F4.7 Blackwater

F4.7.1 General description

The Blackwater estuary is the largest in Essex north of the Thames at 21km long and extends into south Langford, near Maldon. It is situated between Sales Point and West Mersea and covers a total area of 5184ha. The River Blackwater is sourced at Wimbish in Essex, from here it flows southeast past Braintree, then flows south past Witham, forming part of the border between Braintree DC and Colchester BC. It continues south until it converges with the River Chelmer at Beeleigh to the west of Maldon. From here, it flows east as an estuarine system into the North Sea. It converges with the Colne estuary at Mersea Island. The Blackwater estuary is a valuable and popular recreation and tourism resource. Its popularity with visitors and a wide range of recreational users leads to some conflict. There are 8 conservation areas, of which 3 are located immediately adjacent to the coast. The Blackwater estuary is defined as a coastal plain type estuary that is enclosed by a shingle spit. The estuary is an exception to typical estuarine morphology, with a wider landward cross section than seaward. This is predominantly owing to the geology of the area and its quaternary history, which results in constrictions at Bradwell and Mersea. The estuary has two major London Clay islands (Osea and Northey) located within its tidal area and has an over-deepened channel at its mouth. The depth of the channel can also be attributed to the channel constriction which leads to increased scour and hindered deposition.

F4.7.2 Key estuarine processes and issues

The most significant wave action occurs in the outer reaches of the Blackwater estuary. This is because offshore banks shelter the coastline from direct wave action and intertidal flats play a significant role in attenuating incoming wave energy before it reaches the shoreline of Mersea Island and Dengie. The chenier ridges near Sales Point further limit wave penetration onto the upper marsh surface, as a result waves suffer a considerable loss of energy. Modelling of the estuary has shown that wave heights of 1.2m can propagate upstream as far as Mill Point, beyond this waves are more limited by the shallower morphology and locally generated waves become more dominant.

The Blackwater estuary is macro-tidal with a tidal range of 5.2-5.8m. The estuary is ebb dominant and this results in a net export of material from the mouth of the estuary. However, some of the sediment is still carried up the estuary by the flood tide and is deposited in the wider and shallower reaches if the upper estuary beyond Osea Island. The constriction in width at the mouth leads to bed scour so that deposition has not taken place and the channel remains extremely deep here.

F4.7.3 Zones of erosion and accretion

The estuary morphology has been significantly modified owing to the effects of climate change. The lower intertidal mudflats have experienced recession along with the upper mudflats and saltmarsh. Coastal squeeze is a significant issue in the area and is exacerbated by issues of foreshore steepening and loss of wave attenuation leading to increased erosion. The saltmarsh in this estuary has not developed as extensively as the surrounding Essex estuaries. This is owing to a process of natural coastal squeeze where the geology has constrained and limited the transgression of the saltmarsh. The geological constraints of the islands of Osea and Northey and the valley sides at Steeple and Mundon have caused the estuary to subdivide resulting in a greater proportion of saltmarsh to mudflat.

F4.7.4 Opportunities

The Blackwater estuary is a complex system with the adjacent Colne estuary and the Dengie Peninsula. The Blackwater has a range of habitat types including river channels, creeks, shingle and shell banks, saltmarsh and the Islands of Osea and Northey. The Blackwater channel is particularly deep with sand and gravel substrate which supports a distinct local population of spring Herring. The mudflats and fringing saltmarshes support internationally important numbers of over wintering waterfowl. The estuary contains one of the largest areas of saltmarsh (684ha) in Essex which is subject to high levels of erosion.

F4.8 Dengie

F4.8.1 General description

The Dengie Peninsula is located between the outer Blackwater in the North and the River Crouch in the South. Dengie is characterised by extensive inter-tidal mudflats bounded landwards by a continuous flood embankment which protects extensive reclaimed marshland. The Dengie Peninsula has a north-south alignment.

F4.8.2 Key coastal processes and issues

Waves are dominantly derived from the north east and sediment is transported southward.

F4.8.3 Zones of erosion and accretion

Evidence from the Environment Agency profiles on the Dengie marshes demonstrates vertical accretion of the central Dengie Marshes. At both the Northern and Southern edge of the Dengie Peninsula, erosion is taking place. This conforms to pressure on the estuary mouths of both the Blackwater around Sales Point and the Crouch at Holliwell Point.

F4.8.4 Opportunities

It is likely that intertidal mudflats along the Dengie shoreline will respond in different ways to sea-level rise, depending on the presence or absence of salt marsh at the upper shore.

F4.9 Roach and Crouch

F4.9.1 General description

The Crouch and the Roach estuaries drain into the Outer Thames Estuary between two extensive areas of reclaimed marshes; the Dengie Peninsula to the north and the islands of Foulness, Potton and Wallasea to the south. The river Roach runs in a north easterly direction from Rochford, joining with the river Crouch at Wallasea Ness (some 5km upstream from the mouth of the estuary). Owing to the human impacts in the area, the Crouch and Roach estuary are considered as a single tidal morpho-dynamic system which covers a total area of 2754ha. The lower Crouch and the Roach estuaries are largely undeveloped with the exception of farming and military establishments at Foulness and Havengore and the Baltic terminal at Wallasea to the south. The area is used extensively for yachting, dingy sailing, water skiing and motor cruising. The banks of the Crouch and Roach consist of highly productive agricultural land, which provide a significant contribution to the area's economy. The Roach and Crouch are extremely confined and defences are being undermined due to increased hydrodynamic pressure.

The Crouch estuary extends 24km to its tidal extent at Battlesbridge and the Roach is 14km in length to its tidal extent in Rochford; it has numerous tributary creeks along its length. The estuaries are classified as coastal plain estuaries as they deepen and widen at their mouth. Most of the intertidal areas of the estuaries have been reclaimed (11600ha) which has resulted in deep, narrow channels with thin intertidal areas. The reclamation has also resulted in a change in the outer sub-tidal channels.

F4.9.2 Key estuarine processes and issues

The Crouch estuary has a macro tidal spring tidal range of 5.7m at Burnham, decreasing inland towards North Fambridge where the maximum range is 5.5m. The shape of the channel results in the flood tide being more dominant than the ebb tide, this leads to a trend for net sediment accumulation at the mouth of the estuary.

F4.9.3 Zones of erosion and accretion

Erosion is experienced along the Wallasea Island reach but accretion continues further up the estuary. This pattern corresponds with the channel variation within the estuaries and reflects the estuaries attempt to gain equilibrium; eroding where the channel is too narrow and accreting where the channel is too wide. This pattern of erosion and accretion supports the 'rollover' model for sea level rise and suggests that the sediment budget is in balance.

However, the inhibition of the channel width due to the presence of continuous flood embankments along the estuary means that any deposition that occurs as a result of flood asymmetry, leads to a decrease in the channel dimension, an increase in velocity and erosion of deposited material. Consequently the estuaries are experiencing an artificial balance owing to the constraints of the flood defences. As tidal velocities increase, erosion will become a dominant feature of the estuary channel, placing considerable stress on existing flood defences. Although the present sediment budget in the Roach/Crouch appears to be balanced the ultimate sources of sediment are unclear, this may have a significant impact in the future, when increased sediment loads will be required to counter sea level rise.

F4.9.4 Opportunities

Estuarine processes and the rising sea-levels are placing added pressure on the defences. There are several regions of freshwater habitat that may potentially require protection from saline intrusion.

The response of the estuary to sea level rise is to create a wider, shallower channel; however this response is prevented by the presence of flood embankments. The narrow channels mean that sea level rise will result in a rapid increase in flow velocities and tidal amplitudes, therefore increasing the stresses on the toe of the flood embankments and the probability of overtopping.

Maximum increase in channel width occurs at the mouth and totals 60m over the 50 year period. The combination of a wider channel required to achieve equilibrium with present day sea level rise would mean a total increase of 321ha in the channel area of the Crouch. This widening process would involve the erosion of saltmarsh where it existed and therefore in theory, all of the existing saltmarsh area of 308ha would be lost over the next 50 years. Although a wider channel would help to speed the increased tidal energy over a wider area, the enlarged creek system would allow higher wave energy to propagate inland.

The main problems facing the Crouch and the Roach estuary in the future are summarized below:

- Increased flood risk (if defences are not maintained to a suitable standard of protection) owing to undercutting of defences.
- Increased losses of intertidal habitats by coastal squeeze (if defences are maintained and no managed realignment is undertaken).
- Increased erosion as greater wave energy is enabled to propagate into the estuary owing to mouth widening.

F4.10 Southend-on-Sea

F4.10.1 General description

North Shoebury to Southend-on-Sea is an area of extensive urban development and a major centre of tourism, leisure and recreation. Other commercial activities include fisheries and transport (Thames Estuary Port). There are also areas of conservation. This frontage 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 high 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. Beyound the Southend Flats, depths in the Thames Estuary reach up to 17m. This frontage is currently defended to a standard of 1:10,000 for flood protection by 4.3km of vertical high walls mainly from brick and masonry or concrete. In addition, the there are groynes which provide coastal protection. Recharging of the beach to the east of Southend as far as Thorpe Esplanade in 2002 has created a new beach at the Southend-on-Sea.

The coastal area between Shoeburyness to Leigh-on-Sea is characterised by sea cliffs, comprised of London Clay, intersected by lowland in two areas. The cliffs are fronted by a foreshore dominated by mud and fine sand. There is some coarse sand and shingle trapped within groyne compartments along the eastern Southend-on-Sea frontage. The Southend Flats and the Chapman Sands fronting Leigh on Sea continue the wide inter-tidal area westwards into the Thames estuary. However, the inter-tidal flats fronting Canvey Island and those to its west are narrow and discontinuous. The outer Thames flats are characterised by sediment with high sand content due to the winnowing action of waves that propagate into the outer estuary from the North Sea but sediment grain sizes are fine markedly towards Canvey Point and to its west. Saltmarshes are more likely to occur to the west of this coastal unit hence, outside of the study boundary.

Consequently the tidal flats in Southend are likely to act as a sink of sediment suspended within the Thames Estuary and the offshore banks act as sources. Transport of those sediments is likely to take place due to tidal movement and wave action. Beach erosion and development of tidal flats (mud and sands) are the dominant processes. However, beach erosion is not evident on trends analysis due to the influence of beach recharge.

F4.10.2 Key coastal processes and issues

The extensive offshore bank and channel system located to the east of Southend protects much of the estuary from the long period southern North Sea storm waves. Wave activity in the Thames Estuary west of these banks is generated by locally wind-generated waves at this location. Wind generated 1 in 100 year wave height can reach 1.3 to 1.5 m. During the Holocene, as sea level rose, sands and gravels were transported landwards into the estuarine channels and built linear, sub-tidal banks. It has been postulated that these banks form a principal control of (some of) the estuaries. Finer materials have been removed from the coarse deposits by tidal- and wave-driven transport and have been deposited further landward in the inner estuary channels.

F4.10.3 Zones of erosion and accretion

The predominant process at this frontage is the beach erosion which is largely counteracted by beach recharge and coastal protection. The supply of suspended sediment is critical to the development of the coastal plains.

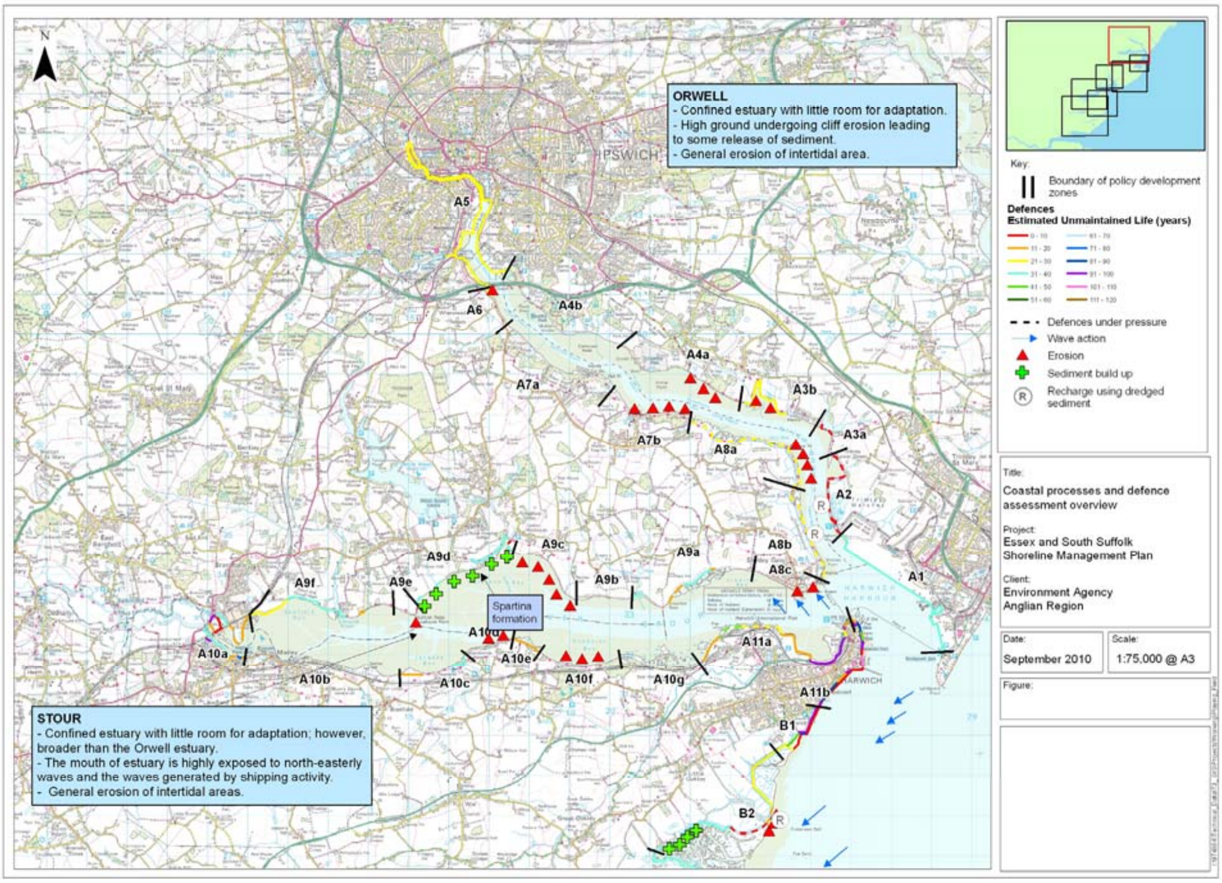

Figure 4-1 Coastal processes and defence assessment overview - Stour and Orwell

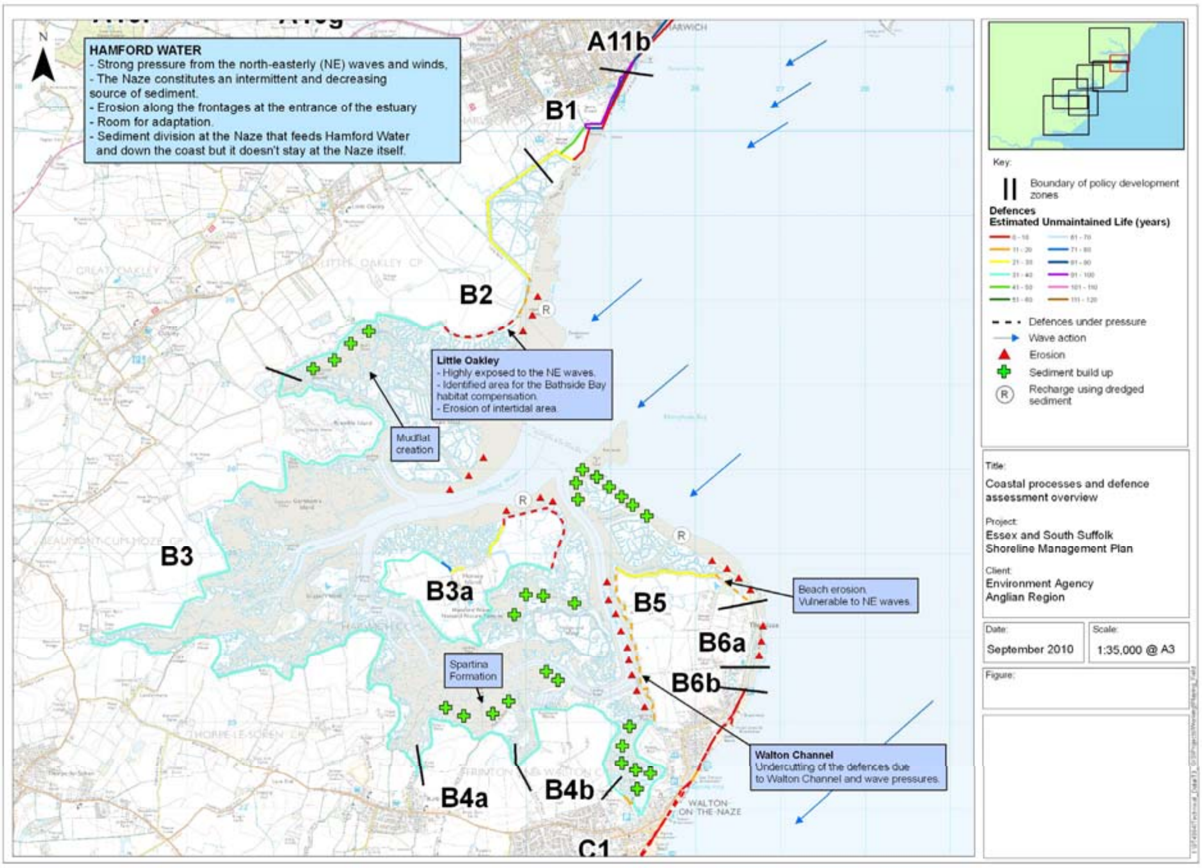

Figure 4.2 Coastal processes and defence assessment overview - Hamford Water

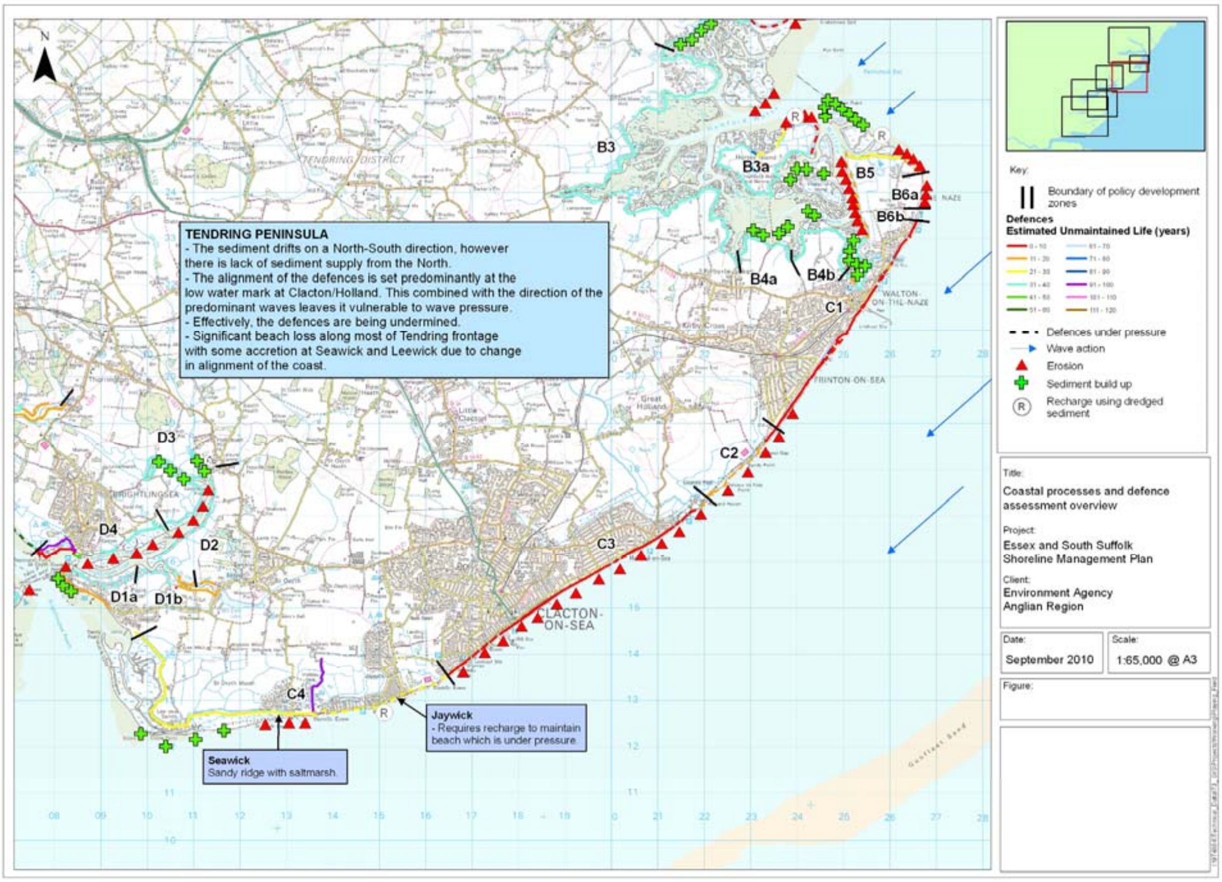

Figure 4-3 Coastal processes and defence assessment overview - Tendring

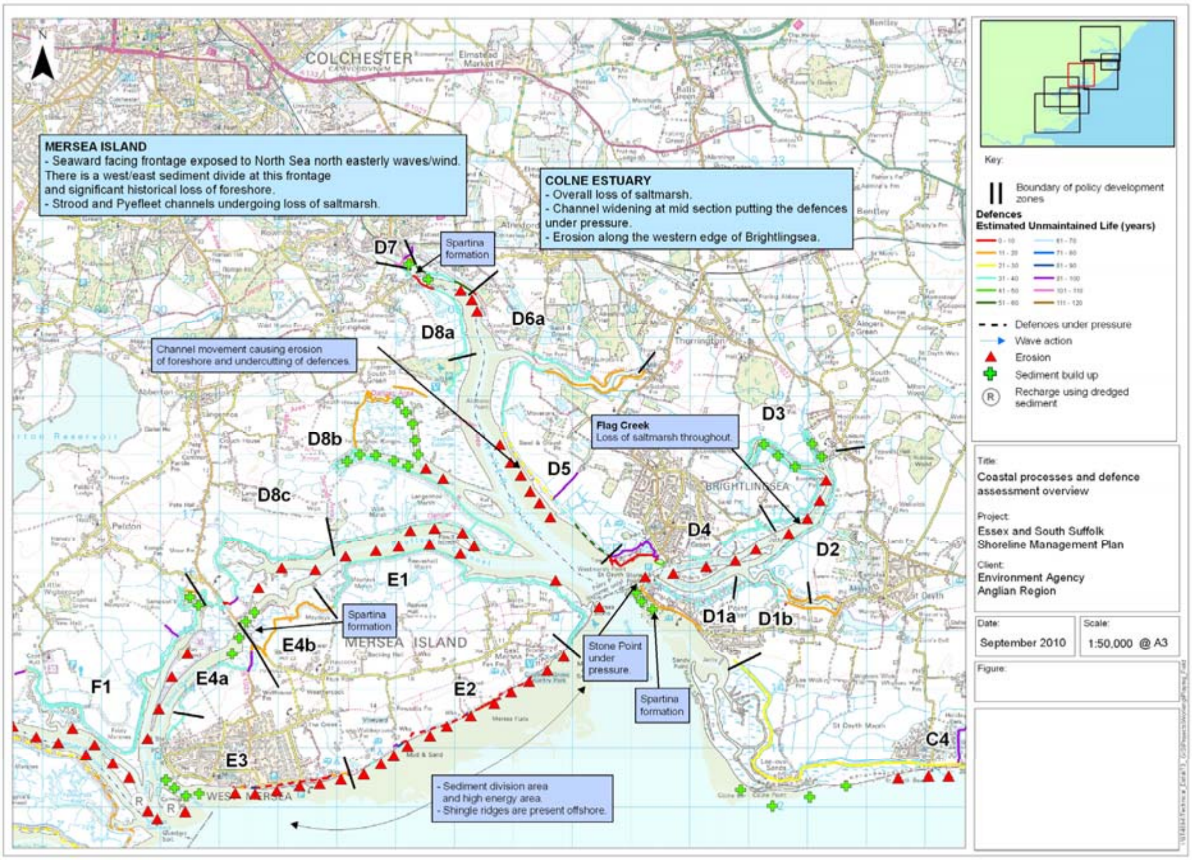

Figure 4-4 Coastal processes and defence assessment overview - the Colne and Mersea Island

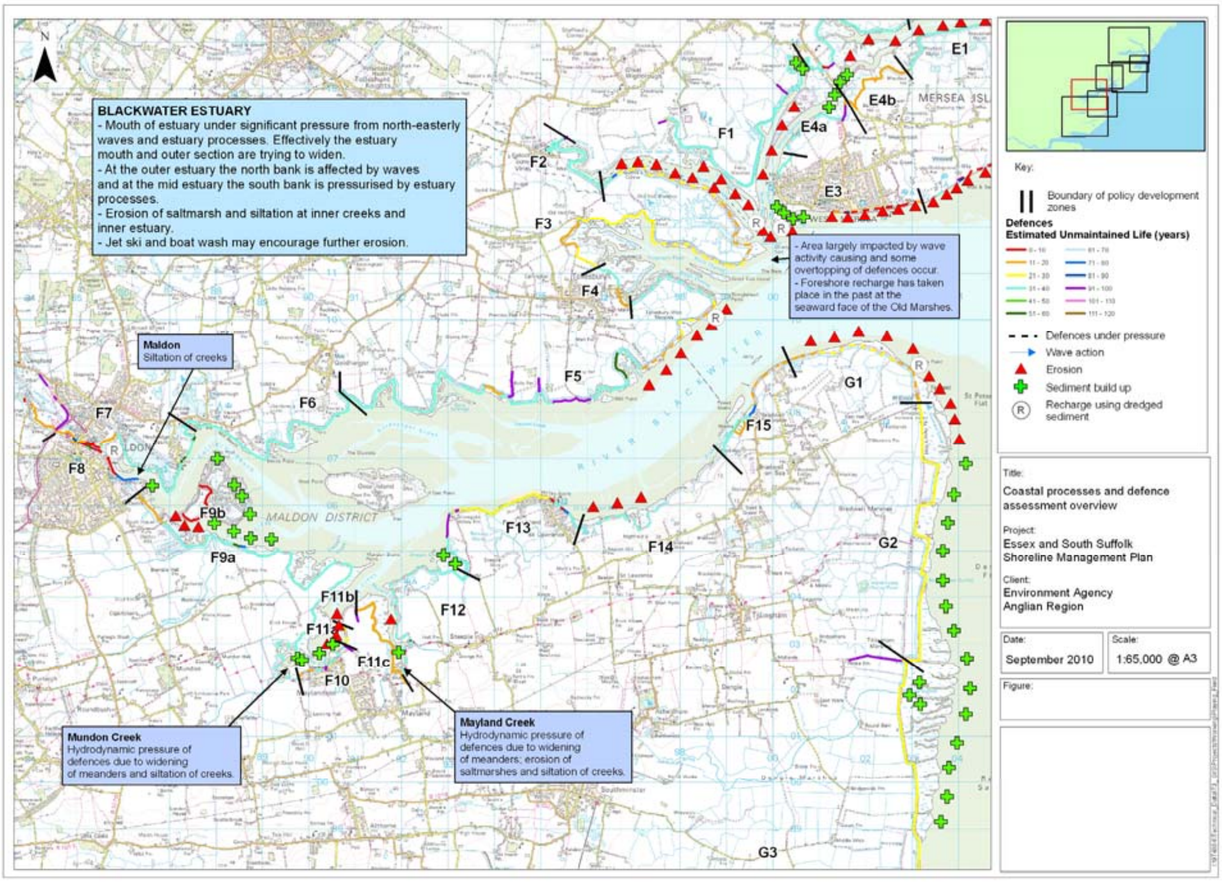

Figure 4-5 Coastal processes and defence assessment overview - Blackwater Estuary

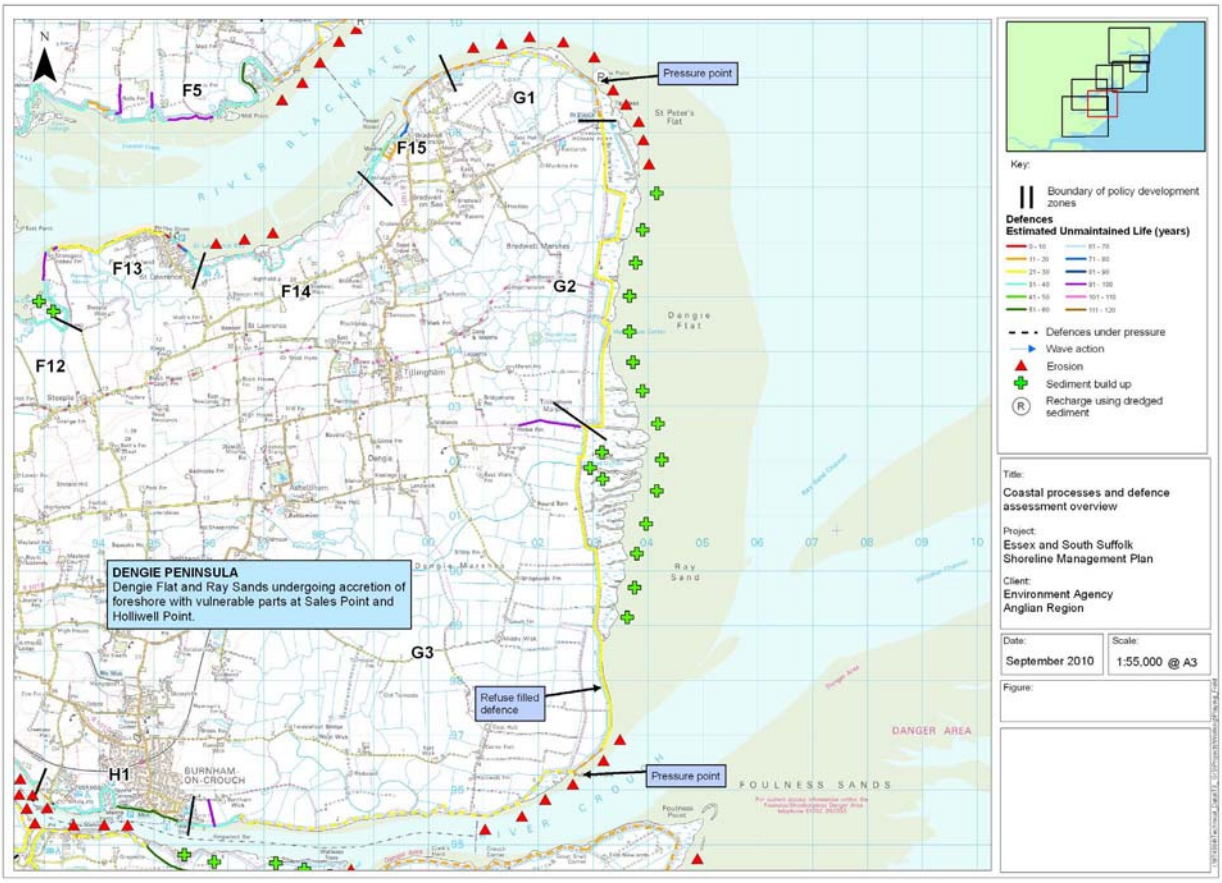

Figure 4-6 Coastal processes and defence assessment overview - Dengie peninsula

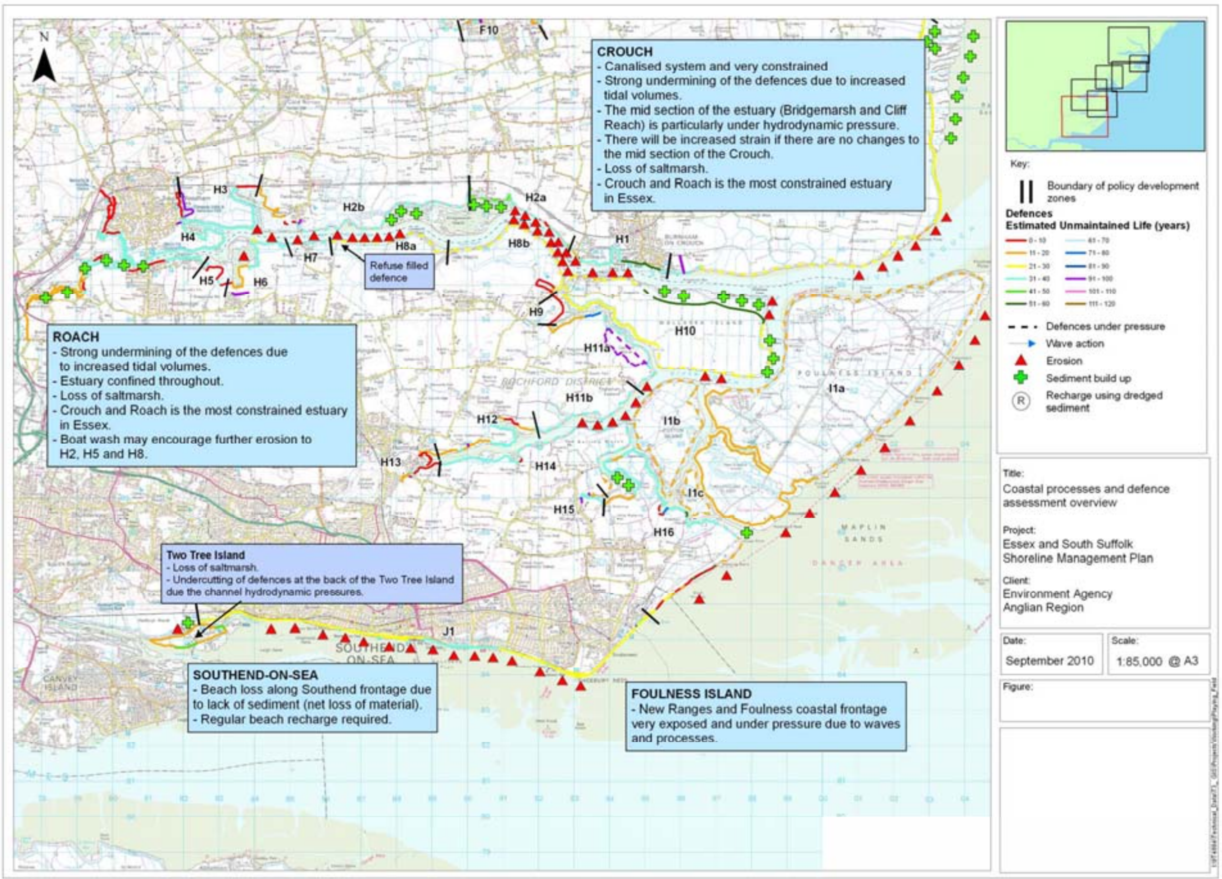

Figure 4-7 Coastal processes and defence assessment overview - Crouch and Roach, Foulness, Potton, Rushley and Southend

F4.11 Results

The coastal risk assessment identified 43 PDZs (Table 4-1) with defences under pressure by coastal and estuarine processes. Identification of those frontages was an important step during the SMP process and played a fundamental role in the appraisal of policy options (Appendix E and Appendix G).

Table 4-1 PDZs with defences under pressure

Management Unit (MU)	Policy Development Zone (PDZ)	Management Unit (MU)	Policy Development Zone (PDZ)
A. Stour & Orwell	A2 (Trimley Marsh)	**F. Blackwater**	F1 (Strood to Salcott-cum Virley)
	A3 (Levington Creek)		F3 (South bank of the Salcott Channel to Tollesbury Fleet)
	A8a (Shotley Marshes West)		F5 (Tollesbury Wick Marshes to Goldhanger)
	A8b (Shotley Marshes East)		F10 (Maylandsea)
	A11 (Harwich Harbour)		F11 (Mayland Creek)
B. Hamford Water	B2 (Little Oakley)		F12 (Steeple)
	B3a (Horsey Island)		F14 (St. Lawrence to Bradwell-on-Sea)
	B5 (Walton Channel)		F15 (Bradwell Creek)
C. Tendring	C1 (Walton-on-the-Naze and Frinton-on-Sea)	**G. Dengie Peninsula**	G1 (Bradwell-on-Sea)
	C2 (Holland-on-Sea)		G3 (Dengie Marshes)
	C3 (Clacton-on-Sea)	**H. Crouch & Roach**	H2a (From Burnham on Crouch to Bridgemarsh)
	C4 (Seawick, Jaywick and St Osyth Marsh)		H2b (Bridge Marsh to North Fambridge)
D. Colne Estuary	D1(Stone Point)		H8a (South bank of Longpole, Shortpole and Raypitts Reaches (Canewdon West))
	D2 (Along the southern bank of Flag Creek)		H8b (Canewdon)
	D3 (Flag Creek to northern bank to Brightlingsea)		H10 (Wallasea)
	D5 (Westmarsh Point to where the frontage meets the B1029)		H11a (Paglesham Churchend)
	D8b (Fingringhoe and Langenhoe)		H11b (Paglesham Eastend)
E. Mersea Island	E1 (Landward Frontage)		H14 (Barling Marsh)
	E2 (Seaward frontage between North Barn and West Mersea)		H16 (Great Wakering)
	E3 (West Mersea)	**I. Foulness**	I1a (Foulness)
	E4a (North Mersea (Strood Channel))		I1b (Potton)
			I1c (Rushley)

The main observed processes include intertidal erosion at the mouth and midsections of the estuaries, and erosion of beach frontage due to wave pressures, tidal flows and other hydrodynamic conditions and the constraint created by the flood defences and geology of the shoreline. There is also intertidal accretion at the inner creeks and widening of meanders.

F5. FLOOD RISK

F5.1 Introduction

Annex G1 of the SMP Guidance (Defra 2006) provides support on classifying the risks according to the *likelihood* of the feature being lost or damaged, and the scale of the *impact*. It presents the following Risk Matrix for each feature under each of the three epochs.

Table 5-1 SMP Guidance for identification of flood risk

IMPACT				
	High	Medium High Risk	High Risk	Very High Risk
	Medium	Low Risk	Medium Risk	High Risk
	Low	Negligible Risk	Low Risk	Medium Risk
		Low	Medium	High
			LIKELIHOOD	

The *likelihood* of the feature being damaged or lost is dependent upon flood risk and or coastal erosion. SMP Guidance (Defra 2006) states that,

> *'For the purpose of the SMP it can be assumed that, should flood defences be breached, the whole flood plain can be defined to be "at risk". The flood risk areas should be based on the information produced by the Environment Agency e.g. the Flood Map'* (p.43, Section 2.5, paragraph 4)

F5.2 The Essex and South Suffolk SMP

For the Essex and South Suffolk SMP an alternative approach has been developed. The outcome consists of the maximum possible flood extent under a No Active Intervention Scenario. For the present day flood extent, the tidal Flood Zone 2 (supplied by the Environment Agency) was considered, in accordance with the SMP guidance. For the future points in time there is much more uncertainty involved and dependency on external factors. Therefore, the maximum extent at the end of each epoch is taken as the 1:1000 year water levels (flood zone 2) plus the sea level rise (based on Defra FCDPAG3, 2006).

Table 5-2 Extreme Water Level

Location/coastline	2024 EWL* (m ODN)	2054 EWL (m ODN)	2105 EWL (m ODN)
Ipswich	4.50	4.76	5.43
Frinton-on-Sea	4.40	4.66	5.32
Colne Point	4.58	4.84	5.50
Holliwell Point	4.74	5.00	5.66
Shoeburyness	4.91	5.17	5.83
Southend-on-Sea	5.07	5.33	5.99
Osea Island	4.86	5.12	5.78

* EWL – Estimated Water Level

For identification of areas with a 1 in 1000 (0.1%) flooding probability level in 2100 for a No Active Intervention scenario, the extreme water levels on Table 5-2 were extrapolated across the digital terrain model. By doing so, coastal and fluvial defences have been ignored. The flood extents represent areas that are potentially at risk.

Figures 5-1 to 5-7 provide an overview of the flood risk for the Essex and South Suffolk SMP area and identify relevant features such as roads and properties at risk.

Figure 5-1 Flood Risk - Stour and Orwell

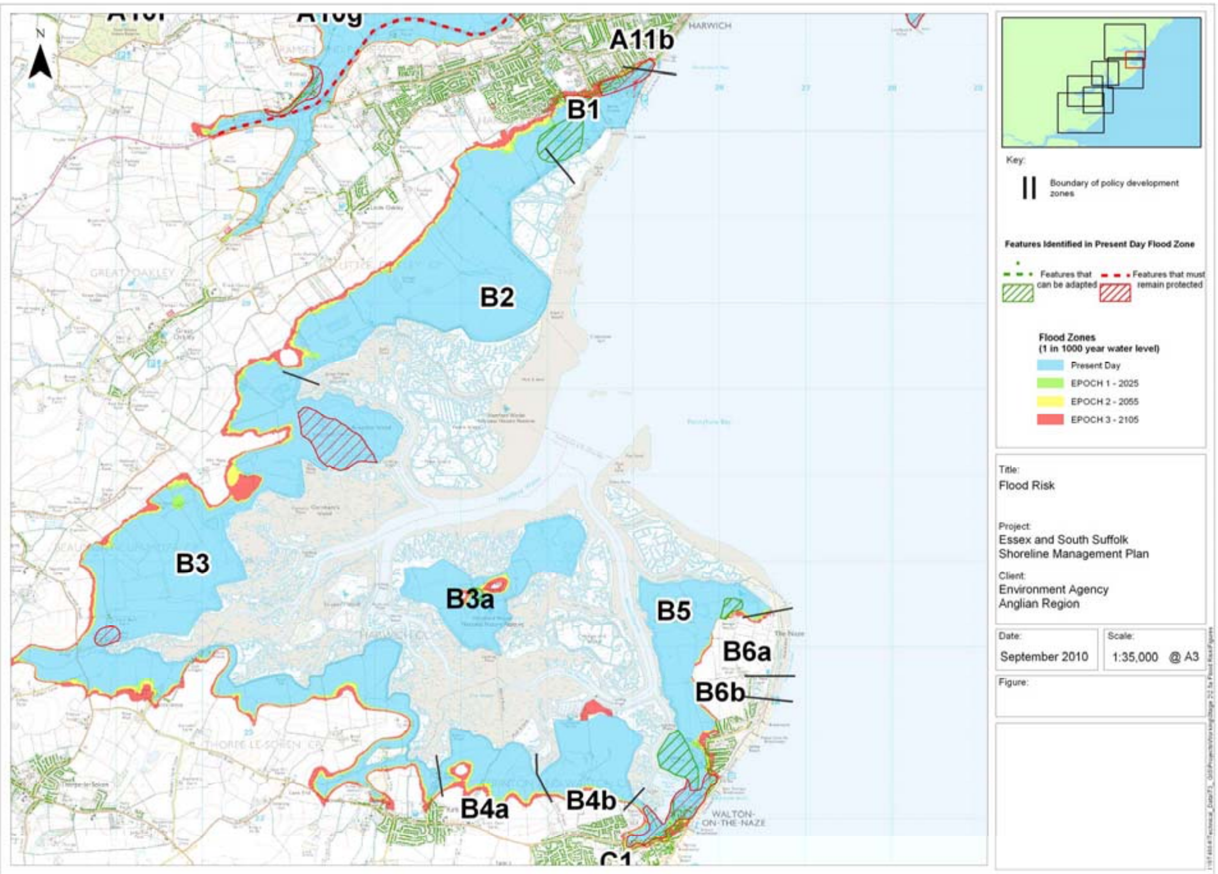

Figure 5-2 Flood Risk - Hamford Water

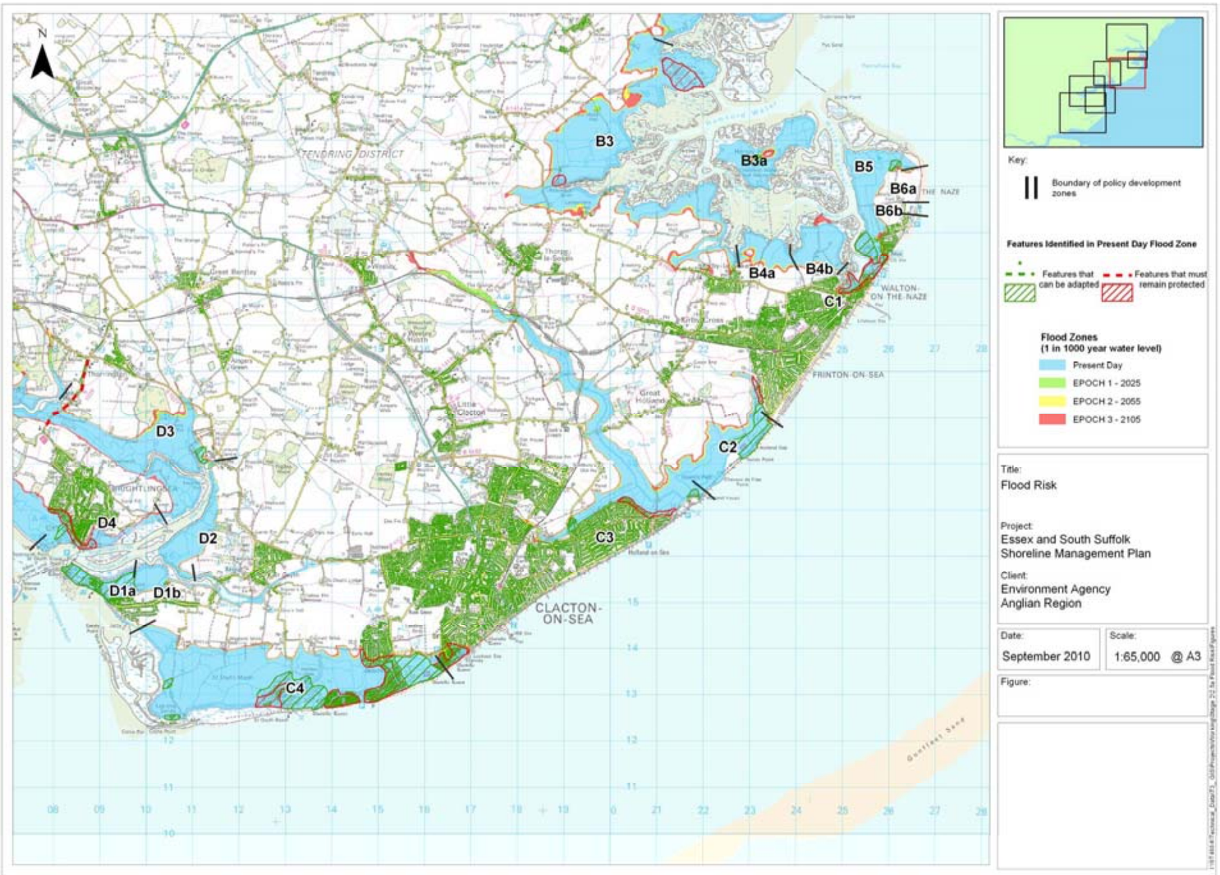

Figure 5-3 Flood Risk - Tendring