Key:

Boundary of policy development zones

Features Identified in Present Day Flood Zone

Features that can be adapted

Features that must remain protected

Flood Zones
(1 in 1000 year water level)

- Present Day
- EPOCH 1 - 2025
- EPOCH 2 - 2055
- EPOCH 3 - 2105

Title:
Flood Risk

Project:
Essex and South Suffolk
Shoreline Management Plan

Client:
Environment Agency
Anglian Region

Date:
September 2010

Scale:
1:50,000 @ A3

Figure:

I:\9T4884\Technical_Data\T3_GIS\Projects\Working\Stage 2\2.5a Flood Risk\Figures

Figure 5-4 Flood Risk - Colne estuary and Mersea Island

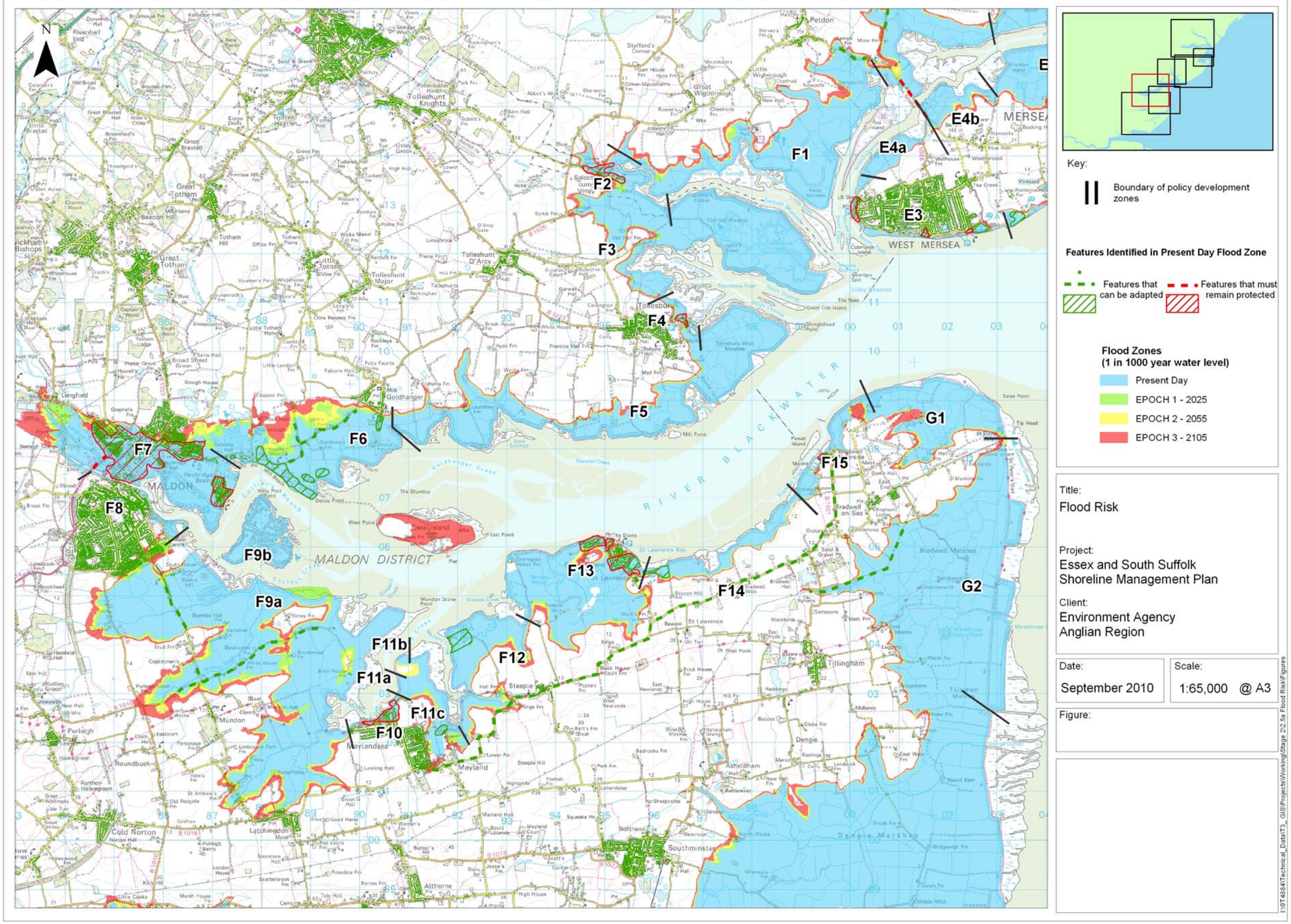


Figure 5-5 Flood Risk - Blackwater estuary

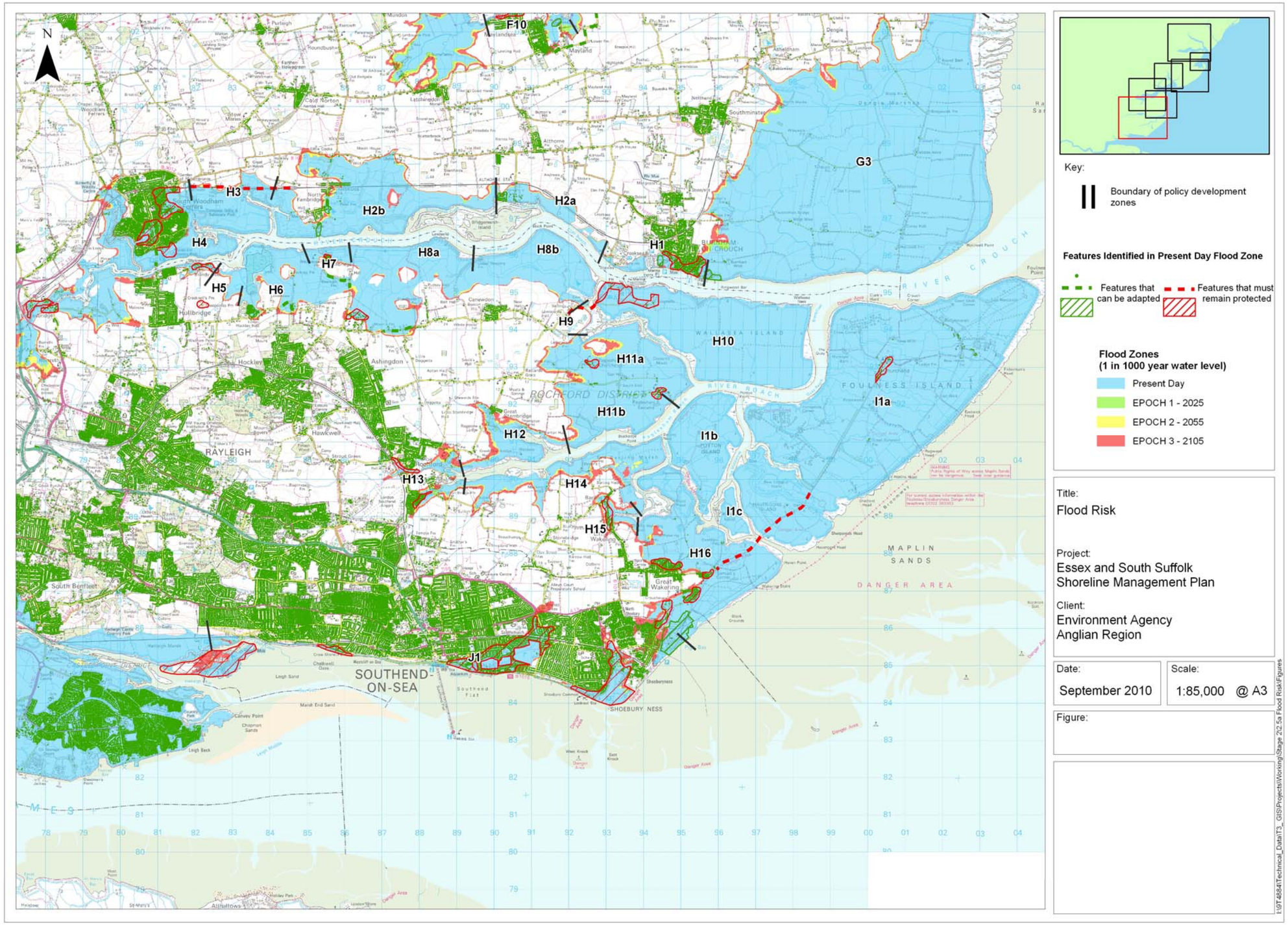


Figure 5-6 Flood Risk - Dengie peninsula

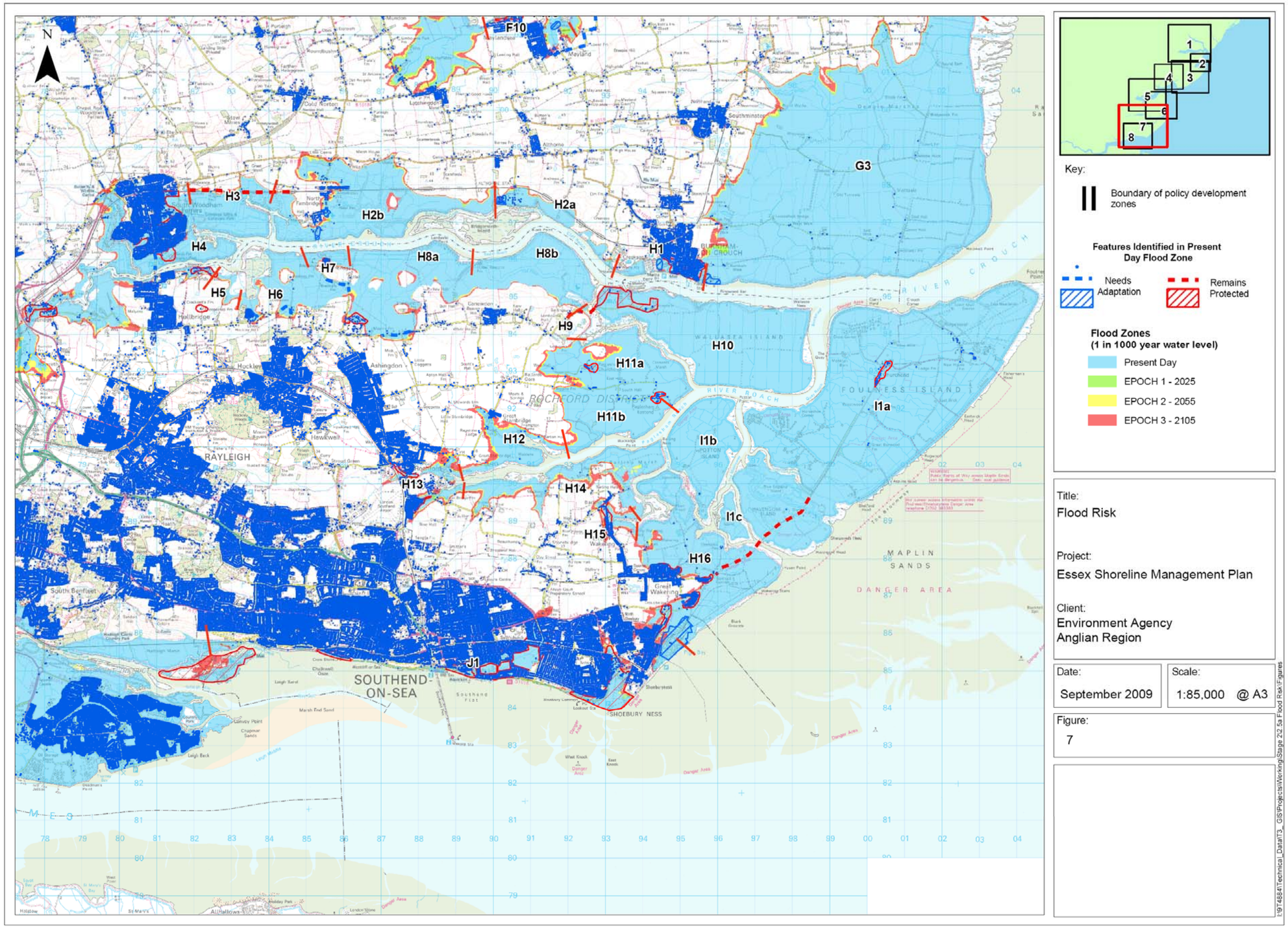


Figure 5-7 Flood Risk - Crouch and Roach, Foulness, Potton, Rushley and Southend

F6. EROSION RISK

F6.1 Introduction

The aim of this task is to identify the erosion risk along the Essex and South Suffolk SMP shoreline. This chapter will summarise the relevant frontage in terms of the features at risk at the end of each Epoch.

Within this task, there will be two activities, which are largely based upon the outcomes of the Assessment of Baseline Scenarios previously formulated for the SMP2 (Chapter F2):

- Derivation of assets at risk for the currently undefended frontages under a "NAI Intervention Scenario"; and
- Demonstration of the above through mapping the assets at risk.

The NAI scenario will discuss the assets at risk from erosion in relation to the 3 Epochs: Epoch 1 (Present day to 2025); Epoch 2 (2025 to 2055); and Epoch 3 (2055 to 2105).

The frontages under a Hold the Line policy (currently defended) are not included in the analysis of assets at risk from erosion as it is assumed that present management measures will ensure that the assets are suitably protected from erosion risk up to the end of Epoch 3 (i.e. 2105).

Erosion and flood risk are evaluated separately as different tasks. The combined impact of both risks is considered at policy appraisal level.

F6.2 Approach

F6.2.1 Overview

Using the outcomes of the Baseline Scenarios report (task 2.2), which provided the predicted future shoreline position at the end of the three epochs; the features at risk from erosion at the end of each Epoch could be identified.

The chapter sections below will outline the erosion rates per frontage per Epoch as well as the number of vulnerable features based on the National property data set. In addition, a brief overview of some of the most important vulnerable features will be provided. Results are presented in a series of maps based on each frontage.

It is important to stress here that the predicted future shoreline evolution put forward in the Baseline Scenarios report includes a degree of uncertainty, which increases into the later epochs. As this assessment of erosion risk is based upon these best estimates put forward in the Baseline Scenarios report, it will also carry a degree of uncertainty.

F6.3 Frontage A – Stour and Orwell

F6.3.1 Orwell Estuary

This frontage comprises the north and south banks of the Orwell Estuary, from Felixstowe Port and Shotley Marshes to Orwell Bridge. Erosion risk along this frontage is derived from the retreat of the cliff edge at the river banks. The Tables below identify the number of assets at risk.

Table F 6-1 Orwell North Bank

Epoch	Annual rate of erosion (m/yr)	Overall frontage movement	Basis for erosion rate	Number of assets affected
1	0.1	1.6	Stretches of unprotected bank, IECS (1993)	0
2	0.1	4.6		0
3	0.1	9.6		0

Features likely to be affected by erosion in the North Bank include the Orwell Park.

Table F 6-2 Orwell South Bank

Epoch	Annual rate of erosion (m/yr)	Overall frontage movement	Basis for erosion rate	Number of assets affected
1	0.2	3.2	Stretches of unprotected bank, IECS (1993)	0
2	0.2	9.2		1
3	0.2	19.2		30

Features at risk due to erosion comprise marinas, boat yards and other properties within the estuary including the Nacton Quay and Wolverstone Marina. Figure 6-1illustrates assets at risk for this frontage.

F6.3.2 Stour Estuary

This frontage comprises the north and south banks of the Stour estuary, from Shotley Gate to Harwich, with the tidal limit at Cattawade Bridge. Erosion risk along this frontage is derived from the retreat of the cliff edge at the river banks.

Table F 6-3 Stour Estuary

Epoch	Annual rate of erosion (m/yr)	Overall erosion over the epoch	Basis for erosion rate	Number of assets affected
1	0.5	8	Based on Jacques Bay erosion rate (Posford, 2002)	0
2	0.5	23		0
3	0.5	48		93

According to the erosion rates applied, features at risk due to erosion comprise marinas, piers, boat yards, railway, caravan parks, roads and properties including Shotley Pier, Shotley Caravan Park, Shotley Marina, Mistley Quay, and sections of the rail line at the southern bank of the Stour. Figure 6-2 illustrates assets at risk for this frontage.

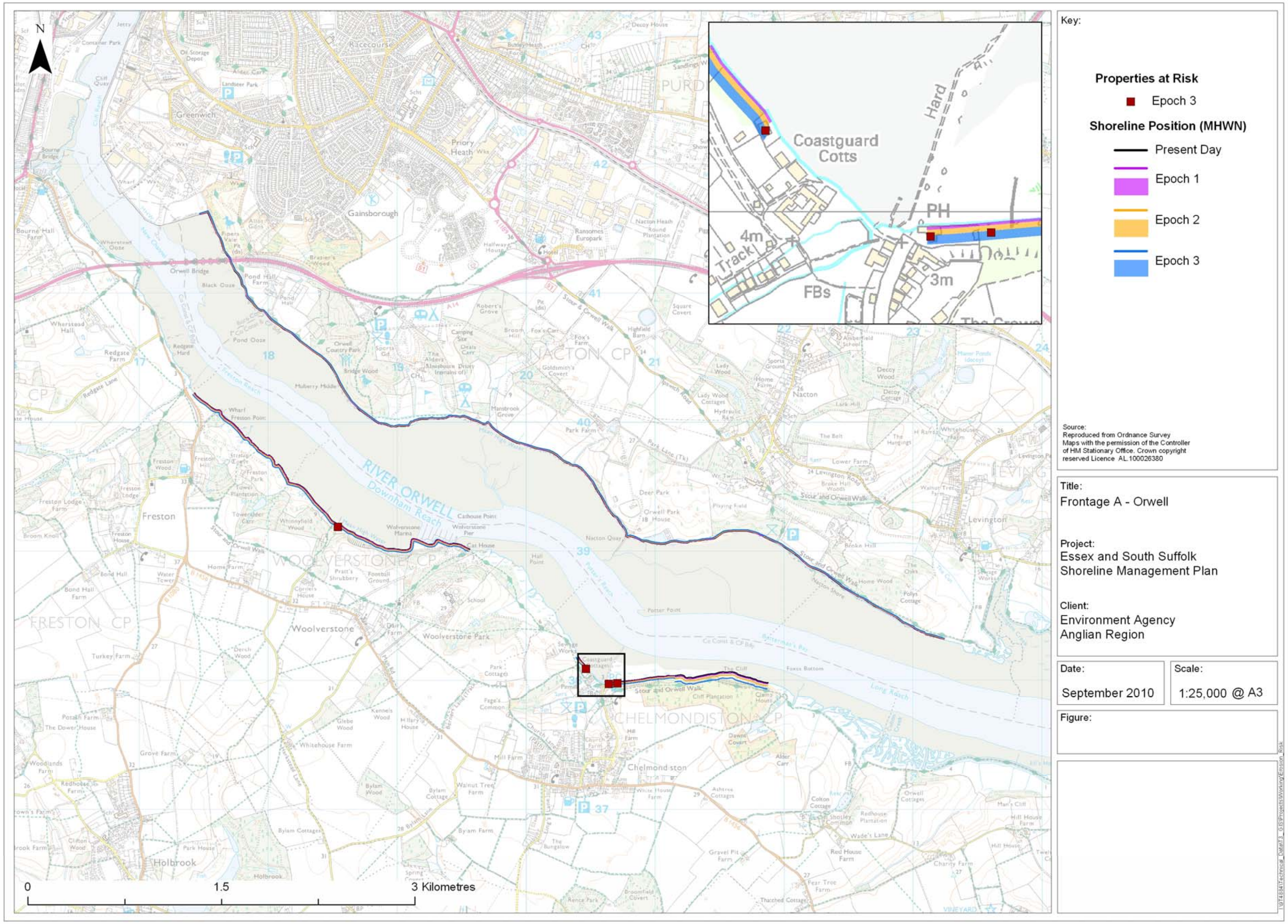


Figure 6-1 Erosion Risk – Orwell

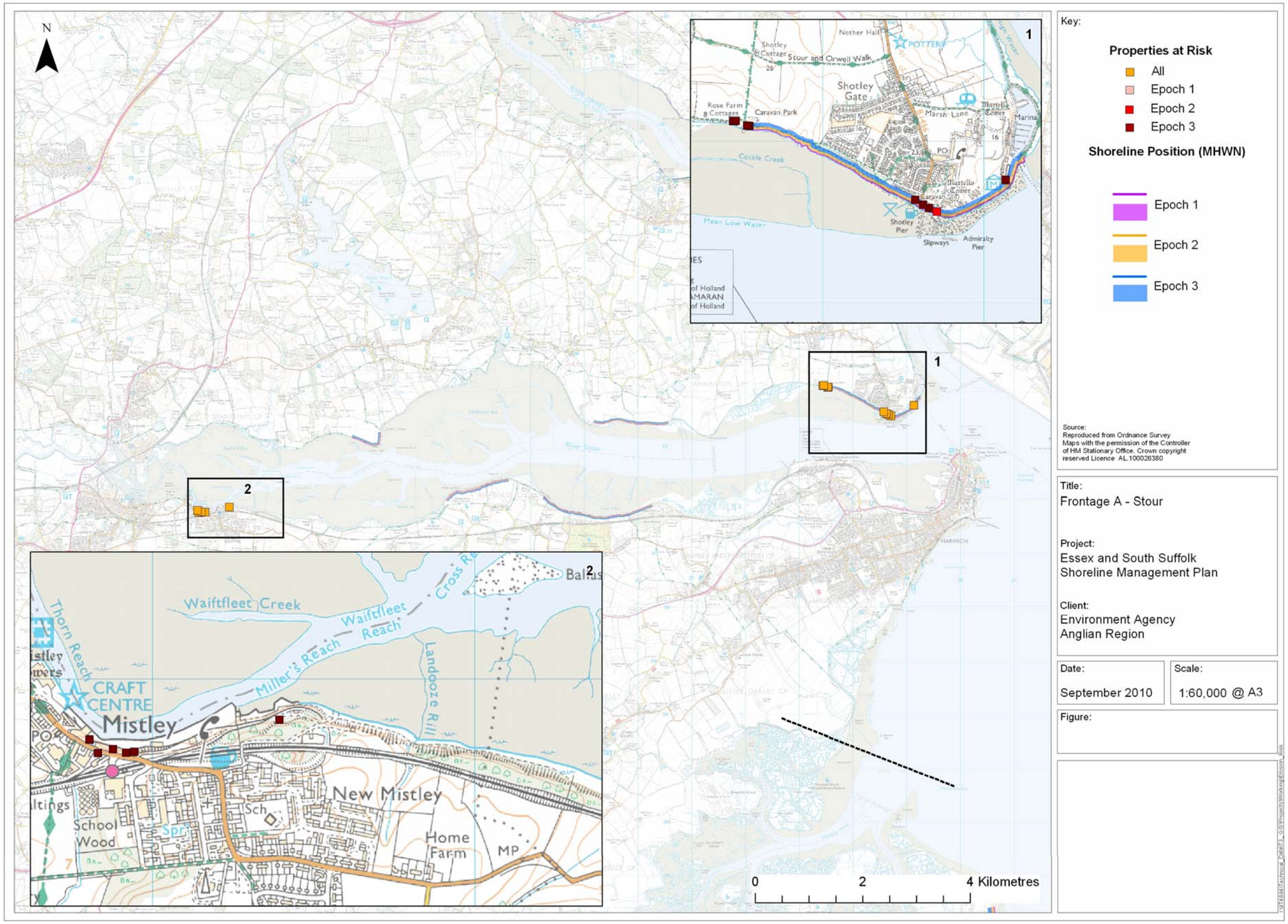


Figure 6-2 Erosion Risk - Stour

F6.4 Frontage B – Hamford Water

F6.4.1 The Naze

This frontage comprises the London clay and Red Crag cliffs of the Naze. Erosion risk along this frontage is derived from cliff retreat due to wave action and cliff instability.

Table F 6-4 The Naze

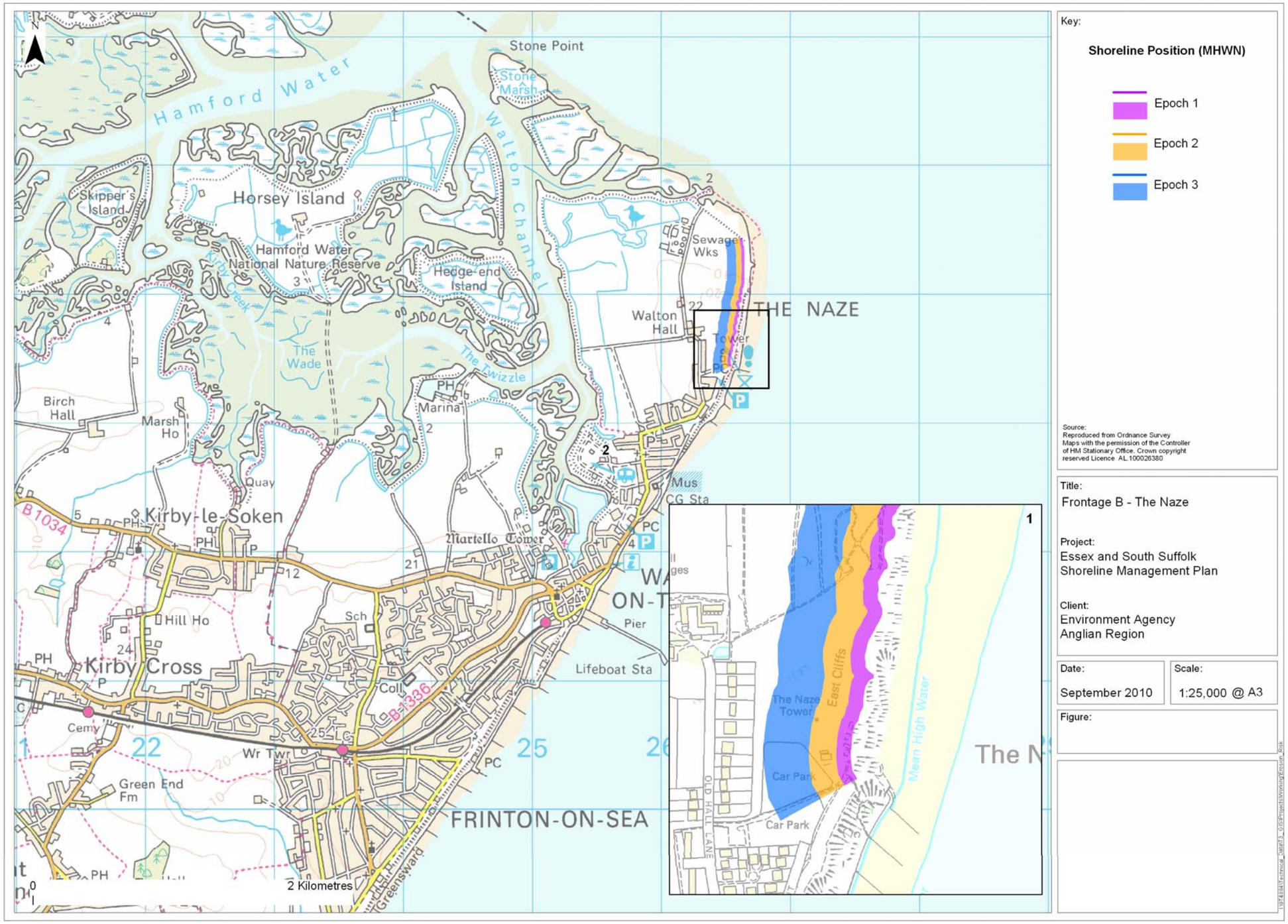
Epoch	Annual rate of erosion (m/yr)	Overall erosion over the epoch	Basis for erosion rate	Number of assets affected
1	1.4	22.6	Based on EA monitoring profiles (Coastal Trend Analysis, 2008)	1
2	1.4	64.9		1
3	1.4	135.4		1

According to the erosion rates applied, the Martello Tower is the most prominent feature likely to be affected by erosion. Figure 6-3 illustrates assets at risk for this frontage.

F6.5 Frontage D – Colne estuary

F6.5.1 Sandy Point

This frontage includes the undefended high ground area landwards of Sandy Point. Coastal processes risk maps indicate that there is no erosion within this frontage. Hence there is no reason to assume present day erosion or indeed erosion in future epochs.



Key:

Shoreline Position (MHWN)

- Epoch 1
- Epoch 2
- Epoch 3

Source:
Reproduced from Ordnance Survey Maps with the permission of the Controller of HM Stationary Office. Crown copyright reserved Licence AL.100026380

Title:
Frontage B - The Naze

Project:
Essex and South Suffolk Shoreline Management Plan

Client:
Environment Agency Anglian Region

Date:
September 2010

Scale:
1:25,000 @ A3

Figure:

Figure 6-3 Erosion Risk - the Naze

F6.6 Frontage E – Mersea Island

F6.6.1 Mersea Island

This frontage includes Mersea Island seaward facing frontages with undefended high ground. Coastal process risk maps indicate that there is accretion of intertidal areas along this frontage. Hence there is no reason to assume present day erosion or indeed erosion in future epochs.

F6.7 Conclusion

The analysis above indicates that there are a number of features at risk from coastal erosion for the NAI frontages.

Figures 1 to 4 of Appendix A, highlight both the location of assets at risk of erosion and the Epochs. These findings will be taken into account in policy appraisal in Stage 3 of the Essex and South Suffolk SMP2.

F7. ASSESS SHORELINE RESPONSE

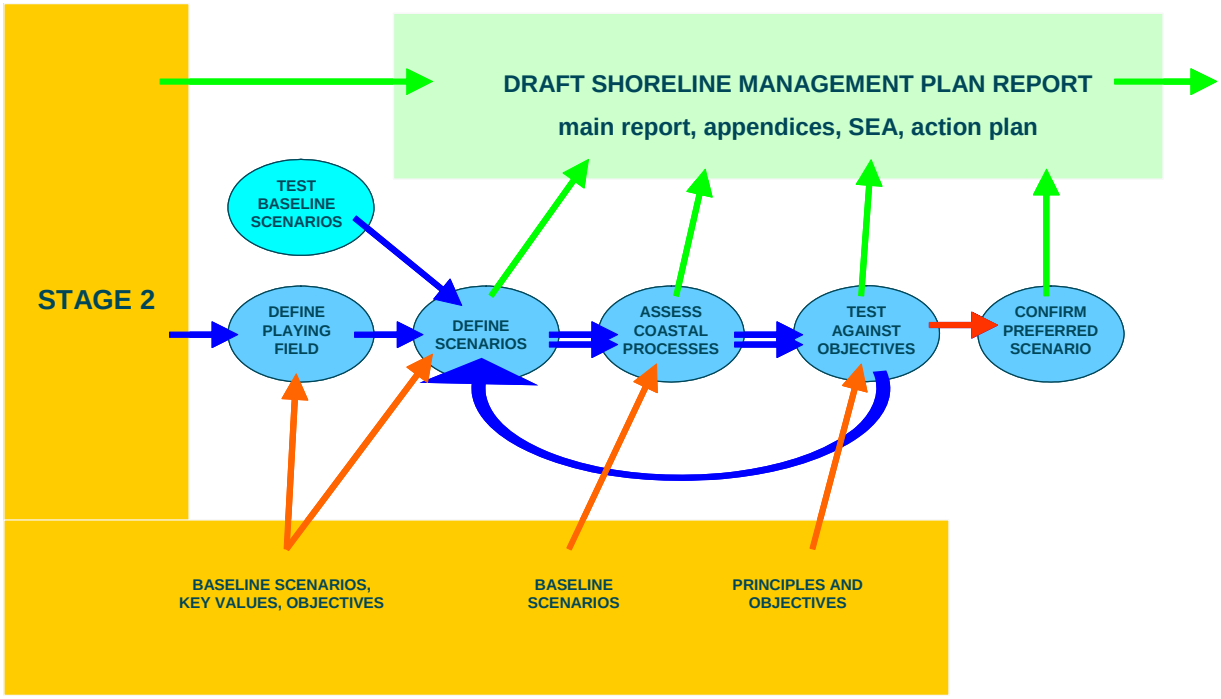
F7.1 Introduction

F7.1.1 Aim

The overall aim of the task (Task 3.2 as defined by the SMP Guidance) is to carry out an assessment of the shoreline interactions and responses to the Policy Packages. They formed an essential input into the appraisal itself. Figure F7-1 provides an overview of where this task sits within the policy development and appraisal process.

It is important to note that an iterative process of fine-tuning with respect to the Policy Packages was undertaken. With each 'cycle' of fine-tuning, the assessment of shoreline response was also updated and presented at the relevant CSG or EMF meeting. This Section will only report on the shoreline interactions and responses to the preferred policies in order to indentify and communicate the likely impacts of the implementation of the SMP policies

Figure F7-1 The Essex and South Suffolk SMP Policy Development and Appraisal Process



F7.2 Overall Shoreline Response and General Assumptions

F7.2.1 Background

The Essex and South Suffolk SMP covers the extent between Felixstowe Port and Two Tree Island, Southend. The entire frontage is intersected by a number of estuaries; The Stour and Orwell estuaries share a common mouth and are subsequently viewed as a single estuary complex to the north, with Hamford Water, a relatively wide-mouthed estuary embayment located

immediately to the south of the Stour and Orwell estuary system. The Colne and the Blackwater estuaries punctuate the central area of the SMP frontage and the Roach and the Crouch estuaries form a second estuary complex in the south of the SMP frontage.

The estuaries predominantly comprise muddy intertidal flats and saltmarsh, whilst the areas of open coast between them include a mixture of; muddy, shingle and sandy beaches and London Clay sea cliffs.

Overall, the coastline is predominantly low lying with the majority being protected by earth clay flood embankments with sea facing revetment works or sea walls with groynes.

F7.2.2 Coastal Response

Before describing the shoreline responses of each management unit it is beneficial to discuss the wider shoreline response of the whole SMP2 frontage. As a whole, the preferred policies for the Essex and South Suffolk SMP2 include “Hold the Line” for the majority of the shoreline; “No Active Intervention” policy for currently undefended high ground; “Advance the Line” for certain port development, particularly Felixstowe and Harwich; and “Managed Realignment” for flood areas in which defences are under pressure, flood areas without features of distinguishable importance, and eroding frontage where location intervention for protection of features may be required

Whilst HtL and AtL is used for protection and development of communities, infrastructure and socio-economic activities, NAI is applied to allow natural development of processes and MR is used to improve the sustainability of defences, development of natural processes and creation of intertidal habitat.

Section F7.3 of the chapter will review the impact of the preferred policies to the management units, specifically for those units with PDZs where there has been a change in management policies. The most significant change in management occurs for those PDZs where the present day HtL policy changes to MR in future epochs. The majority of MR areas are located within estuaries but there are a limited number of realignments considered for coastal frontages. When implemented, MR is likely to increase the tidal prism of the relevant estuary and promote the development of saltmarsh and mudflat. For those areas where the defences are currently under pressure; hydrodynamic pressure (waves, tidal flows, sea level rise), realignment would relieve the pressure and improve the ability of estuaries and coastal frontages to adapt to change in hydrodynamic pressures. Furthermore, creation of intertidal areas adds and improves the environmental significance of the existing shoreline. It should be noted that the development of intertidal areas is largely controlled by the topography.

The sediment dynamics, tidal flows and water level response to MR are highly dependent on the estuary, specific location within the estuary and the

size of the realignment in question. Modelling assessment and monitoring results from recent MR projects within Essex (Wallasea Island, Abbot's Hall and Deveraux Farm) indicate that at a estuary level there was no significant change in tidal flows (including flow speeds, direction of ebb and flood), water levels, sediment concentration or seabed erosion and accretion. At a local level changes within the realigned or neighbouring PDZs are likely to be more pronounced but for the recent project they have been localised, small and short lived.

For PDZs with an HtL policy present day processes are likely to remain unchanged. That will continue to be of concern for those PDZs with defences under pressure by coastal and estuarine processes; defences will remain under pressure and work against coastal processes, sustaining the defences will become increasingly difficult. For those PDZs with no pressure, sea level rise or increased wave action (expected effects of climate change) may or may not lead to increased pressure on the defences.

F7.2.3 Increased Rainfall and Storminess

Climate change impacts have been included in the shoreline response to coastal and estuarine processes. Sea level rise, increased tidal volumes and increased tidal flows are likely effects of climate change and constitute fundamental assumptions of the assessment of shoreline response. However, the potential impact on increased rainfall and storminess has been considered at neither PDZ nor management unit level.

For shingle and/or sandy frontages increased rainfall and storminess is likely to induce or increase beach retreat and changing of beach profiles. For estuaries and intertidal habitats, increased rainfall means potential increased freshwater input from river and outfalls, changes in fluvial sediment sources and changes in the viability of intertidal habitats vegetation.

F7.2.4 Recent Schemes

There are a number of managed realignment schemes that have been undertaken along the Essex and South Suffolk frontage. These include; a minor realignment undertaken at Trimley marshes on the Orwell estuary, several managed retreat sites established along the Blackwater estuary at Orplands, Abbotts Hall, Tollesbury and Northey Island, and a major realignment of the north-east section of Wallasea Island undertaken in the Crouch estuary. Further realignment has been proposed for the Wallasea Island.

F7.3 Management Unit level Shoreline response

F7.3.1 MU A: Stour and Orwell

The Stour and Orwell estuaries are viewed together as one management unit because the two rivers share a common mouth between Landguard Point and Harwich. The MU incorporates a number of centres of significant

populations, as well as the internationally important ports of Felixstowe and Harwich.

The Orwell estuary extends from Felixstowe to its tidal extent at Horseshoe Weir in Ipswich. Its upper reaches are constrained by a narrow, steep sided valley, although the northern banks are consistently steep, particularly at Fagbury Cliff and Sleighton Hill. Furthermore, high ground is located at Bourne Hill, Wolverstone and Collimore Point.

The Stour estuary is limited by a sluice at Cattawade and the channel is strongly influenced by its steeply rising banks. These cliffs consist of low boulder cliffs and are interspersed with fringes of saltmarsh and a total of seven shallow bays along its length. Steep land constrains the estuary at a number of locations including Sutton Ness, Wrabness, Harkshead Point, Erwarton and Parkeston.

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
A1	Felixstowe Port	AtL	HtL	HtL
A2	Trimley Marsh	HtL	MR2	HtL
A3a	Loom Pit Lake	NAI	NAI	NAI
A3b	Levington Creek	HtL	HtL	HtL
A4a	Northern Orwell east	MR	MR	MR
A4b	Northern Orwell west	NAI	NAI	NAI
A5	Ipswich	HtL	HtL	HtL
A6	The Strand	NAI	NAI	NAI
A7a	Southern Orwell west	NAI	NAI	NAI
A7b	Southern Orwell east	MR1	MR1	MR1
A8a	Shotley Marshes west	MR2	HtL	HtL
A8b	Shotley Marshes east	HtL	MR2	HtL
A8c	Shotley Gate	MR1	MR1	MR1
A9a,c,e,g ,l,k	Northern Stour – flood defence	HtL	HtL	HtL
A9b,f,h,j	Northern Stour – not erosional	NAI	NAI	NAI
A9d,g	Northern Stour – erosional	MR1	MR1	MR1
A10a,c,e, g	Southern Stour – flood defence	HtL	HtL	HtL

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
A10b,d	Southern Stour – not erosional	NAI	NAI	NAI
A10f,h	Southern Stour –erosional	MR1	MR1	MR1
A11	Harwich Harbour	AtL	HtL	HtL

Present Day processes

The Stour and Orwell estuary system is confined by geology and/or flood defences which limit the landward development of intertidal areas. The waves and tidal flows promote erosion of the seaward edge of the intertidal areas. The hydrodynamic pressures and erosion are particularly prominent at the mouth of the estuary which is highly exposed to the north-easterly waves and waves generated by shipping activity. There is erosion of London clay river banks in both estuaries.

Epoch 1

At epoch 1 the change in policy will occur at PDZs A8a, from HtL to MR, and PDZs A4a, A7b, A8a, A8c, A9c, A9e, A10d and A10f from NAI to MR. MR would create an intertidal area of approximately 75ha and it would relieve pressure on the currently constrained sections of the Orwell estuary, particularly PDZs A3 and A2 where the defences are under pressure. No other significant changes to the present day processes in the Orwell are expected. For the Stour undefended frontages with change in policy MR means limited local intervention with minimal impact on natural estuary development. Therefore the change in policy is not likely to cause significant changes to present day processes. Some small local reduction on sediment availability may occur. Impact of the preferred policies to the dredging activities remains uncertain. Impacts of the realignment of tidal flows, water levels or sediment dynamics are also not certain but they expected to be localised.

Epoch 2

At epoch 2 further realignment will take place at PDZs A8b and A2 creating approximately 265ha of intertidal areas across the constrained mouth of Orwell estuary. Those realignments would significant relieve the pressure at the mouth of the estuary and reduced the erosion at the mouth of the estuary. As sea level rises the Stour estuary will continue to undergo erosion or intertidal areas and river banks. Impact of the preferred policies to the dredging activities remains uncertain. Impacts of the realignment of tidal flows, water levels or sediment dynamics are also not certain but they are expected to be localised.

Epoch 3

No further changes in policy will take place. Giving the temporal scale (100 years) it is largely uncertain that the present day large scale processes will

continue. For the realignment PDZs and surrounding areas in the Orwell estuary there would be a reduction of overall erosion of intertidal habitats at the new created habitats and throughout the estuary. The high ground will remain a constraint for development of intertidal areas. As sea level rises the Stour estuary will continue to undergo erosion of the rivers banks and intertidal areas.

F7.3.2 MU B: Hamford water

Hamford Water is more commonly described as a tidal embayment, because of the very low fluvial input into its basin. Geologically, it rests on the London Clay bedrock which predominates in the region. It differs from the other Essex estuaries in that it used to be very short and very broad; today this is still true, with a total length of 7km and a total width of 2.1km, giving it the highest ratio of mouth width to estuary length, at 0.5. It is comprised of fine sediments, which have accumulated throughout the marine transgression of the Holocene.

In addition to the fine inner-estuary sediments, Hamford Water is flanked by two shingle spits, which are topped by sand dunes and shell banks. These are; Crabknowle, in the north, and Stone Point, which extends northwards from the Naze, on the southern lip of the embayment mouth. Cliff erosion at The Naze releases a lot of sediment which is predominantly transported north, where some of it is deposited on Stone Point spit, and extending Pye Sands, a bank which blocks and protects the mouth of the embayment.

The embayment and surrounding hinterland consists of: a total 2377ha, including: total 1570ha intertidal, comprising 621ha saltmarsh, and 949 mudflat; 807hha subtidal, and 67.7ha coastal grazing marsh. At 0.8, the embayment has one of the largest ratios of saltmarsh to mudflat. The hinterland area is generally low lying and has an absence of human development.

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
B1	South Dovercourt	HtL	HtL	HtL
B2	Little Oakley	HtL	MR2	HtL
B3	Oakley Creek to Kirby-le-Soken	HtL	HtL	HtL
B3a	Horsey Island	HtL	HtL	MR2
B4a	Kirby-le-Soken to Coles Creek	MR2	HtL	HtL

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
B4b	Coles Creek to the Martello Tower	HtL	HtL	HtL
B5	Walton Channel	HtL	HtL	MR2
B6a	Naze Cliffs north	NAI	NAI	NAI
B6b	Naze Cliffs south	MR1	MR1	MR1

Present Day processes

Hamford Water coastal processes are largely driven by north-easterly waves and winds leading to erosion along the frontages at the entrance of the estuary. Little Oakley is particularly exposed, which causes undermining of the defences. In the Walton channel undercutting of defences takes place due to hydrodynamic pressures (tidal flow and waves). The Naze constitutes an intermittent and decreasing sediment source. Erosion of intertidal areas takes place at the mouth of the estuary with accretion at inner creeks.

Epoch 1

The pressure from the north-easterly waves and winds is likely to increase leading to increased erosion at the entrance of the estuary. The defences under pressure at the present will continue to be undermined and erosion at the Naze will maintain the provision of some sediment to frontages to the south and north. Changing in policy takes place at B6b and the realignment project at B4a is likely to be finalised. Additional realignments may take place at B2 to compensate for the Bathside Bay Port development habitats loss.

Building of new defences at B6b for protection of the Naze tower is likely to limit the availability of sediment locally. On the other hand, the realignment at B4a (71 ha) is likely to reduce intertidal erosion in the areas surrounding the site. The impacts of the realignment of tidal flows, water levels or sediment dynamics are not certain but they are expected to be localised. If realignment of B2 takes place for habitat compensation of the Bathside Bay Port development, it would create more intertidal areas and reduce the pressure on the defences along that frontage. The new defences will be in a more sustainable position since the intertidal area fronting them will act as a buffer for the increased wave pressure from the north-easterly waves and winds. Realignment will reduce the need of beach recharge at B2.

Overall the shoreline position would remain largely the same with the exception of the limited section of the Naze (approximately 100m) and at B4a (Deveraux Farm).

Epoch 2

The processes described at epoch 1 are likely to continue. However change in policy will take place at PDZ B2 (if compensation for Bathside Bay Project does not go ahead at epoch 2). Realignment of the defences at B2 will create approximately 370 ha of new intertidal areas and reduce the pressure on the defences along that frontage. The new defences will be in a more sustainable position since the intertidal fronting them will act buffer for the increased wave pressure from the north-easterly waves and winds. Realignment will reduce the need of beach recharge at B2. The position of the shoreline would be altered at PDZ B2.

Epoch 3

Realignment at B3a and B5 will relieve the pressure on defences along the Walton channel and Horsey Island and reduce the need for maintenance. At B5 the new defences will be set at more sustainable position. The realignment would create approximately 170 ha of intertidal areas. MR will reduce the need for beach recharge at B3a. Accretion at the inner creeks may continue but it is uncertain if those rates will increase or reduce. Through the 3 epochs the position of the shoreline will be altered at PDZs B2, B3a, B5 and B4a.

F7.3.3 MU C: Tendring

The Tendring Peninsula has a general orientation of north-east to south-west. This open coast environment comprises a narrow sand/ shingle beaches (sediments originated from the quaternary) fronting sea defences. To the north of this unit, Walton-on-the-Naze, the shore is backed by the Naze soft cliffs (London Clay) of 15m (CHaMPS, 2003). From Frinton to Holland and from Jaywick to Colne Point the frontage comprises of low-lying reclaimed land. Clacton-on-Sea is situated on high ground which extends south westwards to Jaywick.

South of the Tendring Peninsula there are a series of depositional shingle beach ridges forming part of a spit complex, which extends for 2.5 km between Jaywick and Sandy Point, into the entrance of the River Colne (Scoping study, 2004). There is a small area of saltmarsh, designated Nature Reserve, to the west of Seawick which has been formed due to the protection of this spit complex, the Colne barrier.

Offshore, the seabed increases to depths of 12 metres CD in the Walton Channel, approximately 5.5km from the low water mark. To the west of Clacton, the offshore area is shallower as a result of the presence of the offshore banks associated with the Blackwater and Colne estuaries. The Tendring Peninsula functions as an independent geomorphological unit with little or no linkages with its adjacent estuaries (HR Wallingford, 2002) (Scoping study, 2004)

Final Policies

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
C1	Walton-on-the-Naze and Frinton-on-Sea	HtL	HtL	HtL
C2	Holland Haven	HtL	HtL	MR2/HtL
C3	Clacton-on-Sea	HtL	HtL	HtL
C4	Seawick, Jaywick and St Osyth Marsh	HtL	HtL	MR2/HtL

Present Day processes

Tendring is a beach frontage with a mixture of shingle and/or sand and muddy shores. Here the predominant process is loss of beach material due to its vulnerability to wave pressures (seawards) and landward constraints imposed by coastal and flood defences, set predominantly at the low water mark (including Clacton-on-Sea and Holland). The general orientation of the coast also plays a part in the vulnerability of the frontage and promotes the undermining of the defences. The sediment drifts in a North-South direction; however there is lack of sediment supply from the North. There is some accretion at Seawick and Leewick due to change in alignment of the coast and beach recharge takes place at Jaywick.

Epoch 1

Present day processes are likely to continue. There would be continued pressure on the defences as pressure from the north-easterly waves and winds increases. Sustaining the current alignment will become increasingly difficult. Beach recharge at the Jaywick will still be required and Colne bar will continue to accrete. Overall, the shoreline position would remain unchanged.

Epoch 2

The continuation of present day processes is much more uncertain but it is likely. There would be continued pressure on the defences as pressure from the north-easterly waves and winds are likely to increase. Sustaining the current alignment will become increasingly difficult. Beach recharge at the Jaywick frontage will still be required and Colne bar will continue to accrete. Overall, the shoreline position would remain unchanged.

Epoch 3 (with realignments)

There would be realignment of the PDZ C2 (190 hectares) and PDZ C4. Realignment at C2 would relieve the pressure on those defences and position them at a more sustainable location. It would create 190 hectares of new coastal intertidal areas and improve sediment availability downdrift. Realignment at C4 will be undertaken primarily for flood risk purposes. The

area potentially to be created as intertidal habitat remains uncertain. In addition, the realignment will favour sediment availability along Seawick and Jaywick. There is great uncertainty on the nature of the processes on C1 and C3 in epoch 3.

Epoch 3 (no realignments)
Since there are no changes to present day policies, there would be continued pressure on the defences as pressure from the north-easterly waves and winds are likely to increase. Sustaining the current alignment will become increasingly difficult. Overall, the behaviour of coastal processes remains largely uncertain throughout the MU.

F7.3.4 MU D: Colne

The Colne Estuary is situated south of Colchester and converges with the Blackwater estuary at Mersea Island between Sales Point and Colne Point. The estuary covers an area of 2,335 hectares and extends for approximately 14km; with a tidal extent ending at the Colne Barrier, located on the downstream side of Wivenhoe. The estuary is defined by steeply rising banks, particularly towards its head. It therefore has a long narrow floodplain with the exception of low lying land immediately to the north of Mersea Island and at Brightlingsea. This gives it a large proportion of saltmarsh in relation to its size. It is inferred that this underlying geological structure is partly responsible for the rising land around the Colne estuary which provides a constraint to the system. The geology consists of a Palaeozoic syncline, overlain by Tertiary (London Clays) and Quaternary sands and gravels (dissected sheets of Terrace Gravels) and glacial Till.The estuary has a narrow intertidal zone which is predominantly composed of flats of fine silt with mud-flat communities. The estuary has a relatively large proportion of saltmarsh

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
D1a	Stone Point	HtL	HtL	HtL
D1b	Point Clear to St Osyth Creek	HtL	MR2	HtL
D2	Along the southern bank of Flag Creek	HtL	HtL	MR2
D3	Flag Creek to northern bank to Brightlingsea	HtL	MR2	HtL
D4	Brightlingsea	HtL	HtL	HtL

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
D5	Westmarsh Point to where the frontage meets the B1029	HtL	MR2	HtL
D6a	South of Wivenhoe	HtL	HtL	HtL
D6b	B1029 to Wivenhoe	HtL	MR2	HtL
D7	Colne Barrier	HtL	HtL	HtL
D8a	Inner Colne west bank	HtL	MR2	HtL
D8b	Fingringhoe and Langenhoe	HtL	HtL	HtL
D8c	Langenhoehall Marsh	HtL	HtL	HtL

Present day

The Colne estuary system is confined by geology and/or flood defences which limit the landward development of intertidal areas. The hydrodynamic pressures (tidal flows and waves) and erosion are particularly prominent in the mid section of the estuary where the channel is widening. Hence the defences are under pressure. There is erosion throughout the main sections of the River Colne, Brightlingsea creek and Pyefleet Channel and accretion at the inner sections, including Geedon creek.

Epoch 1

There will be no change from current policies therefore present day processes are likely to continue including intertidal erosion and defence pressure along Brightlingsea creek, Pyefleet channel and the mid section of the Colne. Defences under pressure will continue to work against coastal processes and sustaining the defences will become increasingly difficult. Accretion at inner creeks is also likely to continue.

Epoch 2

At epoch 2 a change in policy will take place in PDZs D1b, D3, D5, D6b and D8a creating approximately 265 hectares of new intertidal areas and increasing tidal volumes within the estuary particularly in Brightlingsea creek. As defences are realigned pressure is reduced as the newly formed intertidal area will act as a natural defence and the new defences would be set in a more sustainable position. Erosion of existing intertidal areas is likely to be reduced and Spartina formation would continue at Stone Point and Colne Barrier. Continued accretion of inner creeks is uncertain.

Epoch 3

At epoch 3 a change in policy will take place in PDZ D2 creating approximately 50 hectares of new intertidal areas and increasing tidal volumes within the estuary. Giving the time scale (100 years) it is largely uncertain that the present day large scale processes will continue. For the realignment PDZs and surrounding areas there would be a reduction in overall erosion of existing intertidal areas.

F7.3.5 MU E: Mersea

Mersea Island is an isolated island of London Clay situated where the Blackwater and the Colne estuary converge. It is the largest of 4 Islands located within the Blackwater river and is an important control on the Blackwater estuary channel morphology. Cudmore Grove in East Mersea is of geological importance with exposures showing organic Pleistocene deposits which occupy one or more post-Anglian interglacial periods.

The Island is fringed to the north by a system of creeks, channels and saltings and to the south by an extensive foreshore of sandy beaches and mudflats. The seaward facing side also contains a long section of low cliff and steep natural slope with two localised areas of low-lying backshore. The foreshore comprises the Mersea Flats, a relatively wide area of mud and fine sand forming an inter-tidal flat. There is very little saltmarsh present along the foreshore (Mouchel, 1997).

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
E1	Landward Frontage	HtL	HtL	MR
E2	Seaward frontage between North Barn and West Mersea	HtL	MR2	HtL
E3	West Mersea	HtL	HtL	HtL
E4a	North Mersea (Strood Channel)	HtL	MR2	HtL
E4b	Pyefleet Inner Channel	HtL	HtL	HtL

Present day processes

The Mersea Island seaward facing frontage is exposed to the North Sea north easterly waves and winds leading to pressure on the defences. In addition, the foreshore facing this part of the island, Mersea Flats, has suffered significant historical losses. There is a west/east sediment divide.

The northern frontage of the island facing the Pyefleet and Strood channels is undergoing loss of saltmarsh. However there is sediment accretion at the heads of the channels.

Epoch 1
There will be no change from current policies therefore present day processes are likely to continue including erosion of muds and sands at Mersea flats and intertidal erosion along the Strood and Pyefleet channels. Defences at the seaward face of Mersea will continue to work against coastal processes and sustaining them will become increasingly difficult. These defences are exposed to the north easterly waves and wind hence, with likely increase of wave energy the defences sustainability is likely to deteriorate.

Epoch 2
Over epoch 2, realignment will take place at PDZs E2 and E4a creating approximately 90 hectares of new intertidal areas. Although pressure on defences and erosion of existing intertidal would be reduced along the Strood channel, given the exposure of the sea facing Mersea frontage, those defences would remain under pressure from the increased energy from the north-easterly waves. Intertidal erosion and pressure on the defences in the Pyefleet channel is likely to continue.

Epoch 3
Giving the timescale (up to 100 years) it is uncertain whether the present day large scale processes will continue. For the realignment PDZs and surrounding areas there would be a reduction in overall erosion of existing intertidal areas.

F7.3.6 MU F: Blackwater

The Blackwater estuary is situated between Sales Point and West Mersea and extends inland to Langford, a distance of 21km. The Blackwater estuary is the largest estuary in Essex north of the Thames, with a plan area of 5,184 hectares. A significant feature of the estuary is that it is wider landward than it is at its mouth owing to the geological constraints imposed by the Terrace Gravel geology at Bradwell and Mersea and flood defences. The mouth of the estuary is 3.5km wide between West Mersea and Sales Point. The estuary channel is particularly deep (<20m) and it is suggested that this channel may mark the mouth of the proto-Thames. To the west of Bradwell and again at Osea, the estuary widens. Osea and Northey Island are two major London Clay islands located within the estuaries tidal area. Mersea Island is also an isolated island of London Clay situated where the Blackwater and the Colne estuary converge.

The Blackwater has a range of habitat types including river channels, creeks, shingle and shell banks and saltmarsh. The Channel of the estuary is particularly deep with a substrate dominated by sand and gravel. The estuary contains one of the largest areas of saltmarsh in Essex (694 hectares) which is subject to high levels of erosion. The estuary also comprises of 2,631 hectares of mudflats and 1869ha of subtidal areas (CHaMP, 2002).

Final Policies

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
F1	Strood to Salcott-cum Virley	HtL	HtL	HtL
F2	Salcott Creek	HtL	HtL	HtL
F3	South bank of the Salcott Channel to Tollesbury Fleet	HtL	HtL	MR2
F4	Tollesbury	HtL	HtL	HtL
F5	Tollesbury Wick Marshes to Goldhanger	HtL	HtL	MR2
F6	Goldhanger to Heybridge	HtL	HtL	HtL
F7	Heybridge Basin	HtL	HtL	HtL
F8	Maldon Inner estuary	HtL	HtL	HtL
F9a	South and Maldon	HtL	HtL	HtL
F9b	Northey Island	HtL	HtL	HtL
F10	Maylandsea	HtL	HtL	HtL
F11a,b	Mayland Creek	NAI	NAI	NAI
F11c	Mayland Creek east	HtL	HtL	HtL
F12	Steeple	HtL	HtL	MR2
F13	St. Lawrence	HtL	HtL	HtL
F14	St. Lawrence to Bradwell-on-Sea	HtL	MR2	HtL
F15	Bradwell Creek	HtL	HtL	HtL

Present day processes

The mouth of estuary is under significant pressure from north-easterly waves and estuary processes. Effectively, the estuary at this section is trying to widen. The widening of the estuary is constrained by the geology and flood defences. The north bank is the section of the estuary most affected by waves whilst at the mid estuary the south bank is pressurised by estuary processes. Overall, at this frontage there is erosion of saltmarsh at outer and mid sections of the estuary and siltation at inner creeks and the inner estuary. Jet skis and boat wash may encourage further erosion. At some locations overtopping is an issue. Foreshore recharge to prevent overtopping has taken place in the past at the seaward face of the Old Marshes. At Mundon Creek and Mayland Creek there is hydrodynamic pressure on the defences due to widening of meanders.

Epoch 1
No changes to policy will take place hence shoreline position will remain unchanged. Present day processes are likely to continue throughout the estuary. Due to predicted increase in wave activity, pressure on defences at the mouth of the estuary is also likely to increase.

Epoch 2
Changes in policy are limited to PDZ F14 where approximately 40 hectares of intertidal areas would be created. At this location pressure on the defences would be reduced and erosion of existing intertidal areas is also likely to be reduced. The degree to which present day processes will continue is uncertain.

Epoch 3
In epoch 3, a change in policy takes place at PDZs F3, F5 and F12 creating approximately 660 hectares of new intertidal areas. The MR would reduce the pressure and erosion of existing intertidal areas at Salcott Channel, Tollesbury Wick and Mayland creek. Giving the time scale (100 years) it is largely uncertain that the present day large scale processes will continue.

F7.3.7 MU G: Dengie

This coastal unit has a north-south orientation and is characterised by an extensive low lying intertidal area with 2,790 hectares of mudflats and upper salt marsh covering approximately 427 hectares. The low water mark at the Dengie flats can extend between 1.5 and 3km offshore. Further offshore, the frontage is protected by the complex system of offshore sands of Buxey and Gunfleet on a north-east to south-west orientation and relatively deeper pockets to the north.

This low wave energy environment forms a rare example of an open coast marsh. The protected land is lower than the saltmarshes on the seaward side of the embankments.

There are chenier features near Sales Point. The Dengie and Bradwell marshes north of the River Crouch are much dissected by small creeks but form a single compact area since reclamation.

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
G1	Bradwell-on-Sea	HtL	HtL	HtL
G2	Bradwell Marshes	HtL	HtL	HtL
G3	Dengie Marshes	HtL	HtL	HtL

Present day processes
The Dengie Peninsula comprises extensive low lying areas of intertidal flats. The Dengie Flats and Ray Sands are currently undergoing accretion of the foreshore with vulnerable parts at Sales Point and Holliwell Point. Majority of defences are not under pressure by coastal processes apart from the pressure point mentioned, where the extent of foreshore is also limited.

Epoch 1
No changes to policy take place, hence present day processes are likely to continue and shoreline position will remain unchanged. Defences at Sales Point and Holliwell will remain under pressure and work against coastal processes. Sustaining them will become increasingly difficult. At these pressure points, intertidal areas will continue to erode. Due to the overall accretional tendency of the frontage, there is likely to be an increase in intertidal areas.

Epoch 2
No changes to policy will take place hence shoreline position will remain unchanged. However, the degree to which those processes will continue remains uncertain.

Epoch 3
No further changes in policy will take place and shoreline position will remain unchanged. Giving the time scale (100 years) it is largely uncertain that the present day large scale processes will continue.

F7.3.8 MU H: Crouch & Roach

The river Roach runs in a north easterly direction from Rochford joining with the river Crouch at Wallasea, the Island is bounded by the estuaries. Anthropogenic interference in the area has resulted in the combination of the Crouch and Roach estuary into a single tidal morpho-dynamic system. The Crouch estuary is tidal to Battlesbridge and the Roach to Rochford.

The geological structure and physiological features of the estuaries classify them as coastal plain estuaries as they deepen and widen towards their mouth. Although the relief produced by the Eocene and quaternary rocks is subdued, rising only to around 40 metres ODN, it has nevertheless played an important part in constraining the coastal landform development, limiting the transgression of Holocene deposits both on the open coast and in the estuaries. The estuary floors have a large width to depth ratio and have been infilled with post-glacial sediments sourced by deposits trapped in the southern North sea (CHaMP, 2002).

As for the other Essex and South Suffolk estuaries, the Roach and Crouch are currently wider and narrower than their predicted equilibrium form, which means that average depths are increased, but the overall cross section is decreased; resulting in bank erosion and undercutting of defences and intertidal areas.

Final Policies

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 – 2105
H1	Burnham on Crouch	HtL	HtL	HtL
H2a	From Burnham on Crouch to Bridgemarsh	HtL	MR2	HtL
H2b	Bridgemarsh to North Fambridge	HtL	HtL	MR
H3	North Fambridge and South Woodham Ferrers	HtL	HtL	HtL
H4	South Woodham, Battlesbridge and Hullbridge	HtL	HtL	HtL
H5	Eastwards of Brandy Hole	HtL	HtL	HtL
H6	Landward of Brandy Hole Reach	HtL	HtL	HtL
H7	South Fambridge	HtL	HtL	HtL
H8a	South bank of Longpole, Shortpole and Raypitts Reaches (Canewdon West)	HtL	HtL	HtL
H8b	Canewdon	HtL	MR2	HtL
H9	Paglesham Creek	NAI	NAI	NAI
H10	Wallasea	MR2	HtL	HtL
H11a	Paglesham Churchend	HtL	MR2	HtL
H11b	Paglesham Eastend	HtL	MR2	HtL
H12	Stambridge	HtL	HtL	HtL
H13	Rochford	HtL	HtL	HtL
H14	Barling Marsh	HtL	HtL	HtL
H15	Little Wakering	HtL	HtL	HtL
H16	Great Wakering	HtL	HtL	HtL

Present day processes

The Crouch and Roach is a very canalised and constrained system, perhaps the most constrained system in Essex. Due to this confined character of the estuary there is very little room for development of intertidal areas in the estuary and the defences are being strongly undermined as the tidal volumes increase. The mid section of the Crouch estuary (Bridgemarsh and Cliff Reach) is particularly under hydrodynamic pressure. There will be increased strain if there are no changes to the mid section of the Crouch. At both the Crouch and Roach there is an overall loss of saltmarsh, with some accretion at inner estuaries and creeks. At the Roach, boat wash may encourage further erosion to H2, H5 and H8.

Epoch 1

The project for managed realignment at Wallasea Island has been approved and it is likely to be undertaken throughout epoch 1. Once completed, the proposed realignment for Wallasea has the potential to create approximately 450 hectares of new intertidal area and reduce the hydrodynamic pressure and erosion of intertidal areas along Roach and the outer section of the Crouch estuary. The Wallasea realignment project has assessed the likely impacts of the realignment on tidal flows, navigation and sediment transport and results indicate that the impacts are likely to have no significant adverse impacts. No further changes in policy will take place, hence present day processes are likely to continue and the shoreline position on the other frontages will remain unchanged.

Epoch 2

At epoch 2, a change in policy from HtL to MR will take place at PDZs H2a, H8b, H11a and H11b creating approximately 600 hectares of new intertidal areas. The realignment would relieve the pressure on defences along Cliff Reach and Easter Reach within the Crouch and Paglesham Pool and Paglesham Reach, and reduce the erosion of intertidal areas in those sections. The impact of realignment on navigation, tidal flows and sediment transport is uncertain but it is likely to be localised. No further changes in policy will take place, hence the shoreline position on the other frontages will remain unchanged. Continuation of present day processes is largely uncertain.

Epoch 3

At this epoch realignment will take place at PDZs H2b and I1c and create approximately 340 hectares of new intertidal habitats and reduce the pressure on defences along The Middleway (Roach) and mid-Crouch. The impact of realignment on navigation, tidal flows and sediment transport is uncertain but it is likely to be localised. Giving the temporal scale (100 years) it is largely uncertain that the present day large scale processes will continue.

F7.3.9 MU I: Foulness, Potton and Rushley

This frontage has a north-east to south-west orientation. To the north, this open coast environment comprises extensive intertidal low-lying areas of mudflats, including 8850ha in Maplin Sands, which can extended up to 6km offshore. The saltmarshes, up to 87ha, are principally located behind a Chenier ridge between Northern Corner and Foulness Point and therefore sheltered. At Shoebury, southern end, the coast comprises clay sea cliffs fronted by mud and fine sand foreshore or sand and shingle. Offshore, lays the main entrance to the Thames Estuary with a channel up to 20m deep. The development of Potton and Rushley is linked with the development of the Roach estuary, detailed at section F7.3.8. Foulness, Potton and Rushley island are areas owned by the Ministry of Defence.

Final Policies

Policy Development Zone		Policy Plan		
		Now - 2025	2025 - 2055	2055 - 2105
I1a	Foulness	HtL	HtL	HtL
I1b	Potton	HtL	HtL	HtL
I1c	Rushley	HtL	HtL	MR2

Present day processes
The Foulness eastern frontages comprise tidal flats, with extensive areas of mudflat. This frontage is very exposed and under pressure due to waves and processes. The northern and the western frontages of Foulness are governed by the Crouch and Roach estuarine processes detailed above. A considerable length of the Foulness defence line within those estuaries is being strongly undermined due to increase in tidal volumes. Potton and Rushley Island, considered as PDZs of this management unit, are also within the Crouch and Roach system and the defences are also being undermined.

Epoch 1
No Change in policy takes place hence present day processes are likely to continue, increasing the the pressure on defences.

Epoch 2
No Change in policy takes place hence present day processes are likely to continue, including pressure on defences. The degree to which those processes will continue remains uncertain.

Epoch 3
Managed realignment at Rushley will enable creation of intertidal habitat and relief of hydrodynamic pressure along the Roach. The impact of realignment on navigation and sediment transport is largely uncertain but is likely to be localised.

F7.3.10 MU J: Southend

The north Shoebury to Southend-on-Sea shoreline has an east to west orientation and is located at the left bank of the eastern end of the Thames Estuary close to its mouth. The frontage is composed of London Clay sea cliffs which constitutes the areas of higher ground. The cliffs are fronted by a predominantly mud and fine sand foreshore (intertidal flats); however, there is some coarse sand and shingle trapped within the groyne compartments along the eastern Southend-on-Sea frontage and Shoebury. Beyond the Southend Flats, depths in the Thames Estuary reach up to 17m.

Final Policies

Policy Development Zone		**Policy Plan**		
		Now - 2025	**2025 - 2055**	**2055 - 2105**
J1	Southend on Sea	HtL	HtL	HtL

F7.3.11 Present day processes

Southend is a narrow beach frontage with a mixture of shingle, sand and muddy shores. Here the predominant process is loss of beach material due to tidal pressures and lack of sediment availability, partly due to cliff protection. Regular beach recharge is required. The sand and mudflats landward of the defences have variable accretion and erosion rates at specific locations but are overall stable.

Epoch 1
Since there are no changes to present day policies, the shoreline position within the MU will remain the same. However, rates of beach erosion may increase. In order to maintain current shoreline position management practices may have to be intensified to counteract the changing dynamics. Tidal flats are likely to remain stable.

Epoch 2
The development observed in Epoch 1 is expected to remain the same. Further increase of beach erosion rates is likely to occur due to the increase in wave energy. However, the actual magnitude of increase remains uncertain. The stability of tidal flats is largely uncertain.

Epoch 3
Since there are no changes to present day policies, the shoreline position within the MU will remain the same. The behaviour of coastal processes remains largely uncertain.