instead of raised flood defences such as a floodwall is that once implemented, no defence maintenance is required and there is very minimal residual risk. This option could be sympathetically landscaped into the development and would help increase the connection between the land and sea and improve access and views in the Unit. As part of the redevelopment, a front edge structure such as a revetment or concrete slope would be required to prevent erosion.

Summary of preferred options for ODU 6

2015 to 2110 – Defended by raised land implemented through redevelopment.

Figure 10-10. Mapping of the preferred option for ODU 6 (Crosshouse / Town Depot).

10.9 Unit 7 - Ocean Village

10.9.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-30.

Table 10-30. Do Nothing' scenario flood risk summary for Option Development Unit 7

Area	Ocean Village	'Do nothing' tidal flood risk summary
Option Development Unit	7	
Present Day Flood Risk 1:200year typical depth (max) metres	0	There is no significant flood risk until after 2060. Risk of flooding begins from a 1:500 year event at 2060, with flood risk from a 1:2 year event at 2110 and significant flood depths and extents from a 1:200 year event at this time. From 2060 flooding would occur from inundation over the quay walls and indirectly via a flow path from Town Depot frontage to the north.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(1)	
Present Day Flood cell		
2030 Flood cell		
2060 Flood cell		
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2060
SMP policy		Hold the Line till 2110

10.9.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-31.

Table 10-31. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 7.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	-	-	-
2060	-	-	-
2110	0.2	1.0	0.6

The initial appraisal of the long list options for this Unit is presented in Table 10-32. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-32. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Road raising.	No	This option does not provide protection to the key receptors in Ocean village so was rejected for detailed appraisal.
	Steel sheet pile front line defences.	No	There is a flood risk mainly 'via the back door' from other areas (i.e. the Port) so this option as a stand alone solution is ineffective at preventing flooding and was rejected for detailed appraisal.
Potentially viable short list options	Defend front line with tide gate / lock across entrance to marina and defences along perimeter of ABP land and demountable defences / ramps on access points.	Yes	A number of receptors and assets are at high risk of flooding, over The Strategy period. Also this is part of a larger continuous flood cell with flow paths through to the City Centre and therefore this option was considered worthy of detailed appraisal.
	Raise quay walls with floodwall defences along perimeter of ABP land and demountable defences / ramps on access points.	Yes	A number of receptors and assets are at high risk of flooding, over The Strategy period. Also this unit is part of a larger continuous flood cell with flow path through to the City Centre and is more cost effective than the option with a tide gate on the Marina entrance so this option was appraised in detailed.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-33 and for the potentially viable short list options in Table 10-34.

The box out in Table 10-34 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.9.3.

Table 10-33. Appraisal of non viable options screened out for ODU 7 (Ocean Village).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Raise Road	None	Potential impacts to heritage assets	Poor – as many assets would remain at risk of flooding in front of the defence	Altered – raised road of significant height	Unaffected	Some land take required	Poor as flood defence set back considerably from front line	None	High cost option due to height required and technical challenges of implementation	Properties in front of road still at risk of significant flooding
Steel sheet pile wall	Minor	None	Mixed – flood protection but operational concerns, views hindered, and access affected.	Some impacts due to required crest height above existing defences and aesthetic impacts	Some restriction due to required height	None	Good	Minimal	High	Some residual risk from overtopping under extreme events with high consequence

Table 10-34. Summary of short list option appraisal for ODU 7 (Ocean Village). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics Impacts	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual risk
Defend front line with tide gate / lock across marina with ABP boundary flood walls	Minor	Potential impacts on assets during construction	Mixed – flood protection but operational concerns, aesthetic impacts and hindered access affected.	Visual impacts due significant lock structure	Some impacts for access	Some	Some failure risk, especially at access points	Some	Very high	Some residual risk from gate failure under extreme events with high consequence
Raise quay walls with ABP boundary flood walls	Minor	Potential impacts on assets during construction	Improved flood protection and relatively low walls that will not hinder views / access to water	Minor impacts – relatively low walls required	Minimal impacts due to relatively low structures	Some	Some failure risk, especially at access points	Some	Low	Some residual risk from overtopping under extreme events with high consequence

10.9.3 *Preferred option*

With the implementation of robust coastal defences along the Itchen frontages to the north of this Unit from 2015, no additional raised flood defences are required at Ocean Village until the longer term (2060). However the current approach of reactive maintenance and repair of minor failures to existing structures and quay walls should be undertaken until this time.

To provide a 1:200 year standard of protection until 2110 the preferred option for this Unit is to implement a relatively low floodwall (typically 0.5m above existing ground levels) near the front line around Ocean Village at 2060 (Figure 10-11). This could be undertaken by raising existing quay walls or setting back a landscaped floodwall.

In addition, with the assumption that ABP do not implement formal raised flood defences in the Port area (See Section 9.1.4), a floodwall (0.2 – 0.8m high) would be required around the Port boundary in order to provide at least a 1:200 year standard of protection at Ocean Village until 2110.

As this area is part of a continuous flood cell after 2060, the floodwall would need to tie into the defences in Unit 8 to the west, and Unit 6 to the north to ensure a robust defence is achieved.

To the south of the former recycling depot and under the Itchen Bridge is the Southampton Water Activities Centre. This area is comprised of a walkway, boat storage areas, slipways and revetments and although flood risk is localised should the land to the north get raised, the Water Activities Centre may benefit from a local flood protection scheme especially as the flood risk increases in the future; however, it is anticipated that because of the very localised benefits, this may need to be funded by means other than national flood defence funding. This could be implemented through raising the slipways and/or implementing a floodwall. Such as scheme would also need to tie into the existing defences to the south to ensure a robust defence is achieved.

Summary of preferred options for ODU 7

2015 to 2060 – Maintain existing quay walls and defence structures.

2060 to 2110 – Defended by raised quay walls with floodwall defences along perimeter of ABP land.

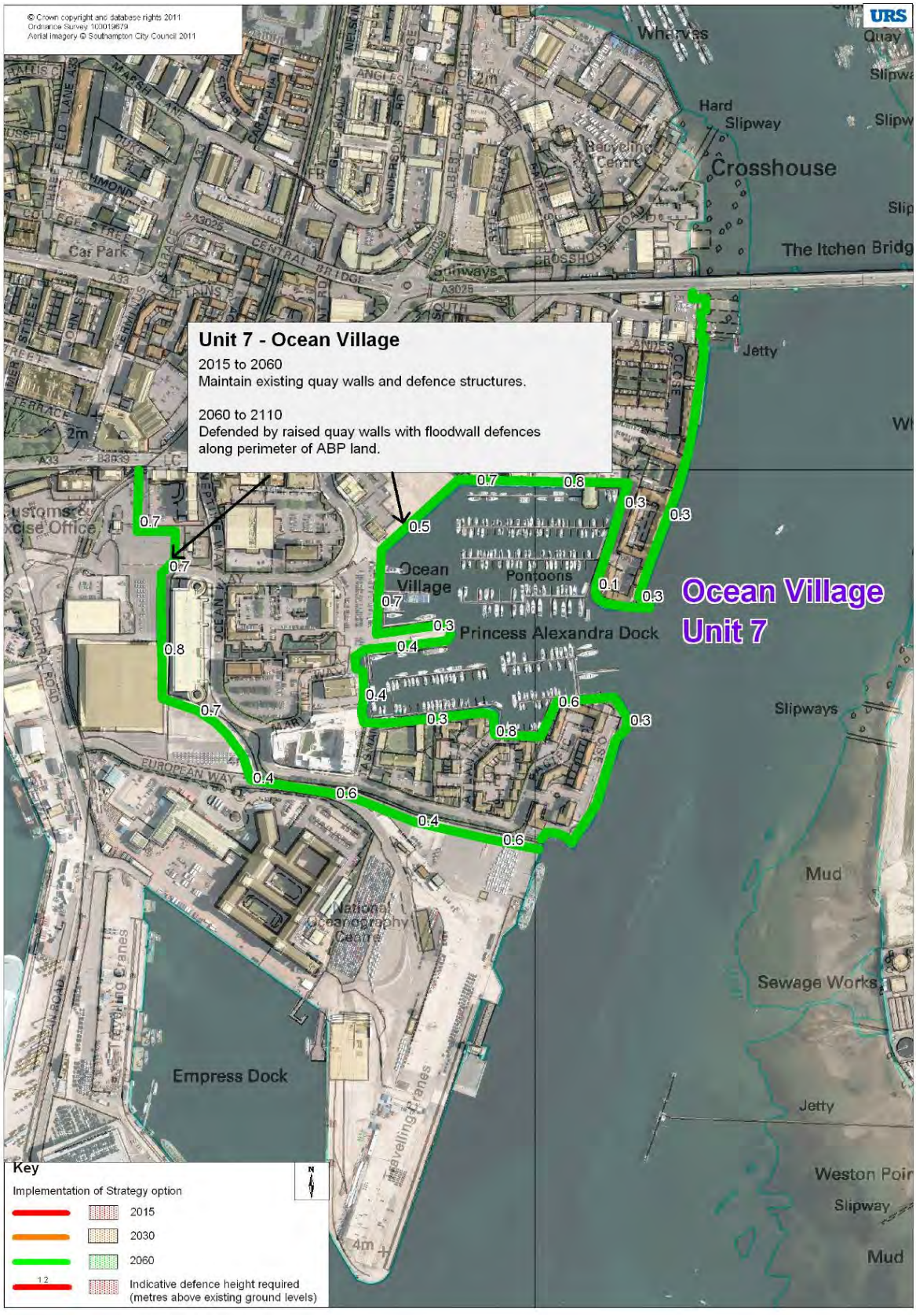


Figure 10-11. Mapping of the preferred option for ODU 7 (Ocean Village).

10.10 Unit 8 - Eastern Docks / Dock Gate 4

10.10.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-35.

Table 10-35. Do Nothing' scenario flood risk summary for Option Development Unit 8

Area	Eastern Docks / Dock Gate 4	'Do nothing' tidal flood risk summary
Option Development Unit	8	
Present Day Flood Risk 1:200year typical depth (max) metres	0	There is no significant risk of tidal inundation over the front line in this area until beyond 2060. The risk of tidal flooding occurs from 1:2 year event by 2110, with significant flood depths under a 1:200 year event in 2110 as water levels exceed the quay wall crest levels and the flood envelope joins with that of adjacent frontages .However, there is a risk of flooding in this area 'via the back door' from the Itchen frontages around Town Depot and St Mary's Wharves under a 1:200 year present day event, and this risk increases over time.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.5(0.75) – via 'back door'	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1(1.75) – via 'back door'	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	1.25(2.0)	
Present Day Flood cell		
2030 Flood cell	A	
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2060
SMP policy		Hold the Line till 2110

10.10.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-36.

Table 10-36. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 8.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	-	-	-
2060	-	-	-
2110	0.5	1.1	0.7

The initial appraisal of the long list options for this Unit is presented in Table 10-37. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-37. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Front line floodwall defences	No	This option was rejected for detailed appraisal due to operational requirements of the Port.
	Raise Canute / Platform Road.	No	This option is technically very challenging, given access requirements and tight urban fabric and was rejected for detailed appraisal on practical and technical grounds.
	Demountable defences along roads	No	It is operationally intensive to use long stretches of demountable defences and requires ongoing maintenance and operation. There is also a high risk of failure with this option due to the need to construct the defences in time to prevent flooding.
Potentially viable short list options	ABP boundary flood wall with demountables / ramps across access points.	Yes	The Port boundary provides a potential defence corridor and this option would provide protection to a large number of receptors behind the Port. This option would also not impinge on Port operations and was appraised in detail.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-38 and for the potentially viable short list options in Table 10-39.

The box out in Table 10-39 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.10.3.

Table 10-38. Appraisal of non viable options screened out for ODU 8 (Eastern Docks / Dock Gate 4).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Front line floodwall	None	Minimal	ABP currently not exploring this option and would cause operational constraints	No significant effects	Some operational constraints	Some – relatively minor	Some failure risk, especially at access points	Some	Medium	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Raise Canute/ Platform Road	None	Likely impacts to heritage assets	Poor – as many assets would remain at risk of flooding in front of the defence	Altered – raised road of significant height	Unaffected	Some possible land take required	Poor as flood defence set back considerably from front line	None	High cost option due to height required and technical challenges of implementation	High – properties in front of road still at risk of significant flooding
Demountable defences along roads	None	Minimal	Poor – high risk of failure and breaching of not implemented in time. Operationally intensive to deploy	Some impacts due demountable defence framework permanently in place.	Unaffected.	Minimal	Poor for such a large stretch – risk of failure if deployment not undertaken in time.	Regular checking, practice deployment and maintenance required	Medium	Residual risk from overtopping under extreme events and failure to deploy in time

Table 10-39. Summary of short list option appraisal for ODU 8 (Eastern Docks / Dock Gate 4). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
ABP boundary flood wall with demountable / ramps on access points	Minor	Potential for impacts on assets if not properly considered or if assets remain seawards of defence on Port land and are unprotected	Mixed – flood protection but operational concerns, aesthetic impacts and hindered access.	Some visual impacts	Access to the waterfront in this area is already poor so would be unaffected	Minor	Some failure risk, especially at access points	Some	Low	Potential for significant and extensive flood event if defence overtopped or breach failure occurs. Access points are a potential source of risk

10.10.3 *Preferred option*

With the implementation of robust coastal defences along the Itchen frontages to the north of this Unit from 2015, no additional raised flood defences are required within this Unit until the longer term (2060).

To provide a 1:200 year standard of protection against flooding until 2110, the preferred option for this Unit is to implement a floodwall (typically 0.7m above existing ground levels) along the boundary of ABP Port.

Provisions for maintaining access would need to be made with ramping over the low flood walls the preferable approach where possible in order to reduce the residual risk of a breach which remains with demountable defences or flood gates which rely on manual deployment in advance of a flood event.

A manned flood gate would be suitable at Eastern Docks / Dock Gate 4 access road to the Port which are continually manned. A demountable flood defence over the railway would also be required (example see Figure 8-5). This railway line is used infrequently so this defence could be permanently in place and removed when necessary to allow trains through. Given the potential frequency of flooding (Greater than a 1:10 year event at 2110) these temporary defences for access points are considered viable.

With the assumption that ABP do not implement formal raised flood defences in the Port area (See Section 9.1.4), a floodwall (0.2 – 0.8m high) would be required around the Port boundary in order to provide at least a 1:200 year standard of protection until 2110 (Figure 10-12).

As this area is part of a continuous flood cell after 2060, the floodwall would need to tie into the defences in Unit 9 to the west, and Unit 7 to the east to ensure a robust defence is achieved.

Summary of preferred options for ODU 8

2015 to 2060 –	**Do nothing. The area behind Port protected against flooding by the Strategy defences along the Itchen frontage to the north and the existing quay walls in the Port which it is assumed will be maintained by ABP.**
2060 to 2110 –	**Defended by a floodwall around Ocean Village and along the boundary of the Port.**

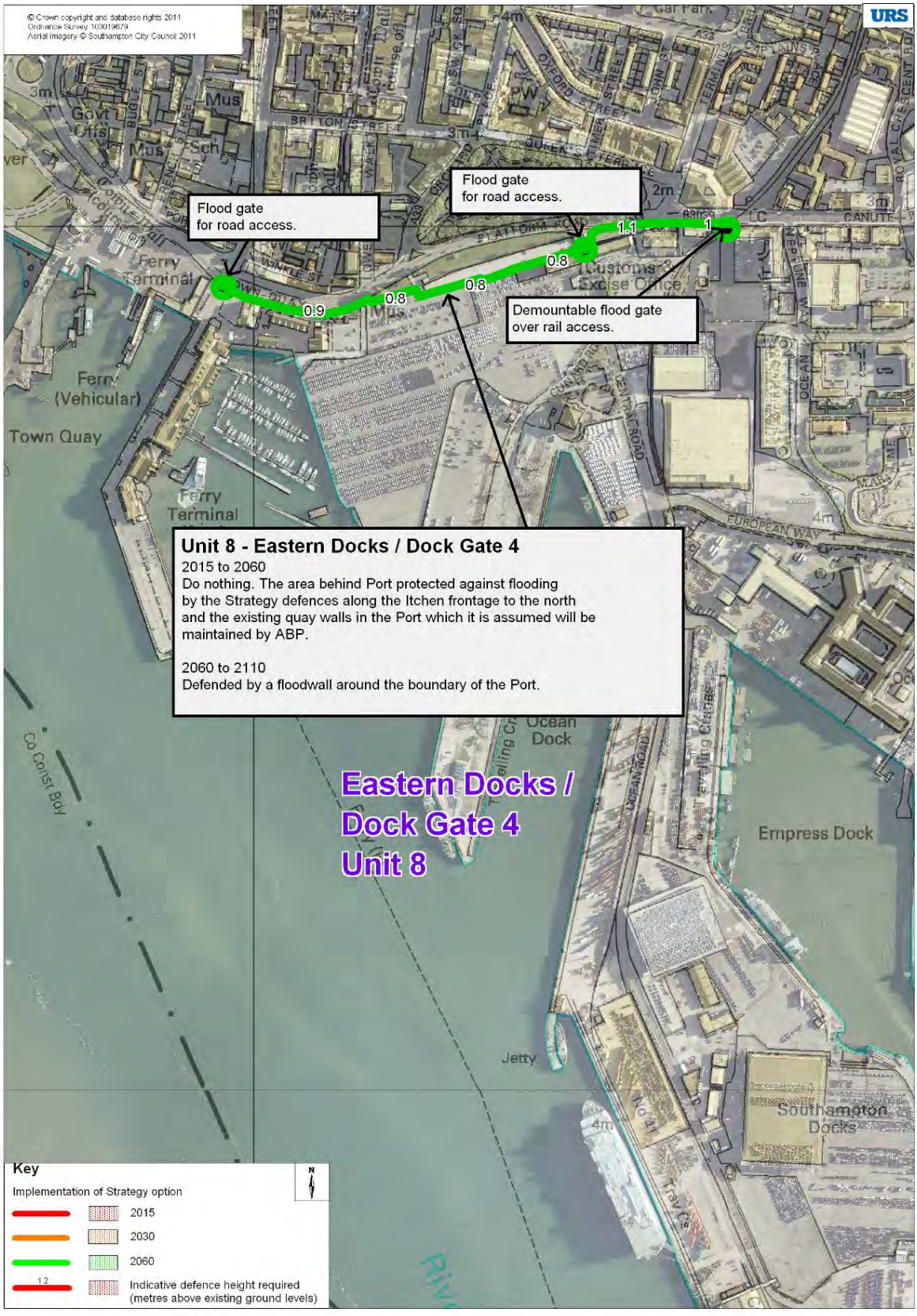


Figure 10-12. Mapping of the preferred option for ODU 8 (Eastern Docks / Dock Gate 4).

10.11 Unit 9 - Mayflower Park / Major Development Quarter

10.11.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-40.

Table 10-40. Do Nothing' scenario flood risk summary for Option Development Unit 9

Area	Mayflower Park / Major Development Quarter	'Do nothing' tidal flood risk summary
Option Development Unit	9	
Present Day Flood Risk 1:200year typical depth (max) metres	0	There is presently a low risk of flooding with no significant flooding from a 1:200 year event until 2060. The risk of significant tidal flooding under a 'Do Nothing' Scenario increases substantially after 2060 with a significant flow path for flooding northwards towards West Quay and Southampton Central Railway station from a 1:2 year event at 2110 and significant flood depths under a 1:200 year event at this time.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.25(0.5)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1.25)	
Present Day Flood cell		
2030 Flood cell		
2060 Flood cell	A	
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2030
SMP policy		Hold the Line till 2110

10.11.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-41.

Table 10-41. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 9.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	-	0.5	-
2060	-	0.7	0.3
2110	0.2	0.8	0.5

The initial appraisal of the long list options for this Unit is presented in Table 10-42. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-42. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Existing road raising.	No	Technically challenging and expensive given access requirements. Also the site is earmarked for re-development and was rejected for detailed appraisal.
Potentially viable short list options	Front line steel sheet pile defences	Yes	A key aspect of the City Masterplan and vision is to maintain the connection between the City and the water front and this would hinder the continuum if the existing front line was raised. However the Royal Pier site is earmarked for redevelopment and this could encompass a front line scheme whilst maintaining the waterfront connection so this option was appraised in detail.
	Land raising through redevelopment	Yes	This option was considered worthy of a detailed appraisal as the site is earmarked for redevelopment so there is the opportunity for land raising to be implemented to form a robust defence line.
	Earth Embankment defences.	Yes	This is a relatively cost effective solution which could be integrated into the park and any redevelopment and therefore was considered worthy of detailed appraisal.
	Floodwall at rear of park and along the port boundary with demountable defences / ramps on access points.	Yes	This option is technically feasible and was considered worthy of detailed appraisal.
	Construct elevated service road as flood defence.	Yes	This could be incorporated and constructed during a potential re-development and would provide robust flood protection to the Major Development Quarter so was appraised in detail.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-43 and for the potentially viable short list options in Table 10-44.

The box out in Table 10-44 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.11.3.

Table 10-43. Appraisal of non viable options screened out for ODU 9 (Mayflower Park / Major Development Quarter.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Raise existing road	None	Potential for compression damage	Poor – larger footprint required. Issues for access and ramping on / off for Port vehicles. Technically challenging	Altered – raised road of significant height	Potential for access impacts	Some possible land take required in order to raise road by required amount	Flood defence set back considerably from front line so assets in front still at risk	Minimal	High cost option due to height required and technical challenges of implementation	Some - properties in front of road still at risk of significant flooding

Table 10-44. Summary of short list option appraisal for ODU 9 (Mayflower Park / Major Development Quarter). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Front line steel sheet pile defences	Minor	Potential impacts on assets during construction	Mixed – flood protection but operational concerns, aesthetic impacts and hindered access affected.	Visual and aesthetic impacts	Some impacts for access	Minimal	Some failure risk, especially at access points	Some	High	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Re-development / land raising	Minimal	Potential for compression damage to assets if present	Existing landscape changed but robust flood defence and maintained access / water views	Existing landscape changed and improved	Access maintained	None once undertaken as land is redeveloped	Excellent – no risk of failure	None	High	Low if continuous wide strip is achieved.
Earth Embankment defences	No significant adverse effects.	Potential for compression damage to assets if present	Good – green corridor / paths. Improve aesthetics. Connect CBD to sea.	Potential to improved	Potential to improve	Significant due to width required.	Good	Minimal	Low	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Flood wall at rear of park and along the port boundary with access demountable defences / ramps	Minor	Potential impacts on assets during construction	Flood protection but operational concerns, aesthetic impacts and hindered access affected.	Visual impacts associated with a wall	Some impacts for access	Minor	Some failure risk, especially at access points	Minor	Low	Some residual risk if defence overtopped, breach failure occurs or access gates not closed in time
Construct elevated service road as flood defence	Minor	Potential impacts on assets during construction	Flood protection but operational concerns, aesthetic impacts and hindered access affected.	Mixed – but opportunity for improving access / connect CBD to sea.	Potential to Improve	Some	Good	Minimal	High	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

10.11.3 *Preferred option*

Presently the existing quay walls and defences protect against tidal flooding however by 2060, there is tidal flood risk within this Unit. To ensure that at least a 1:200 year standard of protection against flooding is achieved until 2110, flood defences would need to be implemented by 2030 (Figure 10-13).

The area to the northwest of Mayflower Park is also earmarked as a Major Development Quarter and it is intended that this area is redeveloped over the coming years. The aspiration should be to raise land through redevelopment here to form a continuous strip of raised land (at least 50m in width and 4.25m ODN in height) to provide a robust flood defence behind the Port area. This would need to tie into the defences of Unit 10 by 2060 to form a continuous defence by this time.

Options for redeveloping the former Royal Pier site and surrounding area are currently being explored and there is continuing liaison and discussions with the Masterplanners for this site. The potential to incorporate a flood defence within the development has been recognised and this should ideally form part of the strategic flood defence solution for this Unit.

A key facet of the City's vision for the future is to improve connectivity between the City Centre and the waterfront. There is a significant opportunity to connect the raised land of the Major Development Quarter with the Royal Pier development through raising part of Mayflower Park. This would form the most technically robust and aesthetically pleasing flood defence and would significantly improve access and connection with the waterfront. The preferred implementation option for flood defences at the Royal Pier site are still unknown at present, however indications from the developers are that a strip of raised land (possibly terraced) providing at least 1:200 year standard of protection against flooding is likely to be incorporated in the development.

As the future plans for the redevelopment at the Royal Pier site and raising of Mayflower Park are still uncertain, the preferred option is to implement a relatively low floodwall (typically 0.7m above existing ground levels) by 2060 if land raising is not undertaken at the Royal Pier site. This wall would be required to form the spine of the flood defence. This could run along the rear of the ferry terminals and the back of Mayflower Park and would need to tie into the flood wall around the rear of the Port to the west or the raised land of the Major Development Quarter by 2060.

Provisions for maintaining access will need to be made with the preferable approach where possible to ramp access roads over the raised land or the low floodwalls to act as passive defences and thereby reducing the residual risk of a breach associated with active defences. The main access Port point in this Unit is at Herbert Walker Avenue where there is a sufficient length of straight road to implement a shallow gradient ramp over the raised land to accommodate the abnormal and outsized vehicles which service the Port.

There should be minimal reliance on demountable defences or flood gates which require manual deployment in advance of a flood event; these should only be used if ramping over flood walls cannot be undertaken. However, flood gates would be suitable for Dock access roads which are continually manned and therefore reduce the risk of failure to close flood gates in advance of flood events.

Summary of preferred option for ODU 9

2015 to 2060 – Land raising through development of Royal Pier Site and the Major Development Quarter preferred. Implementation of a floodwall forming the spine of the flood defence by 2030 if a continuous strip of raised land is not achieved by this time.

2060 to 2110 – Defended by a floodwall and or raised land.

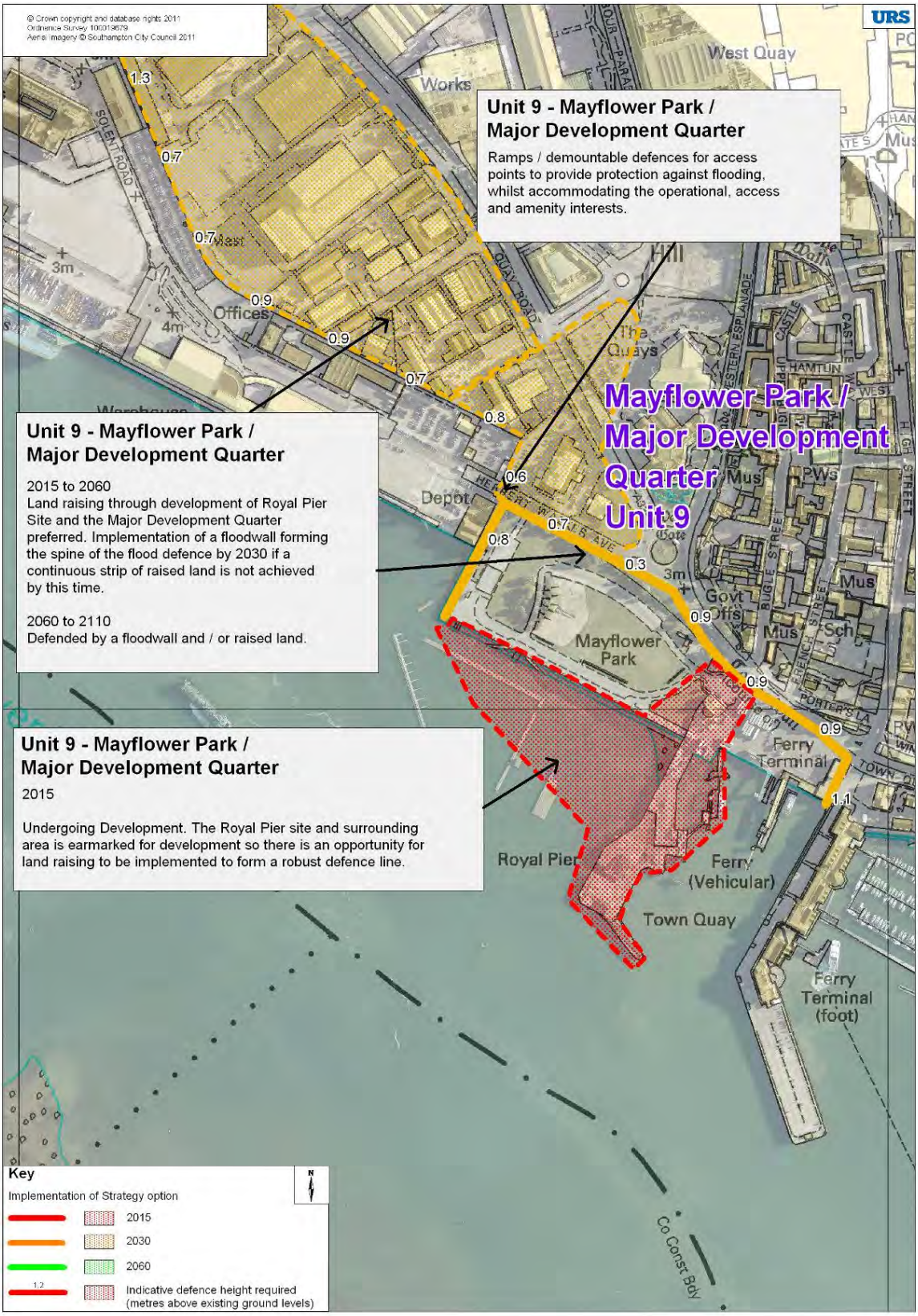


Figure 10-13. Mapping of the preferred option for ODU 9 (Mayflower Park / MDQ).

10.12 Unit 10 - Western Docks

10.12.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-45.

Table 10-45. Do Nothing' scenario flood risk summary for Option Development Unit 10

Area	Western Docks	'Do nothing' tidal flood risk summary
Option Development Unit	10	
Present Day Flood Risk 1:200year typical depth (max) metres	0	There is no significant flood risk in this area until beyond 2060. Without implementing raised flood defences the area becomes at risk of flooding from 2060 with inundation from a 1:2 year event by 2110. There is significant flood risk from a 1:200 year event in 2110 as water levels would significantly exceed the quay wall crest levels under such a scenario. Flooding from such an event would inundate almost the entire Port area and significant flooding would also occur to areas behind the Port.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1.5)	
Present Day Flood cell		
2030 Flood cell		
2060 Flood cell		
2110 Flood cell	A	
Required implementation of 'Do something' option based on flood risk		2060
SMP policy		Hold the Line till 2110

10.12.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-46.

Table 10-46. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 10.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	-	-	-
2060	-	-	-
2110	-	1.1	0.5

The initial appraisal of the long list options for this Unit is presented in Table 10-47. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-47. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	Front line floodwall	No	This option was rejected for detailed appraisal due to the operational requirements of the Port and ABP is not currently exploring this option.
	Raise road at rear of the Port	No	This is a high cost option and logistically very difficult so this was rejected for detailed appraisal. Key infrastructure (Railway and Millbrook WTW) are not protected by this option. Access requirements are also a key issue.
	Upgrade railway line at rear to act as a defence	No	This is a high cost and logistically very difficult. Key infrastructure (Millbrook WTW) will also not be protected by this option so this was rejected for detailed appraisal.
	Raise entire Port area	No	This is a high cost option and very disruptive for a working Port. ABP is also currently not exploring this option so this was rejected for detailed appraisal.
	Raise the service road through the Port.	No	ABP is currently not exploring this option so this was ruled out for detailed appraisal
Potentially viable short list options	Floodwall along ABP boundary with ramps / demountables on access points.	Yes	This option was considered worthy of detailed appraisal as this would provide a defence corridor with minimal disruption to port operations. This option would provide flood protection to the receptors at risk behind the Port whilst maintaining access to the Port.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-48 and for the potentially viable short list options in Table 10-49.

The box out in Table 10-49 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.12.3.

Table 10-48. Appraisal of non viable options screened out for ODU 10 (Western Docks).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Front line floodwall	None	No significant effects	ABP currently not exploring this option and would cause operational constrains affected.	Some visual impacts due to raised walls	Impacts for Port operations / access	Some	Some failure risk, especially at access points	Some	Medium	Potential for significant and extensive flood event if defence overtopped or breach failure occurs
Raise road at the rear of the Port	None	No significant effects	Concerns over access to Port on/off raised road	Mixed – raised road with aesthetic impacts but opportunity for improving access	Implications for Port access on/off raised road. Waterfront connection unaffected.	Some	Good	Minimal	High	Low residual risk
Upgrade railway line to act as a defence	None.	Potential for compression damage to assets if present	Significant disruption to main line railway	No significant effects once constructed	Unaffected	Potentially significant in order to raise track sufficiently.	Technically challenging to implement but potential for robust defence	Some possible	High	Potential for significant and extensive flood event if defence overtopped or breach failure occurs

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Raise entire Port area	Minimal	No significant effects	ABP currently not exploring this option due to disruption and expense	Raised port although no significant impacts to overall character / aesthetics	Access maintained	None once re-development undertaken	Excellent – no risk of failure	None	High – although potential to reduce significantly if dredge material could be utilised	Low if continuous wide strip is achieved
Raise the service road through the Port	Minimal	No significant effects	ABP currently not exploring this option due to disruption and expense	Raised road although no significant impacts to overall character / aesthetics	Potential implications for Port access on/off raised road. Waterfront access unaffected.	Minimal	Good – low risk of failure	Minor	Medium	Some although relatively low if continuous raised strip is achieved

Table 10-49. Summary of short list option appraisal for ODU 10 (Western Docks). Box out shows preferred option or elements of preferred option.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
ABP boundary flood wall with demountable / ramps on access points	None	Potential impacts on assets during construction	Mixed – flood protection but potential access concerns. Risk of flooding at access points	Minor	Some impacts for access to port	Minor	Some failure risk, especially at access points	Some, especially at access points	Low	Some residual risk if defence breach failure occurs or access gates not closed in time

10.12.3 *Preferred option*

By 2060, there is flood risk within this Unit. With the assumption that ABP do not implement formal raised flood defences in the Port area (See Section 9.1.4), a low floodwall (typically 0.5m above existing ground levels) would be required around the Port boundary to provide areas behind the Port with at least a 1:200 year standard of protection against flooding until 2110 (Figure 10-14 to Figure 10-17).

Provisions for maintaining access would need to be made with the preferred approach being to ramp access roads over low flood walls where possible in order to reduce the residual risk of a breach. For access to the Port, ramps over the floodwall would need to accommodate the abnormal and outsized vehicles which service the Docks. Such vehicles have restricted turning circles and can only cope with very shallow gradients. For example, to ramp over a 1m high floodwall, a significant ramp length (at least 50m assuming a 1:50 slope) may be required n order to accommodate the large vehicles.

There should be minimal reliance on demountable defences or flood gates which require manual deployment in advance of a flood event, and these should only be used if ramping over flood walls cannot be undertaken for logistical or operational reasons. However, where Port access roads are continually manned, flood gates would be more suitable as there is very limited risk of failure as gates would be closed in advance of flood events.

Due to the very shallow slopes required for ramping railways, and the limited room to implement such an approach, demountable flood defences are likely to be the only option for Port railway access points (example see Figure 8-5). Given that even by 2110 flooding is relatively infrequent (only from events greater than a 1:10 year event), in operational terms the temporary defences for access points are considered viable.

As this area is part of a continuous flood cell after 2060, the floodwall would need to tie into the defences in Unit 9 to the east, and to the naturally higher land to the west of this Unit to ensure a robust defence is achieved.

Summary of preferred options for ODU 10

2015 to 2060 – Do nothing. The area behind Port protected against flooding by the existing quay walls in the Port which it is assumed will be maintained by ABP.

2060 to 2110 – Area behind the Port defended against flooding by a floodwall along the boundary of the Port with ramps or demountable defences on access points.

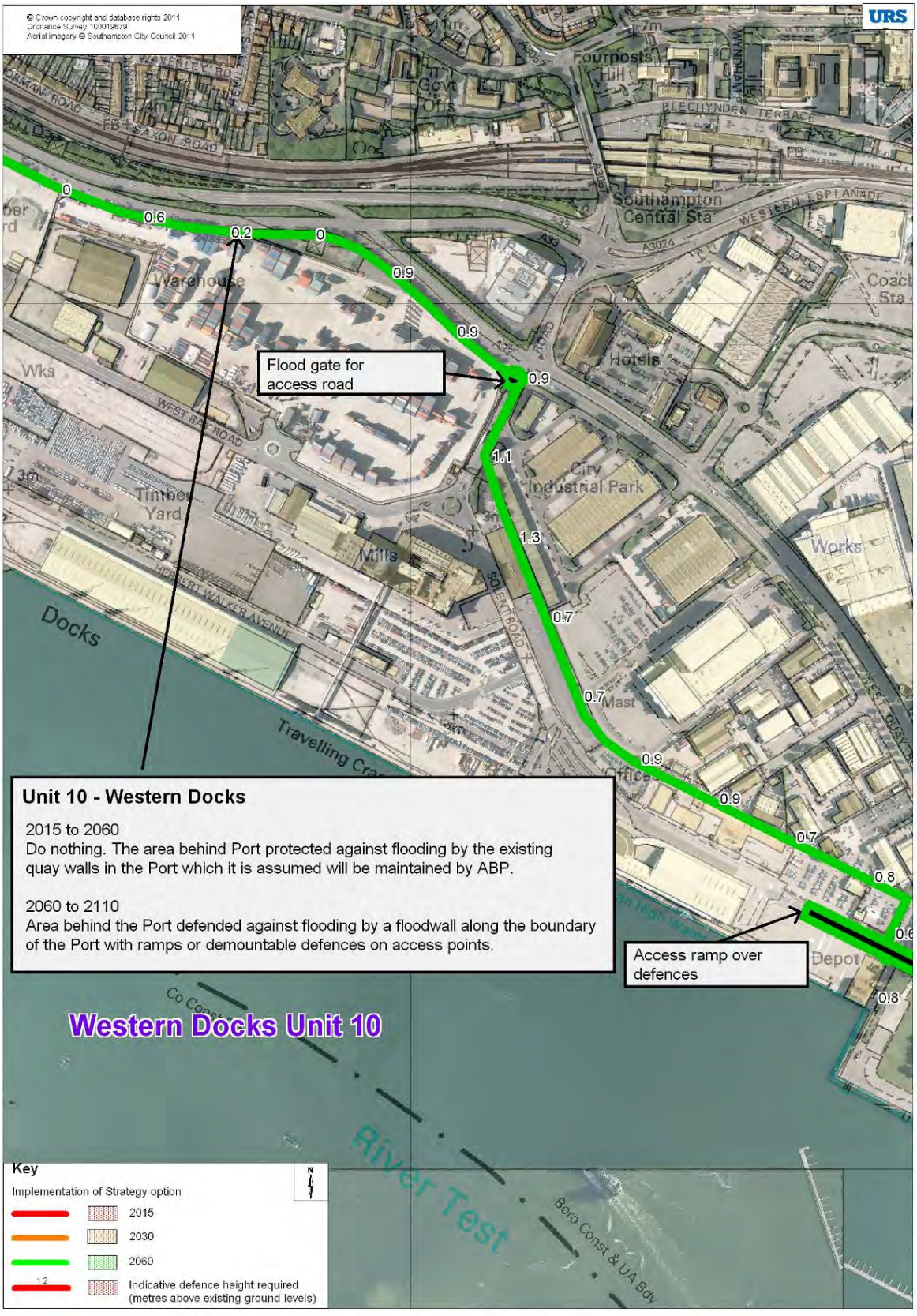


Figure 10-14. Mapping of the preferred option for ODU 10a (Western Docks).

Figure 10-15. Mapping of the preferred option for ODU 10b (Western Docks).

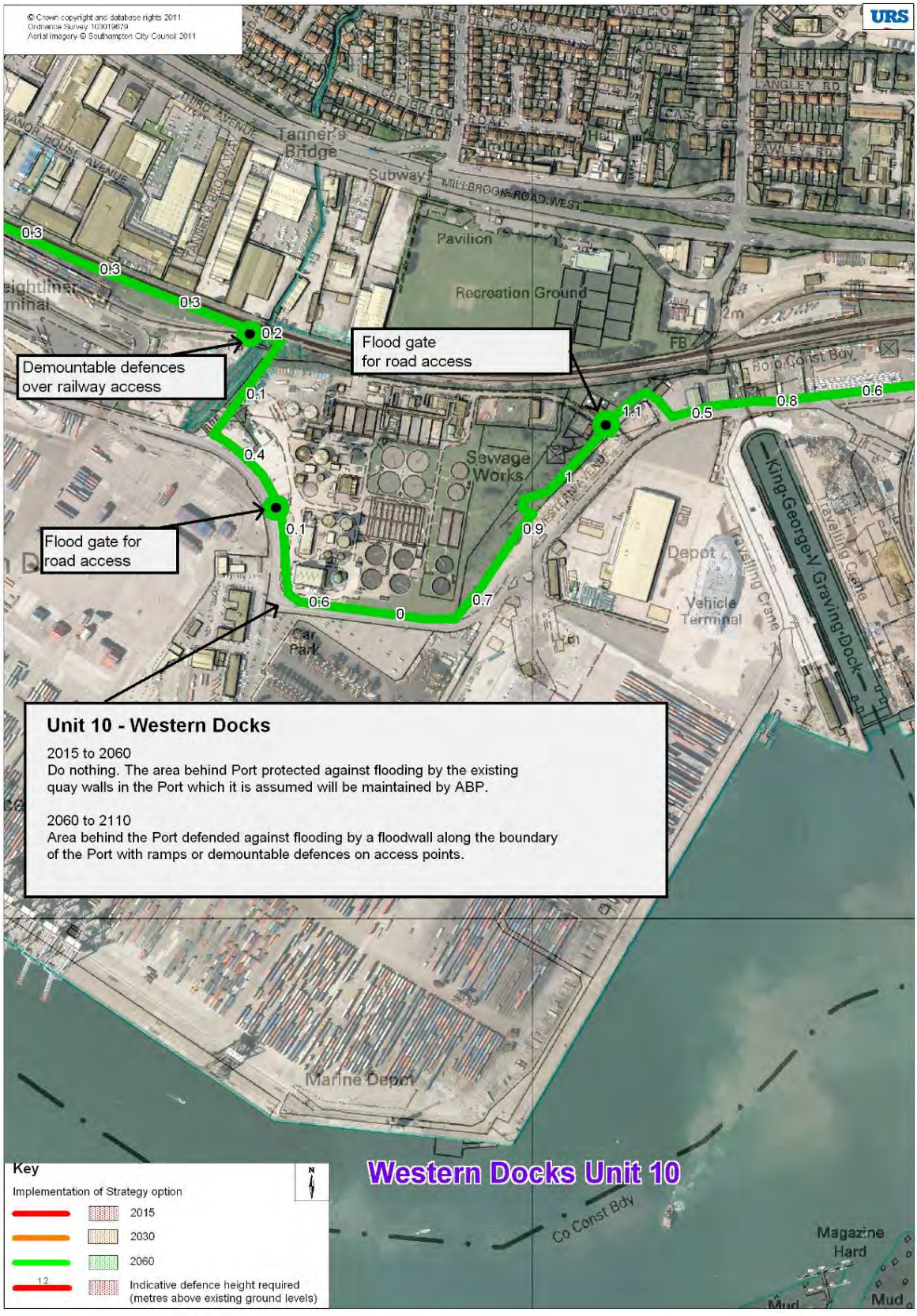


Figure 10-16. Mapping of the preferred option for ODU 10c (Western Docks).

Figure 10-17. Mapping of the preferred option for ODU 10d (Western Docks).

10.13 Unit 11 - Redbridge

10.13.1 *Summary of baseline under 'Do Nothing'*

The 'Do Nothing' tidal flood risk, required phasing for options, and SMP policy for this area are summarised in Table 10-50.

Table 10-50. Do Nothing' scenario flood risk summary for Option Development Unit 11

Area	Redbridge	'Do nothing' tidal flood risk summary
Option Development Unit	11	
Present Day Flood Risk 1:200year typical depth (max) metres	0	The risk of tidal flooding is currently low. By 2030 there is a risk of tidal flooding as sea levels rise and residential properties and rail infrastructure is at risk. The risk increases significantly in the future due to sea level rise with flood depths of up to 1.75m from a 1:200 year event at 2110.
2030 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.25(0.5)	
2060 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.25(0.75)	
2110 'Do Nothing' Flood Risk 1:200year typical depth (max) metres	0.75(1.5)	
Present Day Flood cell		
2030 Flood cell	C	
2060 Flood cell	C	
2110 Flood cell	C	
Required implementation of 'Do something' option based on flood risk		2030
SMP policy		Hold the Line till 2110

10.13.2 *Option appraisal*

To achieve a 1:200 year Standard of Protection for this Unit, the indicative typical, minimum and maximum defence heights required are summarised in Table 10-51.

Table 10-51. Indicative minimum, maximum and typical defence heights (including 0.3m freeboard) above existing structures or ground levels required to achieve a 1:200 year standard of protection for ODU 11.

Year	Minimum defence height (metres above existing ground levels)	Maximum defence height (metres above existing ground levels)	Typical defence height (metres above existing ground levels)
2015	-	-	-
2030	0.3	0.5	0.4
2060	0.5	0.7	0.6
2110	1.0	1.2	1.1

The initial appraisal of the long list options for this Unit is presented in Table 10-52. Clearly 'non viable' options were discarded for further appraisal. The 'potentially viable' short list options were selected for detailed appraisal and evaluation.

Table 10-52. Initial assessment of long list options identifying the short list of options for detailed appraisal

	Long list option	Detailed appraisal?	Explanation
Clearly Non Viable options	**Steel sheet pile front line defences along the river channel.**	No	This option was rejected for detailed appraisal due to the potential environmental impacts of this option on the designated site of the lower Test Valley.
Potentially viable short list options	**Earth embankment defences alongside railway**	Yes	The railway provides a useful feature to utilise as a defence corridor. This option would generate maximum benefits as the greatest number of receptors would be protected and is more environmentally sympathetic in this environmentally designated area and this option was appraised in detailed.
	Steel sheet pile defences along the railway line.	Yes	This option was considered worthy of detailed appraisal as a high number of residential properties and commercial assets are at high risk of flooding over The Strategy period and the railway provides a useful defence corridor.
	Floodwall along the railway line.	Yes	This option was considered worthy of detailed appraisal as a high number of residential properties and commercial assets are at high risk of flooding over The Strategy period and the railway provides a useful defence corridor.
	Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice.	Yes	Due to the SMP policy of No Active Intervention, with a significant flood risk over The Strategy period this option where the risks are managed and adapted to, was appraised in detail.

An indicative summary of the relative impacts, merits and drawbacks of the non viable options is provided in Table 10-53 and for the potentially viable short list options in Table 10-54.

The box out in Table 10-54 indicates the option/s which either form elements of the preferred option, or constitute the preferred option; the preferred option is discussed in detail in Section 10.13.3.

Table 10-53. Appraisal of non viable options screened out for ODU 11 (Redbridge).

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Steel sheet pile wall along river channel	Significant adverse effects for environmentally designated area	Potential impacts on assets during construction	Low – flood protection but significant impacts on environment, character and aesthetics	Fundamental changes and adverse impacts	Detrimental impacts	Minor	Good but issues for surface water drainage	Some	High	Some residual risk if defence breach failure occurs

Table 10-54. Summary of short list option appraisal for ODU 11 (Redbridge). Preferred options highlighted by a box.

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics Impacts	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Earth Embankment	Potential for some impacts on designated area	Potential impacts on assets - compression	Mixed – flood protection but character / views affected	Some restriction to views and aesthetic impacts	Waterfront access is limited but views could be further affected	Some	Good – low risk of failure	Minor / infrequent	Low	Some residual risk if defence breach failure occurs
Steel sheet pile defences	Potential impacts on Environment and designated area	Potential impacts on assets	Mixed – flood protection but character / views affected	Some restriction to views and aesthetic impacts	Waterfront access is limited but views could be further affected	Minimal	Good – low risk of failure	Minimal and infrequent	High	Some residual risk if defence breach failure occurs
Concrete flood wall	Potential for some environment impacts but can be minimised through suitable mitigation	Potential impacts on assets	Mixed – flood protection but character / views affected	Some restriction to views and aesthetic impacts	Waterfront access is currently restricted but views could be affected	Minor	Good – low risk of failure	Minimal and infrequent	Medium cost option	Some residual risk if defence breach failure occurs

Options	Natural Environment impacts	Historic Environment Impacts	Community / stakeholder acceptability	Character / Aesthetics Impacts	Access and waterfront connection	Land take	Technical robustness managing flood risk	Maintenance	Relative Cost	Residual Risk
Community and property level resistance / resilience / adaptation	Minor	Minimal	Mixed – increased protection but some aesthetic impacts. Concerns of defence failure / flooding	Some aesthetic impacts	Access maintained	Minimal	Good short to medium term, not good long term. Risk of failure.	Minimal maintenance required	Low	Properties may be flooded if defences not implemented in advance of flood event and still potential for significant damage under extreme events

10.13.3 *Preferred option*

For the short term (up to 2030) the risk of tidal flooding is low and the economic case to attract public funding for flood risk reduction measures until 2030 is not strong. However properties around the road bridge may benefit from a small scheme to seal the existing small gap in the wall here (Figure 6-17) as this low point is susceptible to breaching. In addition anecdotal evidence and consultation with local residents suggests that a localised area is vulnerable to surface water flooding caused by tide locking of drains and may benefit from a local surface water scheme to address this in the short term.

The tidal flood risk will increase overtime and although currently the flood risk in this unit is not significant enough for properties to qualify for Flood Defence Grant in Aid (FDGiA) funding of a flood protection scheme under the current criteria, by 2030 there will be approximately 30 properties at risk from a 1:50 year tidal flood event. These most vulnerable properties would benefit from property level flood resistance measures from 2030 (Figure 10-18). The property level resistance and resilience would rely on property owners taking responsibility for the operation of the defences ensuring that flood gates are installed in advance of impending flood events. This option would also provide additional benefits reducing the consequences of any surface water flood events that should occur. This preferred approach will also include setting up a flood warning system to provide advanced notice of flood events and also the establishment of a community flood group. For a full description of this option and the types of measures involved see Section 8.3.7.

At 2030 there are also expected to be a further 60 properties at lower risk of tidal flood flooding (greater than a 1:50 year event envelope but within the 1:200 year flood envelope between 2030 and 2060). Under the current criteria these properties would not be eligible for FDGiA funding for property level protection; however engagement and liaison with these residents to facilitate community adaptation should be undertaken to raise awareness of tidal flood risk and the potential increase in risk in the future due to sea level rise. Privately funded property protection measures would also be encouraged for these properties to reduce the consequences of an extreme event.

By 2060, the flood risk is likely to have increased significantly and the economic case for implementing formal raised flood defences may be much stronger; however, depending on the criteria for attracting public funding at the time, additional contributions from major beneficiaries and/or the Community Infrastructure Levy may be required.

The North Solent Shoreline Management Plan[xviii]. policy for the lower Test Valley is for 'No Active Intervention for the coming century. The lower Test Valley SMP Policy Unit (5c13) covers over 8km of shoreline mainly to the north of Redbridge and this frontage includes extensive and significant environmental designations and generally within this Unit there are relatively few benefits to necessitate a 'Hold the Line' Policy. However it is the role of the coastal strategies to review the broad scale SMP policies in greater detail and the assessments undertaken for this study demonstrate that at Redbridge there is locally a strong case to provide raised flood defences beyond 2060 as 'No Active Intervention' would lead to extensive flooding and significant damages to many residential properties and some commercial assets.

The longer term preferred option (beyond 2060) is therefore to provide flood protection in the form of a floodwall utilising the existing infrastructure corridor of the railway line. This would

[xviii] North Solent Shoreline Management Plan 2010

stretch for approximately 1km in total and would encompass 600m of the 8km SMP Policy Unit 5c13. This floodwall would typically need to be 1.1 metres in height above existing ground levels to provide a standard of protection to in excess of 1:200 years against tidal flooding until 2110. By utilising this existing infrastructure corridor the potential impacts of the defence on the environmentally designated sites and on archaeological assets could be minimised. It will be necessary for this Strategy recommendation to be taken into account in the next revision of the SMP.

If the benefits to the community of raised flood defences are perceived to overwhelm the drawbacks, and the necessary non-public funding contributions could be obtained, a floodwall defence could be delivered for this Unit before 2060.

Summary of preferred option for ODU 11

2015 to 2030-	**Defended by current structures and existing land levels.**
2030 to 2060 –	**Community and property level flood resistance and resilience.**
2060 to 2110 –	**Defended by a floodwall constructed along the seaward side of the railway embankment.**

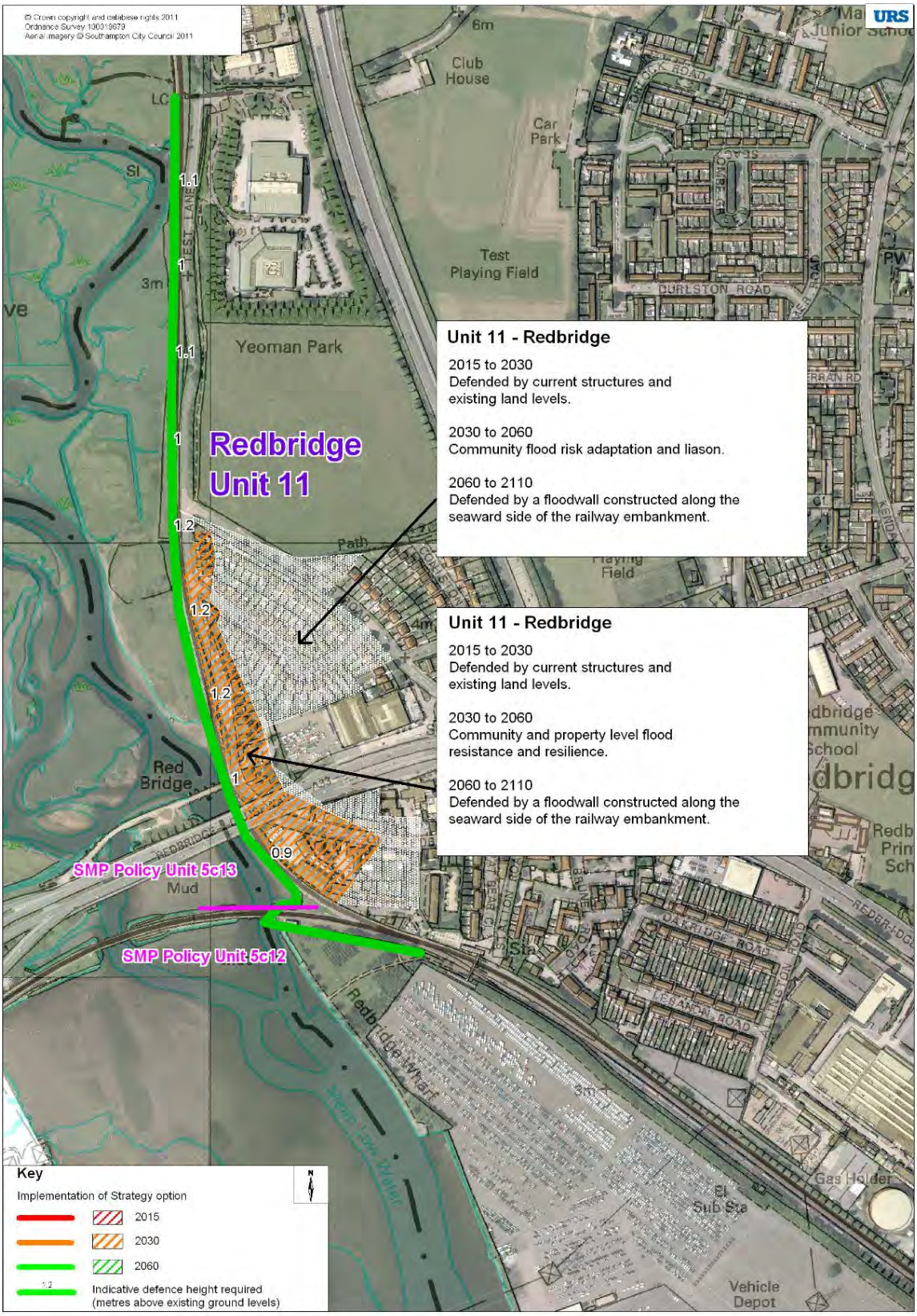


Figure 10-18. Mapping of the preferred option for ODU 11 (Redbridge).

Table 10-55. Summary of the long list and short list options for each Option Development with supporting commentary

Flood Cell	Area (Unit)	Option	Short-listed	Comment
A	Bevois Valley (2)	Community and property level flood resistance / resilience / adaptation.	No	This unit is part of a continuous flood cell and the depths associated with future flood events are significant by 2060 due to the topographic depression behind the front line, so this option was rejected for detailed appraisal.
		Land raising through redevelopment	No	Due to the presence of the railway line at the frontline, and the operational / technical issues of land raising along a railway line this option was rejected for detailed appraisal.
		Steel sheet pile front line defences.	Yes	A number of receptors and assets are at high risk of flooding by the end of The Strategy period. This area is also part of a larger continuous flood cell so this was appraised in detail.
A	Former Meridian Studios Site (3)	Earth Embankment defences	No	The implementation of this option would be impractical due to current land use requirements and the significant land take required so was rejected for detailed appraisal.
		Floodwall front line defences	Yes	This option was appraised in detail as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell with flow paths through to adjacent areas.
		Land raising through redevelopment	Yes	Part of the site is currently awaiting re-development and there is a strong potential for land raising to form a flood defence so this option was appraised in detail
A	Northam (Northam Bridge to Belvedere Wharf) (4)	Community and property level flood resistance / resilience / adaptation	No	Flood risk becomes significant by 2030. Within this unit flood depths become large and the flood extent significant so resistance, resilience and adaptation would not be sufficient to mitigate the risks. The economic benefits of defending this frontage are also large. This area is also part of a larger continuous flood cell so this option was rejected for detailed appraisal.
		Earth Embankment defences.	No	Due to the highly developed, industrial and residential land uses and the operational requirements of the quays, the practicality and acceptability of this option render this a non starter in this area so was rejected for detailed appraisal.
		Steel sheet pile front line defences.	Yes	This option is worthy of detailed appraisal as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell.
		Floodwall front line defences	Yes	A detailed appraisal of this option was undertaken as a number of receptors and assets are at high risk of flooding over The Strategy period. This area is also part of a larger continuous flood cell and this is cheaper option than steel sheet pile defences.
		Land raising through redevelopment.	Yes	Due to potential operational difficulties of implementing a front line defence option, and the potential for re-development, the land raising option was considered worthy of detailed appraisal.
A	St Mary's Wharves (5)	Community and property level flood resistance / resilience / adaptation	No	Flood risk becomes high by 2030. Flood depths become large and the flood extent significant and resistance, resilience and adaptation cannot adequately mitigate the risks. The economic benefits of defending are also large. The unit is also part of a larger continuous flood cell and this option was rejected for detailed appraisal.
		Earth Embankment defences	No	Due to the highly developed, industrial and residential land uses and the operational requirements of the quays, the practicality and acceptability of this option render this a non starter in this area so was rejected for detailed appraisal.
		Road raising at the rear of the Wharves	No	Due to the levels required to provide protection, the limited space due to dense industrial land use and the access requirements for large plant to the wharves this option is a 'non starter' and was rejected for detailed appraisal.
		Steel sheet pile front line defences.	Yes	This option was appraised in detail as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This unit is also part of a larger continuous flood cell.
		Floodwall front line defences	Yes	This option was considered worthy of detailed appraisal due to the high number of receptors and assets at high risk of flooding, over The Strategy period. This option is also a lower cost option than the sheet pile option. Also part of a larger continuous flood cell.
		Land raising through redevelopment	Yes	Due to potential operational difficulties of implementing a front line defence option, and the potential for re-development, the land raising option was considered worthy of detailed appraisal. This is also the most technically robust defence type to protect against flooding.

Flood Cell	Area (Unit)	Option	Short-listed	Comment
A	Crosshouse/ Town Depot (6)	Steel sheet pile front line defences.	Yes	This option was considered worthy of detailed appraisal as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This unit is also part of a larger continuous flood cell.
		Floodwall front line defences	Yes	This option was appraised in detail as there are a number of receptors and assets at high risk of flooding, over The Strategy period. This is also a lower cost option than the sheet pile option. This unit is also part of a larger continuous flood cell.
		Land raising through redevelopment	Yes	This site is earmarked for redevelopment and due to potential operational difficulties of implementing a front line defence option, the land raising option was considered worthy of detailed appraisal. This is also the most technically robust defence type to protect against flooding and requires no maintenance unlike other raised flood defences.
A	Ocean Village (7)	Road raising.	No	This option does not provide protection to the key receptors in Ocean village so was rejected for detailed appraisal.
		Steel sheet pile front line defences.	No	There is a flood risk mainly 'via the back door' from other areas (i.e. the Port) so this option as a stand alone solution is ineffective at preventing flooding and was rejected for detailed appraisal.
		Defend front line with tide gate / lock across entrance to marina and defences along perimeter of ABP land and demountable defences / ramps on access points.	Yes	A number of receptors and assets are at high risk of flooding, over The Strategy period. Also this is part of a larger continuous flood cell with flow paths through to the City Centre and therefore this option was considered worthy of detailed appraisal.
		Raise quay walls with floodwall defences along perimeter of ABP land and demountable defences / ramps on access points.	Yes	A number of receptors and assets are at high risk of flooding, over The Strategy period. Also this unit is part of a larger continuous flood cell with flow path through to the City Centre and is more cost effective than the option with a tide gate on the Marina entrance so this option was appraised in detailed.
A	Eastern Docks / Dock Gate 4 (8)	Front line floodwall defences	No	This option was rejected for detailed appraisal due to operational requirements of the Port.
		Raise Canute / Platform Road.	No	This option is technically very challenging, given access requirements and tight urban fabric and was rejected for detailed appraisal on practical and technical grounds.
		Demountable defences along roads	No	It is operationally intensive to use long stretches of demountable defences and requires ongoing maintenance and operation. There is also a high risk of failure with this option due to the need to construct the defences in time to prevent flooding.
		ABP boundary flood wall with demountables / ramps across access points.	Yes	The Port boundary provides a potential defence corridor and this option would provide protection to a large number of receptors behind the Port. This option would also not impinge on Port operations and was appraised in detail.
A	Mayflower Park / Major Development Quarter (9)	Existing road raising.	No	Technically challenging and expensive given access requirements. Also the site is earmarked for re-development and was rejected for detailed appraisal.
		Front line steel sheet pile defences	Yes	This option was considered worthy of a detailed appraisal as the site is earmarked for redevelopment so there is the opportunity for land raising to be implemented to form a robust defence line.
		Land raising through redevelopment	Yes	This is a relatively cost effective solution which could be integrated into the park and any redevelopment and therefore was considered worthy of detailed appraisal.
		Earth Embankment defences.	Yes	This option is technically feasible and was considered worthy of detailed appraisal.
		Floodwall at rear of park and along the port boundary with demountable defences / ramps on access points.	Yes	This could be incorporated and constructed during a potential re-development and would provide robust flood protection to the Major Development Quarter so was appraised in detail.
		Construct elevated service road as flood defence.	Yes	This option was rejected for detailed appraisal due to the operational requirements of the Port and ABP is not currently exploring this option.
A	Western Docks (10)	Front line floodwall	No	This is a high cost option and logistically very difficult so this was rejected for detailed appraisal. Key infrastructure (Railway and Millbrook WTW) are not protected by this option. Access requirements are also a key issue.
		Raise road at rear of the Port	No	This is a high cost and logistically very difficult. Key infrastructure (Millbrook WTW) will also not be protected by this option so this was rejected for detailed appraisal.
		Upgrade railway line at rear to act as a defence	No	This is a high cost option and very disruptive for a working Port. ABP is also currently not exploring this option so this was rejected for detailed appraisal.

Flood Cell	Area (Unit)	Option	Short-listed	Comment
		Raise entire Port area	No	ABP is currently not exploring this option so this was ruled out for detailed appraisal
		Raise the service road through the Port.	No	This option was considered worthy of detailed appraisal as this would provide a defence corridor with minimal disruption to port operations. This option would provide flood protection to the receptors at risk behind the Port whilst maintaining access to the Port.
		Floodwall along ABP boundary with ramps / demountables on access points.	Yes	Due to the low number of properties at risk (and therefore low economic benefits generated) behind this road, and the technical, access and groundwater drainage issues associated with road raising, this option was rejected for detailed appraisal.
B	Upper Itchen / St Deny's (1)	Raise Priory Road	No	Due to the significant lengths of private residential ownership of much of this frontage, and the relatively low economic benefits generated behind the frontline of properties, this option was rejected for detailed appraisal.
		Wholesale re-development / land raising -	No	Many residential properties and commercial assets along the frontage are at high risk of flooding over The Strategy period so a detailed appraisal of a frontline defence option was undertaken.
		Steel sheet pile front line defences.	Yes	Many residential properties and commercial assets along the frontage are at high risk of flooding over The Strategy period so a detailed appraisal of a frontline defence option was undertaken.
		Floodwall front line defence.	Yes	The flood envelope is relatively narrow and it is mainly waterfront properties at risk of flooding. Due to long stretches of private frontages where waterfront access and riverside views are an important factor for many residents this option (where the risks are managed and adapted to) was appraised in detail.
		Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice.	Yes	The flood envelope is relatively narrow and it is mainly waterfront properties at risk of flooding. Due to long stretches of private frontages where waterfront access and riverside views are an important factor for many residents this option (where the risks are managed and adapted to) was appraised in detail.
C	Redbridge (11)	Steel sheet pile front line defences along the river channel.	No	This option was rejected for detailed appraisal due to the potential environmental impacts of this option on the designated site of the lower Test Valley.
		Earth embankment defences alongside railway	**Yes**	The railway provides a useful feature to utilise as a defence corridor. This option would generate maximum benefits as the greatest number of receptors would be protected and is more environmentally sympathetic in this environmentally designated area and this option was appraised in detailed.
		Steel sheet pile defences along the railway line.	**Yes**	This option was considered worthy of detailed appraisal as a high number of residential properties and commercial assets are at high risk of flooding over The Strategy period and the railway provides a useful defence corridor.
		Floodwall along the railway line.	**Yes**	This option was considered worthy of detailed appraisal as a high number of residential properties and commercial assets are at high risk of flooding over The Strategy period and the railway provides a useful defence corridor.
		Community and property level flood resistance / resilience / adaptation including warnings / incident response / advice.	**Yes**	Due to the SMP policy of No Active Intervention, with a significant flood risk over The Strategy period this option where the risks are managed and adapted to, was appraised in detail.

Table 10-56. Summary of the preferred options for each ODU.

Area	Upper Itchen / St Denys	Bevois Valley	Meridian Studios	Northam	St Mary's Wharves	Crosshouse / Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge
Option Development Unit	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Preferred option	2015 to 2060 Community and property level flood resistance and resilience 2060 to 2110 Flood wall near the front line	2015 to 2030 Maintain existing defence structures 2030 to 2110 Steel sheet pile wall at the front line	2015 to 2060 Intermediate height floodwall forming the spine of defence until raised land supersedes the wall as the main defence by 2060. 2060 to 2110 Defended by a continuous strip of raised land.	2015 to 2060 Intermediate height floodwall forming the spine of defence until raised land supersedes the floodwall as the main defence by 2060. 2060 to 2110 Defended by a continuous strip of raised land.	2015 to 2060 Intermediate height floodwall forming the spine of defence until raised land supersedes the floodwall as the main defence by 2060. 2060 to 2110 Defended by a continuous strip of raised land.	2015 to 2110 Defended by raised land implemented through redevelopment .	2015 to 2060 Maintain existing quay walls and defence structures 2060 to 2110 Defended by raised quay walls with floodwall defences along perimeter of ABP land.	2015 to 2060 Do nothing. The area behind Port protected against flooding by the existing quay walls in the Port and The Strategy defences along the Itchen frontage to the north. 2060 to 2110 Defended by a floodwall around Ocean Village and along the boundary of the Port.	2015 to 2060 Land raising through development of Royal Pier Site and the Major Development Quarter preferred. Implementation of a floodwall forming the spine of the flood defence by 2030 if a continuous strip of raised land is not achieved by this time. 2060 to 2110 Defended by a floodwall and / or raised land.	2015 to 2060 Do nothing. The area behind Port protected against flooding by the existing quay walls in the Port. 2060 to 2110 – Area behind the Port defended against flooding by a floodwall along the boundary of the Port ramps / demountables on access points.	2015 to 2030 Defended by existing structures and land levels 2030 to 2060 Community and property level flood resistance and resilience 2060 to 2110 Floodwall along the seaward side of the railway embankment.

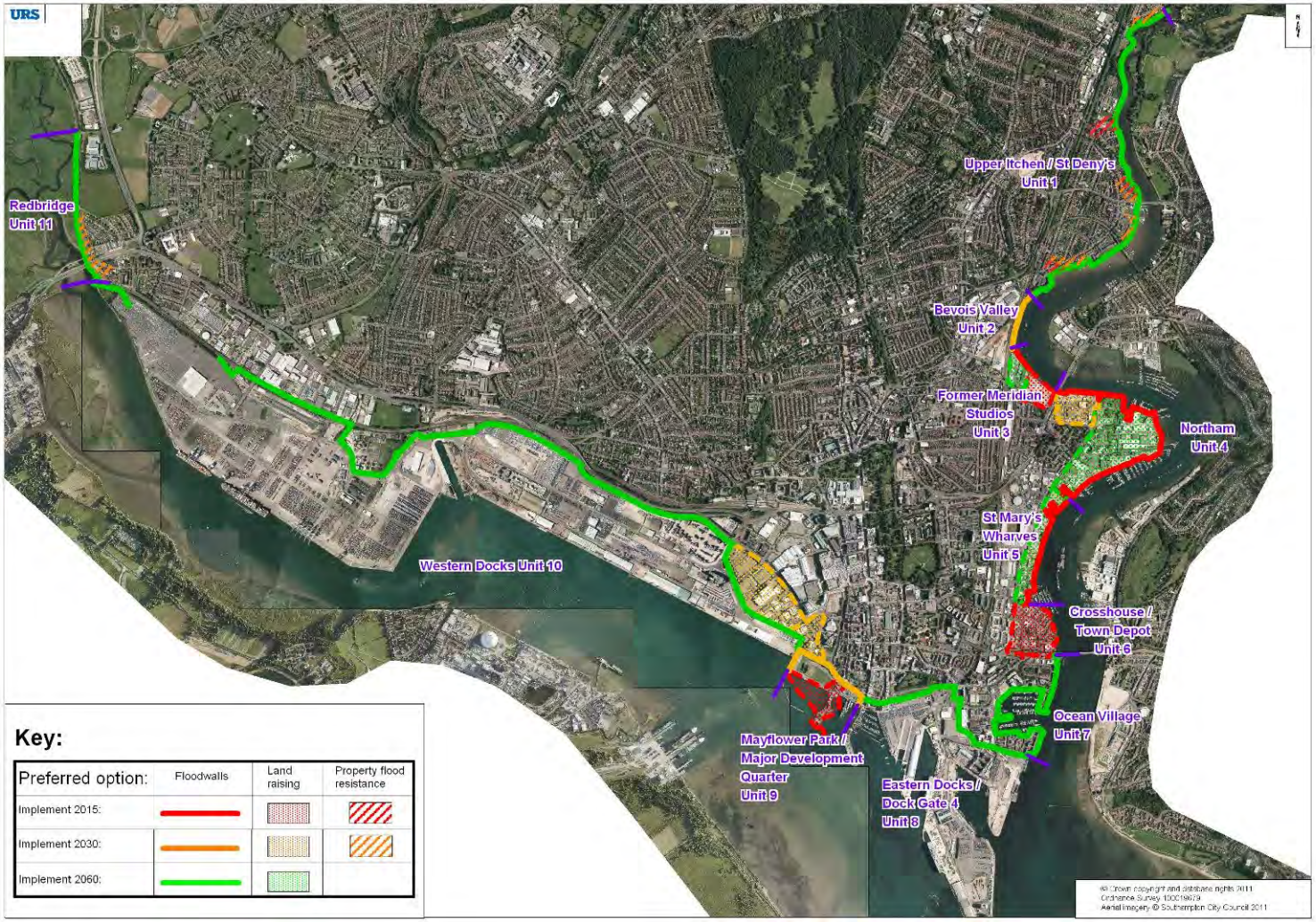


Figure 10-19. Map of the preferred Strategy options for the 11 "Option Development Units".

11 COSTING THE STRATEGY

11.1 Approach to capital construction costs

In order to compare the relative economic merits of the options and generate the benefit cost ratios against the 'Do-Nothing' baseline, outline costs for the different shortlist options have been estimated.

The costing of options has been undertaken using a variety of sources and using the best available information. In the first instance, where actual defence costs were available from previous projects or published data, these costs have been used as a basis for relevant options in this study. In the absence of 'real costs', values have been estimated from rates provided in civil engineering price books (e.g. SPONS)[xix] coupled with experience of costs from similar projects and cross referenced where possible against information obtained from contractors. The indicative costs presented are estimated as of November 2011.

The following sections summarise the costing basis and assumptions for the different options which comprise The Strategy:

11.1.1 *Floodwalls*

Unit rates per meter for floodwalls were estimated using civil engineering price books (e.g. SPONS) coupled with experience of costs from similar projects and benchmarking against information obtained from contractors.

The costing of floodwalls is based on the indicative cross section (Figure 11-1).

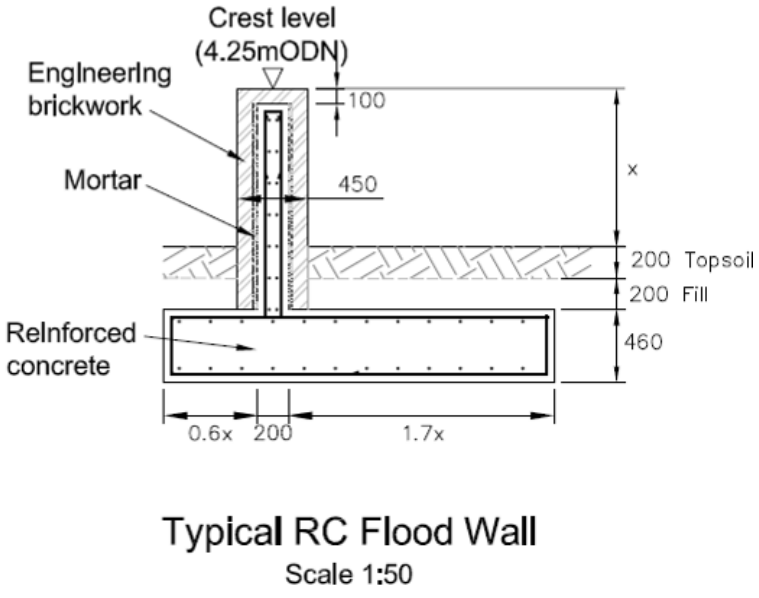


Figure 11-1. Typical cross section for a reinforced concrete flood wall assumed as a basis for costing the floodwalls.

[xix] SPON's Civil Engineering and Highway works price book, Davis Langdon (2007).

The costing of the floodwalls included allowance for the following aspects and materials:

- Excavation and disposal
- Trimming of excavation
- Topsoil
- Fill
- Facing Brickwork
- Concrete Top - Design Mix
- Placing of concrete
- Reinforcement of concrete
- Formwork
- Trimming of filled surfaces and seeding
- Preliminaries and scale of Works
- Overhead/Profit

The costs per metre length of floodwall were then categorised 0.1m height categories (Table 11-1).

Table 11-1. Summary of costs per metre length of floodwall for varying heights.

Height (m)	Cost / m (£)
0.1	800
0.2	800
0.3	800
0.4	800
0.5	800
0.6	880
0.7	960
0.8	1,040
0.9	1,120
1	1,200
1.1	1,280
1.2	1,360
1.3	1,440
1.4	1,520
1.5	1,600
1.6	1,680
1.7	1,760
1.8	1,840
1.9	1,920
2	2,000

To represent the costs of implementing floodwalls which achieve the required standard of protection, the topographic surface described by the LiDAR data was inspected along the indicative alignments identified to define the required defence heights averaged over 100m long defence sections for the relevant Units. By multiplying the relevant unit costs (Table 11-1) by the defence lengths and typical required heights the capital construction costs were estimated for the floodwalls.

11.1.2 *Steel Sheet Pile Wall*

The steel sheet pile wall costs were estimated using civil engineering price books (e.g. SPONS) and benchmarked against real scheme costs for a flood protection scheme at Rochester Riverside, an estuary with poor ground conditions akin to that of the River Itchen. An indicative cross section of a steel sheet pile wall is shown in Figure 11-2.

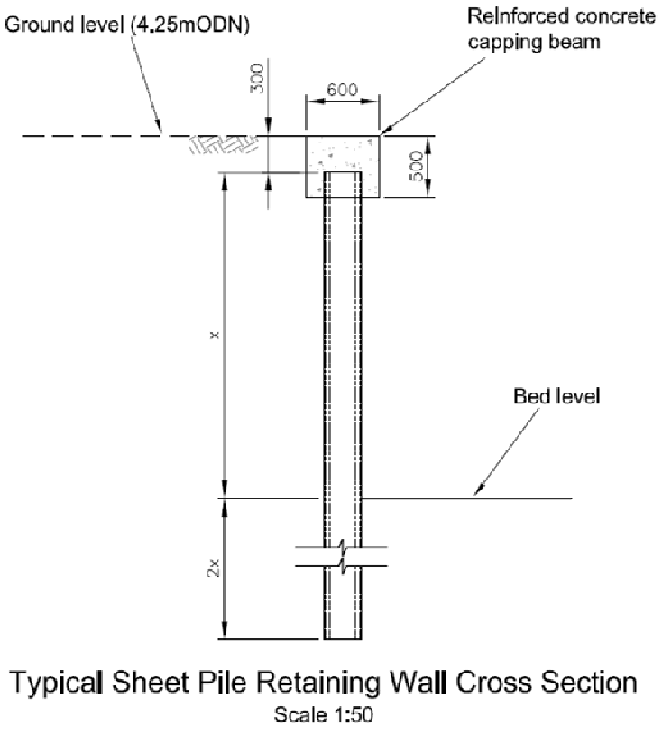


Figure 11-2. Indicative cross section of a steel sheet pile wall

The unit cost assumed for a steel sheet pile wall are given in Table 11-2. To estimate the costs for the sheet pile walls the unit costs were multiplied by the total length required.

Table 11-2. Steel sheet pile wall unit cost estimate.

Steel sheet pile wall	
Unit	Cost (£)
/m length	6,800

11.1.3 *Land raising*

The rates for the land raising were estimated using SPONS and validated against URS experience on the River Medway and against real costs of a land raising scheme as part of a flood protection scheme and redevelopment at Rochester Riverside. The costing of land raising included the following aspects:

- Fill material
- Transport of material to site
- Clearance / preparation / levelling of fill
- Deposition of fill
- Compaction
- Topsoiling
- Contractor Overhead/Profit

An indicative cross section of how raised ground could be implemented is shown in Figure 11-3.

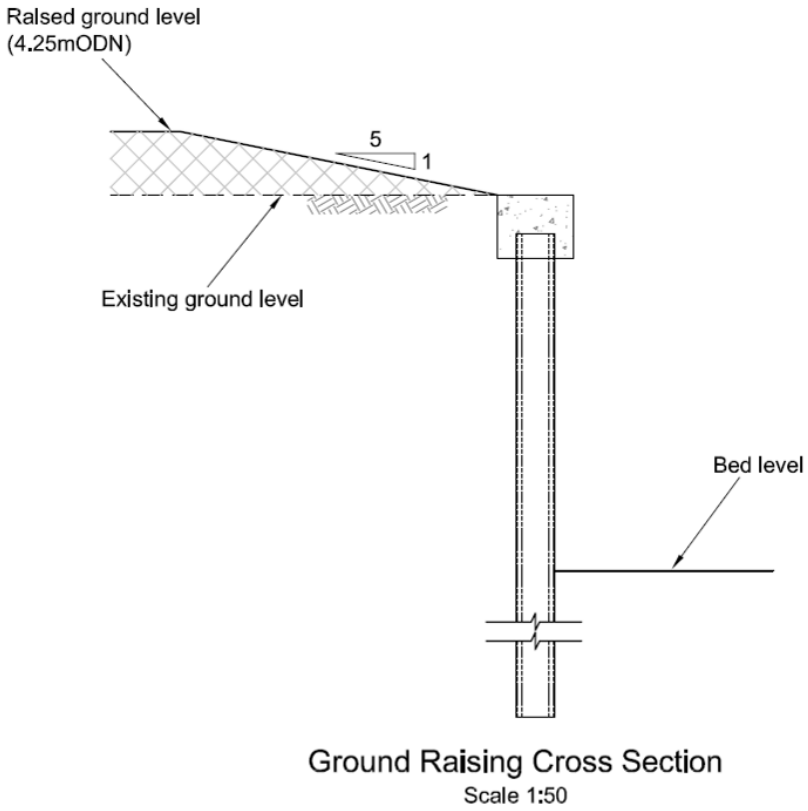


Figure 11-3. Indicative cross section of raised ground behind a front line defence.

Zones have been identified within The Strategy within which sites could potentially be raised over time to eventually form a continuous strip of raised land which would function as a robust flood defence (Figure 11-4). It is not necessary that these zones are raised in their entirety; rather they represent the areas within which individual development sites could be raised to form part of the strategic flood defence.

From a technical aspect, the minimum width of a continuous strip of raised land required in order to achieve a robust flood defence would be in the order of 40-50m. To gain maximum benefits of the defence the raised strip should be as near to the front line as possible. Also the wider the strip of raised land, the more robust the defence and the less visually apparent the defence becomes on the landscape. However this incurs higher costs due to the significant areas which require raising.

It is not within the scope of The Strategy to identify precise alignments or specific sites which may be raised, but in reality, it is anticipated that the width and alignment of a raised strip of land is likely to vary along the frontage depending on factors such as; the size and position of development areas as they become available, the plans and visions of the individual developers, and the funding contributions available at the time.

However wide the strip of raised land, it will be the responsibility of the Council to drive and coordinate the strategic approach to land raising through the planning process to ensure a continuous strip of sufficient width is achieved by the required date.

It was agreed in liaison with the Client Steering Group that costing for raising land for 100% of the zones identified is too conservative as in reality it is unlikely that the identified zones will be raised in their entirety. However, costing only for a 50 metre wide strip as a minimal approach was considered too low and unrepresentative of the true costs and therefore the funding required.

Therefore cost estimates for the land raising option were generated using 50% of the total cost of raising the entire zones. This approach to costing for 50% land raising within the zones provides the compromise between the need to be conservative and the minimum width required for a robust defence. It should be noted that adopting this approach would lead to higher costs than would be required technically to implement a robust flood defence, but it was agreed that this cost may be more representative of the potential costs of this option.

To estimate the cost of land raising to achieve the required standard of protection, the topographic surface described by the LiDAR data (Figure 11-4) was inspected for the zones defined to estimate the required average land raising height per square metre. By multiplying the corresponding unit costs by the area and then taking 50% of this value, the cost of land raising for each of the areas was estimated (Table 11-3).

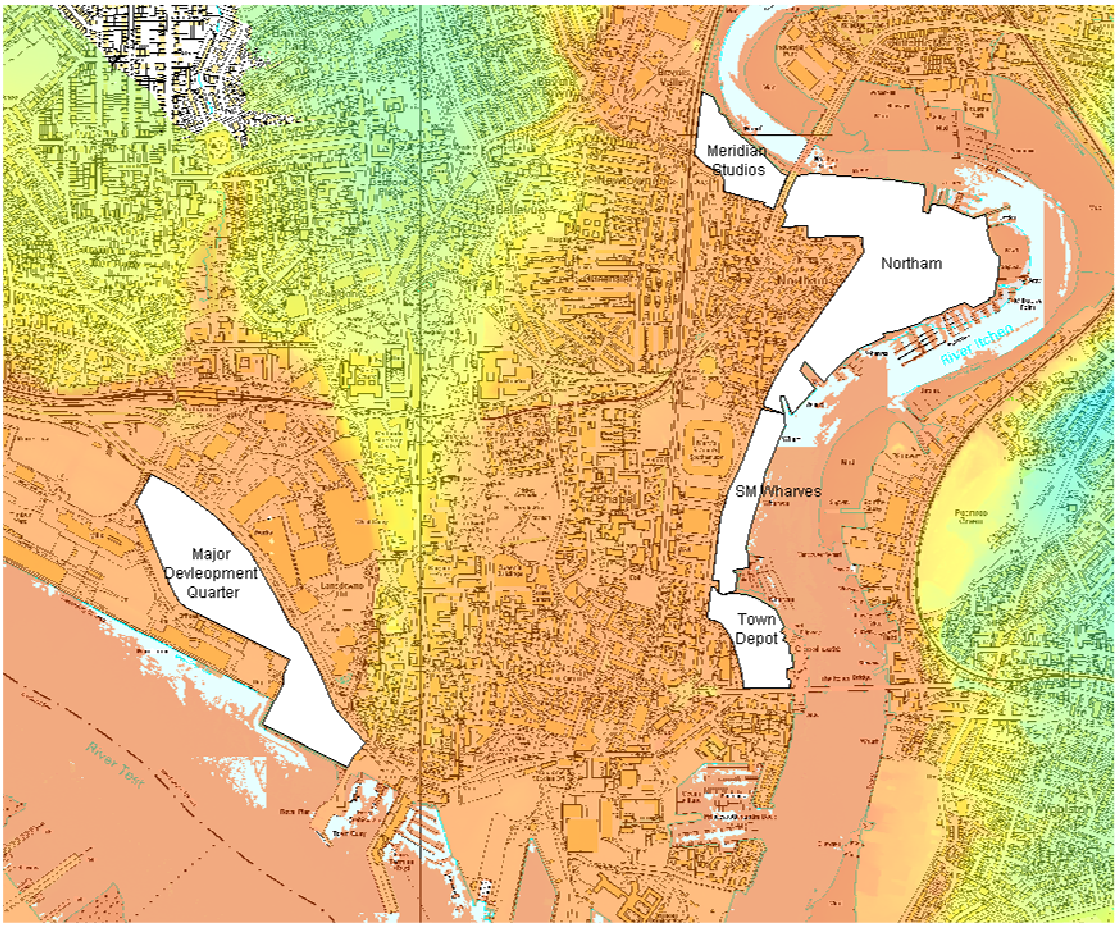


Figure 11-4. Zones within which sites could potentially be raised to form a continuous strip of raised land shown against the LiDAR data used to establish fill volumes and land raising costs required.

Table 11-3. Land raising cost estimates.

	Total Area m^2	Fill Volume (m^3)	Average fill depth (target 4.25m ODN)	m^2 cost	£mill entire area	£mill (50% of area)
Meridian Studios	50000	70000	1.2	65	3.3	1.6
Major Development Quarter	200000	220000	0.9	50	10.1	5.0
Northam	270000	430000	1.4	77	20.8	10.4
Town Depot	54000	95000	1.5	85	4.6	2.3
St Mary's Wharves	54000	80000	1.3	69	3.8	1.9

11.1.4 *Flood resistance and property protection*

Cost estimates for property level flood protection have been based on real costs from a 49 property resistance scheme at Wallington (Fareham), Environment Agency published literature, Defra Pilot studies, quotations for commercially available defences and from direct contractor discussions (UK Flood Barriers).

The worked up estimated costs reach £4,250 per property. This is also the maximum possible FDGiA funding per property[xx] for flood protection measures, including survey and administration. This sum also covers the material and fitting costs estimated per property (Table 11-4) with an additional sum of £750 included for homeowner and community engagement and liaison. This has been applied and it is acknowledged that additional funding would need to come form other sources such as the coastal flood levy or homeowners.

Table 11-4. Estimated cost breakdown for property level flood protection

2x Door Defenders (1m high)	1,270
6x Airbrick covers	360
2 x backwater valve (toilet/sinks)	820
Waterproof paint	200
Fitting	1,000
Survey, engagement, liaison and administration	750
Total	**4,250**

Property level flood protection forms part of the preferred option for Units 1 and 11. Here the eligible properties at risk have been identified using the flood modelling results. The breakdown of the property types and the total scheme costs are presented for ODU 1 in Table 11-5 and Table 11-6 and for ODU 11 in Table 11-7.

Table 11-5. Costing of first phase property level protection scheme implemented at 2015 for ODU 1 (Upper Itchen / St Denys)

Total number of residential properties eligible	69
Total number of commercial properties eligible	1
Rounded total for scheme(£)	**£300,000**

Table 11-6. Costing of second phase property level protection scheme implemented at 2030 for ODU 1 (Upper Itchen / St Denys)

Upper Itchen / St Denys	
Total number of residential properties eligible	121
Total number of commercial properties eligible	1
Rounded total for scheme(£)	**£520,000**

[xx] Environment Agency briefing note issued in August 2011 (Expenditure ceiling update for property level defences).

Table 11-7. Costing of property level protection scheme implemented at 2030 for ODU 11 (Redbridge)

Total number of residential properties eligible	30
Total number of commercial properties eligible	3
Rounded total for scheme (£)	**£150,000**

11.1.5 *Demountable defences and provisions for access*

Costing advice for flood gates over roads and railways was provided by Flood Control plc, Flood Sense, Bauer Demflood, and Floodgate Ltd.

The total costs for each item of work include for site preparation, installation, remedial works and an addition of 15% for preliminary works.

The requirement for different access provisions and demountable defences through or over floodwalls was identified through site inspections and aerial imagery for Units 8 and 10. These were then costed (Table 11-8).

Table 11-8. Costs for demountable flood defences and provisions for access on access through / over floodwalls for ODU 8 and 10.

Defence type	**Cost (£)**
ODU 10 – Western Docks	
Railway demountables	
3 rails	100,000
1 rail	40,000
1 rail	40,000
Road access / gates	
Millbrook WTW West	40,000
Millbrook WTW East	40,000
Southern Road	40,000
Ramp (Herbert Walker)	300,000
Total	**600,000**
ODU 8 – Eastern Docks / Dock Gate 4	
Road access	
Ferry terminal	40,000
Dock Gate 4	70,000
Rail	
Dock gate 4	50,000
Total	**160,000**

Table 11-9 provides a summary of the estimated unit costs for all the short list options. The Strategy capital cost is presented by ODU in Table 11-10 with the estimated costs of the various schemes which comprise the preferred options of each Unit identified. The overall spend profile to implement 'The Strategy' is presented in Table 11-11. In summary, the present day cash cost of The Strategy is £35 million over the 100 years with the initial schemes in 2015 costing £6.45 million.

Table 11-9. Summary of defence costs which form the preferred options of The Strategy.

Defence type	Unit	Cost (£)	Based on
Land Raising	m^2	78	Fill depth 1m
		118	Fill depth 1.5m
Floodwall	m	800	0.5m high
		1,200	1m high
		1,600	1.5m high
Quay wall raising	m	As floodwall	
Steel sheet pile wall	/m length	6800	
Demountables	x1	40,000	
Ramps	x1	300,000	
Property flood protection	/ property	4,250	(see section 11.1.4)

Table 11-10. Summary of preferred option costs for each ODU for a target minimum 1:200 year standard of protection (current day cash values).

	Area	Upper Itchen / St Denys	Bevois Valley	Meridian Studios	Northam	St Mary's Wharves	Crosshouse / Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge
	Option Development Unit	1	2	3	4	5	6	7	8	9	10	11
2015	Scheme	Flood resistance measures (see section 11.1.4)		Floodwall + Raised land	Floodwall	Floodwall	Raised land					
	Details	70 properties		400m long	2000m long	900m long						
	Cost	**£300,000**		**£1,240,000**	**£1,730,000**	**£870,000**	**£2,300,000**					
2030	Scheme	Flood resistance measures (see section 11.1.4)	Steel sheet pile defence		Land raising	Land raising				Floodwall		Flood resistance measures
	Details	122 properties	350m long							1350m		33 properties
	Cost	**£520,000**	**£2,380,000**		**£5,200,000**	**£940,000**				**£890,000**		**£150,000**
2060	Scheme	Floodwall		Land raising	Land raising	Land raising		Floodwall	Floodwall along ABP boundary		Floodwall with access provisions	Floodwall along railway
	Details	2600m long						1800m	850m		4900m	1050m
	Cost	**£3,000,000**		**£820,000**	**£5,200,000**	**£940,000**		**£1,280,00**	**£1,510,000**		**£4,680,000**	**£1,080,000**

Table 11-11. Spend profile by ODU and time period for The Strategy preferred options (current day cash values).

Area (ODU)	Upper Itchen / St Denys (Unit 1)	Bevois Valley (Unit 2)	Meridian Studios (Unit 3)	Northam (Unit 4)	St Mary's Wharves (Unit 5)	Crosshouse / Town Depot (Unit 6)	Ocean Village (Unit 7)	Eastern Docks/ Dock Gate 4 (Unit 8)	Mayflower Park / Major Development Quarter (Unit 9)	Western Docks (Unit 10)	Redbridge (Unit 11)	Total
2015	£300,000		£1,240,000	£1,730,000	£870,000	£2,300,000						£6,440,000
2030	£520,000	£2,380,000		£5,200,000	£940,000				£890,000		£150,000	£10,080,000
2060	£3,000,000		£820,000	£5,200,000	£940,000		£1,280,000	£1,510,000		£4,680,000	£1,080,000	£18,510,000
Total (current day cash)	£3,820,000	£2,380,000	£2,060,000	£12,130,000	£2,750,000	£2,300,000	£1,280,000	£1,510,000	£890,000	£4,680,000	£1,230,000	£35,030,000

11.2 Non-capital costs

The whole life scheme capital cost was developed for the preferred options with the implementation of works underpinned by the flood risk and included the relevant capital construction cost at the appropriate time over the 100 year appraisal period. In addition 'Maintenance costs' which are costs for periodic or annual maintenance works required to maintain the structural integrity of the defences, were applied at a rate of £5,000 per year. Other costs which include costs for site investigations, detailed design, construction supervision etc, and were approximated at 5% of the capital works cost for capital works and at 10% for flood resistance works. Non-capital costs are incurred on the year of construction.

It is noted that there is the potential for the land raising options at the Meridian Studios, Northam, St Mary's wharves and Crosshouse / Town Depot, and CBD / Mayflower Park to be funded by contributions from developers either through direct contributions or a developer tariff. For costing purposes land raising costs have been included, however the strategy will be sensitivity tested to consider the unlikely scenario developer contributions are not forthcoming.

11.3 Whole-life costings

The whole life scheme costs (capital, maintenance and other) were calculated over the 100 year appraisal period. In accordance with FCERM-AG[xxi] guidance these costs were discounted at the appropriate rate to develop a total Present Value (PV) cost for each option.

Discounting is a technique used to compare costs (and benefits) that occur at different points in the appraisal period, or over different time periods. Standard discount rates have been used to convert all costs to 'present values' (PV) so that the whole life costs of each option can be compared, leading to a realistic assessment of the cost implications of each option in today's terms. According with FCERM-AG the following variable discount rates have been used within this economic appraisal: 3.5% for years 0 to 30, 3% for years 31 to 75, and 2.5% for years 76 to 99.

The whole life cash cost and the total PV costs are summarised below (Table 11-12, and Table 11-13).

Table 11-12: Whole life option cash costs before discounting

Option	Cash Costs (£)			
	Capital	Maintenance	Other	Total
'Do Nothing'	0	0	0	0
Maintain	2,000,000	6,500,000	650,000	9,150,000
1:100	33,301,550	2,685,000	1,709,078	37,695,628
1:150	34,165,775	2,685,000	1,754,539	38,605,314
1:200 Year SOP	35,030,000	2,685,000	1,800,000	39,515,000
1:500 Year SOP	38,480,000	2,280,000	1,924,000	42,684,000

[xxi] Flood and Coastal Erosion Risk Management appraisal guidance (Environment Agency, March 2010)

Table 11-13: Whole life Present Value option costs after discounting

Option	PV Costs (£)			
	Capital	Maintenance	Other	Total
'Do Nothing'	0	0	0	0
'Maintain'	596,251	1,274,658	127,466	1,998,375
1:100 Year SOP	13,807,444	549,656	718,177	15,075,278
1:150 Year SOP	14,211,787	549,656	739,740	15,501,184
1:200 Year SOP	14,616,130	549,656	761,303	15,927,090
1:500 Year SOP	16,025,689	471,542	801,284	17,298,516

11.3.1 *Optimism Bias*

"Optimism bias is included to account for the tendency for appraisers to be overly optimistic in early assessments of project costs, timescales and benefits in comparison to the final values. This 'optimism' is a result of uncertainty in the final design detail and implementation as a result of high level strategic approach required at this stage."

To counter this, the HM Treasury issued guidance in the form of a percentage to increase the present value costs by depending on the uncertainty surrounding the estimates. This guidance has been adopted within the FCERM-AG. With regard to Coastal Strategies the FCERM-AG recommends an optimism bias level of 60% as these projects are typically at an early stage and adopt a higher level approach to design and costing. At the scheme level the additional detail completed as part of the Project Appraisal Report (PAR) enables a more accurate costing to be developed and therefore the FCERM-AG guidance recommends that the Optimism Bias be reduced to 30%.

Flood and Coastal Erosion Risk Management appraisal guidance- Environment Agency (March 2010)

*The economic assessment for The Strategy has considered an Optimism Bias of 60%. This was applied to the Present Value whole life costs (in line with FCERM-AG) (*Table 11-14*). This represents the 'worst case' costs with a high level of contingency. A scheme following The Strategy would include more detailed site investigations and design work, and therefore the optimism bias would be reduced.*

Table 11-14: Whole life Present Value option costs including Optimism Bias

Option	PV Costs (£)					
	Capital	Maintenance	Other	Sub Total	Optimism bias @60%	Total Cost
'Do Nothing'	0	0	0	0	0	0
'Maintain'	596,251	1,274,658	127,466	1,998,375	1,199,025	3,197,399
1:100 Year SOP	13,807,444	549,656	718,177	15,075,278	9,045,167	24,120,444
1:150 Year SOP	14,211,787	549,656	739,740	15,501,184	9,300,710	24,801,894
1:200 Year SOP	14,616,130	549,656	761,303	15,927,090	9,556,254	25,483,344
1:500 Year SOP	16,025,689	471,542	801,284	17,298,516	10,379,110	27,677,625

12 ECONOMIC ASSESSMENT

The economic assessment considers the whole life costs and benefits of the preferred strategy relative to a 'Do Nothing' approach to consider the economic efficiency of each option. In the strategy a range of technical options were considered to provide the required defence standard within each defence frontage with different approaches (options) to the phasing of the works. The works were staggered over the 100 year appraisal period based on flood risk. This logical approach ensures that areas at highest risk are addressed first and are a priority for scheme development and funding. By adopting this approach works in areas of reduced risk were therefore postponed until the future and their associated costs are more heavily discounted in the economic appraisal. To validate the strategy approach to prioritisation and flood risk each option was tested in confirm the benefit cost ratio and ensure a strong economic case, in addition to a logical approach to strategy phasing and implementation.

12.1 Flood damages

To develop strategy benefits, the flood mapping developed in Section 6.2.1 was applied to estimated potential 'Do Nothing' and 'Do Something' flood depths. The modelling process is described in detail in Appendix B.

The flood modelling simulated the hydrodynamic processes associated with a series of extreme water level events. These events were allowed to inundate the floodplain described by the existing ground levels and cause flooding and generate a flood map. The flood map results were output to GIS to facilitate the inspection of flood depths for individual assets within the flood areas for a range of return periods.

'Do Nothing' flood depths and flood depths with the preferred options in place were estimated for Years 2010, 2030, 2060 and 2110 for a range of extreme water level events between 1 in 1 and 1 in 500 years which was used to calculate the property damages for the economic appraisal.

12.1.1 *Flood cells and property at risk - residential*

Inspection of the flood modelling allowed the identification of discrete flood cells within which flooding of other areas are not significantly impacted. The flood plain was divided in to three independent flood cells. These were based on natural divides in the flood extent, typically areas of higher ground. Figure 12-1 shows the three flood cells over time.

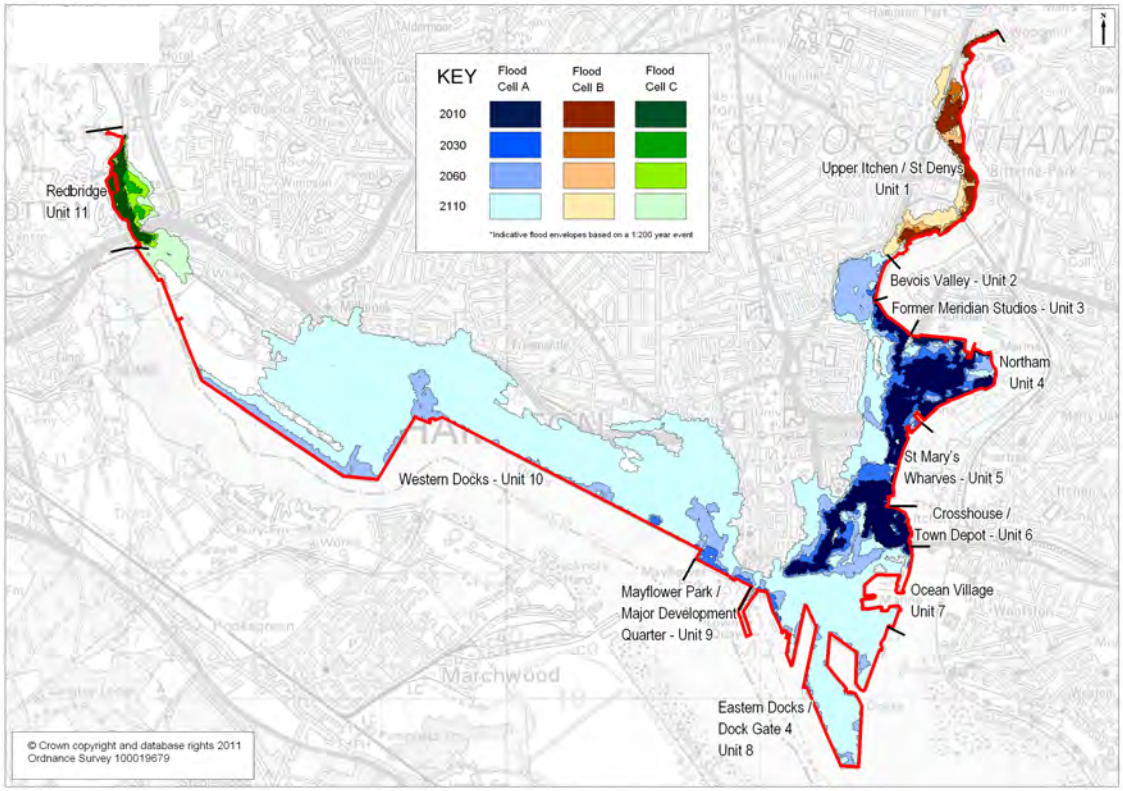


Figure 12-1: Economic flood cells

To identify individual properties in the flood map Southampton City Council provided an address point dataset which included the property address, post code, type (e.g. Residential - Flat, Residential - Detached) and property coordinates for all residential assets within the Southampton City Council area. The database was checked to remove duplicate address points and also to rationalise the number of flats counted in the assessment. Where a single location had multiple residencies these were reduced to include only ground floor flats. No basement areas have been allowed for in the economic analysis.

Flood depths for each individual property were obtained by conducting point inspections in GIS using the property location and the flood modelling for each water level modelled (Figure 12-3). The majority of residential assets at risk from flooding are located within Flood Cell A. A summary of the total number of residential and commercial property at risk within each cell are shown in Table 12-1. A further breakdown of residential property type by flood cell is provided in Figure 12-2.

Table 12-1: Properties at risk within each flood cell.

Property Type	Number of properties at risk			
	Cell A	Cell B	Cell C	Total
Residential	1,924	585	224	2,733
Commercial	1,279	52	7	1,338
Total	3,203	637	231	4,071

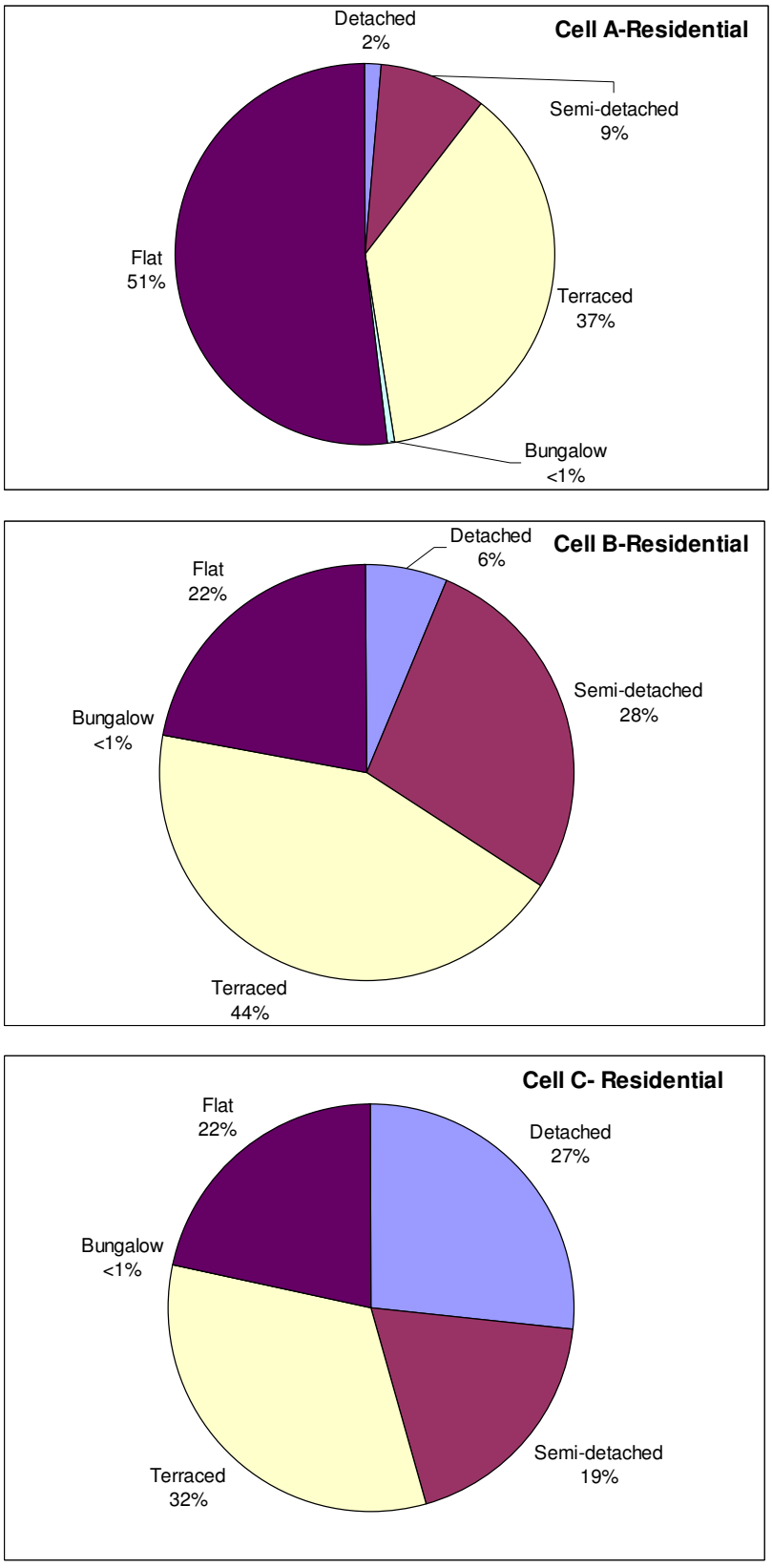


Figure 12-2: Breakdown of residential property type within each flood cell.

The analysis shows that residential property in Flood Cell A is dominated by flats and terraced houses with a minority of detached properties and bungalows. Cell B is also predominantly terraced houses with a similar proportion of flats and semi-detached houses. Within Flood Cell C there is a similar distribution of all residential property types.

The value of each residential property is required to consider potential write-off within the economic analysis. House sale data over the past 5 years was obtained from the Land Registry. The data was averaged by post code region for each property type (detached, semi, terrace, bungalow and flat). These were then applied to each property in the appraisal.

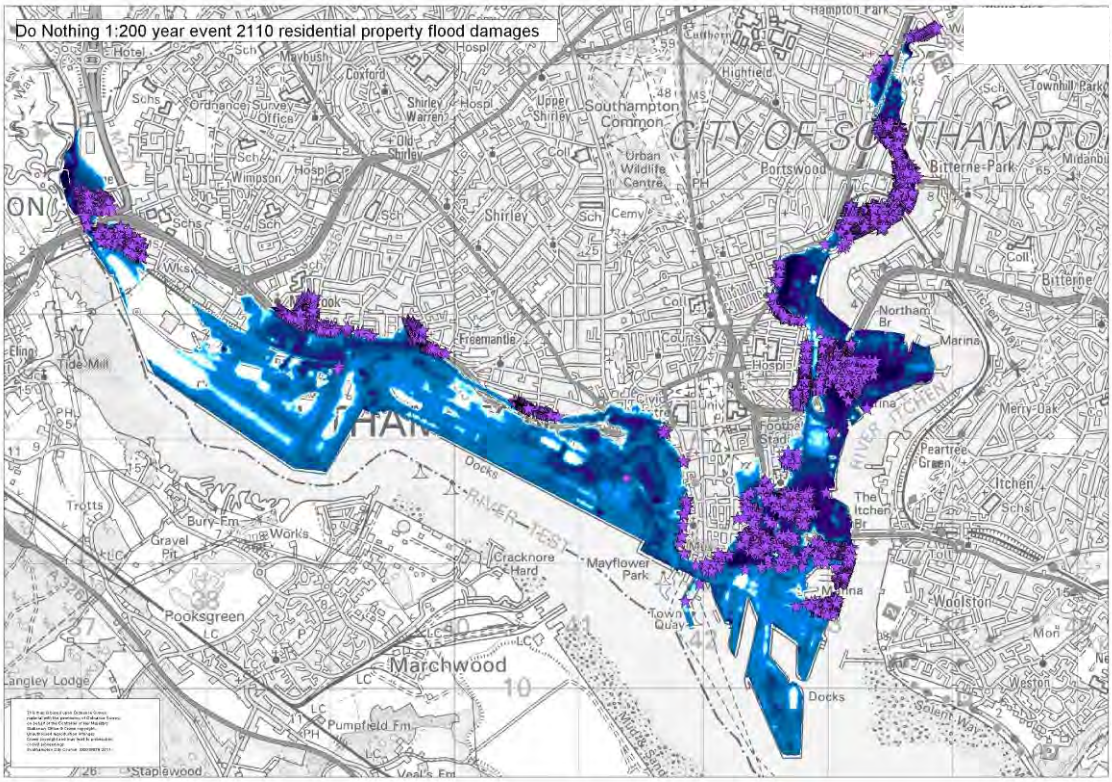


Figure 12-3. Example of how address point data was matched to flood mapping to generate flood depths to calculate 'Do Nothing' damages for residential properties (purple stars).

12.1.2 *Flood cells and property at risk - commercial*

With regard to the commercial properties, Southampton City Council provided a commercial address point dataset for the property address, post code, flood space (m^2), type (e.g. Commercial - Office, Commercial - Warehouse) and property coordinates for all assets within the Southampton City Council catchment area.

A breakdown of the types of commercial properties at risk are summarised below (Figure 12-5). The commercial property within Flood Cells A and B represents a broad range of 'workshop' industries including factories, assembly plants, port research and development establishments, laboratories and manufacturing. Flood Cell C represents a mostly residential area with only six commercial properties.

The commercial properties were valued based on the rateable value for their business type (provided by the Valuation Office). Average values for retail, workshop, warehouse, offices of between £10/m^2 and £90/m^2 were estimated and when multiplied by the building floor space to estimate the rentable value of the business. In accordance with FCERM-AG, the rentable value was multiplied by 10 (the business yield) to provide an estimate of the market value for flood damage capping and write-off purposes.

A manual check of the commercial properties and infrastructure was undertaken to ensure that these valuations were realistic in relation to the asset size and function. Some commercial properties, key infrastructure were significant enough that they required individual valuation and these have been valued based on construction costs of similar commercial properties or developments (Table 12-2, Table 12-3).

Commercial flood depths were determined by matching the address point database with OS Mastermap (See example - Figure 12-4). Flood depths for each individual property were obtained by conducting point inspections in GIS using the property location and the flood modelling for each water level modelled. This was considered an appropriate approach as flood depths within Southampton are unlikely to exceed ground floor levels and reach upper floor assets; however, no basement areas have been allowed for in the economic analysis.

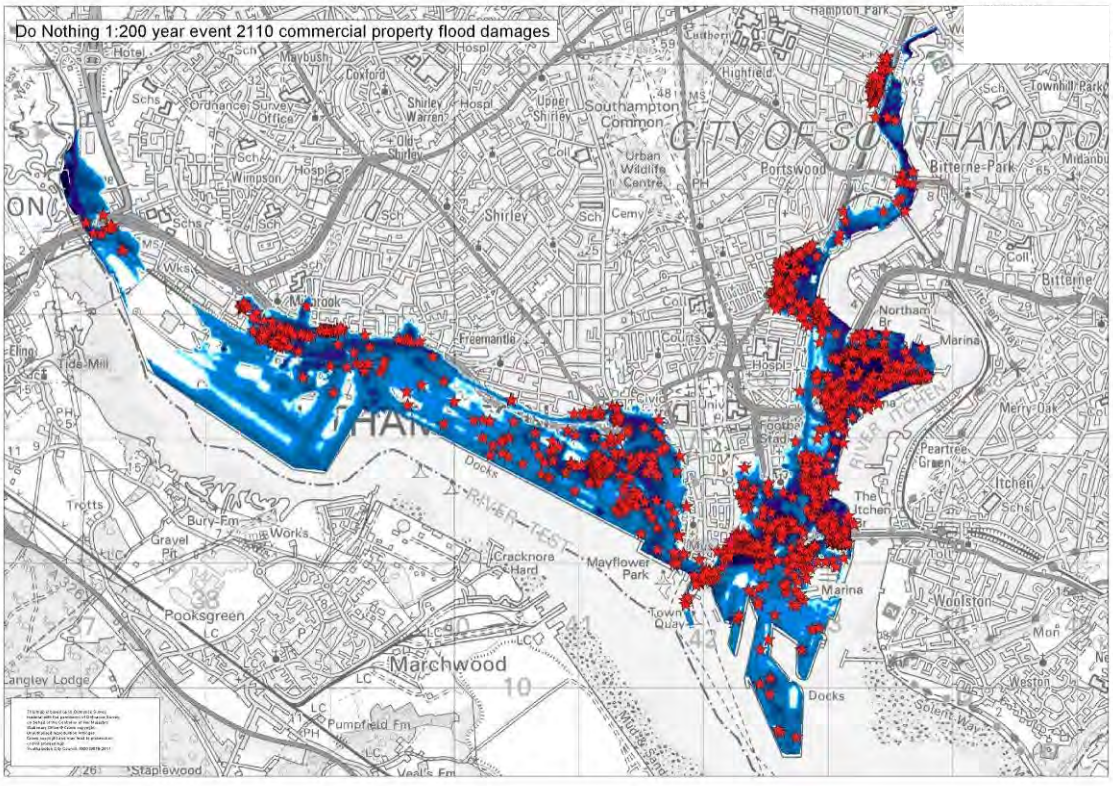
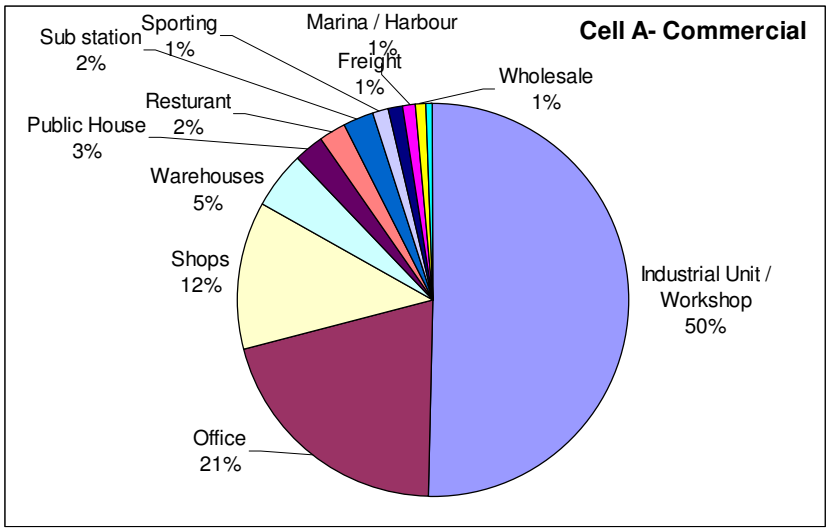
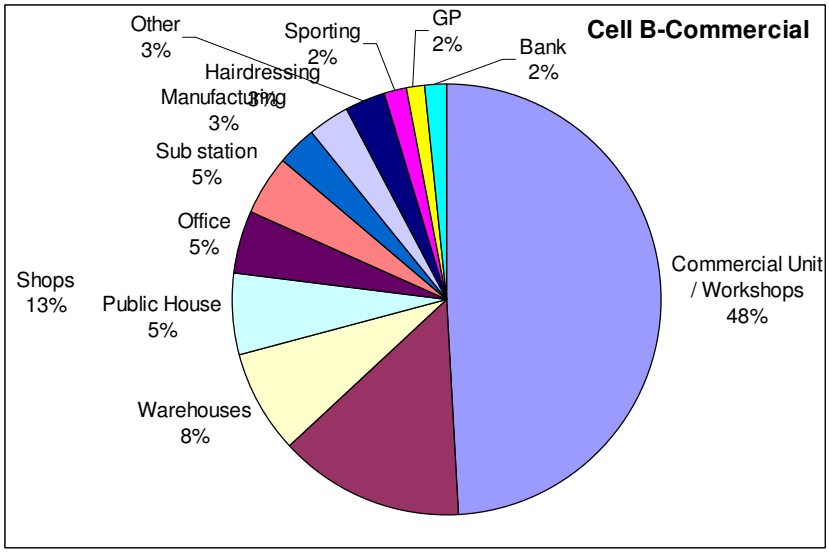


Figure 12-4. Example of how address point data was matched to flood mapping to generate flood depths to calculate 'Do Nothing' damages for commercial properties (red stars).


Cell A- Commercial
Sub station 2%
Sporting 1%
Marina / Harbour 1%
Freight 1%
Wholesale 1%
Resturant 2%
Public House 3%
Warehouses 5%
Shops 12%
Industrial Unit / Workshop 50%
Office 21%


Cell B-Commercial
Other 3%
Sporting 2%
GP 2%
Bank 2%
Hairdressing 3%
Manufacturing 3%
Sub station 5%
Office 5%
Shops 13%
Public House 5%
Warehouses 8%
Commercial Unit / Workshops 48%

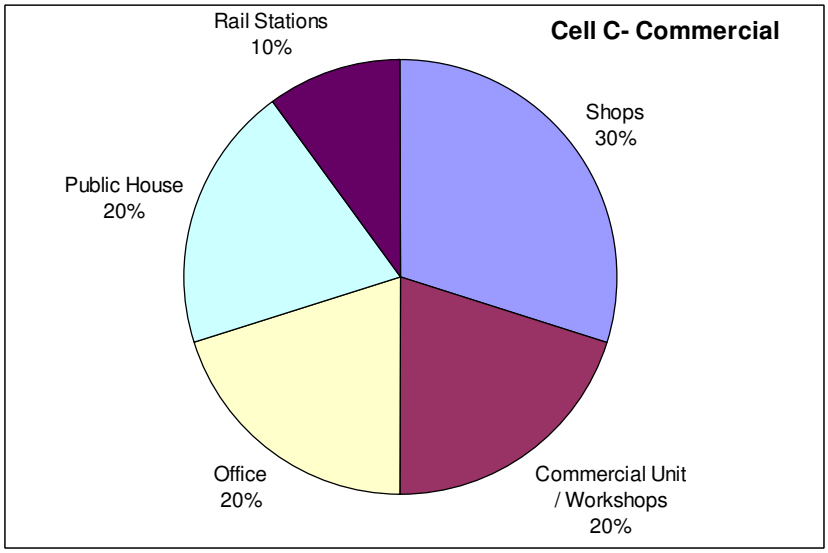

Cell C- Commercial
Rail Stations 10%
Shops 30%
Public House 20%
Office 20%
Commercial Unit / Workshops 20%

Figure 12-5: Breakdown of commercial property type within each flood cell.

Table 12-2: Key commercial asset values.

Asset	Value £ (2011)	Source	First year of flooding	Year of write-off
Network Rail Maintenance Yard	500,000	Estimate	20	>100
St Mary's Football Stadium	32,000,000	Construction cost in 2000	50	>100
Ocean Cruise Terminal	19,000,000	Construction cost of the terminal in 2009	50	>100
QE2 Cruise Terminal	19,000,000	Construction cost of the Ocean Terminal in 2009	50	90
City Cruise Terminal	19,000,000	Construction cost of the terminal in 2009	50	>100
Mayflower Cruise Terminal	19,000,000	Construction cost of the Ocean Terminal in 2009	50	>100
Solent Sky Museum, Albert Road	1,000,000	Estimate	20	60
The Quays	9,900,000	Construction cost in 1999	50	>100
IKEA	1,850,000	Estimate based on market value	50	85
West Quay	1,850,000	Construction cost in 2000	50	>100

Table 12-3: Key infrastructure asset values

Asset	Value £ (2011)	Source	First year of flooding	Year of write-off
Central Railway Station	10,000,000	Construction cost for a new station at Shepard's Bush in 2007	50	>100
St Deny's railway station	1,000,000	Estimate	NA	NA
Redbridge railway station	1,000,000	Estimate	50	>100
Gas Works	10,000,000	Estimate	50	>100
Southampton Geothermal	5,000,000	Construction cost £1.24M in 1986 raised by multiplier of 4 to 2011 valuation	50	>100
Central Police Station	38,000,000	Construction cost 2010	50	>100
Sub-stations (34 total)	991,916 (total)	Estimate	Varies	Varies
Kent Road Sewage works	29,000,000	Refurbishment cost for Peel Common Wastewater treatment works, Southern Water.	0	50
Millbrook Sewage works	29,000,000	Refurbishment cost for Peel Common Wastewater treatment works, Southern Water	50	>100

12.1.3 *Flood depth damages*

Flood damages were obtained from data in Appendix 5 of the Multi-Coloured Manual (Penning-Rowsell 2010)[xxii], updated to November 2011 prices using the Retail Price Index. The value of

[xxii] Penning-Rowsell Edmund Penning-Rowsell, Christophe Viavattene,

flood damage was based on the residential property type (detached, semi, terrace, flat etc) and the depth of flooding for each property in each of the modelled water levels. Values within Appendix 5 for 'Indicative Susceptibility' were adjusted by a factor of 1.107 to allow for the emergency costs that can be justified as real economic costs, not counted elsewhere in the benefit assessments as recommended in the Penning-Rowsell et al(2010). The damage costs were adjusted depending on the flood depth to include for emergency accommodation cost, at a rate of £71 per week.

Commercial property damages were also obtained from the Penning-Rowsell et al(2010) based on the commercial property type, the footprint area (m^2) and the depth of flooding for each of the modelled water levels. Values within Appendix 5 for 'Indicative Susceptibility' were also adjusted by a factor of factor of 1.107 to allow for the emergency costs that can be justified as real economic costs, not counted elsewhere in the benefit assessments as recommended in the MCM.

The commercial flood damages considered damage to both the contents and fabric of the commercial and residential buildings. For the large premium retail units West Quay and IKEA, only damages to the building fabric were considered as the ground floors of these properties consist of car parking and building services only.

This data was then used to feed into the FCERM-AG spreadsheets for Years 0, 20, 50 and 100 (2011, 2031, 2061 and 2111). Intermediate years were linearly interpolated to ensure a value for Annual Average Damage was entered for each year within the assessment period.

12.1.4 *Write Off and Capping of damages*

In accordance with FCERM-AG residential and commercial property were defined as written off once flooded by an event of 1:3 year return period or less, as the property would no longer be habitable or functional. Once written off, these properties no longer accrue flooding damages and their market values were discounted to the present value at the year of loss. The guidance also requires that the property flood damages over the appraisal period must not exceed the property market value. The cumulative damages were monitored for each property and once they exceeded the property value further flood damages were capped and the property was written off.

12.2 Indirect flood damages

In addition to direct flood damage to commercial and residential property, indirect flood losses have been considered. Indirect flood losses reflect deviations from the economic theory suggests that in a perfectly competitive world, all sales or production would simply transfer to a competitor with no financial loss to the nation as a whole. In reality deviations from the completive model exist and trade cannot simply be transferred, leading to indirect flood damages.

With regard to the Southampton Strategy the effect of flooding on the Port Service industries in the surrounding area and the cruise industry were identified as two areas likely to benefit indirectly from improved flood protection. The benefits were estimated from the Atkins (2011) report 'Economic Impact of the Port of Southampton', which ranked Southampton Port as the 5th busiest in the UK. Although the provision of flood defences to the port area remains the responsibility of Associated British Ports, services industries and business which are located

Joanna Pardoe, John Chatterton, Dennis Parker and Joe Morris (2010) The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques. Flood Hazard Research Centre, Middlesex UK.

outside the Port boundaries will benefit from the flood protection put forward by the coastal strategy. Given the importance of the Port and the need for these services to remain in close proximity to it, their sales or production cannot simply be transferred to a competitor, and they were claimed as an indirect benefit.

Flood damages to the major retail assets at West Quay Shopping Centre and IKEA have been considered as part of the direct damages assessment. However the direct damages only included for damage to the building fabric as the lower levels include building services and car parking. During a flood event the car parks would be forced to close leading to an indirect damage to retail sales as the nearest alternative at Gun Wharf Quays (Portsmouth) is over 20 miles away and unlike West Quay is focused towards designer outlets, lifestyle products, food and drink. The nearest IKEA store is located 90 miles away in Croydon, South London. Therefore indirect benefits have been considered for these assets.

A major flood event would lead to general disruption of the road, rail and other critical infrastructure. Inspections of the flood mapping identifies that the major dual carriageway serving the port and providing motorway access to Southampton City centre would be at a low risk of flooding over most of the 100 year appraisal period. However flooding within the River Itchen could lead to flooding of access to the Itchen Toll bridge during events of 1:100 years or greater from Year 20. This would require traffic to be diverted and therefore represents an indirect benefit of the coastal strategy.

Rail services serving Southampton provide a fast service direct to London Waterloo and West Country, in addition to freight services for the vehicle handling facility and container terminal. Penning-Rowsell (2010) notes that any delay in service or performance as a result of weather events results in a payment from Network Rail to train operating companies in the form of compensation, therefore these potential payments were assessed and included in the appraisal of benefits.

The flood inundation modelling identified sewage treatment works in Flood Cell A (St Denys) and Flood Cell B (Redbridge) remain at risk. Although the direct damages to this critical infrastructure has been estimated, these damages do not consider general disruption to the treatment of sewage as a result of saline water intrusion in to the sewage network. Experience of other sewage treatment works located within the tidal flood plain suggests that saline water into the sewer network has a detrimental effect on biological treatment processes within the sewage plant, leading to major disruption. The financial cost of this disruption was estimated and included as an indirect benefit.

Potential clean-up costs following a significant flood to remove flood debris from the neighbouring designated intertidal habitats were considered as indirect benefits. It is not envisaged that the loss of land due to erosion will impinge on any designated sites, nor will the proposed options provide additional intertidal habitat therefore indirect benefits associated with these issues have not been considered.

A summary of the indirect benefits is provided below (Table 12-4) and detailed in the Economic Appendix.

Table 12-4: Summary of Cash and PV Value (£) of Indirect Damages for the 'Do Nothing' Scenario

	Cell A	Cell B	Cell C	Total
Cash	14,210,224	410,840	1,037,400	15,658,464
PV	1,924,634	95,824	180,765	2,201,223

12.3 Do Nothing Direct Damages – residential and commercial

The cash direct damages and PV direct damages for each flood cell resulting from the economic assessment of the 'Do Nothing' scenario are shown in Table 12-5 and Table 12-6 respectively. The cumulative PV direct damages for each flood cell for residential and commercial properties over the 100 year appraisal period are shown in Figure 12-6 and Figure 12-7. The full calculation sheets are included in Appendix 1.

Table 12-5: Cash Value (£) of Direct Damages for the 'Do Nothing' Scenario

Damage Type	Cash Damages (£)			
	Cell A	Cell B	Cell C	Total
Residential	369,724,987	106,233,580	46,355,403	522,313,970
Commercial	693,920,114	39,287,328	1,933,139	735,140,581
Total	1,063,645,101	145,520,909	48,288,542	1,257,454,551

Table 12-6: Present Value (£) of Direct Damages for the 'Do Nothing' Scenario

Damage Type	Present Value (PV) of Damage (£)			
	Cell A	Cell B	Cell C	Total
Residential	61,848,878	19,184,643	6,471,823	87,505,344
Commercial	153,871,309	8,098,615	607,859	162,577,783
Total	215,720,187	27,283,258	7,079,682	250,083,127

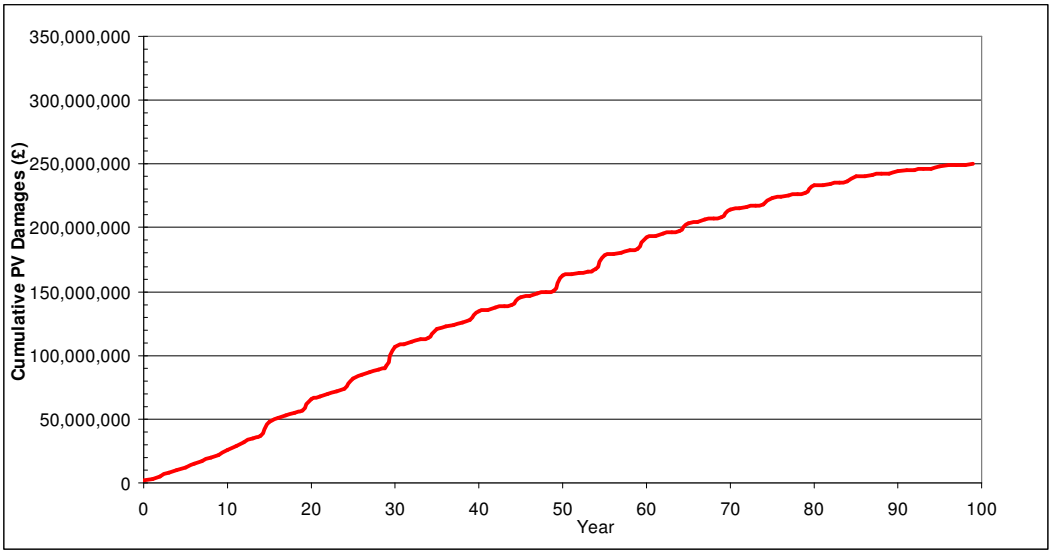


Figure 12-6: Cumulative PV Do Nothing Direct Damages

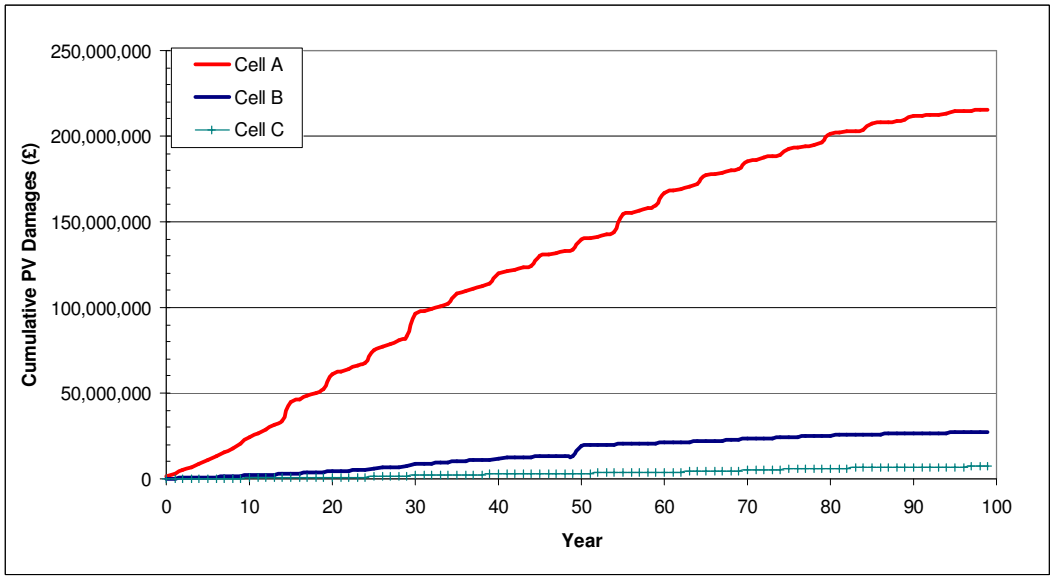


Figure 12-7: Cumulative PV Direct Damages by food cell.

The PV damage increases at a fixed rate for the first 65 years, after which the rate of annual average damage increase reduces as more properties are written off and can no longer accrue flood damages. The figures demonstrate how the flood damage increase as a result of rising sea level and the occurrence of future extreme water level events. The gradient of the line is dependent upon the depth of flooding and the type of asset at risk. The small step changes in the curves are a result of property write-off as discussed above. When split into individual flood cells, Figure 12-7 shows that most flood damage occurs in Flood Cell A, mostly as a result of commercial damage. Cell B also includes a significant proportion of flood damages but is dominated by residential property damage.

12.4 Residual damage

Option damages (sometimes referred to as residual damages) are those damages that would still occur after an option has been implemented. The difference between the value of option damages for a particular option and the 'Do Nothing' damages gives the value of benefits for that option. The option damages, benefits and benefit cost ratios for the 'Do Something' options were determined.

12.4.1 *Strategy residual damage*

The residual damages were considered based on the type and timing of the proposed defences. In Flood Cell A a 1:200 year flood standard is proposed through construction of flood walls leading to land raising in later years. Therefore residual flood damages to properties behind the defence line only occur during events greater then 1:200 years. These flood damages were appraised by repeating the flood modelling to include the proposed defences (see example- Figure 12-8 and Figure 12-9).

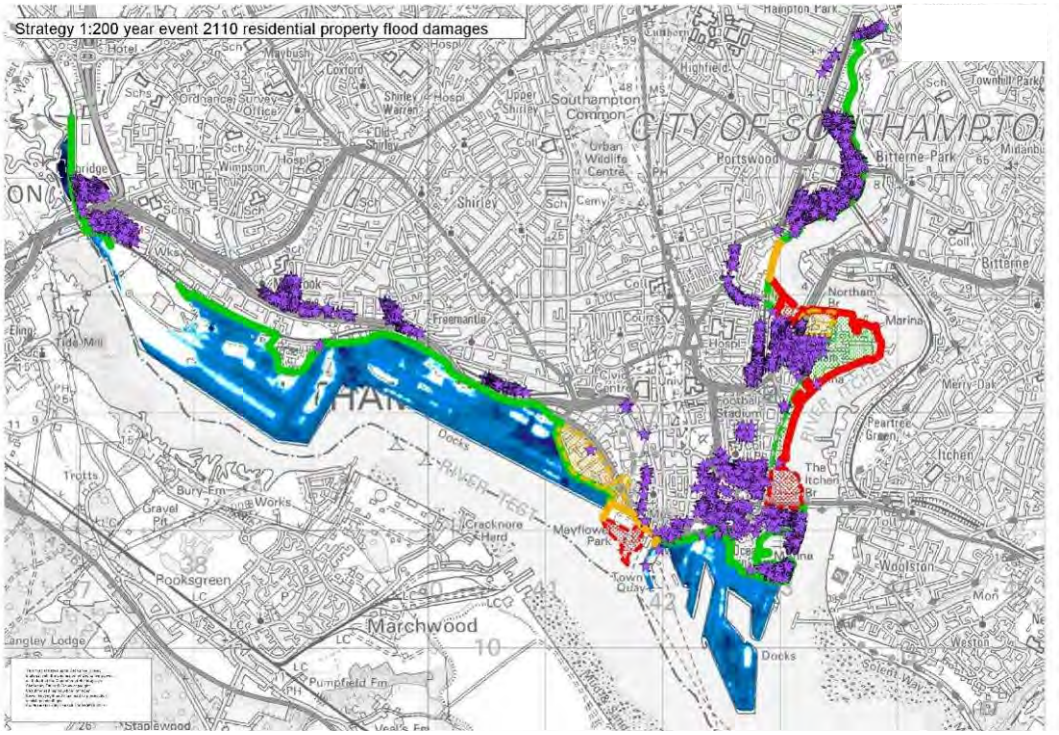


Figure 12-8. Example of how address point data was matched to flood modelling to calculate residential property (purple stars) residual damages under The Strategy option.

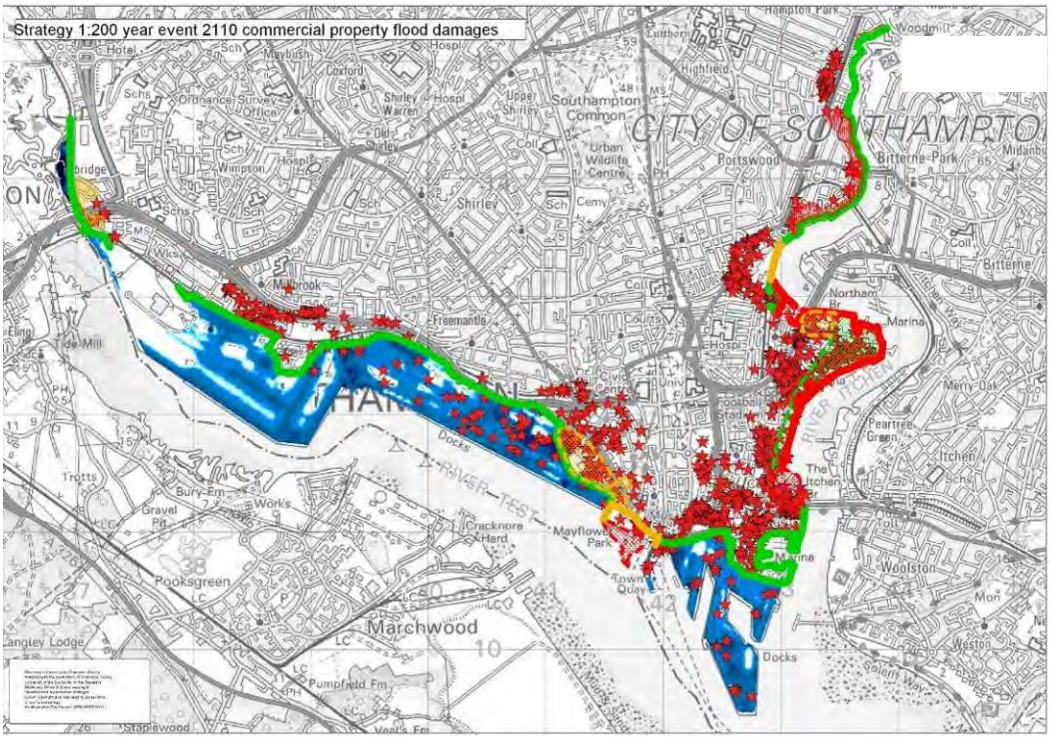


Figure 12-9. Example of how address point data was matched to flood modelling to calculate commercial property (red stars) residual damages under The Strategy option.

The modelling results show that the raised defence significantly reduce flood inundation, which is limited to a relatively small amount of water overtopping the defence line (Figure 12-10). The modelling identified a group of residential and commercial properties that are positioned on ABP land in front of the defence line and would be susceptible flooding after 2060 (Figure 12-9). These properties were identified from the modelling and assigned 'Do Nothing' flood damages.

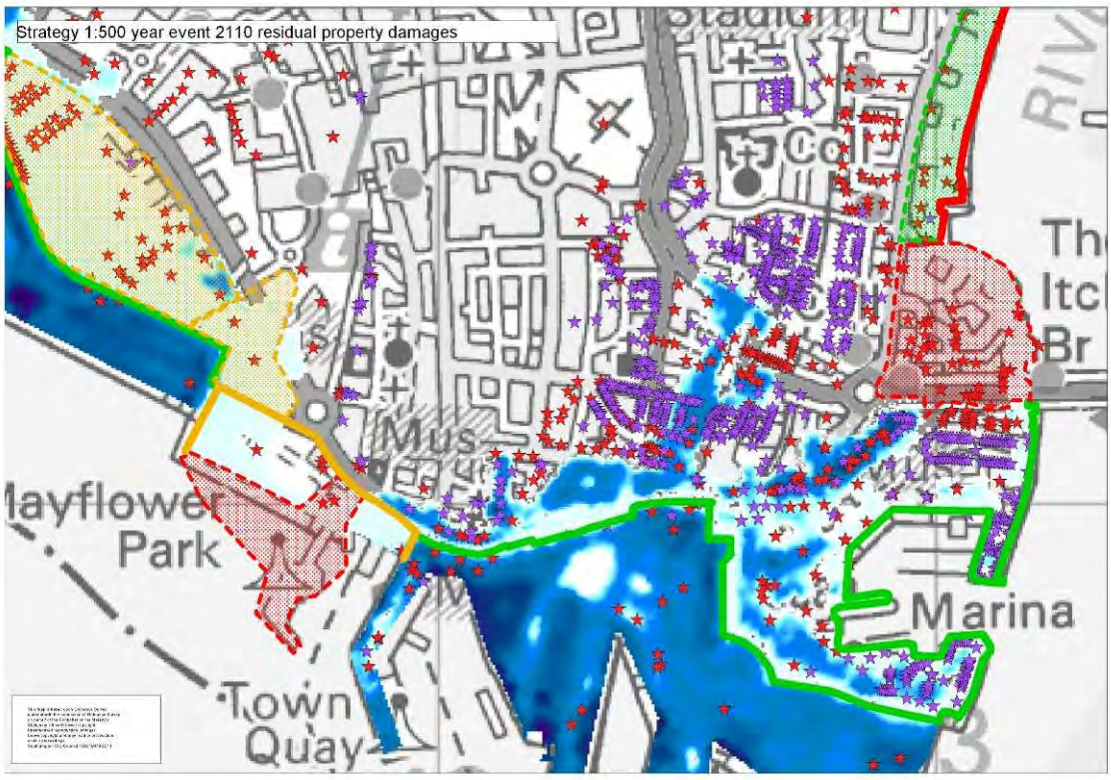


Figure 12-10. Example of how residual damages are accrued behind the defence from an event greater than the design standard (1:500 year event). Purple stars represent residential properties, red stars represent commercial assets.

The proposed capital works in Flood Cell A included front lines defences or land raising. To consider residual flood damages for these options the hydrodynamic model was re-run with the defences in place to determine the depth of flooding for the 1:500 years events and calculate residual damages at 2030, 2060 and 2110.

The preferred strategy option in flood Cell B is to implement flood resistance and resilience for the first 20 years therefore these properties receive protection up to the 1:200 year standard. At Year 20 Cell B additional properties benefit from flood resistance and therefore a 1:200 year standard of protection. Beyond Year 50 a flood defence wall will be implemented to a 1:200 year standard of protection for the whole of Cell B. For this scenario the hydrodynamic model was re-run with the defences in place to determine the depth of flooding for the 1:500 years events and calculate residual damages at 2060 and 2110.

There are no works proposed in Flood Cell C until 2030, therefore during the period 2011 to 2030 Do Nothing damages were assigned to the properties within this flood cell. In 2030 flood resistance and resilience measures will be constructed to additional properties in Cell C. In Year 2060 a frontline defence is to be constructed in Cell C providing a 1:200 year standard of protection and residual damages would only occur for a 1:500 year event.

As part of The Strategy development the benefits of adopting a 1:100, 1:150 and 1:500 year standard of protection were also considered. The cost estimate was revised to allow for revised wall heights for the front line defences. Therefore the residual flood damages associated with these alternative standards were also revised. Table 12-7 and Table 12-9 below summarises

the overall strategy and flood cell total PV damage (direct and indirect) and the damages avoided or benefits ('Do Nothing' damage minus residual damage) for each standard of protection. The full calculation sheet is included in Appendix I.

Table 12-7: Total residual damage (direct and indirect) and damages avoided in The Strategy.

Option	PV Damages £	
	Residual Damage	Damages avoided (benefits)
'Do Nothing'	252,284,350	0
'Maintain'	154,604,168	95,479,182
1:100 Year SOP	18,752,132	233,532,219
1:150 Year SOP	15,632,070	236,652,281
1:200 Years SOP	13,401,971	238,882,379
1:500 Year SOP	11,823,336	240,461,014

Table 12-8: Total residual damage (direct and indirect) and damages avoided in each flood cell for The Strategy for a 1:200 Year SOP.

Damage Type	PV Damages £	
	Residual Damages	Damages avoided
Cell A 1:200 SOP	8,639,131	209,005,690
Cell B 1:200 SOP	3,633,026	23,746,057
Cell C 1:200 SOP	1,129,814	6,130,633

12.5 Benefit costs ratios

To appraise the strategy option and the proposed approach within each flood cell the FCERM-AG requires that a whole life benefit (direct and indirect) to cost ratio be calculated. Scheme benefits were calculated by subtracting the residual damages derived above from the Do Nothing damages to determine the value of damages avoided and hence the level of flood protection benefits provided by the strategy and the proposed works in each flood cell. The options were compared below using the FCERM-AG decision making criteria where the options are sorted by the standard of protection and the benefit costs ratio was calculated. This was applied for a likely scenario that developer contributions are forthcoming (Table 12-9).

Table 12-9: Damages, Benefits and Benefit Cost Ratios for the preferred approach

Option	PV (£)				
	Costs	Residual Damages	Damages avoided	Benefit/Cost Ratio	Incremental Benefit/Cost Ratio
'Do Nothing'	0	252,284,350	0	0.0	-
'Maintain'	3,197,399	156,805,168	95,479,182	29.9	-
1:100 Year SOP	17,148,015	18,752,132	233,532,219	13.6	9.9
1:150 Year SOP	17,652,283	15,632,070	236,652,281	13.4	6.2
1:200 Year SOP	18,156,551	13,401,971	238,882,379	13.2	4.4
1:500 Year SOP	19,302,004	11,823,336	240,461,014	12.5	1.4

The 'Maintain' option only provides £95M of benefits when compared to the 'Do Nothing' because the existing erosion defences become overwashed and crest heights are still exceeded. Therefore this option was rejected.

The 'Improve' options, provide a varying standard of protection from 1:100 Years to 1:500 Years. When applying the FCERM-AG economic decision-making rule the 1:100 and 1:150 standards both exceed the threshold of 3 and therefore these options are demonstrated not to be the optimised solution.

The benefit cost ratio for the 1:500 Year standard of protection is slightly smaller at 12.5 compared the 1:200 Year standard (B/C of 13.2). The 1:500 Year standard also produces an incremental benefit cost ratio of 1.4 which using the FCERM-AG economic decision-making rule does not exceed the threshold of 5 and therefore a higher standard cannot be justified on an economic basis.

A 1:200 Year standard of protection achieves a robust benefit cost ratio of 13.2, with PV costs of £18.2M leading to £238.8M of damages avoided over the 100 year appraisal period. A 1:200 Year standard represents the optimal economic option when tested against the FCERM-AG economic decision-making rule.

The economic appraisal was then split out in to the individual flood cells to demonstrate the economic case on a cell by cell basis for a 1:200 year standard of protection. Table 12-10 presents an economic appraisal including developer contributions for each flood cell. When considered on a cell by cell basis, all cells achieve a robust benefit cost ratio greater than 9.

Table 12-10: Damages, Benefits and Benefit Cost Ratios for the preferred approach in each flood cell

Damage Type	PV (£)			
	Costs	Damages	Damages avoided	Benefit/Cost Ratio
Cell A 1:200 SOP	15,144,001	8,639,131	209,005,690	13.8
Cell B 1:200 SOP	2,337,432	3,633,026	23,746,057	10.2
Cell C 1:200 SOP	675,118	1,129,814	6,130,633	9.1

12.6 Sensitivity testing the benefit costs ratios

The proposed strategy approach was tested under various scenarios to consider the robustness of the preferred strategy approach, and if under different circumstances a higher standard of protection could be justified. The following tests were applied and are discussed in the following sections:

- Exclusion of developer contributions
- Accelerated sea level rise
- Increased option costs
- Decreased options costs
- Delay capital works until 2030

12.6.1 *Developer contributions*

Table 12-11 presents an economic appraisal if no developer contributions were forthcoming and FDGiA funds were required to achieve the required standard of protection.

Table 12-11: Damages, Benefits and Benefit Cost Ratios for the worst case scenario, no developer contributions).

Option	PV (£)				
	Costs	Residual Damages	Damages avoided	Benefit/Cost Ratio	Incremental Benefit/Cost Ratio
'Do Nothing'	0	252,284,350	0	0.0	-
1:200 Year SOP	25,483,344	13,401,971	238,882,379	9.4	6.4
1:500 Year SOP	27,677,625	11,823,336	240,461,014	8.7	0.7

The inclusion of developer contributions decreases the benefit cost ratio of the 1:200 year strategy option to 9.4 but remains strongly positive. Table 12-12 presents a sensitivity test excluding developer contributions for flood Cell A, which is the only cell to benefit from developer contributions.

Table 12-12: Damages, Benefits and Benefit Cost Ratios for the preferred approach (1:200) in flood Cell A with the worst case, no developer contributions.

Cell	PV (£)			
	Costs	Damages	Damages avoided	Benefit/Cost Ratio
Cell A	22,470,794	8,639,131	209,005,690	9.3

When excluding developer contributions the PV cost increases in Cell A but the strategy delivers the same level for flood protection benefits, therefore the overall benefit cost ratio decreases from 13.8 to 9.3 for a 1:200 year standard of protection, and therefore remains strongly positive.

12.6.2 *Accelerated sea level rise*

The strategy has considered the recommended EA 2011 medium emissions scenario (including surge factor). A sensitivity test was completed to consider the effect of the 'Upper end estimate including surge' on the choice of strategy standard of protection.

The 'upper estimate' sea level rise estimate broadly follows the medium emissions scenario for the first 50 years, however beyond this period the sea level rise estimate increase significantly and by 2110 sea levels are predicted to be 280mm higher. In order to accommodate the increased sea levels the defence height costs were factored up accordingly, leading to an overall increase in the PV costs. The impact of the upper estimate sea level rise on the strategy costs and benefits are shown in Table 12-13.

Table 12-13: Impact of upper estimate sea level rise on strategy options

Option	PV (£)				
	Costs	Residual Damages	Damages avoided	Benefit/Cost Ratio	Incremental Benefit/Cost Ratio
'Do Nothing' (Medium sea level estimate)	0	252,284,350	0	0	-
'Do Nothing' (Upper end sea level estimate)	0	331,260,000	0	0	-
1:200 Year SOP (Medium sea level estimate)	18,156,551	13,401,971	238,882,379	13.2	-
1:200 Year SOP (Upper end sea level estimate)	24,086,359	31,959,409	331,260,000	12.4	-
1:500 Year SOP (Medium sea level estimate)	19,302,004	11,823,336	240,461,014	12.5	-
1:500 Year SOP (Upper end sea level estimate)	21,214,864	30,303,997	300,956,003	11.4	-

As a result the economic damages for the 'Do Nothing' and the residual strategy damages are increased relative to the medium emissions scenario. The residual damages are increased as a result of an increase in flood depths and also due to the phasing of the proposed works being based on the medium emission scenario. The outcome of the sensitivity test is to reduce the

benefit cost ratio for both the 1:200 and 1:500 year standards of protection, however in both cases the 1:200 years standard remains the preferred option with the highest benefit cost ratio.

12.6.3 *Increased option costs by 25%*

The effect of increases in options cost was considered by increasing each option cost by 25% to consider uncertainty in the cost estimate and the potential for increase in material costs (Table 12-14). This leads to a small reduction in the benefit cost ratio, but remains robustly above 7.

Table 12-14: Impact of increase scheme costs on strategy options

Cell	Baseline		Sensitivity Test	
	PV Costs	Benefit/Cost Ratio	PV Costs	Benefit/Cost Ratio
Cell A	15,144,001	13.8	20,678,432	10.1
Cell B	2,337,432	10.2	2,827,481	8.4
Cell C	675,118	9.1	793,809	7.7

12.6.4 *Reduced option costs by 25%*

The impact of a reduction in options cost was considered by reducing each option cost by 25% through early contractor involvement and efficient procurement of the works for example (Table 12-15). This leads to a small increase in the benefit cost ratio, which remains robustly over 11 for all options.

Table 12-15: Impact of reduced scheme costs on strategy options

Cell	Baseline		Sensitivity Test	
	PV Costs	Benefit/Cost Ratio	PV Costs	Benefit/Cost Ratio
Cell A	15,144,001	13.8	9,609,570	21.7
Cell B	2,337,432	10.2	1,847,382	12.9
Cell C	675,118	9.1	548,625	11.2

12.6.5 *Delay till 2030*

This test considered that the proposed flood wall at Cell A and flood resistance scheme at Cell B would be postponed from 2015 to 2030. During the period 2011 to 2030 these cells were assigned Do Nothing damages. The delayed expenditure profile increases the discounting applied to the scheme costs, while the lack of protection increases the residual flood damages, decreasing option benefits. The overall result is an increase in the benefit cost ratio (Table 12-16). However this small increase would result in an additional £12.9M PV damages in Cell A and £0.5M damages in Cell B, furthermore residential properties in these area would fall below the 1:75 year standard of protection for house insurance. Therefore delaying the implementation of these schemes does not meet the strategy objectives.

Table 12-16: Impact of delayed implementation of 2015 schemes to 2030

Cell	Baseline			Sensitivity Test		
	PV Costs	PV Benefits	Benefit/Cost Ratio	PV Costs	PV Benefits	Benefit/Cost Ratio
Cell A	15,144,001	209,005,690	13.8	12,850,467	196,102,064	15.3
Cell B	2,337,432	23,746,057	10.2	2,068,848	23,216,614	11.2

12.7 Scheme prioritisation

12.7.1 *Outcome Measures and FDGiA*

In May 2011 the Environment Agency implemented revised funding guidance for flood and coastal protection schemes. The new Defra Flood and Coastal Resilience Partnership Funding arrangement defines the level of Flood Defence Grant in Aid (FDGiA) a project could achieve based on a series of Defra Outcome Measure (OM) targets.

The OM's specific to the Southampton Coastal Strategy include OM 1: Benefits arising from the investment and OM 2: Households moved from one flood category to a lower category, these are defined in Table 12-17 and Table 12-18.

Table 12-17. Key Outcome Measure definitions relevant to the Southampton Coastal Strategy, Defra (2011)

OM No.	Outcome measure definition	Benefits and outcomes qualifying for national funding
OM1	Average benefit to cost ratio of schemes	Under OM1, present value of whole-life benefits of the current investment, less benefits paid for (e.g. from OM2) or payments made under the other outcome measures
OM1a	Present value of whole –life benefits per £1 of FDGiA	
OM2	Households moved from one category of flood risk to a lower category Households must be at direct risk of flood damage and have been built or converted into housing before January 2012 to be counted.	Under OM2, present value of direct damages to residential properties and their contents avoided, in the: -20% most deprived areas -21-40%most deprived areas -60%least deprived areas

Table 12-18. Flood Risk categories and assumed flood probabilities from Defra (2011)

Risk Category	Annual chance of flooding	Assumed annual chance of flooding for the purposes of national funding
Very significant	5% or greater 1 in 20	5% (1 in 20)
Significant Risk	Greater than 1.3% (1 in 75) but less than 5%	2.5% (1in 40)
Moderate Risk	Greater than 0.5 (1 in 200) but less than or equal to 1.3%	1% (1in 100)
Low Risk	0.5% or less	0.5% (1in 200)

Based on the economic appraisal the potential for FDGiA funding has been considered for the first schemes to be implemented in The Strategy. These include the floodwall in Cell A at 2015, (termed Scheme A1) and the flood resistance and resilience measures in Cell B in 2015

(termed Scheme B1). The potential for funding for these schemes have been considered individually as each scheme is likely to be put forward in separate Project Appraisal Reports (PAR). The first scheme in Cell C (termed C1) occurs in 2030 has also been considered however it is noted that FDGiA funding criteria beyond 2015 is likely to be subject to change.

The Environment Agency has prepared a standard spreadsheet sheet (Version 2013/14) to calculate the level of FDGiA based on a series of input parameters. It should be noted that the input parameters for the OM scoring consider the design life of the scheme, 45 years in this case (2015 - 2060), and differ from the economics which require a 100 year appraisal period as part of options appraisal process.

The scheme duration was defined from the construction to the year of replacement. The first schemes are due to be implemented in 2015 and will provide the required standard of protection until 2060 therefore a 45 year design life was considered.

The PV Whole life cost and PV Whole life benefits of the scheme were calculated by summing these over the 45 year scheme duration up to 2060.

The cash cost of the scheme for approval was taken from the option cost estimate for the works proposed in 2015 and includes a conservative 60% contingency sum. At PAR stage, in light of more detailed costing information and a concept design, it is envisaged the contingency could be reduced closer to 30%.

To consider the households better protected against flood risk over the duration of investment, flood inundation mapping before and after scheme implementation was inspected to calculate the number of households within each flood risk category. To complete the analysis the Multiple Index for Deprivation Rank for each property was determined, to enable the level of deprivation to be considered in the OM score calculation. These values are summarised in Table 12-19.

Table 12-19: Number of households, their respective flood risk and their score on the Index of Multiple Deprivation (IMD).

Multiple Deprivation	**IMD<20%**			**≥20%IMD<40%**			**IMD ≥ 40%**		
Scheme	*Moderate flood risk*	*Significant flood risk*	*Very Significant flood risk*	*Moderate flood risk*	*Significant flood risk*	*Very Significant flood risk*	*Moderate flood risk*	*Significant flood risk*	*Very Significant flood risk*
A1	22	83	167	22	99	173	63	103	128
B1	0	0	0	0	0	39	0	0	30
C1	0	0	26	0	0	0	0	0	0

The calculation provides an initial 'Raw' OM score which represents the percentage of FDGiA available based on the scheme costs, benefits and design life and therefore describes the proportion of scheme cost that could be justified from Environment Agency national budgets (up to a limit of the full scheme cost). The calculator then considers any potential contributions secured against the project to develop a 'Partnership Funding' score.

The Defra policy statement puts forward a minimum OM threshold of 100% to receive national funding, however notes that any contributions secured towards projects scoring 100% or above can either a) reduce the cost of the scheme to the national taxpayer, making it more likely to go ahead sooner rather than later, or b) be used to help fund other local schemes in the local strategy. For the Strategy a contribution comprises private contributions from either private developers (or the CIL) and a contribution from Southampton City Council to maintain the condition of the proposed defences.

For example a scheme with a strong benefit cost ratio and capital cost of £1M, achieving a raw OM score of 90%, could receive up to £900k in FDGiA with the remaining £100k coming from contributions to achieve at least the 100% target. If a private £200k contribution to this same scheme was available then it improves the OM score to 110%, and the FDGiA required funding could be reduced to £800k. In this example situation the likelihood of funding is higher if in competition with a similar project scoring only 100%.

Following implementation of the new funding arrangements, the Environment Agency suggests that coastal protection schemes should aim to achieve an OM score of greater than 120% in an effort to offset for an uncertainty in the appraisal process and to promote competition and efficiency within the FDGiA process. Schemes with 'Raw OM' scores falling below this threshold, require a contribution of sufficient value to bring their 'Partnership Funding' score over 120%. There is a suggestion that this threshold may increase further in 2012/13 to 150% in an effort to drive further efficiency.

The input parameters above were defined for schemes A1, B1 and C1 to derive the 'OM Score' as discussed below.

12.7.2 *Assessment for Scheme A1 2015*

The 2015 scheme in Flood Cell A consists of either floodwalls or land raising near the front line in Units 3 to 6 which provides at least a 1:200 year standard of protection against tidal flooding for the short to medium term (until 2060). The scheme includes a developer contribution towards land raising of £3.12M.

Table 12-20 below presents a summary of the OM calculation and the full calculation sheet is included in Appendix I.

The calculation shows that this scheme achieves an OM score of 171% and should be eligible for full FDGiA funding. The high score is a result of the large number of households at risk of flooding, the very significant flood risk and the level of deprivation within the flood risk zone. These factors lead to a strong case for a priority scheme for full national funding. Sensitivity testing of the OM score to consider an over estimate of flood risk and moving half the properties into the next flood risk category reduces the OM score to 159%.

In the unlikely case that a developer contribution was not forthcoming the baseline OM score (171%) would be reduced to 136% which satisfied the current EA funding threshold. Any increases to the threshold would require a contribution from the Community Infrastructure Levy.

12.7.3 *Assessment for Scheme B1 2015*

The 2015 scheme in Flood Cell B consists of provision of flood resistance and resilience measures in Unit 1 to mitigate flood risk to properties and provide a 1:200 year standard of protection. The 2015 scheme provides short to medium term flood protection until 2060 when flood depths have been shown to increase significantly due to sea level rise, necessitating a front line defence. Table 12-21 below presents a summary of the OM calculation and the full calculation sheet is included in Appendix I.

The calculation shows that this scheme achieves a very robust OM score of 163% and would not require a contribution to achieve the required OM threshold. It is however noted that value of flood resistance measures are capped at £4250 per property. In the event that a property requires protection measures in excess of this amount or this amount is reduced, this would need to be drawn from the project contingency. A contingency of the order £18k (considering that 25% of the properties require £1000 of additional works) would be required either as a contribution from the householders or from Southampton City Council. Further sensitivity testing of the OM score to consider an over estimate of flood risk and moving half the properties into the next flood risk category reduces the OM score from 163% to 141%.

12.7.4 *Assessment for Scheme C1 2030*

The flood resistance and resilience scheme in Cell C (Unit 11) in 2030 will mitigate flood risk to individual properties and provide a 1:200 year standard of protection.

Table 12-22 below presents a summary of the OM calculation and the full calculation sheet is included in Appendix I.

The calculation shows that this scheme achieves an OM score of 200% and would be eligible for FDGiA funding. Considering the current 120% threshold, it is noted that property protection measures are capped at £4250 per property. In the event that a property requires protection measures in excess of this amount or this cap is reduced in the future, this would need to be drawn from the project contingency. A total contribution of the order £6.5k (considering that 25% of the properties require £1000 of additional works) would be required from either a householder contribution, or from Southampton City Council.

Table 12-20. Summary OM for Scheme A1 (2015)

Outcome Measure	Value or FDGiA Contribution (£k)
Scheme Cash Cost inc 60% contingency Yr 0[xxiii]	£10,320
PV Costs	£9,142
OM1- Economic Benefit	£6,198
OM2 Households at risk from Flooding	£6,219
Total FDGiA Contribution[xxiv]	£12,418
Raw' Outcome Measure Score[xxv]	136%
External Contributions (Private)	£3,120
SCC Contribution to future maintenance[xxvi]	£102
'Partnership Funding' Score[xxvii]	171%
FDGiA Sum for Approval[xxviii]	£7,200

Table 12-21. Summary OM for Scheme B1 (2015)

Outcome Measure	Value or FDGiA Contribution £k
Scheme Cash Cost inc 60% contingency Yr 0	£540
PV Costs	£563
OM1- Economic Benefit	£314
OM2 Households at risk from Flooding	£502
Total FDGiA Contribution	£816
Raw' Outcome Measure Score	145%
External Contributions (Private)	£0
SCC Contribution to future maintenance	£102
'Partnership Funding' Score[xxix]	163%
FDGiA Sum for Approval	£540

[xxiii] Scheme cash cost including 60% Optimism Bias
[xxiv] Qualifying monetarised benefit from the overall scheme measured against National Outcome Measure payment rates
[xxv] Total FDGiA benefit divided by the scheme PV Cost
[xxvi] Value of private contribution from CIL or Developers or Landowners
[xxvii] Total FDGiA benefit divided by scheme cash cost (or PV cost, which ever is greater) less private contributions
[xxviii] Total amount of FDGiA for approval
[xxix] Total FDGiA benefit divided by scheme cash cost (or PV cost, which ever is greater) less private contributions

Table 12-22. Summary OM for Scheme C1 (2030)

Outcome Measure	Value or FDGiA Contribution £k
Scheme Cash Cost inc 60% contingency	£270
PV Costs	£188
OM1- Economic Benefit	£56
OM2 Households at risk from Flooding	£272
Total FDGiA Contribution	£329
Raw' Outcome Measure Score	175%
External Contributions (Private)	£0
SCC Contribution to future maintenance	£48
'Partnership Funding' Score[xxx]	200%
FDGiA Sum for Approval	£270

12.8 Scheme Funding Contributions

In order to implement The Strategy, funding for the various schemes will be required from different sources. An estimate of the relative potential breakdown of public / other contributions for future schemes has been provided in Table 12-23 and

Table 12-24 on the basis of the economic assessments and sensitivity testing undertaken above for the priority schemes.

A total contribution of £3.1M to £4.3M will be required over the next 30 years depending on the outcome measure threshold and level of property resistance. However, these future estimates are subject to future reviews and the public funding criteria used at the time.

The analysis shows that Scheme A1 with a contribution of £3.1M from developers would achieve an adjusted OM of 171%. Should developer contributions not be forthcoming, the land raising works may need to be funded initially by the Community Infrastructure Levy (CIL).

Based on stated costs and benefits Scheme B1 would exceed the 120% Outcome Measure thresholds and therefore may not require a contribution. However if property level works were required in excess of the £4250 cap per property, a sum of £18k may be required from the scheme contingency or local householders. Further sensitivity testing of the OM score to consider an over estimate of flood risk and moving half the properties into the next flood risk category reduces the OM score from 163% to 141% and would require a contribution of £50k to reach the 150% OM threshold.

At 2030, Scheme C1 significantly exceeds the 120% threshold. If property level works were required in excess of the £4250 cap per property, a contribution of £6.5k may be required from householders or from Southampton City Council.

The financial arrangements for The Strategy will be optimised during the development of the Strategy Appraisal Report (StAR) and the potential funding streams and opportunities explored

[xxx] Total FDGiA benefit divided by scheme cash cost (or PV cost, which ever is greater) less private contributions

in more detail through liaison with potential contributors and major beneficiaries of The Strategy.

Table 12-23: Estimated value of contributions for the best case scenario for Schemes A1, B1, C1 at 120% OM threshold

Cell	Cash Contributions (£k)			
	CIL	Householder	Developer	Total (Min 120% OM)
Cell A1	0	0	3,120 (or CIL)	3,120
Cell B1	0	0	0	0
Cell C1	0	0	0	0

Table 12-24: Estimated value of contributions for the alternative scenario for Schemes A1, B1, C1 at 150% OM threshold plus a reduced property level cap.

Cell	Cash Contributions (£k)			
	CIL	Householder	Developer	Total (Min 150% OM)
Cell A1	1,000	0	3,120 (or CIL)	4,120
Cell B1	0	74	0	74
Cell C1	0	60.5	0	60.5

13 ENVIRONMENTAL ASSESSMENTS

13.1 Strategic Environmental Assessment

13.1.1 *Introduction*

A Strategic Environmental Assessment (SEA) was undertaken to identify possible effects that The Strategy may have on the existing environment and the consideration of environmental issues has played an integral role in the decision making process and in confirming the preferred options. This Section provides a synopsis of the SEA for The Strategy and presents the key messages. For full details of the assessment see Appendix F.

SEA involves the systematic identification and evaluation of the potential environmental impacts of high-level decision-making (e.g. a plan, programme or strategy). By addressing strategic level issues, the SEA aids the selection of the preferred options, directs individual schemes towards the most appropriate solutions and locations and helps to ensure that resulting schemes comply with legislation and other environmental requirements. The SEA process also facilitates a transparent audit trail of how The Strategy has been revised to take into account the SEA.

The potential environmental impacts of all proposed strategic approaches must be considered before deciding which approaches will be adopted. Consideration should be made with regards to both the positive and negative impacts of options on wildlife and habitats, populations and health, soil, water, air, climate factors, landscape, cultural heritage and the inter-relationships between these receptors.

13.1.2 *Legislative context*

In 2001, the European Union legislated for SEA with the adoption of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (the 'SEA Directive'). The Directive was transposed into English law on 21 July 2004 and applies to a range of English plans and programmes including coastal strategies.

The main aim of the EU Directive is to "provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development". The Directive is transposed into English law via the Environmental Assessment of Plans and Programmes Regulations (SI 1633, 2004).

13.1.3 *Stages in the SEA process*

Government Guidance[xxxi] identifies five key stages in the SEA process which have been followed for this Strategy:

- Stage A: Setting the context and objectives, establishing the baseline and deciding on the scope;
- Stage B: Developing and refining alternatives and assessing effects;
- Stage C: Preparing the Environmental Report;

[xxxi] CLG (formerly ODPM) (2006) A practical guide to the Strategic Environmental Assessment Directive, Available: http://www.communities.gov.uk/publications/planningandbuilding/practicalguidesea (accessed: 06 October 2010)

- Stage D: Consulting on the draft plan or programme and the Environmental Report;
- Stage E: Monitoring the significant effects of implementing the plan or programme on the environment.

The interface of the SEA process with The Strategy is shown in Table 13-1. The Environmental Report (Appendix F) documents Stage C of the SEA process and should be referred to for the detailed assessments and information. The following subsection provides a summary of the SEA assessments and presents the key findings.

Table 13-1. Coastal Strategy and SEA Interface

	SEA	Coastal Strategy Study
Stage A	**Scoping Stage** • Setting the context and develop SEA objectives • Establishing the baseline • Deciding on the scope	**Stage 1 - Data collection and review** • Establishing the baseline • Condition and effective life of existing defences • Surveys and modelling **Stage 2 - Establishing the Baseline** **Stage 3 - Setting the objectives**
Stage B	**Appraisal of alternatives and effects** • Test Plan against objectives • Develop alternatives and consider effects	**Stage 4 & 5 – Option development and appraisal** • Developing and appraising the options • Stakeholder consultation • Technical and Environmental Assessment • Evaluate options for maintenance and improvement of defences and their impacts
Stage C	**Preparing the environmental report**	**Stage 6 – The Draft Strategy**
Stage D	**Consultation on the draft report and preparation of final report**	**Stage 7 – Strategy Approval and Strategy Appraisal Report**
Stage E	**Monitoring and implementation of the plan**	

13.1.4 *Scoping the SEA*

Stage A of the SEA was undertaken by URS in January 2011 and the findings documented in the Scoping Report. It involved establishing the context within which The Strategy is being prepared including identifying key issues and reviewing relevant plans, programmes and strategies. The Scoping Report was submitted to Southampton City Council, Environment Agency, Natural England and English Heritage for comment before being finalised.

The SEA Regulations require the assessment of the likely significant environmental effects of the plan or programme on issues such as:

- Air
- Biodiversity (including flora and fauna)
- Climate
- Cultural heritage
- Human health
- Landscape
- Material assets
- Population
- Soil
- Water
- And the interrelationship between the above factors

The SEA Scoping Report included a chapter on each of the relevant topics, taking into consideration those that have been scoped out. In order to successfully integrate differing issues and competing objectives it identified the range of issues and interests that exist through the review of relevant plans and programmes and the collection of relevant baseline data.

Related Plans and Programmes

Consideration of the context in which The Strategy is being prepared involves two steps. Firstly, related Plans and Programmes considered relevant to The Strategy must be identified. Secondly, these must be reviewed with the aim of establishing their implications for The Strategy and SEA (e.g. the opportunities they create or the constraints they present).

For practical reasons the identification of plans and programmes cannot result in an exhaustive or definitive list. The number of plans and programmes has been limited to the plans that are most relevant to the topic area and the implementation of The Strategy to provide an overview of the objectives and targets that are most likely to influence the development of The Strategy.

Environmental Baseline

Collection of baseline information forms an essential part of the SEA process. It is important to obtain sufficient baseline information on the current and likely future state of the environment in order to enable the plan's effects to be adequately predicted and evaluated. Where possible data should be collected which is able to show either a spatial or temporal trend. This allows

for a more informed judgement of the current situation in terms of the sustainability baseline of certain areas relative to others.

Identifying Environmental Issues

The ultimate purpose of the Scoping stage of SEA is to identify environmental receptors that are likely to be significantly affected by The Strategy and the SEA Directive outlines aspects of the environment that must be considered. However, if there are unlikely to be any significant effects upon a particular receptor it is possible to scope it out of the assessment.

One of the issues identified in the SEA Directive is climatic factors and this was taken to refer to potential effects of the implementation of The Strategy on the climate. Given that flood risk and coastal processes are driven by the climate rather than having an effect on the climate, it was considered that this topic is not relevant to the issues relating to The Strategy and was scoped out of the assessment. The potential effects of climate change such as extreme weather and flooding have been addressed under the appropriate topic headings, such as material assets and water.

The following SEA topics have been considered unlikely to be significantly affected by The Strategy and were therefore scoped out of the assessment:

- Air - The implementation of The Strategy will not have an effect on air quality.
- Landscape - The area covered by The Strategy is urban in character and there are no landscape designations. Therefore the implementation of The Strategy is unlikely to have any significant effects.
- Population - Although there is the potential for some individuals to be affected by the implementation of The Strategy it is unlikely that the wider population will be significantly affected. Effects relating to topic areas that are linked to population, such as flood risk and material assets, will be assessed in detail.

13.1.5 *SEA Framework*

The output of the Scoping process was an SEA Framework comprising the identified environmental issues and potential indicators to measure the effects of the implementation of The Strategy on the environmental receptors.

The Framework provides a means by which the environmental effects of The Strategy can be assessed and has been derived from the key environmental issues identified for the area and the key environmental objectives identified in the policy review. The SEA Framework is detailed in Table 13-2.

Table 13-2. SEA Key Environmental Issues and potential indicators

SEA Topic	Key Environmental Issue	Potential Indicator
Biodiversity	• The study area is surrounded by environs that are designated habitats; some of these habitats are at risk from climate change and coastal squeeze. However they do not fall within the area of The Strategy. • Non designated BAP mudflats are at risk from land reclamation and coastal squeeze.	• Condition and extent of BAP mudflats • Condition and extent of adjacent designated sites
Cultural Heritage/Historic Environment	• There are a number of historical assets in the study area at risk from flooding. • Scheduled Monuments near to the shoreline, in particular the medieval town wall and associated structures. • Listed and historic buildings, many of which have associated underground cellars which would be vulnerable to flooding. • Archaeological remains buried in foreshore sediments could be impacted by the development or upgrade of new flood defences. However, increased sea-level rise could have a potentially beneficial effect on the survival of such remains, particularly with any associated sedimentary deposition. • Palaeo-environmental evidence of ancient land surfaces could also be preserved in the now submerged foreshore sediments. These layered sediment surfaces may also benefit from added protection by further deposition.	• Number of historic assets at risk of flooding
Health	• Flooding can result in effects on both physical and psychological health, which could exacerbate existing health issues. Repeated flooding can be a particular issue in relation to psychological health and well-being.	• Properties at risk of flooding
Material Assets	• As a port city, many assets are at risk from flooding and sea level rise	• Properties at risk of flooding
Soil	• There are a number of historic landfill sites and areas of made ground with pockets of contamination within the study area at risk of flooding and erosion. There is an increasing risk that flooded historic landfills could have negative effects on water quality as sea levels rise, especially where erosion occurs.	• Number of historic landfill sites at risk from flooding (coastal and fluvial)
Water	• Southampton is at risk from coastal and fluvial flooding, including backing up of the drainage system.	• Number of properties at risk of flooding • Standard of coastal defence • Area at risk in present day 1:200 year flooding event

13.1.6 *SEA Methodology*

Introduction

The performance of the preferred option for each Option Development Unit was assessed against each of the key environmental issues using a set of matrices (see Appendix F).

The aim of this stage was to screen the options for those that are likely to have a significant effect. The assessment was a qualitative exercise based on professional judgement taking into account the information gathered in the Scoping Report and other available data and background information relevant to the issues raised in The Strategy.

General Approach

The short list of options was assessed across three time periods: 2015-2029, 2030-2059 and 2060-2110. The annual likelihood of flooding occurring at the start of each period in the 'Do Nothing' scenario was considered, together with the likely physical extent of flooding and the potentially vulnerable sensitive receptors. These were used to determine the risk to the receptors in each period. This risk assessment was then used as a benchmark to assess the relative merits of each option.

The effects of the options were assessed in terms of the nature of their impacts (beneficial/adverse/neutral/uncertain). These criteria were then used to judge whether the resulting effect would be minor or significant.

It was assumed that the likelihood of flooding in each period would increase during the period and the stated annual probability of flooding was considered in this light. Similarly it should be understood that uncertainty increases with time and the predictions made for the later periods are made with a lower degree of confidence.

An assessment of the preferred options is reproduced in Appendix D of the Environmental Report (Appendix F).

13.1.7 *Structure of the Environmental Report*

The SEA Regulations require the assessment of the likely significant environmental effects of the plan or programme on a number of environmental receptors. This Environmental Report (Appendix F) includes a chapter on each of the relevant environmental topics, taking account of those that were scoped out at the Scoping stage. Each chapter is structured in a series of themes, as follows:

- Introduction
- Environmental Protection Objectives (where applicable)
- Context Review (summary only, the complete Context Review is in Appendix A)
- Baseline Review
- Future Trends
- Appraisal findings - likely significant effects of The Strategy
- Proposed mitigation - recommended measures to ameliorate adverse impacts or enhance beneficial impacts

- Proposed monitoring - recommended ongoing monitoring of significant effects

13.1.8 *Key assessment findings*

The following subsections present the key findings of the environmental assessment for each environmental receptor. For the detailed findings and assessments see Appendix F.

13.1.9 *Historic Environment/Cultural Heritage*

Likely Future Conditions

The archaeological potential of the area is unlikely to alter in the foreseeable future. The number of Scheduled Monuments and Listed Buildings is likely to remain the same. However, increased flood risk over time has the potential to damage historic environment assets.

Environmental Problems

The following problems have been identified through the baseline review:

- Flood defence works have the potential to disturb or damage buried archaeology in the sands, gravels and muds of the foreshore.
- Increased flood risk has the potential to damage historic environmental assets such as Scheduled Monuments and Listed Buildings.
- Land raising has the potential to damage buried archaeological assets through compression.

Likely Significant Effects

Significant benefits have been identified in relation to reduced flooding to the historic built environment and cultural heritage assets in ODUs 1 and 9 for the period 2060 – 2110 when the extent of flooding is considerable. Flood risk during this time period starts from a 1 in 2 year event in ODU 1 and a 1 in 20 year event in ODU 9 (Mayflower Park / CBD).

Likely Minor Effects

Minor beneficial effects have been identified in relation to reduced flooding to the historic built environment and cultural heritage assets for the period 2060 – 2110 for ODU 2 (Bevois Valley). The extent of flooding during this time period is regarded as considerable but flooding is around 1 in 200 year event and therefore the benefits offered are not significant.

Proposed Mitigation

The character and setting of nearby designated sites and structures needs to be considered when re-developing a site and raising the height of the land. This is to ensure that the character and setting of important historic buildings and structures is not compromised by an increase in the height of land, which has the potential to alter the overall character and setting of the area.

Similarly, the implementation of flood risk adaptation measures for historic buildings and structures must respect the character of the building or structure to ensure that this is maintained.

Proposed Monitoring

The following indicators are proposed to monitor the effects of The Strategy:

- Number of historic assets at risk of flooding

13.1.10 *Health*

Likely Future Conditions

Demands on health care are set to increase due to a growing population and an increasingly elderly population.

Environmental Problems

The following problems have been identified through the baseline review:

- Two of the most health-deprived wards within Southampton, Bargate and Bevois, are located in areas at risk of flooding. This has implications in relation to the potential effects to health that a flood event might have in these areas.
- Flood events carry the risk of both physical injury and psychological effects.

Likely Significant Effects

The assessment identified significant beneficial effects for several ODUs in relation to improved physical and psychological health of people at risk from flooding as a result of reduced flood risk:

- 2030 – 2110 – ODU 4, 5, 6 (Northam to Crosshouse / Town Depot; and
- 2060 – 2110 – ODU 1, 3, 9 and 11 (Upper Itchen, Meridian Studios, Mayflower Park / CBD and Redbridge)

The risk of flooding in 2030 is around 1 in 50 in ODUs 4 and 5 whereas it is around 1 in 10 in ODU 6 in the same time period. In 2060 the annual risk of flooding is around:

- 1 in 2 in ODU 1 (Upper Itchen);
- 1 in 5 in ODU 6 (Crosshouse / Town Depot);
- 1 in 10 in ODUs 3, 4 and 5 (Meridian Studios to St Mary's Wharves); and
- 1 in 20 in ODUs 9 and 11 (Mayflower Park / CBD and Redbridge).

The extent of flooding in these units is considerable.

Likely Minor Effects

Minor beneficial effects have been identified for several ODUs through improved physical and psychological health for those people at risk of flooding:

- 2030 – 2060 – ODU 1, 3 and 11 (Upper Itchen, Meridian Studios and Redbridge); and
- 2060 – 2110 – ODU 2 (Bevois Valley).

The annual risk of flooding in ODUs 1 and 3 is around 1 in 50 in 2030 whereas in ODU 11 flooding is around 1 in 200 year event in the same time period. The annual risk of flooding in ODU 2 in 2060 is around 1 in 200.

The extent of flooding in these units is considered to be limited.

Proposed Mitigation

None proposed.

Proposed Monitoring

The following indicators are proposed to monitor the effects of The Strategy:

- Number of properties at risk of flooding

13.1.11 *Material Assets*

Likely Future Conditions

Southampton is likely to continue to be a major container port and cruise port, supporting both the local and UK economy. The City of Southampton will be subject to planned regeneration, redevelopment and growth and will continue to comprise residential and commercial properties, along with associated infrastructure.

Environmental Problems

The following problems have been identified through the baseline review:

- Some areas identified as being potentially suitable for development or re-development are subject to flood risk.

Likely Significant Effects

Significant beneficial effects have been identified for several ODUs in relation to reduced flood risk to material assets such as residential development, commercial and industrial units, retail, leisure and recreation facilities and infrastructure:

- 2030 – 2110 – ODU 4, 5 and 6 (Northam to Crosshouse / Town Depot); and
- 2060 – 2110 – ODU 1, 3 and 9 (Upper Itchen, Meridian Studios and Mayflower Park / CBD).

ODUs 4, 5 and 6 contain commercial and industrial units and residential properties. In addition to this ODU 4 contains wharves/marinas and ODU 5 contains St Mary's Stadium (Southampton Football Club) and utilities infrastructure (gas towers).

In addition to residential properties, ODU 1 contains a sewage treatment works, ODU 3 contains industrial units and a railway line and ODU 9 contains major retail parks, Southampton Central Rail Station, the Civic Centre and a major road.

Both the risk and extent of flooding in these units in the relevant time periods is considerable.

Likely Minor Effects

There is the potential for minor beneficial effects in relation to reduced flood risk for:

- 2030 – 2060 - ODU 1, 3 and 11 (Upper Itchen, Meridian Studios and Redbridge); and
- 2060 – 2110 - ODU 2 (Meridian Studios).

In addition to residential properties, ODU 1 contains a sewage treatment works and ODUs 2, 3 and 11 contain a railway line. ODUs 2 and 3 also contain industrial units.

Such benefits are considered minor due to the limited extent of flooding predicted during these periods or the low level of flood risk associated with the unit during the relevant time period.

Proposed Mitigation

None proposed.

Proposed Monitoring

The following indicators are proposed to monitor the effects of The Strategy:

- Number of properties at risk of flooding

13.1.12 *Soil*

Likely Future Conditions

There is the potential for further reclamation of land to take place to accommodate new development. In the absence of The Strategy erosion will occur in areas that are behind aging sea defences or have no defence from the sea and this could increase in severity with sea level rise.

Environmental Problems

The following problems have been identified:

- Erosion is likely to be taking place in areas behind aging sea defences or in areas that have no defence from the sea. This has the potential to lead to contamination of the water.
- There is the potential for the release of methane during construction works.

Likely Significant Effects

Significant beneficial effects have been identified for the period 2060 – 2110 for ODU 9 (Mayflower Park/ CBD) in relation to reduced erosion of reclaimed land through reduced flood risk as this area contains large areas of reclaimed or made land. The annual risk of flooding in 2060 is around 1 in 20 and the extent of flooding is considerable.

Likely Minor Effects

Minor beneficial effects have been identified for the period 2060 – 2110 for ODU 2 (Bevois Valley) and for the period 2030 – 2060 for ODUs 3 and 4 (Meridian Studios and Northam) in relation to reduced erosion through reduced flood risk as these ODUs contain areas of reclaimed or made land. Although the extent of flooding in these units is considerable, the risk of flooding is relatively low (a 1 in 200 year event in 2060 in ODU 2 and 1 in 50 year event in 2030 in ODUs 3 and 4) and the potential for erosion within the units is limited. Therefore the benefits offered are considered to be minor.

Proposed Mitigation

Continued maintenance of private defence structures and the introduction of a floodwall from 2060 should mitigate the potential minor adverse effects associated with community and property level resistance and resilience measures in ODU1.

The potential for methane pollution during land raising or redevelopment should be addressed through the introduction of methane venting during such works.

Proposed Monitoring

The following indicators are proposed to monitor the effects of The Strategy:

- Number of historic landfill sites at risk from flooding (coastal and fluvial)

13.1.13 *Water*

The South East River Basin Management Plan produced under the Water Framework Directive (WFD) shows the current ecological status of Southampton Water estuarine system as moderate and the chemical status as good. Current groundwater quantitative quality is good and the chemical quality is also good[xxxii].

Southampton falls into The Test and Itchen Catchment Abstraction Management Strategy boundary within which Southampton is classified as an urban area. The majority of the study area is not covered by a water resource management unit (WRMU); however a small area near Redbridge falls into the WRMU 8 Lower Test, which is classified as being Over-Licensed[xxxiii].

No bathing waters have been designated by the Environment Agency along the tidal foreshores of Southampton.

Likely Future Conditions

Sea level rise will continue in the future and may increase over time[xxxiv]. This being the case, the areas currently at risk of flooding will increase in size. The ecological and chemical status of Southampton Water estuarine system is unlikely to improve significantly in the short- to medium-term. The quality of groundwater is likely to remain the same. There is the potential for water resources to decline over time as the population of Southampton increases.

Environmental Problems

The following problems have been identified through the baseline review:

- Southampton is at risk from coastal and fluvial flooding.
- Sea level rise is likely to increase in the future.
- The ecological and chemical status of Southampton Water needs to improve.
- There is the potential for water resources to decline over time as the population increases.

xxxii Environment agency website www.environment-agency.gov.uk

xxxiii The Test and Itchen CAMS http://publications.environment-agency.gov.uk/pdf/GESO0306BKMB-E-E.pdf

xxxiv Intergovernmental Panel on Climate Change, Fourth Assessment Report: Climate Change 2007 http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1 [Accessed 16 August 2011]

Likely Significant Effects

No significant effects have been identified.

Likely Minor Effects

There is the potential for minor adverse effects in the period 2060 – 2110 for ODUs 1 and 11 (Upper Itchen and Redbridge) in relation to the drainage of increased surface water as a result of introducing formal flood defences which would prevent surface water from freely draining into existing water bodies.

The risk of flooding in ODU 1 is minimal and no flooding is predicted in this period. The annual risk of flooding in ODU 11 is around 1 in 20 and the likely extent of flooding is considerable. However, the drainage of increased surface water from increased precipitation or storm events could be impeded by the implementation of floodwalls in these units.

Proposed Mitigation

There is the potential for increased surface water flooding as a result of introducing formal flood defences. This should be mitigated through the implementation of a surface water management plan (SWMP) and the introduction of sustainable drainage systems (SUDS).

Proposed Monitoring

The following indicators are proposed to monitor the effects of The Strategy:

- Number of properties at risk of flooding
- Standard of coastal defence
- Area at risk of present day 1:200 year flooding event

13.1.14 *Cumulative Effects*

A topic-based approach was utilised for the assessment of the effects of the implementation of The Strategy against the Key Environmental Issues and the findings of the assessment are reported Chapters 5-10 of the SEA Report. The assessment of individual effects is an important aspect of the SEA process as it identifies potential issues relating to the implementation of The Strategy. However, it is also important to assess how the individual effects interact with one another to ascertain whether there are any cumulative effects relating to the implementation of Strategy.

Cumulative effects occur where several minor beneficial or adverse effects across a number of Preferred Options work in conjunction with one another. The following potential cumulative effects were identified for The Strategy:

- Material Assets and Cultural Heritage
- Biodiversity and Water
- Biodiversity and Soil

The minor effects identified relate to the topics of biodiversity, cultural heritage, health and material assets. The effects are such that they are quite specific to the receptor and are unlikely to interact significantly with other receptors or topics. For example, the minor adverse effects identified for biodiversity relate to potential disturbance to the Solent and Southampton Water SPA/Ramsar and the species for which they were designated. This effect is unlikely to interact with either of the topics of soil or water and therefore no cumulative effect is likely.

Similarly, a minor beneficial effect has been identified for cultural heritage in relation to reduced flooding to Listed Buildings and Scheduled Monuments. This has the potential to have a cumulative effect with the topic of 'material assets', given that historic buildings and monuments can be considered as being a material asset. However, significant beneficial effects have been identified in relation to reduced flooding to material assets and therefore the minor beneficial effect in relation to cultural heritage will not increase this.

13.1.15 *In-Combination Effects*

There is also the potential for in-combination effects between The Strategy and other plans, policies and programmes affecting the area. An assessment of the related plans, policies and programmes identified in the SEA Scoping Report established cumulative effects with the following:

North Solent Shoreline Management Plan (SMP)

A Shoreline Management Plan (SMP) provides a large-scale assessment of the risks associated with shoreline evolution, coastal flooding and erosion and presents a policy framework to address these risks to people and the developed, historic and natural environment in a sustainable manner. In doing so, an SMP is a high-level document that forms an important part of the strategy for flood and coastal defence[xxxv].

The SMP aims to provide realistic and achievable policies that are in accordance with current legislation and constraints. The policies must also be technically sustainable, environmentally acceptable and economically viable.

[xxxv] North Solent Shoreline Management Plan 2010

The SMP Policy for the majority of the area covered by The Strategy is to 'hold the line' through the maintenance or upgrade of the standard of protection through new defences. However, the policy for the area which includes ODU 11 – Redbridge is 'no active intervention', whereby there is no investment in providing or maintaining defence.

The policy of 'no active intervention' for the Redbridge area offers the potential for a conflict between The Coastal Strategy and the SMP. The key policy driver for no active intervention at this site is that the undefended and naturally confined tidal floodplain presents a suitable opportunity to allow the estuary to evolve and migrate upstream naturally over the next 100 years in response to rising sea levels. This permits inter-tidal, coastal grazing marsh and other freshwater habitats to establish and function naturally. It is the intention that undefended shoreline frontages continue to be undefended. Property level flood defences may be appropriate where flood risk will increase in the longer-term[xxxvi].

The Coastal Strategy proposes a local approach in the Redbridge area (ODU11) of 'hold the line' from 2060 given that there are a number of residential properties that will be at increased flood risk from 2060. The Habitats Regulations Assessment of The Coastal Strategy concludes that this approach will not have an adverse effect on the integrity of the Solent and Southampton SPA/Ramsar and Solent Maritime SAC.

Given that the North Solent SMP is the overarching document which dictates the strategy for the Coastal Strategy to follow, it is considered that there will be no in-combination effects likely as both strategies seek to achieve the same end.

Test and Itchen Catchment Abstraction Management Strategy (CAMS)

Catchment Abstraction Management Strategies (CAMS) are strategies for the management of water resources at a local level. CAMS are also the mechanism for managing time-limited licences by determining whether they should be renewed and, if so, on what terms. The main issue that is common to both the CAMS and The Strategy is their effect on the Solent and Southampton Water SPA/Ramsar site and Solent Maritime SAC.

The lower reaches of the River Test are designated as part of Solent Maritime SAC and also as part of Solent & Southampton Water Special Protection Area (SPA) and a Ramsar site under the UN Ramsar Convention. The River Itchen also flows into the Solent Maritime SAC. The lower reaches of the Test show well developed transitions from fen meadow through brackish floodplain grassland to saltmarsh and reed bed. This complete transition of freshwater flood plain habitats to estuarine saltmarsh and mudflat is better developed on the Test than on any other river in the Hampshire and Isle of Wight Area. The ecological interests of this site are dependent upon the balance between freshwater input and the tidal influence, and the associated brackish zone. With sea level rise the zonation from freshwater to salt is shifting. Freshwater inputs are important to maintaining the system. The area is also internationally and nationally important for wetland breeding birds and as a wader and duck feeding and roosting ground[xxxvii].

Given that ecological interests of the Solent Maritime SAC are sensitive to changes in the balance between freshwater input and tidal influence the control of both is paramount to maintaining the ecological integrity of the SAC. The CAMS identifies the Lower Test WRMU as being 'over-licensed' and therefore water resource management will be necessary to maintain the balance between freshwater and saltwater. Similarly, The Strategy seeks to reduce flood

[xxxvi] North Solent Shoreline Management Plan 2010
[xxxvii] Environment Agency, Test and Itchen Catchment Abstraction Management Strategy 2006

risk which will stabilise the tidal influence and, therefore, the balance between freshwater and saltwater.

On the basis that both the CAMS and The Strategy seek to maintain the ecological integrity of the SAC it is considered that the in-combination effect will be neutral as through the implementation of both plans the condition of the SAC should be maintained.

River Itchen, Weston Shore, Netley and hamble Coastal Technical Study (CTS)

The CTS study area is located within the boundaries of the North Solent Shoreline Management Plan. The options developed in this study informed the policy options presented in the North Solent SMP.

The CTS study area lies along the north eastern shores of Southampton Water which connects via the Solent to the English Channel. The study area includes the east bank of the River Itchen as far upstream as Woodmill Lane Bridge.

Given that the CTS has also been developed alongside the North Solent SMP, and is subservient to it, it is considered that the in-combination effects are likely to be neutral.

13.1.16 *Conclusions*

The implementation of The Strategy is likely to result in significant beneficial effects for a number of receptors and minor adverse effects for biodiversity and archaeology. An assessment of the cumulative effects of The Strategy identified that cumulative effects were unlikely to occur. Similarly, an assessment of in-combination effects with other plans also identified that no effects were likely.

The SEA identified that The Strategy could have the following significant benefits on the environment:

- **Historic Environment / Cultural Heritage** – there will be a reduction in the number of important historic buildings and structures at risk from flooding.
- **Health** – people who are currently at risk from flooding in their homes or places of work will feel safer from knowing that flood risk has been reduced by building flood defences.
- **Material Assets** (homes, businesses, roads, railway lines, energy and water infrastructure) – there will be a reduction in the number of properties at risk of flooding in areas where flood defences are built.
- **Soil** – large areas of the Southampton coastline are made up from 'reclaimed land' or contain historic landfill sites. Flood defences will reduce the risk of flooding and erosion in these areas.
- **Water** – flooding is an important concern, with around five millions people live in areas at risk of flooding in England and Wales.

13.2 Water Framework Directive Assessment

As a part of The Strategy development process, and confirmation of the preferred options, an assessment of the implications of the preferred options against the Water Framework Directive (WFD) Regulations was required. The requirements of the WFD need to be considered at all stages of the coastal planning process.

13.2.1 *The Water Framework Directive*

The WFD was passed into UK law in 2003 and for the first time, combines water quantity and quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, transitional (estuarine) and coastal waters (TraC) at the river basin level has been adopted. It effectively supersedes all water related legislation which drives the existing licensing and consenting framework in the UK.

The Southampton Coastal Strategy (the Strategy) area lies in the Southampton Water transitional waterbody (GB520704202800), which lies in the South East River Basin District (RBD). In addition this to this there is one surface waterbody, the Tanner's Brook (GB107042016620), and one ground waterbody, the Central Hants Bracklesham Group (GB40702G500900), within the strategy area.

The overall requirement of the Directive is that all river basins must achieve "good ecological status" by 2015 unless there are grounds for derogation. It also requires that Environmental Objectives be set for all waterbodies; the River Basin Management Plans (RBMPs) set out the objectives for the waterbodies within the study area.

Ecological Status is expressed in terms of five status classes (high, good, moderate, poor or bad) which are defined using biological, physico-chemical and hydromorphological criteria. The biological assessment criteria uses numeric measures of communities of plants and animals (e.g. fish, rooted plants). The physico-chemical assessment uses elements such as temperature and nutrient levels, which support the biological communities. The hydromorphological assessment uses water flow, sediment composition and movement, continuity (in rivers) and the structure of physical habitat. The overall ecological status of a waterbody is determined by whichever of these criteria is assessed to be the poorest. For example, if a waterbody achieved 'Good status' for chemical and physico-chemical assessments, but only achieved 'Moderate status' for the biological assessment; it would be classed overall as having 'Moderate ecological status'. To achieve the overall aim of good surface water status, the WFD requires that surface waters be of at least Good Ecological Status (GES) and Good Chemical Status (GCS).

The WFD recognises that some waterbodies have been physically altered, for example for navigation or flood defence, and allows for these water bodies to be designated as Heavily Modified Water Bodies (HMWB) or Artificial Water Bodies (AWB) and need to achieve good ecological potential rather than ecological status. Ecological potential means that the waterbody is managed to achieve the biology that can be achieved given its modified condition. HMWBs are classified by:

- identifying the impacts of physical modification affecting the water body;
- identifying possible mitigation measures necessary to ensure the hydromorphological characteristics of a water body are consistent with Good or maximum ecological potential; and
- assessing whether all of those measures have been taken.

The Southampton Water transitional waterbody is a HMWB, due to the presence of extensive hard coastal defences along the length of the Strategy frontage and reclaimed land in the dock areas. The waterbody is therefore classified as being at Moderate overall potential with an objective of reaching 'Good potential' status by 2027. It has been deemed to be disproportionately expensive and technically infeasible to achieve Good potential by 2015. The

Central Hants Bracklesham Group groundwater body is currently classed as Good status, with an overall objective of Good chemical and quantitative status by 2015.

13.2.2 *WFD objectives*

The WFD contains five Environmental Objectives, which aim to prevent a negative change to the status of water bodies, which could be caused by a deterioration of any of the biological, physico-chemical or hydromorphological Quality Elements listed in Annex V of the WFD, as shown in Table 13-3 below. The Environmental Objectives taken from Article 4 of the Water Framework Directive (WFD) are shown Table 13-4.

Table 13-3.Biological, physico-chemical or hydromorphological Quality Elements

Quality Elements	Description
Biological assessment	Uses numeric measures of communities of plants and animals (for example fish and rooted plants)
Physico-chemical assessment	Looks at elements such as temperature and the level of nutrients, which support the biology
Hydromorphological assessment	Looks at water flow, sediment composition and movement, continuity (in rivers) and the structure of physical habitat

Table 13-4. Environmental Objectives in the WFD

Objectives	Description
WFD1	No changes affecting high status sites
WFD2	No changes that will cause failure to meet surface water Good Ecological Potential or result in a deterioration of surface water Ecological Potential
WFD3	No changes which will permanently prevent or compromise the environmental objectives being met in other waterbodies
WFD4	No changes that will cause failure to meet good groundwater status or result in a deterioration in groundwater status

There is also a duty to enhance and restore water bodies where possible and by implication there is a need to ensure that actions do not prevent water bodies from reaching a good status and potential. In order to meet the objectives, any activity which has the potential to have an impact on any of the Quality Elements must be assessed. The preferred Strategy options will therefore be considered to ensure there are no future failures in meeting the Environmental Objectives, and any failures that do occur can be defended.

13.2.3 *North Solent SMP WFD assessment*

The North Solent SMP2 was assessed under the requirements of the WFD. For all Water Bodies in the North Solent SMP2 area, the hydromorphological parameters that potentially could be changed by SMP policies, with potential impact on the Biological Quality Elements (BQEs), were identified. BQEs that potentially could be affected by SMP policies for each waterbody were identified and the potential impact of the SMP policy for each Policy Unit was assessed in relation to aspects of the WFD.

The WFD assessment for the 5C13 Lower Test Valley unit did not identify any potential failures of WFD objectives from the preferred policy. However, the assessment concluded that for the Woodmill Lane to Redbridge policy unit:

'The recommendation to continue to maintain and improve flood defences would provide considerable economic and societal benefits to the heavily developed and populated conurbations of Southampton City within the extensive area of coastal flood risk. The commercial and industrial dominated frontage extending northwest from the River Itchen, is principally owned and the defence structures maintained by the port authority. The west bank of the River Itchen is wholly developed with substantial numbers of residential and commercial properties, heritage sites, transport networks and other associated city centre infrastructure. Maintenance of defence structures would continue to contribute towards the erosion and lowering of intertidal foreshore habitats. This could impact on the fish, benthic invertebrate and macroalgal BQEs through potential changes in heterogeneity of habitat, continuity for migration routes, substrate conditions, accessibility to nursery area, presence of macrophytes, connectivity with riparian zone, availability of organic debris, groundwater connectivity, light, beach water table, in abrasion and salinity. Whilst this SMP policy may result in potential short term deterioration in surface water Ecological Potential, the policy would not prevent obtaining good groundwater status or result in deterioration in groundwater status.'

The assessment concluded that environmental Objective 2, '*Protect, enhance and restore all bodies of surface water, with the aim of achieving good surface water status in 2015*', would not be met by the proposed policy for the Woodmill Lane to Redbridge policy unit. A Summary Statement was therefore completed for the Southampton Water TraC waterbody, which could be adversely affected by the proposed policy. The Summary Statement outlined the reasons behind selecting the final SMP policy and any mitigation measures that have been incorporated into the policies. It concluded for the Southampton Water TraC waterbody:

- **Mitigation measures:** No Active Intervention (NAI) and Managed Realignment (MR) policies at other units will improve hydromorphological conditions and contribute towards offsetting the localised coastal squeeze impacts predicted at the HTL sites.
- **Overriding public interest:** The policy of maintaining defences is required to protect property, heritage, commercial, industrial and agricultural developments, transport and cross-harbour infrastructure assets and designated habitats and sites.
- **Better environmental options:** NAI and MR have been discounted for the developed areas due to the need to protect the properties, infrastructure and assets along these frontages.
- **Effect on other Water Bodies:** SMP policies which will modify coastal, estuarine and groundwater processes will only do so in localised areas and no effects on adjacent waterbodies or frontages in Dorset/Hampshire and Sussex are expected as a result of SMP2 policies.
- **Other issues:** SMP Appendix J (Appropriate Assessment) sets out the conclusions of the assessments of the potential for the SMP policies to have significant effects on any internationally designated site within the SMP study area.

In effect, for each waterbody where a failure to meet one of the WFD environmental objectives has been recorded, the Summary Statement concludes that there is overriding public interest, no environmentally better options which would meet the required public interest and no significant effects on any internationally designated nature conservation site, designated fishery or shellfishery, or other water body.

13.2.4 *Assessment methodology*

The methodology used for this assessment has been taken from the Environment Agency document *'Assessing new modifications for compliance with WFD: detailed supplementary guidance, Environment Agency, 2010'*. This follows an 8 step process which is illustrated below in Figure 13-1.

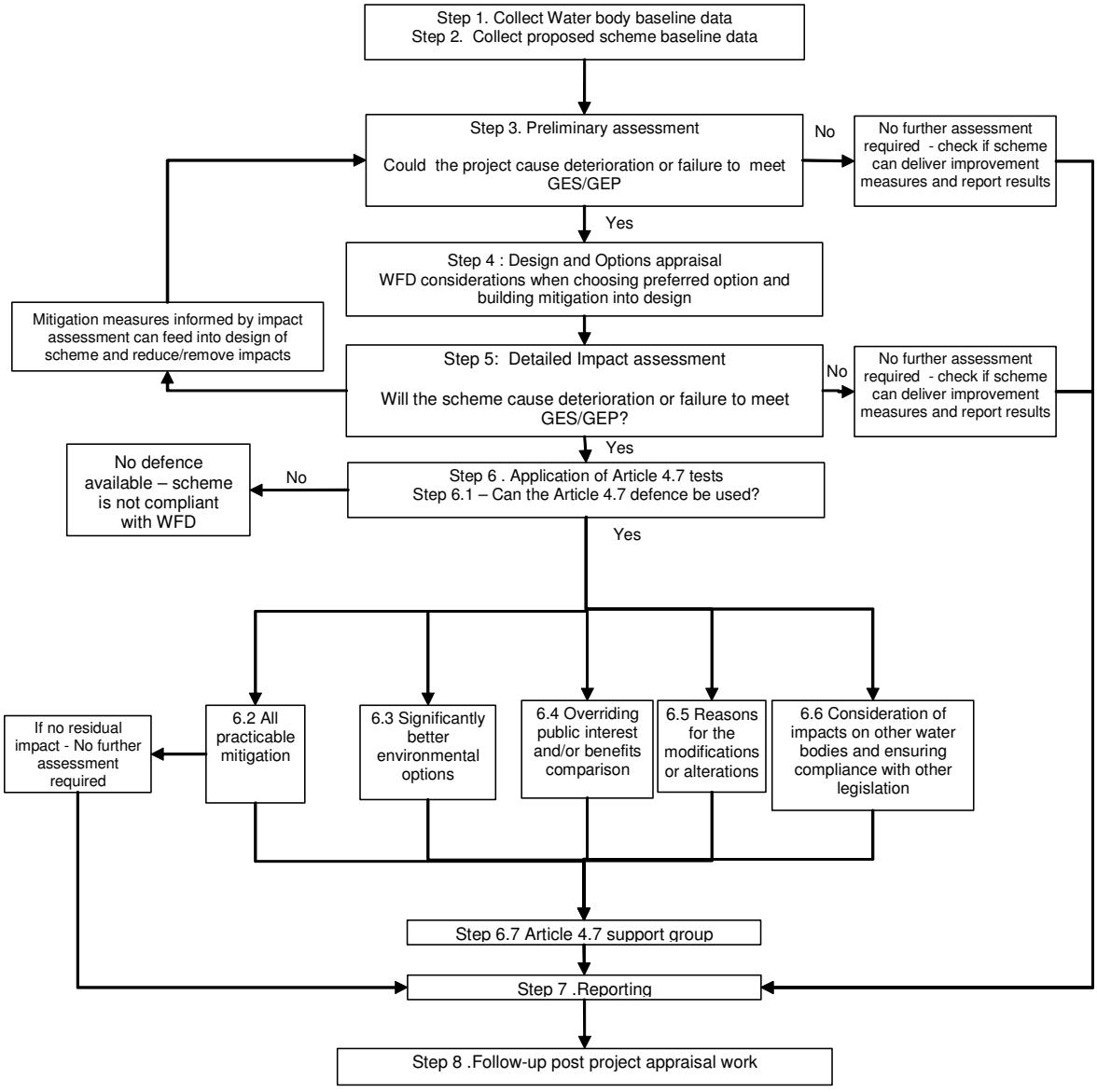


Figure 13-1: Overview of the 8 step process

13.2.5 *Preliminary assessment*

The aim of this stage is to screen out the preferred options of the Strategy from further assessment if they are unlikely to have any impact on the WFD objectives. If it is envisaged that no deterioration will occur across any of the WFD quality elements as a result of the preferred options and that they will not prevent the water body from meeting its status or potential objectives, then no further WFD compliance assessment is required. The following

step by step process (Figure 13-2) was used in the preliminary assessment of each of the preferred options for each of the ODUs.

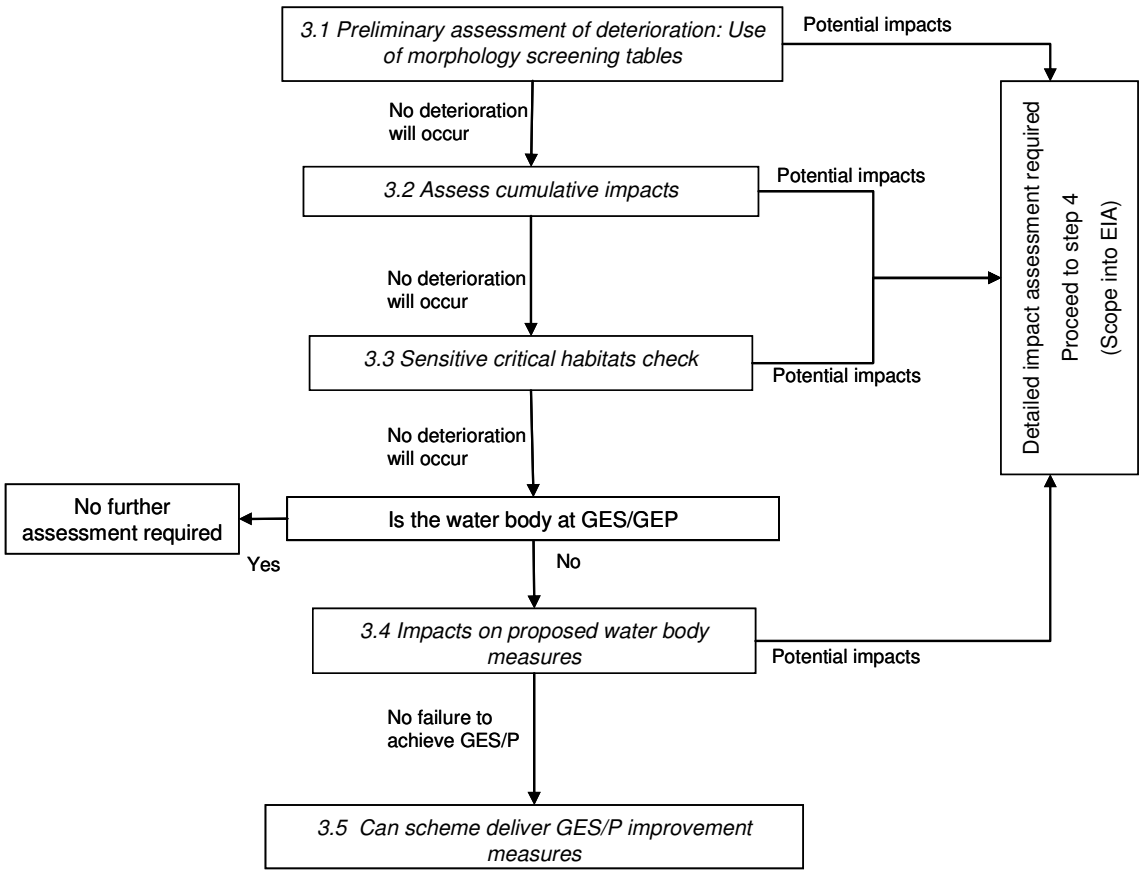


Figure 13-2. Overview of the preliminary assessment stages undertaken.

In terms of the preliminary assessment of deterioration, there are certain activities that were considered not to be at risk of causing deterioration or failing to achieve WFD status/potential objectives. These are listed in the below Table 13-5.

Table 13-5: Activities not requiring WFD compliance assessment

Types of modification not requiring WFD assessment	
Maintenance activities	Re-pointing (block work structures)
	Void filling ('solid' structures)
	Re-positioning (rock or rubble or block work structures)
	Replacing elements (not whole structure)
	Re-facing
	Skimming/covering
	Blockage removal
	Removal of management of in-stream debris/rubbish from culverts and trash screens (not woody debris)
	Vermin control
Linear flood defences	Temporary flood defences

If the preferred options fall in to the above activities then they can be screened out of further WFD assessment. If a quality element is not likely to be affected by the preferred options then it can also be scoped out of any further assessment.

If there are no impacts likely across any of the quality elements, then it is necessary to move to the second step which involves a consideration of cumulative impacts within a water body. Whilst an individual scheme may have an insignificant impact on WFD quality elements within a reach, the combined effect of several small-scale schemes within a water body may cause deterioration.

The third step involves checking if the proposed development is located on habitats that are critical to the individual biological quality elements or on particularly sensitive habitats then further investigation is required. It may also be necessary to carry out further investigation if the proposed development is predicted to negatively impact on any salt marsh or seagrass habitat in transitional/coastal waters.

If it is determined that no deterioration of sensitive critical habitats will occur then water bodies of GES/GEP can be scoped out of any further assessment. If the water body is not of GES/GEP then the fourth step is required. This involves considering if the Strategy will impact on proposed WFD improvement/mitigation measures by causing a deterioration or failure to meet the water body objectives.

In terms of the fifth step, for water bodies that are of less than good status, it is necessary to consult the River Basin Management Plan to ascertain whether the required measures can be built into the Strategy so as to meet GES/GEP.

13.2.6 *Unit 1 - Upper Itchen / St Denys*

Preliminary assessment of deterioration

The short to medium term (2015 to 2060) option for ODU 1 is to implement community and property level flood resistance and resilience. At 2060 a floodwall near the front line will be required. The short to medium term option will therefore not cause any change or deterioration to WFD objectives and does not require further consideration. However, the longer term option

of a floodwall is screened in to the WFD compliance assessment as the construction works would involve an upgrade to the existing defences and/or creation of new defences.

The morphology screening tables in the Environment Agency guidance do not apply to TraC water bodies such as Southampton Water, so expert judgement is required to ascertain whether any quality elements will be affected by the scheme. It is considered that Environmental Objective WFD3 will be met. However, the preferred option for this ODU requires more detailed assessment as it is possible that Objective WFD2 will not be met

Therefore, this preferred option requires further assessment and is taken forward to the detailed impact assessment stage.

13.2.7 *Unit 2 - Bevois Valley*

Preliminary assessment of deterioration

The preferred option for this ODU is the maintenance of existing defences in the short term (2015 to 2030) with the construction of new sheet pile front line defences at the front line in 2030 providing flood protection until 2110 for the critical infrastructure (railway line) immediately adjacent to the shoreline and the area behind. There is little available land in front of the railway at this point, hence the preference for the sheet pile option which requires a minimal footprint. It is considered that Environmental Objectives WFD2 and WFD3 will be met by the proposed scheme. ODU2 is just 350 m in length and while the effects of the proposed piling may reduce the intertidal area at this point due to a landward movement of the low tide mark, the length of shore to which this applies will be too small to have an effect on the overall status of the Southampton Water waterbody. It is therefore considered that both WFD2 and WFD3 will be met by the proposed scheme and it is necessary to move to the second step of the preliminary assessment.

Cumulative impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. The proposed sheet pile defence will be located behind the current front line defence and the extent of coastal squeeze will therefore be limited. No other proposed schemes within Unit 2 which could cause similar pressures were known of at the time of writing this assessment and it is therefore considered that there is no likely cumulative effect with the other stretches of front line defence proposed for other ODUs within the study area. The preferred option for this ODU therefore does not require more detailed assessment.

Critical/sensitive habitats

Mudflats are a protected habitat under the Southampton City Council Biodiversity Action Plan[xxxviii] (BAP) and are found within ODU2. Southampton City Council's policy for biodiversity protection, from the adopted local plan, includes policy NE5 on Intertidal Mudflat Habitats. The policy states:

'Development will not be permitted which would result in the reclamation of, or disturbance to, the remaining intertidal mudflat habitat and land along the River Itchen, the River Test and

[xxxviii] Biodiversity Action Plan, An update of the 1992 Nature Conservation Strategy, Southampton City Council, 2005, http://www.southampton.gov.uk/s-environment/Biodiversity/action.aspx

Southampton Water and Weston Shore outside of the SPA as shown on the Proposals Map unless:

1. *there is no adverse affect on nature conservation interests;*
2. *there is no damage to the open character of the riverside and landscape;*
3. *there is no damage to water-based recreation or leisure interests; and*
4. *there is no net loss of intertidal mudflat habitat.'*

It is thought that the proposed policy for ODU2 will meet policy NE5, as the construction of defences will follow the present alignment of the defences so will not increase the potential for coastal squeeze and the loss of mudflat habitat and the preferred option for this ODU therefore does not require more detailed assessment.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be affected by The Strategy. However, while the preferred option for Unit 2 would reduce the intertidal area at this point due to a landward movement of the low tide mark, the length of shore to which this applies will be too small to have an effect on the overall status of the Southampton Water waterbody. It is therefore not considered that the proposed option for ODU2 would compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU2.

13.2.8 *Unit 3 - Meridian Studios (railway line to Northam Bridge)*

Preliminary assessment of deterioration

The preferred option for this ODU in the short to medium term (2015 to 2060) is an intermediate height floodwall, which will form the spine of defence until land raising as and when sites are brought forward and cleared for redevelopment. The raised land will then provide robust flood protection from 2060 to 2110. In the case of the former Meridian Studios site, the land has already been cleared and would be suitable for raising in the immediate future.

As with ODU3, it is considered that Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme. ODU3 is just 400 m in length and while the effects of the proposed flood wall may reduce the intertidal area at this point due to a landward movement of the low tide mark, the length of shore to which this applies will be too small to have an effect on

the overall status of the Southampton Water waterbody. It is therefore considered that both WFD2 and WFD3 will be met by the proposed scheme and it is necessary to move to the second step of the preliminary assessment.

Cumulative impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. The only planned scheme in Unit 3 that was known of at the time of writing this assessment is the redevelopment of the former Meridian studios site. However, as this redevelopment is integrated within the preferred option for Unit 3, it has been included within this assessment. In addition, the proposed intermediate flood wall will be located behind the current front line defence and the extent of coastal squeeze will therefore be limited. It is therefore considered that there are no likely cumulative impacts with the other stretches of front line defence proposed for other ODUs within the study area. The preferred option for this ODU therefore does not require more detailed assessment.

Critical/sensitive habitats

Mudflats are a protected habitat under the Southampton City Council Biodiversity Action Plan[xxxix] (BAP) and are found within ODU3. Southampton City Council's policy for biodiversity protection, from the adopted local plan, includes a policy on Intertidal Mudflat Habitats, as discussed above in section 13.2.7.

It is thought that the proposed policy for ODU3 will meet policy NE5, as the setting back of defences will minimise the potential for coastal squeeze and the loss of mudflat habitat and the preferred option for this ODU therefore does not require more detailed assessment.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be affected by The Strategy. However, while the preferred option for Unit 3 would reduce the intertidal area at this point due to a landward movement of the low tide mark, the length of shore to which this applies will be too small to have an effect on the overall status of the Southampton Water waterbody. It is therefore not considered that the proposed option for

[xxxix] Biodiversity Action Plan, An update of the 1992 Nature Conservation Strategy, Southampton City Council, 2005, http://www.southampton.gov.uk/s-environment/Biodiversity/action.aspx

ODU3 would compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU3.

13.2.9 *Unit 4 - Northam (Northam Bridge to Belvedere Wharf)*

Preliminary assessment of deterioration

It is considered that Environmental Objective WFD3 will be met by the proposed scheme. The proposed floodwall would only be a short to medium term defence, with the proposed land raising providing adequate flood protection for the ODU in the long term. It is therefore anticipated that the design life of the wall would be 50 years (lasting until 2060), which would mean that a reduced crest height would be required. This reduced crest height would allow for continuity from the City to the water and help maintain access to the waterfront. It is not anticipated that any adverse effects will result and Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme. It is therefore necessary to move to the second step of the preliminary assessment.

Cumulative Impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. As this preferred option represents an extension to the existing situation in the ODU, it is not anticipated that there are likely to be any cumulative impacts with any recent schemes or other planned schemes in the area.

Although redevelopment is proposed within Unit 4, as with Unit 3, the longer term land raising is integrated within the redevelopment and has therefore been included within this assessment.

Critical/sensitive habitats

There are no critical or sensitive habitats within this ODU, as intertidal mudflats are not present within this ODU.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be affected by The Strategy. However, the long term (from 2060 to 2110) preferred option for Unit 4 of land raising would not involve operational changes to beach control and would minimise the impact on the foreshore in this Unit and therefore preserve its ecological value.

It is therefore not considered that the proposed option for ODU4 would compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU4.

13.2.10 *Unit 5 - St Mary's Wharves*

Preliminary assessment of deterioration

As this preferred option represents an extension to the existing situation in the ODU, it is not anticipated that any adverse effects will result and Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme. It is therefore necessary to move to the second step of the preliminary assessment.

Cumulative Impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. No other proposed schemes within Unit 5 which could cause similar pressures were known of at the time of writing this assessment.

In addition, as this preferred option represents an extension to the existing situation in the ODU, it is not anticipated that there are likely to be any cumulative impacts with any recent schemes or other planned schemes in the area.

Critical/sensitive habitats

There are no critical or sensitive habitats within this ODU, as intertidal mudflats are not present within this ODU.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be affected by The Strategy. However, the long term (from 2060 to 2110) preferred option for Unit 4 of land raising would not involve operational changes to beach control and would minimise the impact on the foreshore in this Unit and therefore preserve its ecological value.

It is therefore not considered that the proposed option for ODU5 would compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU5.

13.2.11 *Unit 6 - Crosshouse / Town Depot*

Preliminary assessment of deterioration

The preferred option for this ODU is land raising and as this area is earmarked for redevelopment there is an opportunity to raise the site from 2015, which will need to tie in to the defences in the adjacent Unit to the north to form a continuous defence line. It is considered that Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme, which will not involve hard structures seawards of the current front line structures or significant alterations to the foreshore for the majority of the 600 m frontage of the ODU.

Cumulative impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. The only planned scheme in Unit 3 that was known of at the time of writing this assessment is the redevelopment of the Town Depot site. However, as this redevelopment is integrated within the preferred option for Unit 6, it has been included within this assessment.

Critical/sensitive habitats

Mudflats are a protected habitat under the Southampton City Council Biodiversity Action Plan[xl] (BAP) and are found within ODU6. Southampton City Council's policy for biodiversity protection, from the adopted local plan, includes a policy on Intertidal Mudflat Habitats, as discussed above in section 13.2.7.

It is thought that the proposed policy for ODU6 will meet policy NE5, as the land raising will occur behind current front line structures and will not increase the potential for coastal squeeze and the loss of mudflat habitat and the preferred option for this ODU therefore does not require more detailed assessment.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be affected by The Strategy. However, the long term (from 2060 to 2110) preferred option for Unit

[xl] Biodiversity Action Plan, An update of the 1992 Nature Conservation Strategy, Southampton City Council, 2005, http://www.southampton.gov.uk/s-environment/Biodiversity/action.aspx

4 of land raising would not involve operational changes to beach control and would minimise the impact on the foreshore in this Unit and therefore preserve its ecological value.

It is therefore not considered that the proposed option for ODU6 would compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU6.

13.2.12 *Unit 7 - Ocean Village*

Preliminary assessment of deterioration

Due to the presence of sufficiently high quay walls and land levels, no work other than maintenance of the existing quay walls and structures will be required on this ODU until 2060, when the raising of quay walls within the marina and the construction of defences along the perimeter of ABP land and demountable defences / ramps on access points will be required. As this preferred option represents an extension to the existing situation in the ODU, it is not anticipated that any adverse effects will result and Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme. It is therefore necessary to move to the second step of the preliminary assessment.

Cumulative Impacts

The assessment of cumulative impacts has considered existing pressures on the waterbody, any recent schemes, local knowledge and other planned schemes that may introduce similar pressures to those already experienced by the waterbody. The only planned scheme in Unit 3 that was known of at the time of writing this assessment is the development of a proposed hotel adjacent to marina. However, this would not impact on the defences at this point and as this preferred option represents an extension to the existing situation in the ODU, it is not anticipated that there are likely to be any cumulative impacts with any recent schemes or other planned schemes in the area.

Critical/sensitive habitats

There are no critical or sensitive habitats within this ODU, as intertidal mudflats are not present within this ODU.

Is the water body at GES/GEP?

The Southampton Water TraC waterbody is currently classified as having Moderate potential, with a proposed overall objective of reaching 'Good Potential' status by 2027. In order to achieve Good potential, the RBMP has identified a series of proposed improvement and/or mitigation measures to bring the waterbody up to Good potential. For Southampton Water the measures relevant to this Strategy are given in Table 1-2 above, which shows that the following identified mitigation measures are not currently in place:

- Indirect / offsite mitigation (offsetting measures);
- Operational and structural changes to locks, sluices, weirs, beach control, etc; and
- Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone.

Of these, the first option is not considered to be relevant but operational changes to beach control and the preservation of marginal aquatic habitat, banks and riparian zone could be

affected by The Strategy. However, this preferred option represents an extension to the existing situation in the ODU and therefore does not involve changes to structures. In addition, the preferred option would not alter the current form of the marginal aquatic habitat, banks and riparian zone and would therefore preserve it. Obviously, this does not allow for enhancement measures but this is not considered to compromise the above measures and therefore the Strategy should not prevent the achievement of Good potential within ODU7.

13.2.13 *Unit 8 – Eastern Docks / Dock Gate 4*

Preliminary assessment of deterioration

Due to the presence of sufficiently high quay walls and land levels no work will be required in this ODU until 2060, when the preferred option is to implement a floodwall (typically 0.9m above existing ground levels) along the boundary of ABP Port to provide flood protection until 2110. It is not anticipated that any adverse effects will result, and Environmental Objectives WFD2 and WFD3 will both be met by the proposed scheme. No further WFD compliance assessment is therefore needed.

13.2.14 *Unit 9 - Mayflower Park / Major Redevelopment Quarter*

Preliminary assessment of deterioration

The preferred option for ODU 9 is to raise land through redevelopment to form a continuous strip of raised land to provide a robust flood defence behind the Port area. As discussed in the Interim Strategy Reportxli, liaison with ABP has screened out the option of front line defence options which ABP are currently not exploring as the flood risk is not till the longer term in the docks area. The preferred option therefore involves the creation of a defence line behind the ABP owned land, which would ensure the protection of the Major Quarter, whilst accommodating access and operational requirements for the Port. The proposed work would therefore be at some distance from the actual shoreline and it is therefore considered that there would no effect on the waterbody from the preferred strategy.

This preferred option can be screened out of any further WFD assessment.

13.2.15 *Unit 10 – Western Docks*

Preliminary assessment of deterioration

As with ODU9, liaison with ABP has screened out the option of front line defence options which ABP are currently not exploring as the flood risk is not till the longer term in the docks area. The preferred option therefore involves the creation of a defence line behind the ABP owned land, which would ensure the protection of the land behind the 5.9 km of ABP owned frontage, whilst accommodating access and operational requirements for the Port. The proposed work would therefore be at some distance from the actual shoreline and it is therefore considered that there would no effect on the waterbody from the preferred strategy.

This preferred option can be screened out of any further WFD assessment.

[xli] Southampton Coastal Flood and Erosion Risk Management Strategy, Interim Report, URS/Scott Wilson, June 2011 (DRAFT)

13.2.16 *Unit 11 – Redbridge*

Preliminary assessment of deterioration

Existing land levels and current structures are sufficiently high to provide flood protection until 2030. As sea levels rise and the flood risk increases by 2030, the preferred option for ODU 11 is to implement community and property level flood resistance and resilience which will manage the flood risk until 2060. This option will include providing warnings to residents of potential flood events in good time, along with flood resistance measures at the property level (flood gates, waterproof air brick covers and paint, non return valves etc.). This option will have considerably less disruption on the designated conservation sites in the vicinity (Solent and Southampton Water SPA/Ramsar and Solent Maritime SAC) than front line defence options.

At 2060, a floodwall along the seaward side of the railway line is required. The construction of a hard defence such as that proposed could reduce morphological and ecological diversity within the floodplain and reduce the tidal range while increasing the subtidal area. However, it must be noted that the railway embankment forms an existing infrastructure corridor and is maintained by Network Rail.

Due to the construction of a hardened front line from 2060 the preferred option for this ODU therefore requires more detailed assessment as it is possible that Objective WFD2 will not be met, although it is considered that Environmental Objective WFD3 will be met.

13.2.17 *Summary of preliminary assessment*

Table 13-6 below shows the outcome of this preliminary assessment, in terms of whether WFD environmental objectives will be met for Southampton Water and whether detailed assessment is required.

Table 13-6: ODUs requiring detailed assessment

ODU	Reason
ODU1 - Upper Itchen / St Denys	Possible failure to meet WFD2 due to floodwall construction at 2060
ODU11 - Redbridge	Possible failure to meet WFD2 due to floodwall along the railway line at 2060.

13.2.18 *Detailed impact assessment*

Following the preliminary assessments the preferred options in the following ODUs have reached this stage and were subject to a detailed impact assessment:

- ODU1 - Upper Itchen / St Denys; and
- ODU11 - Redbridge.

The preferred Strategy options for these management units either do not meet objective WFD2 on their own, or have the potential to cause a failure of WFD2 when considered in combination with other ODUs within the Strategy area.

13.2.19 *Will the strategy prevent the achievement of GES / GEP*

This assessment has identified that based on the preferred options, there is not anticipated to be a negative impact on the ecological status of the coastal water body for the majority of the

frontage. However, within ODU 1 and ODU11 there could be possible impacts caused by the preferred Strategy options in the longer term.

Until 2060, flood risk in ODU 1 and 11 will be managed through property level flood resistance measures (flood gates, waterproof air brick covers and paint, non return valves etc.) along with flood warnings, incident response and resilience measures at the property level. The flood resistance and resilience option and assumed maintenance of private 'ad-hoc' defences in the short to medium term in ODUs 1 and 11 will not affect the overall classification of the Southampton Water waterbody and would not prevent the target status of Good potential being achieved by 2027.

In order to protect the residential and commercial properties and critical infrastructure (Portswood Wastewater Treatment Works) in ODU 1 after 2060, upgrading of the defences is essential. A hard defence (floodwall) is proposed for ODU 1 at 2060 and this will replace the current informal and often 'piecemeal' private defences with varying type, condition and standards.

The construction of a hard defence such as the proposed floodwall at 2060 could reduce morphological and ecological diversity within the floodplain. Beach narrowing and steepening and an overall reduction in the non-designated intertidal area may result from increased sea levels resulting from climate change. While ODU 1 lies adjacent to the Solent and Southampton Water SPA, the designation does not cover the western shore of the tidal Itchen, which reflects the commercial and heavily modified nature of the waterbody at this stage. In the context of the wider Southampton Water waterbody, this stretch represents just 2.5km of the overall >100 km waterbody length and is not considered to be of significant ecological importance.

Within ODU11, the floodwall defences proposed along the railway line after 2060 has the potential to prevent approximately 0.2 Ha of intertidal habitat from being created at Redbridge, subject to the realisation of sea level rise predictions. ODU11 lies within the Solent and Southampton Water SPA and Ramsar site and adjacent to the Solent Maritime SAC, which could potentially be affected by the proposed Strategy. As the flood wall follows the embankment, it would lie within the existing footprint of the railway infrastructure and consequently the effects of the wider Southampton Water body are not anticipated to be significant as this is a relatively short section of defence (~1km), especially in the context of the rest of the 10km lower Test valley area which falls under the SMP policy of 'No Active Intervention'.

Cumulative effects across the Southampton Water waterbody as a whole were assessed by the North Solent SMP, as discussed above in section 1.8. The SMP concluded that the recommended policy of Hold the Line in policy unit 5C12 (Woodmill Lane to Redbridge) could contribute towards the erosion and lowering of intertidal foreshore habitats, which in turn could impact on the fish, benthic invertebrate and macroalgal communities of the foreshore. The SMP also concluded that the SMP policy may result in potential short term deterioration in surface water Ecological Potential for the 5C12 unit and the following policy units within the Southampton Water waterbody could also be at risk of failing WFD objective 2:

- 5C03 Swanwick Shore to Road Bursledon Bridge – beach narrowing and lowering along marina frontage;
- 5C07 Hamble Oil Terminal to Ensign Industrial Park – narrowing and loss of fronting beach due to maintaining the standard of privately owned defences;

- 5C09 Cliff House to Netley Castle – beach narrowing and lowering due to maintaining the current standard of defence;
- 5C11 Weston Point to Woodmill Lane – continued maintenance of defence structures would cause the erosion and lowering of intertidal foreshore habitats;
- 5C14 Redbridge to Calshot Spit – the maintenance and upgraded standard of protection of the defences along this stretch of coast would allow for the continued erosion and lowering of the designated intertidal foreshore habitats; and
- 5C15 Calshot Spit – the continued maintenance of defence structures would cause the erosion and lowering of intertidal foreshore habitats.

The preferred strategy options in policy unit 5C12 could therefore have a cumulative effect.

It is considered that in the context of the wider Southampton Water waterbody, potential impacts of the Strategy options on ecological elements will be localised and they are unlikely to prevent the achievement of GES or GEP within the water body as a whole. As the frontage is currently mostly defended by significant structures, intertidal habitat will be lost due to coastal squeeze due to a landward movement of the low tide mark. However as strategy preferred options fall within existing defence footprints or behind existing defences coastal squeeze impacts will not be exacerbated by the strategy, except potentially at Redbridge from 2060, but the length of shore to which this applies is too small to have an effect on the overall status of the Southampton Water waterbody. It is therefore not considered that The Strategy would compromise the mitigation measures and therefore The Strategy should not prevent the achievement of Good ecological potential.

Opportunities for mitigation against intertidal habitat loss beyond 2060 are limited within The Strategy area, due to the urban nature of the shoreline, but should be investigated further in the future. Where possible, mitigation opportunities should be identified within The Strategy area, but where this is not possible other mitigation options within the Southampton Water waterbody should be investigated. The mainly undefended Lower Test Valley and the western flank of Southampton Water could present opportunities for mitigation in the future; this should be explored further by other strategies in these areas where there is greater scope for mitigation provision.

13.2.20 *Impacts on other water bodies*

This assessment has included all landward waterbodies that have the potential to be impacted by the preferred Strategy options and the adjacent coastal water bodies will not be affected by the preferred Strategy options.

13.2.21 *Other European legislation*

WFD article 4.8 requires any new scheme to be consistent with other European environmental legislation. As shown in , there is a designated Shellfish Water within Southampton Water, namely Southampton Water Shellfish Water.

There is the possibility that there is contamination present in the soils along the strategy frontage. However, as the preferred Strategy options do not allow for the erosion of these soils, there is no possibility that any contamination present could be released. Temporary construction effects do not require assessment and the release of contaminated soils by construction works required to maintain and upgrade coastal defences has not been assessed.

It is therefore concluded that there would be no impact on the designated Shellfish Waters from the Strategy.

In addition, the Strategy would ensure continued protection of inland sites, which would have the potential to cause pollution of the Shellfish Waters if allowed to flood from the sea e.g. sewage treatment works.

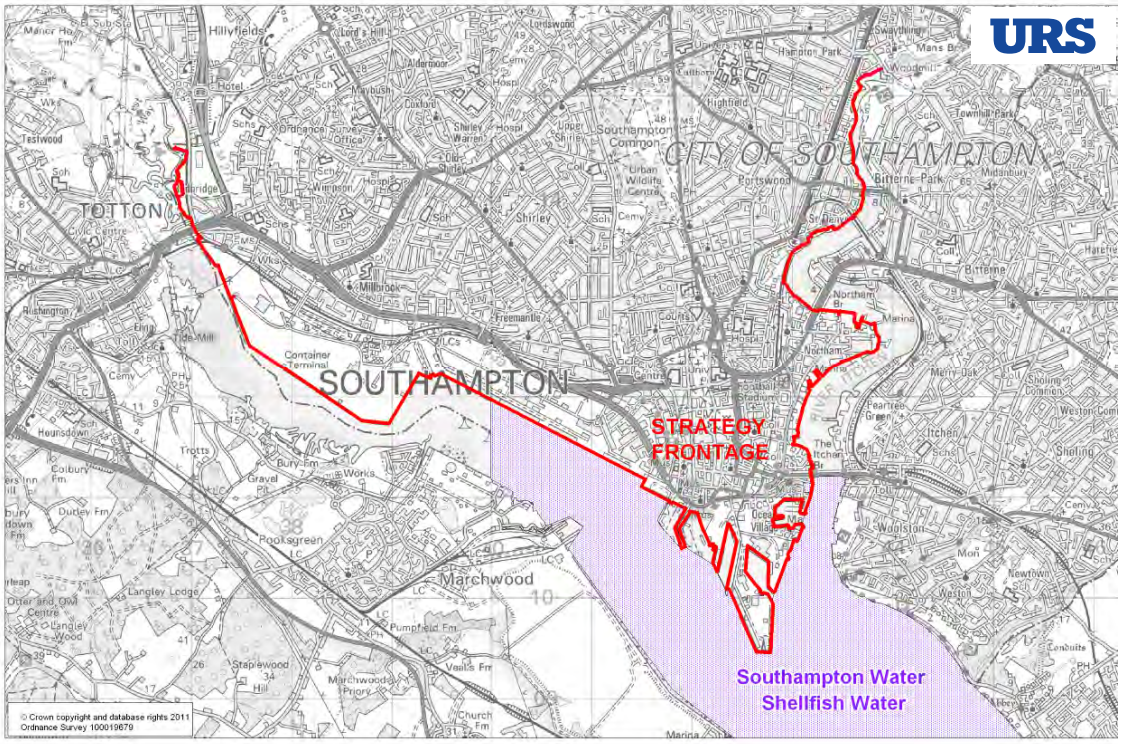


Figure 13-3. Designated Shellfish Waters in the Solent and Southampton Water

13.2.22 *Conclusion*

It is concluded that overall the Strategy is unlikely to have any significant adverse effects on the waterbodies present as scheme works are generally within, or often landwards, of existing defence footprints. The effects of the Strategy on other European Directives have also been considered and it is concluded that standards set by the Habitats and Shellfish Waters Directives will not be affected.

In the short to medium term (until 2060) there will be no significant adverse impacts resulting from the Strategy options; however, as a result as a result of the detailed assessments, two ODUs were identified as areas where there is the potential for the longer term schemes (2060 implementation) to cause adverse impacts. These were identified as ODU 1 and ODU11. Here the potential for failure of Environmental Objectives was identified as a result of the planned construction of a floodwall defence.

The construction of hard structures (i.e. floodwalls / sheet piling) has the potential to reduce morphological and ecological diversity within the floodplain. This in turn can reduce sediment mobilisation, which could result in the water column ceasing to be the provider of sediment onto mudflats and sandflats, especially in natural or semi-natural catchments. Coastal squeeze in

the form of beach narrowing and steepening and an overall reduction in the intertidal area may result from increased water levels due to climate change and sea level rise.

However, ODU1 is not considered to be of ecological significance, as the designation of the Solent and Southampton Water SPA does not cover the western shore of the tidal Itchen, which reflects the commercial and heavily modified nature of the waterbody at this stage. On a wider catchment scale the loss of small sections of the intertidal area in these units would not be significant. Also the floodwall in the Unit is likely to be within or behind the existing defence footprints.

It is concluded that this impact will be minimal as the ODUs represent a very small section of the overall Southampton Water waterbody; ODUs 1 and 11 represent just 4 km of the overall >100 km waterbody length. Therefore placing the local impact of the ODU1 and ODU11 Strategy options within the context of the wider water body and heavily modified catchment, and given that the implementation of these options is planned for 2060, any potential effect on ecological elements is unlikely to prevent the achievement of GES or GEP within the water body as a whole. The Strategy has the potential to prevent approximately 0.2 ha of intertidal habitat from being created at Redbridge post 2060, although in the context of the wider habitat losses across Southampton Water (figures unavailable) this is considered to be insignificant and would not cause a failure to reach Good ecological potential.

Opportunities for mitigation against intertidal habitat loss beyond 2060 are limited within The Strategy area, due to the urban nature of the shoreline, but should be investigated further in the future. Where possible, mitigation opportunities should be identified within The Strategy area, but where this is not possible other mitigation options within the Southampton Water waterbody should be investigated. The mainly undefended Lower Test Valley and the western flank of Southampton Water could present opportunities for mitigation in the future; this should be explored further by other strategies in these areas where there is greater scope for mitigation provision.

For all ODUs, it was noted that there may be localised and temporary water quality impacts as a result of maintenance or construction works, although it is anticipated that this will be minimal and can be further reduced with sensitive construction techniques and reference to the Environment Agency's Pollution Prevention Guidelines. In addition, works should be timed to avoid sensitive times such as bird breeding seasons. In any case, impacts resulting from construction are unlikely to cause a permanent change in the ecological status or ecological potential of the water body.

13.3 Habitat Regulations Assessment

ABP Marine Environmental Research Ltd (ABPmer) was commissioned as sub-consultants by URS to undertake a Habitats Regulations Assessment (HRA) for The Strategy in accordance with the UK Conservation of Habitats and Species Regulations (2010).

13.3.1 *Legislative context*

Under the Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive) it is necessary to undertake a HRA of a plan or project to determine whether it will have a "likely significant effect" (LSE) on sites designated for their nature conservation interest at an international level. This Directive has been transposed into national laws through the Conservation of Habitats and Species Regulations 2010 (Habitats Regulations 2010). In particular Regulation 61 states that:

"A competent authority, before deciding to undertake, or give any consent, permission, or other authorisation for a plan or project which:

(a) is likely to have significant effect on a European site in Great Britain (either alone or in combination with other plans or projects); and

(b) is not directly connected or necessary to the management of the site shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives".

A European site (also referred to as a *Natura 2000* site) is either a Special Area of Conservation (SAC) identified through the EU Habitats Directive (Council Directive 92/43/EEC) or Special Protection Area (SPA) identified through the Birds Directive (Council Directive 79/409/EEC). Additionally, it is a matter of policy throughout the UK that Ramsar sites identified through the Ramsar Convention 1976 should receive the same protection as designated SPAs and SACs. Therefore, Ramsar sites are included under the European Site heading for the purposes of carrying out an Appropriate Assessment, even though they are not technically classed as European sites.

In the UK, it is also Government policy (as indicated in the following documents: Scottish Government (SG), 2010; Office of Deputy Prime Minister (ODPM), 2005; Welsh Assembly Government (WAG), 2010; Department of Environment for Northern Ireland (DOENI), 1997), that these requirements are also extended to the consideration of effects on sites that are proposed for designation such as potential SPAs (pSPAs) and candidate SACs (cSACs), and this would also include any proposed extensions or additions to existing Natura 2000 sites.

When evaluating the effects on designated sites as part of the HRA process, if the relevant Competent Authority, cannot conclude that the plan or project will not have an adverse effect on the integrity of a European site (either alone or in combination with other plans or projects) the plan can only be adopted if it has been ascertained that there are no alternative solutions and it is necessary for Imperative Reasons for Overriding Public Interest (IROPI), including those of a social or economic nature[xlii]. In such cases, compensatory measures must be taken to ensure that the overall coherence of the network of Natura 2000 sites is maintained.

[xlii] Article 6 of the Habitats Directive also states that, where the site concerned hosts a priority natural habitat, type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

Given the proximity of The Strategy frontage to internationally designated sites (See section 3.1, Figure 3 in Appendix G) the possibility of 'likely significant effects' (LSE) on European designated sites cannot be excluded and therefore an HRA is required. In the case of this HRA Southampton City Council is the competent authority. Southampton City Council, with advice from Natural England, will need to ensure that if there is a negative assessment of a plan or project, agreement to that plan or project is only given if there are no alternative solutions, it must be carried out for Imperative Reasons of Overriding Public Interest (IROPI), and any compensatory measures that may be required are secured.

13.3.2 *Methodology*

For The Strategy HRA, an iterative and auditable process was followed to ensure that there is as much clarity as possible in the process and also to ensure that the relevant documentation can be readily accessed, interpreted and interrogated. In particular, the information and detail provided in the HRA report (Appendix G) is based on recommendations within the relevant Habitats Regulations Guidance (HRGN1) on Appropriate Assessment methods (English Nature, 1997) and agreed guidance for undertaking HRAs for plans in England which has been produced by David Tyldesley and Associates (2010).

Throughout the HRA an assessment was made in relation to each of the respective ODU preferred options and their impacts on the integrity of European Designated sites.

With respect to the project-level responsibilities of implementing the policies, it is important to note that The Strategy-level HRA does not preclude the need for HRAs at a project level and, indeed, it will remain a legal requirement for projects undertaken as part of this Strategy to also undergo a project-level Appropriate Assessment wherever the possibility of a Likely Significant Effect on a European site cannot be excluded. It is recognised however that the high-level plan assessment can provide valuable information for project-level HRAs.

Consultation with respect to all aspects of this HRA will be undertaken by Southampton City Council, as the competent authority.

13.3.3 *Screening and Scoping*

This stage in the methodology involves analysing the Conservation Objectives for each of the relevant European sites identified. For some sites generic conservation objectives may need to be used. Based on these specific and generic objectives, the potential effects on each site via each of the impact pathways will be reviewed and an initial view taken about the effect on site integrity of the proposed plan both alone and in-combination with other extant plans or projects. The views expressed about the effects on site integrity will be based on: current scientific understanding; the proposed manner in which the plan is to be implemented and any proposals for mitigation measures to avoid or reduce impacts.

The next stage involves selecting the final list of the sites and interest features which are to be 'screened into' the AA either because there is a 'Likely Significant Effect' (or LSE) or because a LSE cannot be excluded via the identified impact pathways. The impact pathways are listed in Appendix G, Section 3.2.1. Therefore, this screening stage of the process determines which of these impact pathways needs to be taken into the assessment process because they represent a LSE.

It should be noted that LSE is not defined in the Habitats Regulations. LSE is recognised within Natural England as being a 'coarse filter' or statement that the anticipated effects of the proposal will be more than trivial, i.e. that the anticipated change(s) resulting from the proposal

has the potential to impact on a receptor designated as a feature of the European Site. It does not automatically follow that an impact will occur, or that the impact would be significant, with a decision of LSE being purely an indication of the need for an Appropriate Assessment.

Given the need for a high level of certainty to meet Habitats Regulations requirements, there is a presumption in favour of 'screening issues in' at this stage, following the precautionary approach. This will be important also for undertaking any detailed assessments (at this Plan-level or in future Project-level assessment work) where there needs to be sufficient confidence in the evidence base and that the delivery of projects under the plan can be sufficiently controlled to avoid adverse effect on integrity. When considering the relevant screening methods to determine LSE, it is therefore understood that there again needs to be a presumption in favour of including rather than excluding interest features and designated sites in the HRA process at this stage.

Furthermore a potential impact pathway as a result of the proposed scheme will only be an issue to interest features that form part of the marine and coastal environment in the study area. In other words, there is no route of interaction for terrestrial and/or freshwater organisms and habitats, excluding those that are able to use different environments, such as migratory Atlantic salmon moving between the open sea and rivers (mainly the chalk rivers of the Test and Itchen). Furthermore, an impact pathway will only exist at locations where a direct and/or indirect impact will occur as a result of the preferred options.

13.3.4 *Summary of Key findings*

The international nature conservation importance of The Strategy area has been recognised through a number of statutory designations. All internationally designated sites greater than 5km from The Strategy were screened out of the assessment. Internationally designated sites within 5km of The Strategy include:

Special Protected Areas (SPA) designated under the Birds Directive (Council Directive 79/409/EEC):

- New Forest SPA;
- Solent and Southampton Water SPA.

Wetlands of International importance designated under the Ramsar Convention:

- New Forest Ramsar site;
- Solent and Southampton Water Ramsar site.

Special Areas of Conservation (SAC) designated under the EU Habitats Directive (Council Directive 92/43/EEC):

- New Forest SAC;
- River Itchen SAC;
- Solent Maritime SAC.

The Solent and Southampton Water SPA and Ramsar site and the Solent Maritime SAC form part of the Solent European Marine Site as defined in the Habitats Regulations. Where the European Site lies below highest astronomical tide i.e. land covered (continuously or

intermittently) by tidal waters, or any part of the sea, in or adjacent to Great Britain, up to the seaward limit of territorial waters, it is described as a European Marine Site.

The boundaries of these designated sites in relation to The Strategy Frontage are shown in Figure 13-4. Further information on the qualifying and interest features, conservation objectives and vulnerabilities for the designated sites that will be covered by the assessment are given in Appendix G.

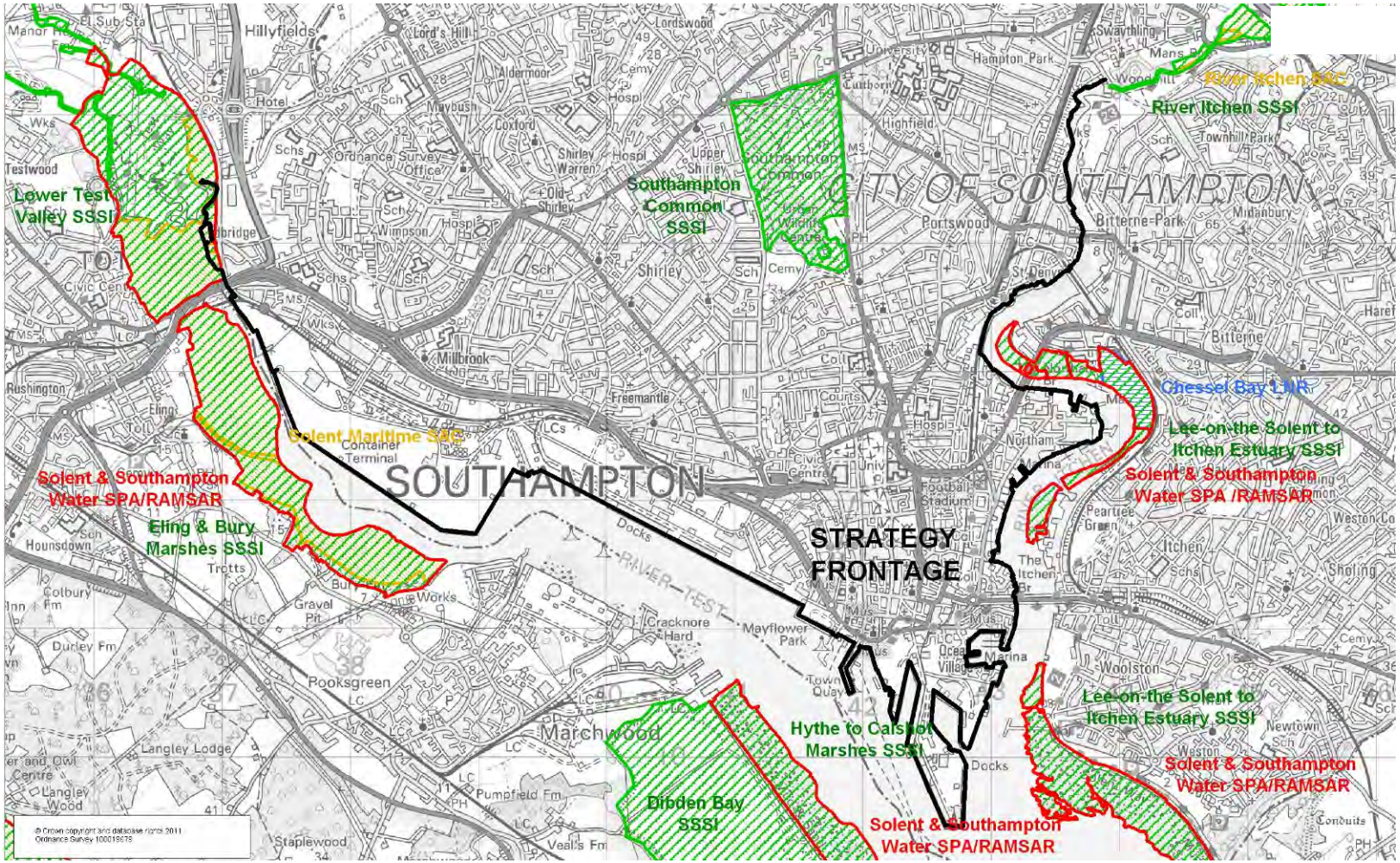


Figure 13-4. Environmentally designated sites in close proximity to The Strategy frontage.

A tabulated summary of the interest features and conservation objective habitats is presented in Table 13-7.

Table 13-7. Summary of interest features and conservation objective habitats for designated sites within the vicinity of The Strategy area.

European Site	Interest Feature	Conservation Objective - Habitats
Solent and Southampton Water SPA	Annex I species (Common Tern, Little Tern, Mediterranean Gull, Roseate Tern, Sandwich Tern)	Sand and shingle
		Saltmarsh
		Intertidal mudflats and sandflats
		Shallow coastal waters
	Migratory species (Black-tailed Godwit, Dark-bellied Brent, Teal, Ringed Plover) and Waterfowl assemblage	Saltmarsh
		Intertidal mudflats and sandflats
		Boulder and cobble shores
		Mixed sediment shores
New Forest SPA	Annex I species (Hen Harrier, Nightjar, Woodlark, Honey Buzzard and Dartford Warbler) Migratory species (Eurasian Hobby and Wood Warbler).	Wet heaths
		Dry heaths
		Mires
		Inland water bodies
		Bogs
		Marshes
		Fens
		Woodland
		Grassland
Solent and Southampton Water Ramsar	Atlantic biogeographical region	Estuaries
		Saline lagoons
		Saltmarsh
		Intertidal reefs
	Assemblage of rare, vulnerable or endangered species	Saline lagoons
		Saltmarsh
		Cordgrass swards (*Spartinion* spp.)
	20,000 waterfowl species	Saltmarshes
		Intertidal mudflats and sandflats
		Boulder & cobble shores
		Mixed sediment shores
	1% or more of the individuals in a population of waterfowl species	Saltmarsh
		Sand & shingle
		Shallow coastal waters
		Intertidal mudflats and sandflats
		Boulder and cobble shores
		Mixed sediment shores

European Site	Interest Feature	Conservation Objective - Habitats
New Forest Ramsar	Important wetland habitats Internationally important fauna and flora	Wet heaths
		Dry heaths
		Mires
		Inland water bodies
		Bogs
		Marshes
		Fens
		Woodland
		Grassland
Solent Maritime SAC	Estuaries	
	Annual vegetation of drift lines	
	Atlantic salt meadows	
	Salicornia and other annuals colonising mud and sand	
	Spartina swards	
	Intertidal mudflats and sandflats	
	Subtidal sandbanks	
	Coastal lagoons	
	Perennial vegetation of stony banks	
	Shifting dunes along the shoreline with *Ammophila arenaria*	
	Desmoulin`s whorl snail	
River Itchen SAC	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	
	Southern damselfly	
	Bullhead	
	White-clawed crayfish	
	Brook lamprey	
	Otter	
	Atlantic salmon	
New Forest SAC	Oligotrophic waters containing very few minerals of sandy plains, *Littorelletalia uniflorae*	
	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoeto-Nanojuncetea*	
	Northern Atlantic wet heaths with *Erica tetralix*	
	European dry heaths	
	Molinia meadows on calcareous, peaty or clayey-silt-laden soils	
	Depressions on peat substrates of the *Rhynchosporion*	
	Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer	
	Asperulo-Fagetum beech forests	
	Old acidophilous oak woods with *Quercus robur* on sandy plains	
	Bog woodland	
	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	

European Site	Interest Feature	Conservation Objective - Habitats
	Transition mire and quaking bog	
	Alkaline fen	
	Southern damselfly	
	Stag beetle	
	Great crested newt	

13.3.5 *Assessment of Likely Significant Effect*

Potential impact pathways that could arise as a result of The Strategy were identified as:

- Direct habitat loss;
- Saline intrusion;
- Changes to coastal processes resulting in morphological changes;
- Disturbance; and
- Coastal squeeze.

These pathways are broadly consistent with the impact pathways identified in the North Solent SMP, with the addition of direct habitat loss which we have brought in at this strategy level.

Following an assessment of impacts, coastal squeeze was considered the principle impact pathway for The Strategy.

Coastal squeeze occurs where a physical structure is in place along the coastline, restricting the ability of intertidal habitats to naturally migrate inland due to sea level rise. Any loss of intertidal habitat will also have implications for bird and fish species so all are reviewed in the context of habitat change as a result of coastal squeeze.

The Solent CHaMP and North Solent SMP have already considered that coastal squeeze is likely under future epochs over the next 100 years and found that the progressive shift of mean low water has been a consistent trend over large areas of Southampton Water since the 1840s and can be anticipated to continue (Bray and Cottle, 2003).

The HRA for the SMP concluded that there would be a significant adverse affect on the European sites due to coastal squeeze. To compensate for this adverse affect managed realignment sites have been identified by the SMP at Medmerry, East Chidham and Chidam. The cumulative compensation requirements for saltmarsh, freshwater habitats, coastal grazing marsh, estuaries (function) and bird roost and feeding sites for Solent and Southampton Water SPA and Ramsar, and for saltmarsh and estuaries for Solent Maritime SAC will be passed onto the Regional Habitat Creation Programme for delivery.

This HRA has assumed that the coastal squeeze losses identified by the SMP have been fully addressed. The HRA for The Strategy has investigated any additional affects to those defined and addressed in the SMP. This reflects the advice from Natural England which is expecting The Strategy to adopt the findings of the SMP and focus on local adjustments where appropriate. Notably this HRA has clarified the situation at areas such as Redbridge where the broad scale SMP policy has been reviewed at a local scale by The Strategy.

Within this HRA for The Strategy, an assessment has been made over whether the preferred options change the predictions that were made under the CHaMP and SMP for the internationally designated sites. Effects on intertidal habitat loss will be considered across the extent of The Strategy influence on the designated sites.

Sites Screened In/Out

Table 13-8 summarises the designated sites that were fully screened in or out at this stage of the HRA process. Since the main impact pathway was identified as coastal squeeze, any designated sites which only support non-coastal terrestrial habitats and species were screened out.

Table 13-8. Internationally designated sites within 5km of The Strategy frontage screened in and out of assessment

Sites screened in	Solent and Southampton Water SPA Solent and Southampton Water Ramsar site Solent Maritime SAC River Itchen SAC
Sites screened out	New Forest SPA New Forest Ramsar New Forest SAC

The environmental designations identified as being potentially affected by coastal squeeze resulting from the Strategy preferred options of each Unit are identified in Table 13-9.

Table 13-9. Habitats within each option development unit and designation status

ODU	Habitats Within Cross Section of Unit Frontage	Preferred Option	Potential Impact Pathway	Designation Status
1	Mudflat	2015-2060: Community and property level flood resistance and resilience 2060-2110: Flood wall near the front line	Coastal squeeze	Not designated
2	Mudflat	2015-2030: Maintain existing defence structures 2030-2110: Steel sheet pile wall at the front line	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
3	Mudflat	2015-2060: Intermediate height flood wall forming the spine of defence until raised land undertaken through redevelopment supersedes the floodwall as the main defence by 2060. 2060-2110: Defended by a continuous strip of raised land achieved through redevelopment.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
4	Mudflat	2015-2060: Intermediate height flood wall forming the spine of defence until raised land undertaken through redevelopment supersedes the floodwall as the main defence by 2060. 2060-2110: Defended by a continuous strip of raised land.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
5	Mudflat	2015-2060: Intermediate height flood wall forming the spine of defence until raised land undertaken through redevelopment supersedes the floodwall as the main defence by 2060. 2060-2110: Defended by a continuous strip of raised land.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
6	Mudflat	2015-2110: Defended by raised land implemented through redevelopment.	Coastal squeeze	Not designated
7	Mudflat	2015-2060: Maintain existing quay walls and defence structures 2060-2110: Defended by raised quay walls with floodwall defences along perimeter of ABP land.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
8	Mudflat Subtidal habitat	2015-2060: Do nothing 2060-2110: Defended by a floodwall around Ocean Village and along the boundary of the Port.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
9	Mudflat Subtidal habitat	2015-2060: Land raising through development of Royal Pier Site and the Major Development Quarter preferred. Implementation of a floodwall forming the spine of the flood defence by 2030 if a continuous strip of raised land is not achieved by this time. 2060-2110: Defended by a floodwall and or raised land.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
10	Mudflat Saltmarsh Subtidal habitat	2015-2060: Do nothing. The area behind Port protected against flooding by the existing quay walls in the Port. 2060-2110: Area behind the Port defended against flooding by a floodwall along the boundary of the Port ramps / demountables on access points.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar* Solent Maritime SAC*
11	Mudflat Saltmarsh Grazing marsh Subtidal mud	2015-2030: Do nothing 2030-2060: Community and property level flood resistance and resilience 2060-2110: Floodwall along the seaward side of the railway embankment.	Coastal squeeze	Solent and Southampton Water SPA and Ramsar Solent Maritime SAC
* Designation falls on opposite side of bank to The Strategy frontage				

13.3.6 *Appropriate Assessment*

The main objective of the Appropriate Assessment is to ascertain that The Strategy will not have an adverse effect on the integrity of the European Sites and, where adverse affects do arise from the plan, to quantify these effects and recommend mitigation measures to offset these impacts on the site. An adverse effect of The Strategy is one which prevents the European Site from reaching or maintaining its targets for the site's conservation objectives.

The precautionary approach is also enshrined in the Appropriate Assessment. In particular, under the Habitats Regulations, there is a need for a high level of certainty in the assessment conclusions (also following the precautionary principle). This approach was applied in this assessment.

Key findings

Following an assessment of Likely significant effects it was concluded that coastal squeeze as a result of The Strategy has the potential to significantly affect the following habitats and species designated under the Solent and Southampton Water SPA and Ramsar site and the Solent Maritime SAC:

Habitats:

- Intertidal mudflat;
- Saltmarsh; and
- Grazing marsh.

Species:

- Atlantic salmon; and
- Bird species (overwintering and migratory).

To assess the impacts of coastal squeeze on habitats and species designated under European sites over and above those defined in the SMP, the likely intertidal habitat changes were determined by modelling water level changes throughout the Estuary. Comparisons have been made between a 'baseline' scenario and a 'preferred option' scenario. The baseline scenario is one in which water levels have been calculated if no new defences were constructed and as such any impacts on intertidal habitats are a result of climate change and natural processes over time. The preferred option scenario calculates water levels with The Strategy preferred options in place over the duration of the plan. The difference between calculated water levels under the two scenarios gives an indication of the potential hydrodynamic changes which will result from The Strategy. Implications for designated habitats and species can then be inferred.

The results of the model revealed that there is no change in water levels with and without The Strategy options in place until the time period 2060 to 2110. This is due to the fact that a sea level rise of 31cm (as a result of climate change) up until 2060 will not overtop the existing structures in place along the Southampton frontage, for example ABP quay walls. Therefore there will be no effect along the frontage as a result of The Strategy to 2060.

By 2110, the difference in peak water levels at high water between a 'Do Nothing' scenario and with the Strategy implemented is shown in Table 13.10 for each ODU. The biggest increases in water levels as a result of The Strategy options are expected to occur towards the top of the tidal limit of the River Itchen and at Redbridge within upper Southampton Water. A maximum

increase 0.5cm in water levels in 2110 was calculated with and without The Strategy preferred options in place. Smaller increases are estimated further downstream, with changes as little as 0.1cm calculated at Netley shore (to the south of The Strategy frontage on the Eastern Shore of Southampton Water). Downstream of Netley no differences in water level changes were estimated with or without The Strategy options in place, indicating that Netley Shore is the maximum extent of influence of The Strategy.

A maximum increase in water levels of 0.5cm should be considered minimal within the context of 100 years and a predicted sea level rise of 73cm due to climate change. Furthermore, the Solent and Southampton Water is an extremely complex system with a large number of human activities taking place and hence subject to huge variability. Following a precautionary approach, an assessment of the influence of these changing water levels has been undertaken.

Table 13-10. Maximum difference in water levels at high water in 2110 under a baseline scenario (no defences) and a preferred option scenario (with defences).

ODU	Difference (Preferred option – baseline) (cm)
1	0.5
2	0.5
3	0.5
4	0.4
5	0.3
6	0.3
7	0.2
8	0.3
9	0.3
10	0.4
11	0.5

Using the results of the water level changes, the effects on intertidal habitat changes have been inferred along the length of Southampton Water and the River Itchen. The effects on estuary features have been looked at through the change in intertidal habitat, which in the case of The Strategy includes mudflat and saltmarsh, and grazing marsh. Water levels under the two scenarios, baseline and preferred option, have been compared to assess the effects on intertidal habitat specifically as a result of The Strategy.

Coastal squeeze assessment

For Southampton Water as a whole there is expected to be no change in water levels before 2060 as a result of The Strategy. There is the potential for a minimal change in maximum water levels across the entire site as a result of the preferred option scenario between 2060 and 2110, when compared to a baseline scenario. Due to the inherent inaccuracies of the model and uncertainty in sea level rise predictions, overall increases are deemed insignificant.

Therefore there is predicted to be no adverse effect on intertidal habitats and associated species, over and above those identified and addressed within the SMP, and **no adverse effect** on the integrity of European sites.*

ODU 11 at Redbridge is the only ODU where The Strategy frontage is internationally designated. The area is a mosaic of grazing marsh and intertidal channels. The two bridges that cross the River act as a constriction for water from Southampton Water through the submerged weir and bathymetry of the area, therefore creating very different hydrodynamics as compared to the Itchen and Southampton Water frontages. Due to the topography of the intertidal area at Redbridge and the numerous channels which run through the area, intertidal habitat will not increase/decrease in a linear way throughout the 100 year epoch as a result of sea level rise, as it would along on open coast.

Within The Strategy, this area (ODU 11) has a preferred option between 2060 and 2110 of implementation of a floodwall in order to protect properties, the rail infrastructure and a former landfill site at Redbridge from flooding. Thus the Mean High Water line will be prohibited from 'rolling back' over the top of the railway embankment. Under the North Solent SMP this area (5c13) has a preferred policy of NAI throughout the 100 year timeline. Between 2060 and 2110 water levels are high enough to over top the existing railway line embankment, currently acting as a defacto defence.

Thus a policy of No Active Intervention would in theory allow the intertidal habitat to 'roll back', overtopping the railway line and creating a new area of intertidal habitat (approximately 0.2ha) behind the railway line (See Appendix G – Figure 4). However, it should be noted that the proportion of the SMP Policy Unit (5c13) defended through the implementation of a floodwall within ODU 11 is less than 15% with a preferred policy of NAI. A change in intertidal habitat composition in front of the railway line will still occur with a transition from grazing marsh to intertidal mudflat and saltmarsh.

The potential for up to 0.2 ha of intertidal habitat to be created behind the railway under the SMP NAI policy would not occur under The Strategy preferred option between 2060 and 2110.

The current conclusion using the best scientific information available is that there is the potential for an adverse effect after 2060, which will require re-investigation during a future revision of The Strategy prior to 2060. At that point, if it is concluded that an adverse effect would in fact occur, the potential area loss of intertidal habitat, in combination with other losses elsewhere along the Solent frontages, would need to be factored in to the next round of Strategic Habitat Mitigation. Since The Strategy preferred option differs from SMP policy for this epoch it will also be necessary for this to be taken into account in the next revision of the SMP.

The loss of grazing marsh in front of the defence line would occur with or without The Strategy preferred option in place and therefore The Strategy would have **no adverse effect** on coastal grazing marsh, over and above that identified in the SMP.

* The calculations of water level differences and potential habitat losses were undertaken using the applicable Defra 2006 sea level rise allowances at the time. The EA 2011 sea level rise guidance has since been adopted and this guidance produces less relative sea level rise from 2060 to 2110 compared to Defra 2006 allowances. The potential changes presented here are therefore considered precautionary and 'upper end' estimates and the impacts are likely to be less significant under the new guidance .than presented here.

Therefore, in summary it can be concluded that The Strategy will have no adverse effect on the following designated sites:

- Solent and Southampton SPA;
- Solent and Southampton Ramsar;
- Solent Maritime SAC; and
- River Itchen SAC.

However, it is also concluded that a reinvestigation and analysis will be required for ODU 11 before the flood wall preferred option is implemented in that area.

13.3.7 *Cumulative and In-Combination Impacts*

The Habitats Regulations require that, in determining whether a plan or project is likely to have a significant effect on a European site, the plan or project should be considered both alone and in-combination with other plans or projects. However, given the uncertainties that exist about how and when The Strategy options will be implemented, it is recognised that this exercise is necessarily limited and that the assessment of in-combination effects will need to be revisited and addressed in a more comprehensive way at the project-level.

By way of guidance and direction to project-level HRAs, the potential sources of in-combination effects to The Strategy plan included the following relevant projects, plans and activities:

- The Test and Itchen Catchment Abstraction Management Strategy;
- River Itchen, Weston Shore, Netley & Hamble Coastal Technical Study;
- North Solent Shoreline Management Plan; and
- Port of Southampton Dredging Works.

The Test and Itchen Catchment Abstraction Management Strategy (CAMS) sets out how much water is available in the catchment and details the Environment Agency's policies and actions relating to the management of this water. It describes actions the Environment Agency will take to ratify its findings and work towards possible solutions. The CAMS could have an additional influence on water levels through existing and future abstraction licenses and discharge consents, which would need to be considered in more detail within a project level HRA.

The River Itchen, Weston Shore, Netley & Hamble Coastal study forms a continuous boundary with The Strategy along the River Itchen. The HRA for the River Itchen, Weston Shore, Netley & Hamble CDS study indicates that there will be no impact on the integrity of any European site, including the Solent and Southampton Water SPA and Ramsar site, the Solent Maritime SAC and the River Itchen SAC. It has been concluded that there will be no in-combination impacts on these designated sites.

This HRA for The Strategy has been considered within the wider context of the North Solent SMP. With the exception of Redbridge (ODU 11), preferred policies within the SMP are identical to the options within The Strategy. The adverse effects of the SMP on habitats will be compensated for within the Southern Regional Habitat Creation Programme. The Strategy preferred option at Redbridge may lead to a loss of intertidal habitat (mudflat and saltmarsh) over and above that identified within the SMP but not to the extent of significant adverse effect.

The Port of Southampton is proposing to undertake two major projects to ensure that the Port of Southampton remains competitive and successful as a major port into the future. The first of these projects is a capital dredge to improve the navigational accessibility to the Port of Southampton and involves selective deepening and widening of the navigation channel at various locations through Southampton Water and the Solent. The second proposal is to reconfigure and deepen part of the Western Docks fronting the container terminal at Berths 201 and 202 to enable the Port to accommodate the current generation of large container vessels at their loaded draught. Works are expected to commence on this project by July 2012 and the new berths should be operational by January 2014. The design of the proposed projects has been optimised with a view to avoiding and/or minimising environmental impacts where possible. EIAs for both projects have shown that in most cases the impacts will be either insignificant or minor and that, where larger adverse impacts are likely to occur, they can be mitigated such that the residual impacts will be reduced to acceptable levels. Impacts from these proposed projects are unlikely to add any additional pressures to the integrity of designated sites in combination with The Strategy preferred options. In fact, the dredging activities will increase the depth of the channel. The EIAs for both projects indicate that this will tend to marginally reduce HW levels in the Southampton Strategy area thus offsetting any potential effect attributable to The Strategy preferred options themselves.

It is acknowledged that wider issues may also cause additional pressures impacting on the integrity of European sites. These include pressures arising from new housing and recreational requirements expected over the next 20 years. These pressures are currently the subject of research by the Solent Forum. In addition, associated river and coastal infrastructure (moorings, slipways, and Sewage Treatment Works, etc) could lead to potential habitat and water quality effects. The in-combination impacts of these projects will need to be dealt with in more detail at a project level, where appropriate.

13.3.8 *Mitigation*

There is the opportunity for mitigation and environmental enhancement within the Redbridge scheme through topographical modifications of the frontage and associated grazing marsh in areas behind the railway line adjacent to ODU 11. The potential for any adverse effect on European designated features will be considered further as part of a future revision of The Strategy prior to 2060. At that point, if it is concluded that an adverse effect would in fact occur, the effect will either have to be avoided or a case for 'no alternatives' or IROPI be made to the Secretary of State and compensation secured. The potential loss of up to 0.2ha of intertidal habitat should therefore be factored in to the next round of Strategic Habitat Mitigation as this may need to be considered in combination with other losses elsewhere along the Solent frontages. This will also be investigated at a project level and if necessary appropriate mitigation measures will be identified.

Since The Strategy preferred option for ODU 11 differs from SMP policy for this epoch it will also be necessary for this to be taken into account in the next revision of the SMP.

14 STRATEGY IMPLEMENTATION

14.1 Strategy to schemes

A number of schemes have been identified in order to implement the preferred options within The Strategy. Before any scheme is implemented or constructed there are a number of steps required from The Strategy recommendations through to completion of the scheme (

Figure 14-1).

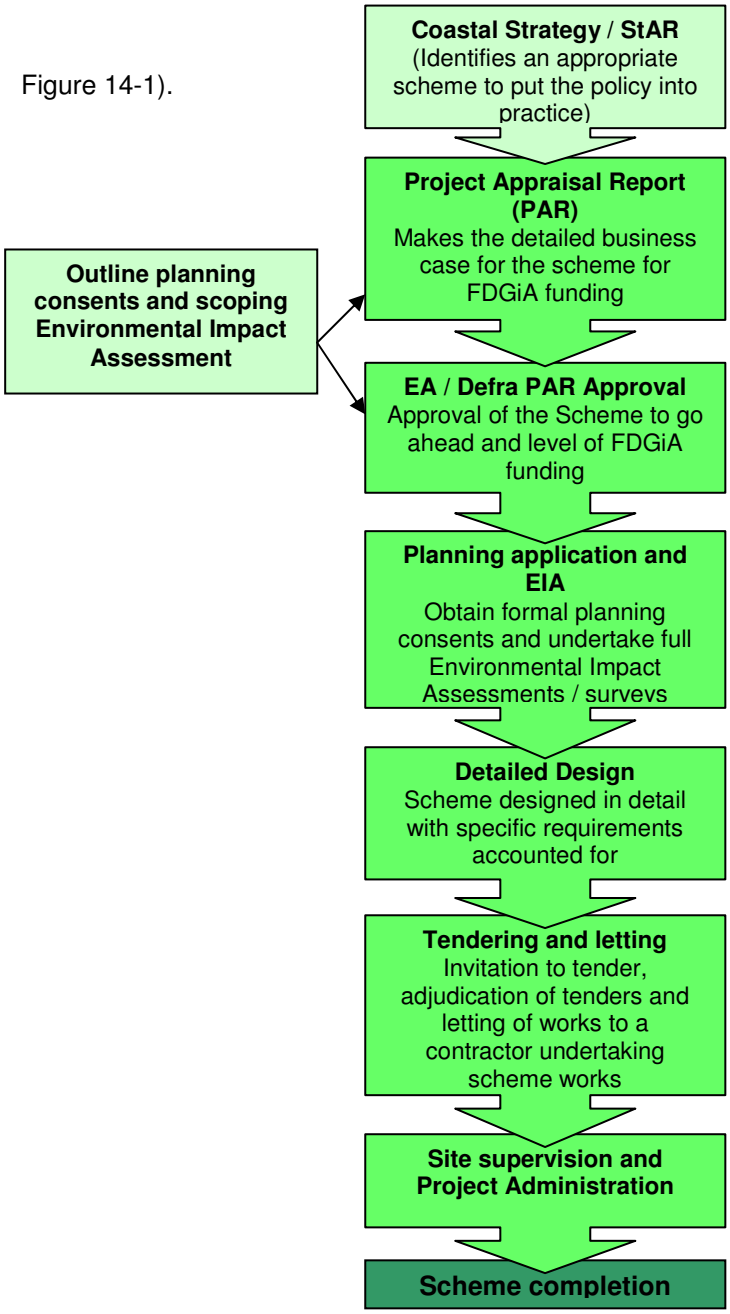


Figure 14-1. Flow chart of stages to achieve implementation of a scheme from The Strategy.

Once The Strategy (StAR) has been adopted by Southampton City Council and approved by the Environment Agency, and Defra,, a Project Appraisal Report (PAR) will need to be produced for each of the initial schemes required under The Strategy. A PAR makes the detailed business case for a specific scheme and this goes to the Environment Agency and Defra for consideration for FDGiA (Flood Defence Grant in Aid) funding and approval.

Initial Environmental Impact Assessments should normally be completed at the Scoping Stage to ensure that Environmental consents are in place through letters of comfort.

Following Environment Agency and Defra approval of the PAR, formal planning consent will be required along with the completion of relevant surveys. At this stage, completion of the Environmental Impact Assessment or Environmental Statement will be necessary and the relevant approvals sought.

Detailed design of the scheme is then undertaken. This phase produces detailed design drawings and refines and optimises specific aspects of the scheme such as, in the case of a floodwall, precise alignments and accounting for local scale features and issues. Once the detailed design is completed and approved, the contract will be tendered. Contractors will then submit tenders for the work and the work let to the successful contractor.

On commencement of the construction phase, site supervision and project administration will need to be in place to oversee the work for quality assurance and successful completion of the scheme.

14.2 The Strategy implementation timetable

The preferred options for each Option Development Unit have been discussed in Section 10.2. This Section discusses the implementation timetable for the required schemes and works. The timetable of works is summarised in Table 14-1.

14.2.1 *Short Term*

2015 Schemes

Priority works are required along the Itchen frontage from the railway line at Bevois Valley to The Itchen Bridge (ODU 3 to ODU 6) to provide flood protection to Northam, St Mary's, Town Depot and towards the City Centre.

A scheme will be required to implement a floodwall with a design crest height of 3.75mODN (includes 300mm freeboard)* along the frontage in ODUs 3, 4 and 5, as near to the front line as possible to maximise the area benefiting from the raised flood defences. Locally, if demands require, this floodwall may be aligned further inland where appropriate, especially if water resilient industries are present at the front line. The floodwall will provide the spine of flood defence along this frontage offering protection against flooding up to at least a 1:200 year event at 2060.

Where areas are currently earmarked and available for redevelopment (Meridian Studios and Town Depot) land levels in these areas should be raised to a level of 4.25mODN* (includes 300mm freeboard) to provide protection against flooding to a 1:200 year event at 2110. The raised strip of land should be at least 50m wide. These raised areas would need to tie into the floodwall to form a continuous flood defence.

In addition to the implementation of raised flood defences and land raising in ODU 3 to 6, a scheme will be required to implement flood resistance measures for approximately 70 properties at greatest immediate risk of tidal flooding along the Upper Itchen and St Denys (ODU 1). This scheme will require planned and coordinated effective community and resident by resident engagement as well as the use of drop in 'flood fairs' in the local area to roll out the scheme. This will include presentations to inform residents of the risk and to discuss the pros and cons of the property level measures to reduce the potential impacts of tidal flooding and manage the risks. There will also need to be community flood groups established and advice at hand to provide guidance and answer questions on implementation and the operational aspects of the property level flood resistance measures. Liaison with residents would also be required to roll out the scheme and implement the fitting of flood resistance measures. In addition a flood warning system should be established. The Environment Agency will need to take a lead in much of the above.

2015 – 2030 Schemes

During this period, as areas along the Itchen frontage (ODUs 3 – 5) become available, land will be raised as part of a co-ordinated and strategic plan so that by 2060 a continuous raised strip of land is achieved to supersede the flood wall as the main flood defence by this time.

* Design heights based on achieving at least a 1:200yr standard of protection until the end of the design life, adopting the EA 2011 sea level rise central change factor and surge allowances (based on UKCP09 medium emissions scenario 95%tile) and including 300mm freeboard to allow for uncertainty, settlement and small waves.

It is likely that there will be the opportunity for some of this area to be raised through redevelopment during this time period as part of this area to the east of Northam Bridge is already earmarked for potential redevelopment.

During this time there may be the opportunity to incorporate a raised strip of land as part of the redevelopment of the Major Development Quarter and the Royal Pier / Mayflower Park area which can later be tied into the flood walls around the boundary of ABP Port land.

Maintenance

In the short-term no scheduled maintenance would be undertaken, the major capital works refurbishment programme detailed in the previous section would be undertaken to ensure that the coastal defences remain in a good state of repair. Maintenance during the short-term would be limited to small works undertaken in response to specific individual issues along the frontage.

Privately funded maintenance of Ocean Village and Port defences should continue to ensure the integrity of the docks and quay walls to prevent erosion and maintain their flood defence function.

14.2.2 *Medium Term*

2030 Schemes

A scheme implementing a new steel sheet pile defence along the Bevois Valley frontage (ODU 2) will be required to provide at least a 1:200 year standard of protection until 2110. This defence will require a crest level of 4.25mODN* which would need to be typically 1m above existing levels. This defence would need to tie into the higher ground at the north of the unit and to the defence scheme in ODU 3 to the south.

Should the redevelopment of sites in ODU 9 not occur, or they fail to incorporate a raised strip of land acting as a flood defence through Mayflower Park, a floodwall with a crest height of 4.25mODN* will need to be constructed at the rear of the Park at 2030.

A scheme will also be required to implement flood resistance, and adaptation measures for approximately 30 properties at greatest risk of tidal flooding at Redbridge (ODU 11). In addition a further 130 properties in the Upper Itchen / St Denys (ODU1) will require property level protection at this time. These schemes will involve careful planning and co-ordination and will require effective community engagement and the use of drop in 'flood fairs' in the local area to roll out the scheme. This will include presentations to inform residents of the risk and discuss the pros and cons of the property level measures to reduce the potential impacts of tidal flooding and manage the risks. There will also need to be community flood groups established and advice at hand to provide guidance and answer questions on implementation and the operational aspects of the property level flood resistance and resilience measures. Liaison with residents will also be required to roll out the scheme and implement the fitting of flood resistance measures. In addition a flood warning system should be established. The Environment Agency will need to take a lead in much of the above.

* Design heights based on achieving at least a 1:200yr standard of protection until the end of the design life, adopting the EA 2011 sea level rise central change factor and surge allowances (based on UKCP09 medium emissions scenario 95%tile) and including 300mm freeboard to allow for uncertainty, settlement and small waves.

2030 - 2060 Schemes

In order to achieve a continuous strip of raised land of at least 50m width with a height of 4.25mODN* between ODU 3 and 5, sites not already raised, through redevelopment or otherwise, prior to this period would need to be raised by 2060 as part of a co-ordinated and strategic plan to provide a flood defence with at least a 1:200 year standard of protection until 2110. To achieve this it would typically require land to be raised by 1.2m - 1.5m.

Maintenance

In the medium-term scheduled maintenance would commence after the undertaking of the capital works. Scheduled maintenance reviews should assess the defences along the frontage to identify small areas of work where maintenance is necessary to continue the good condition of defences following the completion of the capital works. Again a prioritised approach to maintenance should be adopted. The scheduled maintenance reviews should be undertaken based on a 5 to 10 year cycle for the floodwalls and a 3 to 5 year cycle for homeowners with property levels flood defences. The differing intervals are necessary due to the structural life differences between the options.

14.2.3 *Long Term*

2060 Schemes

As sea levels rise, and the risk of tidal flooding increases significantly, a number of schemes will be required to implement floodwalls around the City to continue to provide a 1:200 year standard of protection against tidal flooding.

In the Upper Itchen and St Denys a scheme will be required to implement a floodwall near the front line to provide protection against tidal flooding up to a 1:200 year event at 2110. This would require a wall of typically 1.4 metres in height. The wall would ideally run close to the front line and would need community support to ensure a continuous defence is achieved so that there are no weak points where breaching of the defence could occur.

If the benefits to the community of raised flood defences are perceived to overwhelm the drawbacks, and the necessary non-public funding contributions could be obtained, a scheme to implement a floodwall defence could be delivered for this Unit before 2060.

A scheme to construct a floodwall with a crest height of 4.25mODN[†] will be required near the front line around Ocean Village (ODU 7) and along the Port boundary in ODU 8 at 2060. At Ocean Village this could be undertaken by raising existing quay walls or setting back slightly a landscaped flood retaining wall. At dock Gate 4 and the Eastern Docks the wall will need to tie into the floodwall or raised land in ODU 9.

In addition, with the assumption that ABP do not implement formal raised flood defences within the Port area, a scheme to implement a floodwall (typically 0.5m above existing ground levels) will be required around the Port boundary in ODU 10 to provide at least a 1:200 year standard of protection to areas behind the Port. The floodwall in ODU 10 will need to tie into the defences in Unit 9 to the east.

[†] Design heights based on achieving at least a 1:200yr standard of protection until the end of the design life, adopting the EA 2011 sea level rise central change factor and surge allowances (based on UKCP09 medium emissions scenario 95%tile) and including 300mm freeboard to allow for uncertainty, settlement and small waves.

The floodwall schemes will need to assess in detail the mechanisms and defence solutions for maintaining access, with ramping over the low flood walls the preferable technical solution, or using demountable defences or flood gates where ramping is not possible.

At Redbridge (ODU 11), a scheme to implement a floodwall will be required, utilising the existing infrastructure corridor of the railway line, to provide protection against tidal flooding up to a 1:200 year event at 2110. This will require a wall of typically 1.3 metres in height above existing ground levels.

If the benefits to the community of raised flood defences are perceived to overwhelm the drawbacks, and the necessary non-public funding contributions could be obtained, a floodwall defence could be delivered for this Unit before 2060.

Maintenance

In the long-term scheduled maintenance should continue to ensure that defences remain in good condition. Scheduled maintenance reviews should assess the defences along the frontage to identify small areas of work where maintenance is necessary to continue the good condition of defences. A prioritised approach to maintenance should be adopted. The scheduled maintenance reviews should be undertaken based on a 5 to 10 year cycle for floodwalls and an annual inspection for flood gates / demountables on access points.

Table 14-1. Implementation timetable for schemes resulting from The Strategy

Area	Upper Itchen / St Deny's	Bevois Valley	Meridian Studios	Northam	St Mary's Wharves	Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge
Unit	1	2	3	4	5	6	7	8	9	10	11
2015	Implement community and property level flood resistance / resillience / adaptation	Defended by existing structures	Implement floodwall defences and raising of land at former Meridian Studios site.	Implement floodwall defences	Implement floodwall defences	Raising of land through re-devleopment of Town Depot site	Defended by existing structures	Defended by existing structures	Defended by existing structures. Land raise where opportunities arise	Defended by existing structures	Defended by existing structures
2030		Implement Steel Sheet pile defences	Raise land as opportunities arise						Implement floodwall along rear of Mayflower Park / Port Boundary		Implement community and property level flood resistance / resillience / adaptation
2060	Implement floodwall near front line		Defended by a continuous strip of raised land	Defended by a continuous strip of raised land	Defended by a continuous strip of raised land		Implement floodwall along Port boundary and raising of quay walls	Implement floodwall along Port boundary		Implement floodwall along Port boundary	Implement floodwall along railway line
2110											

14.3 Strategy Funding

In order to implement The Strategy, funding for the various schemes will be required from different sources. An estimated funding Strategy has been developed (Figure 14-2). This has identified the indicative funding contributions required and includes a breakdown of the potential public FDGiA funding that may be acquired based on the economic assessments undertaken in Section 11.2, along with the potential funding required from other sources.

The economic assessments undertaken suggest the business case for attracting public FDGiA funding is strong for the priority scheme of implementing an intermediate height floodwall along the vulnerable frontages of the Itchen (Scheme A1, 2015). The raw outcome measure score of 152% for this floodwall indicates that this scheme should receive full FDGiA funding.

The raw outcome measure score of 163% for the 2015 implementation of resistance measures on the Upper Itchen (Scheme B1) also suggests full FDGiA funding.

It has been assumed that the raising of land option will be funded either via direct developer contributions or indirectly via a Community Infrastructure Levy (CIL). A CIL empowers local authorities to levy a new charge on most types of development and the levy is intended to provide new infrastructure, including transport, flood defences, schools, hospitals and other health and social care facilities, needed to support the development of an area.

An estimate of the relative potential breakdown of public / other contributions for future schemes has been provided in Figure 14-2 on the basis of the economic assessments undertaken, a 120% OM threshold and rationale used for the priority schemes; however, these future estimates are subject to future reviews and the public funding criteria used at the time.

Figure 14-2. Estimated funding Strategy and potential breakdown of contributions to implement the preferred options at 120% OM threshold.

	Area	Upper Itchen / St Denys	Bevois Valley	Meridian Studios	Northam	St Mary's Wharves	Crosshouse / Town Depot	Ocean Village	Eastern Docks / Dock Gate 4	Mayflower Park / Major Development Quarter	Western Docks	Redbridge	Total
	Option Development Unit	1	2	3	4	5	6	7	8	9	10	11	
2015	Scheme	Flood resistance scheme		Floodwall + Raised land	Floodwall	Floodwall	Land Raising						
	Total Cost	£300,000		£1,240,000	£1,730,000	£870,000	£2,300,000						
	FDGiA	£300,000		£420,000	£1,730,000	£870,000							£3,320,000
	Developer/ CIL			£820,000			£2,300,000						£3,120,000
2030	Scheme	Flood resistance scheme	Steel sheet pile defence		Land raising	Land raising				Floodwall		Flood resistance scheme	
	Cost	£520,000	£2,380,000		£5,200,000	£940,000				£890,000		£150,000	
	FDGiA	£420,000								£890,000		£100,000	£1,410,000
	Developer / CIL	£100,000	£2,380,000		£5,200,000	£940,000						£50,000	£8,670,000
2060	Scheme	Floodwall		Land raising	Land raising	Land raising		Floodwall	Floodwall along ABP boundary		Floodwall with access provisions	Floodwall along railway	
	Total Cost	£3,000,000		£820,000	£5,200,000	£940,000		£1,280,000	£1,510,000		£4,680,000	£1,080,000	
	FDGiA	£2,000,000						£800,000	£1,000,000		£3,000,000	£500,000	£7,300,000
	Developer / CIL	£1,000,000		£820,000	£5,200,000	£940,000		£480,000	£510,000		£1,680,000	£580,000	£11,210,000

14.4 Monitoring and data capture

Sea Level Rise

Predicting the rate of sea level rise and future extreme water levels is a complex science; the interaction of processes leading to increased relative sea levels is highly dynamic, and there are many possible scenarios and variables to consider. There is consequently unavoidable uncertainty and variation relating to sea level rise predictions and the envelope of uncertainty increases significantly the further into the future the prediction goes.

Data for monitoring the rate of sea level rise should continue to be collected and collated in order that analysis of the rate of sea level rise can be reviewed. In addition, data relating to extreme water level events (especially larger ones) that are observed in the future should be recorded and analysed in order to update extreme water level predictions and improve confidence in future predictions.

The rate of sea level rise will impact decisions made regarding the phasing of schemes and design heights of defences in order to provide protection against tidal flooding. This Strategy has developed options based on current water level estimates and these have also underpinned the phasing of the schemes. It is prudent to realise that given the uncertainty surrounding future predictions, allowance for future flexibility in terms of the phasing options should be made as further data is collected and water level predictions updated.

A consideration for the future is the potential to use water levels as triggers for the timing of the implementation of the various schemes identified in this Strategy. The extreme water levels relating to the requirement to implement the various Strategy options are given in Table 4-2 and Table 9-1. If monitoring shows mean water levels (and therefore extreme water levels) rise sooner or later than currently predicted, schemes may need to be brought forward or may be delayed as required.

Defence Condition Reviews

Formal defence condition reviews should be undertaken at regular intervals; these reviews should assess the condition of the defences and inform the capital works and schedule maintenance over The Strategy period.

Impact of other schemes and developments

Southampton Water and the city of Southampton is continually evolving and a number of future developments and programmes will be undertaken. For example the next capital dredge for the navigation channel will occur in 2012. The impacts of such events on the estuary wide coastal processes and morphology should be monitored and this data should feed into future Strategy reviews as there will be potential impacts to the baseline currently assessed in this study.

Environmental Monitoring

Monitoring of changes to environmental receptors and habitat designations should continue. Impacts of schemes and Strategy works should be quantified to inform future works and ensure significant adverse impacts do not occur. Monitoring of the quality and extent of habitats and impacts on receptors should be undertaken and the data collated and analysed as outlined in the Strategic Environmental Assessment (Appendix F) and Habitat Regulations Assessment (Appendix G). As and when contaminated land records and survey data are produced, this

information should be added to the knowledge base to further improve future understanding of the baseline.

15 HEALTH AND SAFETY CONSIDERATIONS

Under the Construction (Design and Management) Regulations 2007, it is a statutory requirement to consider Health and Safety issues in the design phase. The integration of H&S management into the design phase of a project ensures that decisions made at design stage can improve the health and safety on the construction site. It is necessary to identify and record the health and safety issues related to the various options. At the strategic level, options are not sufficiently defined to allow a comprehensive assessment of health and safety issues. However, an initial assessment of the general health and safety hazards can be undertaken.

15.1 Construction Hazards during Capital and Maintenance Works

Due to the nature of the site, any of the proposed works are potentially hazardous, involving work near water, exposed to waves and tides and close to unstable cliffs. The main generic hazards include the following:

Contaminated land

The desktop review of land quality records undertaken for this study identified a range of potentially contaminating land uses and sources across The Strategy frontage: the findings are presented and discussed in more detail in Appendix E.

The findings demonstrate that although contamination issues have been demonstrated in the historic records, any significant risks have been subsequently dealt with through the planning process. However, there are parts of the frontage where data gaps exist, and the map of potential contaminated land areas (Figure 3-2) shows that land containing potential contaminating sources remains within the study area.

It is evident that potentially contaminating sources could become exposed and linked to receptors if land use changes or scheme works introduced under the recommendations of The Strategy create pathways linking the sources to one or more receptors. The delivery and detail of the preferred Strategy options should therefore duly consider the potential contaminative risks using the 'source, pathway, receptor' model during the development of the Project Appraisal Report (PAR). Endeavours should be made to ensure defence alignments and construction methods do not cause risks to receptors from one or more potentially significant contaminative sources (e.g. former landfill areas).

It is apparent from the review of historic records that some of the developments and construction works required to deliver The Strategy will be on sites with potentially contaminating sources. Before any works are undertaken a review of existing land quality records for the sites should be carried out and relevant surveys undertaken to establish the current contamination potential as required. Any works required under The Strategy will require detailed site investigations, including borehole studies and gas monitoring studies to identify the risks from various sources to site workers, but also to ensure that flow paths linking the sources to receptors are not introduced as a result of the schemes.

Historically, remedial works have been a necessary requirement for many developments to deal with contaminants such as elevated methane and carbon dioxide gases. Should a contamination risk be identified, the steps outlined in Appendix E to deal with contaminated land should be followed including the use of appropriate remedial works. Such a process will also provide information to expand the existing database of land quality records held by

Southampton City Council, thereby also contributing towards achieving the aims and objectives of the Council's Inspection Strategy for contaminated land in the city.

Working close to the sea

Ensure that experienced marine contractor is used that is familiar with the particular risks associated with tidal working. Provide life saving apparatus where appropriate. Ensure that staff working on the beach have adequate communication and can summon assistance if required. Working on the foreshore anywhere within the study area will require careful consideration of access and retreat lines in relation to works and tides. Ensure that those working on the foreshore know tide times and levels.

Working during periods of severe weather

Avoid winter working if possible. Works to be suspended during inclement weather conditions and/or highly agitated seas. Use experienced marine contractors. Ensure plant and in particular personnel can egress from the foreshore during all workable tidal states to ensure they are not trapped.

Limited access to sites

Provide temporary access (ramps etc) where possible; otherwise ensure lifting equipment is adequately sized for weight and lifting radius.

Constructing new floodwalls and steel sheet piling

Ensure that suitable handling equipment and procedures are used for large concrete or sheet pile sections. Ensure tool operators use suitable apparel and PPE when cutting or trimming sections. If vibration tools are used to drive piles or excavating foundations then ensure suitable working limitations are enforced to avoid vibration injuries.

Managing debris

Temporary storage of debris should be fenced off from the Public. Ensure debris, life expired and ineffective fencing or other materials, which may cause a hazard, are removed from the foreshore / construction areas.

Working in publicly accessible areas

Banksmen, demarcation of working areas, restricted access, information signs, bespoke viewing areas. Restrict public access to areas where plant is working by physical means (e.g. fencing) and notices around the perimeter. Provide banksmen for all plant. Operation of speed limits on and off site. Use of appropriately trained and experienced personnel.

Utilities

The implementation of schemes within an urban environment with its many utilities will require co-ordination and liaison with key utilities to ensure the safe construction of options and avoidance of these critical assets during any works.

Traffic

Traffic re-routing and the relevant traffic safety precautions may need to be considered in order to maintain public and contractor safety when implementing the schemes.

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