Appendix C: Baseline Process Understanding

Contents by Policy Unit

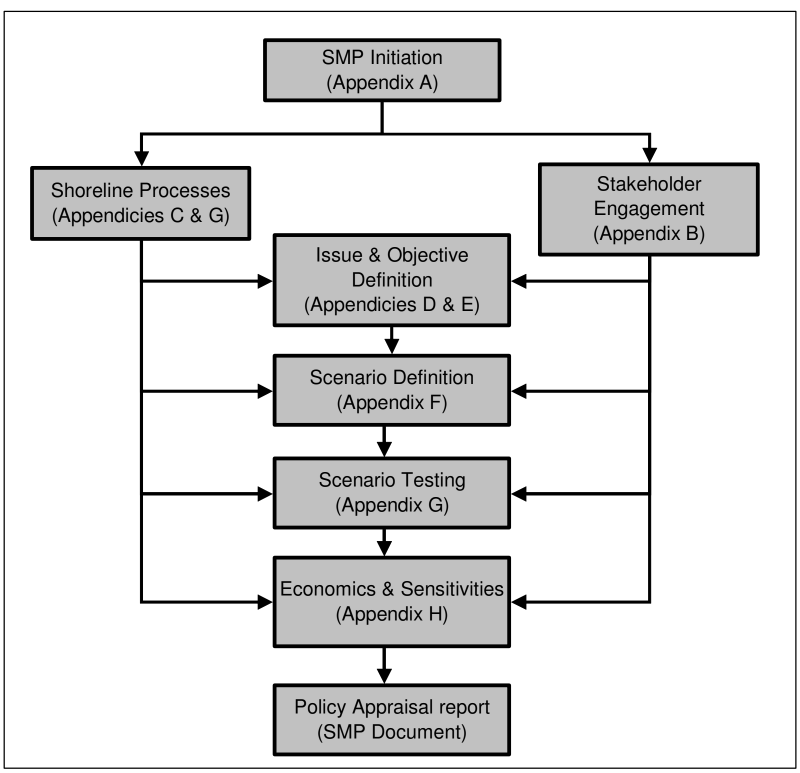
Note the geographic breakdown of the appraisals presented in this Appendix is not necessarily the same as the final Policy Units (PU). Here the breakdown has been based upon coastal process and morphological changes along the shoreline. For ease of reference, the following table identifies the page number on which appraisals relevant to each PU start.

The Supporting Appendices

This appendix and the accompanying documents provide all of the information required to support the Shoreline Management Plan. This is to ensure that there is clarity in the decision-making process and that the rationale behind the policies being promoted is both transparent and auditable. The appendices are:

A: SMP Development	This reports the history of development of the SMP, describing more fully the plan and policy decision-making process.
B: Stakeholder Engagement	All communications from the stakeholder process are provided here, together with information arising from the consultation process.
C: Baseline Process Understanding	Includes baseline process report, defence assessment, NAI and WPM assessments and summarises data used in assessments.
D: Thematic Review	This report identifies and evaluates the environmental features (human, natural, historical and landscape).
E: Issues & Objective Evaluation	Provides information on the issues and objectives identified as part of the Plan development, including appraisal of their importance.
F: Initial Policy Appraisal & Scenario Development	Presents the consideration of generic policy options for each frontage, identifying possible acceptable policies, and their combination into 'scenarios' for testing.
G: Scenario Testing	Presents the policy assessment and appraisal of objective achievement towards definition of the Preferred Plan (as presented in the Shoreline Management Plan document).
H: Economic Appraisal and Sensitivity Testing	Presents the economic analysis undertaken in support of the Preferred Plan.
I: Metadatabase and Bibliographic database	All supporting information used to develop the SMP is referenced for future examination and retrieval.

Within each appendix cross-referencing highlights the documents where related appraisals are presented. The broad relationships between the appendices are as below.



C1 Assessment of Shoreline Dynamics

C1.1 INTRODUCTION

This report should be viewed as supplementary to information held within Futurecoast and more specifically the Shoreline Behaviour Statements for the following areas:

- South Foreland to Sandgate[1]
- Sandgate to Cliff End[1]
- Cliff End to Beachy Head[1]

It contains relevant information produced post Futurecoast or at a level of detail not included within Futurecoast e.g. alongshore variations in sediment transport rates. The two must be read in conjunction with one another to provide a full understanding of dynamics and behaviour across different spatial and temporal scales.

C1.2 OVERVIEW

The coastline between South Foreland and Beachy Head has been retreating and changing in orientation over the last millennia in response to sea level rise and the large-scale drowning of the English Channel since the Holocene Marine Transgression (c.10, 000 years Before Present (BP). The rate of recession has been slowed by the construction and maintenance of coastal defence, which means that much of the coast is not commensurate with the shoreline energy conditions, which has implications for future shoreline management. Foreshore steepening is a prevalent feature of beaches throughout the frontage and this characteristic has been exacerbated by the coastal defences.

A key control on evolution of this stretch of coast is the presence of moderately resistant Chalk geology at South Foreland and Beachy Head. Waves along this frontage are predominantly from the southwest but the headland at Beachy Head reduces the incident wave energy that affects the western shoreline and influences wave diffraction patterns.[1]

This coastline is susceptible to storm surges, which tend to be caused by two main mechanisms; easterly surges generated in the North Sea and westerly surges generated by depressions in the Atlantic (Bray *et al.*, 1997; Halcrow, 2000a). Surges are the main conditions under which significant amounts of the beach shingle are moved. Tidal levels vary along the length of this frontage (Halcrow, 2000a) but are generally higher at the eastern end.

There are significant low-lying areas, for example Romney and Walland Marsh, Marsh, Pett, Pevensey, Broomhill and Hooe Levels that are dissected by sections of cliff, nominally at Dover, Fairlight, Hastings and Beachy Head. There is only one estuary along the entire frontage, the River Rother. Long jetties have trained the mouth and consequently the course, asserting an influence on the hydraulic discharge.

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[1] Refer to Futurecoast (2002)

There are two distinct zones of sediment on the beaches between South Foreland and Beachy Head; (i) an upper beach composed of shingle-size material and; (ii) a lower beach composed of medium sand. In many areas the shingle ridges are perched above wave-cut platforms (Halcrow, 2000a), whereas at Rye and Dungeness, the shingle ridges are banded with intervening silts and peats, indicative of sea level change (Halcrow, 2000). In some places, such as Cliff End to the River Rother, the stability of the shingle beach ridges is closely related to the presence of finer sediments on the lower foreshore. These provide a stable base, with their erosion or deposition being one factor that can alter the form and behaviour of the upper beach. Historically tidal flat and saltmarsh deposits have accumulated in the lee of the shingle barriers, creating platforms onto which the barrier can naturally migrate.

Virtually all (99%) of the shingle along the East Sussex coast is believed to be composed of flint (silica). The source of this material is a culmination of the erosion of flint from the chalk cliffs between Brighton and Beachy Head, a chalk outcrop between Newhaven and Beachy Head and fluvial deposits from the Rivers Arun, Adur, Ouse, Cuckmere and Rother (Jennings & Smyth 1990, Halcrow 2000).

Halcrow (2000, p.30) estimated that between Beachy Head and Rye Harbour the shingle input to the sediment budget, both natural and artificial, is in the region of c.12, 000 to 15,000 m3 /year. The BERM project (2004)[2] fine tuned this, calculating chalk inputs to be in the region of 5000m3/year between Brighton and Beachy Head. A major limiting factor on supply to the study frontage is thought to be the harbour arm at Newhaven, which has intercepted longshore supply from cliff erosion further west (Halcrow, 2000 p.30)

Man-made structures interfere with natural sediment movement; inputs to the system have been affected with the construction of seawalls at Brighton and Peacehaven. These prevent cliff erosion whereas structures such as Brighton marina and the Newhaven western breakwater intercept large sediment travelling alongshore (Halcrow 2000, p.60).

Along the frontage itself, the construction of Sovereign Harbour, in 1992, has significantly affected shingle movement eastwards, nominally to the Pevensey Bay area (Halcrow 2000, p.61). The construction of the Rye terminal groyne has also intercepted sediment movement to the Lydd Range frontage. It is not clear if there are any significant losses of coarse sediment from the sediment system (Halcrow 2000 p.28).

East of Beachy Head, there is an almost continuous cover of mobile seabed sediments in the form of tidal sand ridges (Halcrow, 2000a). The ridges are largely composed of medium-sized sand, with lag deposits interspersed. The ridges tend to be immobile, with some re-working of material during storms. Muddy sands occur near the coastline, derived from the underlying clay and sandstone substrata. A north-eastward transportation predominates and although the offshore gravel deposits, at Owers and Hastings Bank, may no longer be directly linked to the coastal system but are both licensed dredging areas.

Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that sediment flows at the shoreline are greater than those offshore and that generally only fine to medium sand is

[2] (http://www.geog.sussex.ac.uk/BERM/BERM-final-report-UK.pdf)

mobilised within the sub-tidal zone. This means that if shingle is drawn down off the beach under storm conditions, the sub-tidal currents are not strong enough to carry it any distance offshore, if however sand is drawn down then the opposite can take place.

Predicted sediment transport rates for the frontage are variable; ranging between 105,000 m^3/year (westwards) and 115,000 m^3/year (eastwards), giving a net drift of around 10,000m^3/year to the east (Babtie, 1994).

Both Halcrow (2000) and Babtie (1994) agree that the overall pattern of sand movement within the bay between Beachy Head and Dungeness is one of sand moving in from the southwest and migrating towards the main sandsheet depocentre* of Rye Bay, in a north-easterly direction. Other depocentres, located along the study frontage, are at Eastbourne and Pevensey Bay (Halcrow 2000, p.31). Regarding the movement of shingle the predominance is eastwards due to the influence of wave diffraction patterns.

(*) A depocentre is a space created in a basin for sediments to infill. Accommodation space is created, for example, by either tectonic processes (e.g. by thermal contraction, orogenic loading) or sea-level changes.

The study frontage can be split into two main environments cliffs and low lying land, which over the next 100 years are likely to respond in the following manner:

1. The cliffed sections will generally continue to erode at a rate slightly greater than that previously experienced as a consequence of sea level rise, increased sub-aerial weathering. Rates of retreat will depend on geology but they could range from as low as 50 to 60m at Beachy Head to as high as 110 to 130m at Fairlight by 2105. Rising sea levels will force the rocky platforms, fronting the cliffs to become increasing less effective, which will increase wave attack at the cliff toe. It is unlikely that cliff erosion will keep pace with sea level rise, which could have increased some 60cm by 2105 (UKCIP, 2002). The erosion at the cliff toe will trigger further instability, providing predominantly fine sediment to the system, as periodic slumps become more frequent. Initially this will be in the form of foreshore ‘cover’ before being dispersed downdrift and offshore. Despite an increase in cliff erosion, very little additional beach building material will be released into the system; resulting in little benefit to low-lying downdrift frontages.

2. The low-lying areas are predominantly, shingle barriers and it is anticipated that they will roll back across the low-lying hinterland in response to sea level rise and a lack of contemporary sediment entering the system. The pace at which this occurs is however, dependant on the rate of sea level rise, the indolence of the barrier and the topography of the hinterland. Sediment feed to these low-lying frontages will be low as cliff erosion would yield mainly fines. This would result in cannibilisation of the barrier, prompting re-alignment to a swash aligned form and in the long term (+100 years) a bay shape may develop. The cannibalised material, from these frontages would feed units downdrift. With time, breaching of the barrier and inundation of the low-lying hinterland would become more frequent and expand the area of transitional saline-influenced habitat. This would lead to the development of brackish environments and potentially the future creation of a tidal inlet. Such change is intrinsic to a

dynamic coastal environment and therefore an important component in delivering sustainable shoreline management.

C1.3 SOUTH FORELAND TO SANDGATE

REGIONAL SCALE: SOUTH FORELAND TO SANDGATE

Interactions:

Coastal cliffs extending from Sandgate to Copt Point in Folkestone are of variable geology (Cretaceous sequence exposing Gault, Lower Chalk and Middle Chalk at Folkestone Warren) and have been subject to a range of landslide processes shaping the cliff line into a series of near-vertical cliffs, shallowly sloping cliffs and undercliffs. At the southern end of East Wear Bay, the town of Folkestone has been built on a headland where the relatively more resistant Folkestone Beds (Lower Greensand) meet the coast. Much of the cliff line is presently protected by a range of defences and stabilisation measures (with the exception of Copt Point) to prevent marine erosion and further over-steepening and destabilisation. However, landslide movements within the Sandgate Undercliff continued until the early 1990s, being triggered by prolonged periods of heavy rainfall and high groundwater levels

The net littoral drift of shingle is eastwards but the supply from the west (i.e. Dungeness to Hythe) has been declining in the recent past. East of Sandgate the shingle foreshore is noticeably narrower, disappearing completely at Mill Point, approximately midway between Sandgate and Folkestone Harbour. There has been recent accretion of Folkestone Beach (Rotunda), estimated at 1000 to 3000m^3/ year and as a direct consequence of the trapping mechanism of the harbour arms.

Anthropogenic constraints have greatly influenced coastal morphology along specific sections of this frontage; none more so than at Dover Harbour, which has been constrained since the 15th Century. More recent interferences include the construction of Samphire Hoe, a square plateau extension at the base of the Abbots Cliff.

LOCAL SCALE: SOUTH FORELAND

Interactions:

Chalk cliffs run from the eastern end of Dover Harbour to the western end of St. Margaret's Bay, rising up to 150m in height. The foreshore comprises a chalk wave cut platform with varying accumulations of cliff fall debris. The cliffs are composed of Lower and Middle Chalk and because of this are able to maintain a steep cliff face.

The development of the Dover Harbour Arms has effectively cut off the longshore beach material supply. Drift is predominantly eastwards, although a very weak drift reversal from South Foreland to Dover does exist. Thus net annual alongshore sediment transport rate is in the region of 550m^3/year (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and/or update the quantative estimates stipulated.

There is a general lack of contemporary sediment supply throughout the frontage, tending to result in only limited protection offered by the natural shingle foreshore and, consequently, a propensity for continued cliff recession (Futurecoast, 2002). The small-scale recession of the Chalk cliffs yields flinty shingle to the foreshore, which can be transported eastwards along and beyond the frontage by longshore drift.

Movement:
The Chalk cliffs are actively receding, albeit at a relatively slow rate (in the order of centimetres per year). They are susceptible to sub-aerial weathering and periodic slumps and block failures that can result in large falls from the cliff face and the formation of wide aprons of debris containing boulders and chalk rubble (Futurecoast, 2002).

Predictions of shoreline evolution:
There is expected to be continued relatively slow rates of shore platform lowering, with continued slow rates of natural cliff recession (due to both marine and sub-aerial processes). The Chalk rubble released from rock falls will initially accumulate at the cliff toe until it becomes gradually broken down and transported alongshore by marine processes.

LOCAL SCALE: DOVER (includes the harbour)

Interactions:
The steep sided valley of the River Dour, which is fronted by reclaimed land and artificial structures, intersects the chalk cliff line at Dover Harbour. Dover Harbour has been protected since the 15th Century with the development of harbour arms. The foreshore to the west of the harbour traps material moving alongshore, resulting in accretion.

Movement:
Dover Harbour has been constrained since the 15th Century; it is therefore extremely difficult to try to identify any historic trends - as records suggest there has been no change, with the exception of sea level rise.

Predictions of shoreline evolution:
The natural evolutionary tendency of the frontage has been constrained by and will continue to be constrained by, the presence of defences. This is likely to lead, over periods of several centuries, to the emergence of a localised ‘artificial’ headland, with embayments either side that will act to further segment and contain the limited available foreshore deposits, further reducing the limited longshore transport that presently occurs.

Sea level rise and the propensity for greater wave attack will put increased stress on the resources and defences within the confines of the harbour.

LOCAL SCALE: SHAKESPEARE CLIFF

Interactions:
The lower cliff is composed of Lower Chalk whilst the upper cliff, rising to over 90m, is composed of Middle Chalk. The foreshore is composed of shingle with Lower Chalk bedrock outcrops and with occasional ‘aprons’ of cliff debris and boulders.

The shore platform is chalk and covered with very little foreshore sediment because of the general lack of contemporary sediment supply throughout the frontage. As a consequence there is a propensity for continued cliff recession. The small-scale recession of the Chalk cliffs yields flinty shingle to the foreshore, which can be transported eastwards along and beyond the frontage, by longshore drift. Net annual alongshore sediment transport rate is in the region of 500m^3/year (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and/or update the quantative estimates stipulated.

Movement:

The Chalk cliffs are actively receding, albeit at a relatively slow rate (in the order of centimetres per year). They are susceptible to sub-aerial weathering and periodic slumps and block failures that can result in large falls from the cliff face and the formation of wide aprons of debris containing boulders and chalk rubble. Any chalk rubble released will initially accumulate at the toe until it becomes broken down and transported alongshore.

Predictions of shoreline evolution:

There is likely to be continued relatively slow rates of shore platform lowering, with continued slow rates of natural cliff recession (due to both marine and sub-aerial processes). The Chalk rubble released from rock falls would initially accumulate at the cliff toe until it becomes gradually broken down and transported alongshore by marine processes.

LOCAL SCALE: SHAKESPEARE CLIFFS TO ABBOTS CLIFF

Interactions:

Prior to the construction of Samphire Hoe Abbots Cliff (rising to similar heights as Shakespeare Cliff and composed of chalk with a fronting rock platform) erosion in the region of 0.25m to 0.5m / year was experienced. However, after 1993 a square plateau extension at the base of the Abbots Cliff, composed of Chalk Marl dug from the English Channel for use in the creation of the Channel Tunnel, was constructed, reducing the rates of retreat. There is no inter-tidal zone along the majority of this frontage, due to the presence of the artificial platform at the base of the cliffs.

Drift along this frontage is in an eastward direction but is interrupted by the presence of Samphire Hoe, which is held seaward of the natural cliff line alignment. Net annual alongshore sediment transport is estimated at being in the region of 500m^3/year (South Foreland to Beachy Head SMP, 1996). Research / monitoring being conducted by the South East Regional Strategic Monitoring Programme will hopefully support and/or update the quantative estimates stipulated.

Movement:

Since the 1840s this section of the coastline has been altered, the most drastic to date has been the construction of Samphire Hoe, at the toe of Abbot's Cliff, which prevents cliff recession and has given way to a completely artificial coastal morphology.

Predictions of shoreline evolution:

Erosion of Abbots Cliff will be re-activated, which will lead to slumps. Any chalk rubble released will initially accumulate at the toe until it becomes broken down and transported alongshore, in an eastward direction. The cliffs will erode at a rate slightly higher than that experienced historically due to the effects of sea level rise and increased storminess.

LOCAL SCALE: FOLKESTONE TO COPT POINT

Interactions:

The eroding undeveloped cliffed coast, at Copt Point, extends from the site of the cross-channel cable landfall eastwards to the seawall in East Wear Bay. This section of the frontage also comprises Folkestone Warren; 4km of sea cliffs highly susceptible to major and classic landsliding characteristics. The cliffs are up to 160m high and are composed of Chalk underlying Gault and Lower Greensand, which periodically falls in rotational slips. The Gault Clay is a bed of weakness allowing slippage and rotational displacement of blocks of overlying Chalk, falls of chalk also occur on the high cliff. This is fronted by a shore platform and when the tide recedes a rocky shelf made of Lower Greensand is exposed.

There is a general lack of contemporary sediment input to the frontage from updrift sources, due to supply being interrupted by Folkestone harbour arm, resulting in limited protection at the base of the cliffs, offered by the natural shingle foreshore. This has consequently led to a propensity for sea cliff landsliding.

Movement:

This frontage is generally receding (albeit at a relatively slow rate) whilst the immediately updrift frontage of Folkestone Warren is static due to the presence of a seawall which fixes its plan-form position and reduces sediment input from (now) relict landslides. The past tendency has been for major episodic occurrences of rotational landsliding, resulting in the present complex combination of cliffs and under cliffs. Twelve major slips have occurred since 1765 (Futurecoast, 2002).

Predictions of shoreline evolution:

Copt Point and the ‘Warren’ cliff line will probably retreat at a rate greater than that experienced historically due to the influence of sea-level rise and increased storminess. It can be expected that the toe of the cliffs will come under greater attack, prompting instability. Any debris derived from landslides will initially provide some stability but marine processes will remove the material; transporting it alongshore.

LOCAL SCALE: COPT POINT TO SANDGATE

Interactions:

From Sandgate to Folkestone Harbour the cliff line forms the immediate backshore, pinching the urbanised area of Sandgate into a narrow strip of low lying land at the foot of the cliffs. The cliffs at Sandgate consist of the Sandgate Beds (silts and clays) with the Folkestone Beds (sandstones and clays) extending east to the Harbour. Both cliff types are unstable, and the eastern cliffs have been subject to considerable land slippage forming an “undercliff” between Sandgate and Folkestone Harbour (called The Leas).

This frontage has an alignment relative to the predominant wave direction and as there is a general lack of contemporary sediment supply to the frontage, this has resulted in limited protection; consequently the beach was artificially nourished in 1996.

The presence of the Folkestone Harbour arm, located at the extreme eastern end of this frontage, constrains alongshore transport processes. Trapping material (sand and shingle) moving alongshore, it builds beaches around the Rotunda Beach area but has resulted in localised erosion downdrift at locations such as Coronation Parade.

Although the harbour arms arrest virtually all shingle transport, the movement of fine material is not significantly affected and consequently a sand beach exists at East Cliff Sands

Movement:

Although the natural tendency of the frontage is erosional, its behaviour over the past 140 years has been constrained by the presence of coastal defences that maintain a fixed plan-form position of the shoreline. Due to intervention the foreshore has demonstrated volatility. Due to the high water line becoming coincident with the line of the seawalls and a lack of contemporary sediment supply, the beach has increasingly declined and this has led to foreshore squeeze.

Beach levels have been falling for several decades and the defences (originally constructed 1861) fix the plan-form position of the cliffs between Sandgate and Folkestone. Folkestone Harbour arm (constructed 1863) has experienced the accretion of shingle on its western side (Folkestone West Beach), although the rate of accretion is now declining (c.2000m^3/year) due to sediment transport being interrupted updrift by 'fish tail' groynes.

The shoreline in this area has been defended since the middle of the 19th Century. Continued loss in beach volume has caused beach levels in front of the walls to drop, and as a result of this "coastal squeeze", the seawalls have been subject to considerable wave attack.

Predictions of shoreline evolution:

The general lack of contemporary sediment supply to the frontage ensures the natural shingle foreshore can only offer limited protection. Consequently there is a relatively high probability of continued or accelerated recession, especially in conjunction with sea level rise and increased storminess. To the east, localised slippages of the cliffs will continue and provide a degree of protection to the toe of the cliffs. The frontage will continue to erode due to the lack of sediment entering the system, primarily due to the presence of the breakwater at Folkestone.

C1.4 HYTHE TO CLIFF END

REGIONAL SCALE: HYTHE TO CLIFF END

Dungeness forms a large promontory that extends from Winchelsea Beach in the west to Hythe Ranges in the east and is composed of 98% flint. The growth of successive shingle ridges at Dungeness has enclosed Romney and Walland marshes, much of which has been subsequently drained and claimed, as well as the relict cliff line which meets the sea again at Sandgate.

A survey report by ABP & Associates (1996) concludes that the majority of large shoals and bars were in the same location, off Rye Harbour, between 1973 and 1989, as they were in 1805 and 1844, which affirms the relative stability of the nearshore zone.

The frontage has been subjected to regional subsidence, a consequence of crustal forebulge, from the Pleistocene epoch. This has occurred at a rate of 1-2mm per annum over the past 4,000 years (Long & Shennan, 1993), exacerbating the problem of sea level rise.

This section of the coastline is anthropogenically controlled primarily by groynes, which work to slow the transportation of beach material along the frontage and subsidised, where required, with shingle recycling. The Table below illustrates net shingle transportation rates along this frontage and on into Folkestone.

Location	Type of Coastal Defence Structures	Net shingle transport rates and directions m^3 / year	Variability m^3 / year
Cliff End	Groynes	1,000 (E)	± 1,000 (E)
Rye Terminal Groyne	Groynes	20,000 (E)	± 5,000 (E)
Camber Sands	Open Beach	0 (E)	± 1,000 (E)
Dungeness	Groynes	100,000 (E)	± 50,000 (E)
Lydd-on-sea and Littlestone-on-sea	Groynes	6,000 (E)	Not available
Dymchurch	Groynes	4,000 (E)	Not available
Hythe and Sandgate	Groynes	12,500 (E)	Not available
Folkestone	Groynes	3,000 (E)	Not available

Net shingle transport rates along the Cliff End to Folkestone frontage (Cliff End to Folkestone Strategy Study, Halcrow, 2002)

LOCAL SCALE: HYTHE

Interactions:

The shingle ridges that form a wide backshore at Hythe Ranges narrow rapidly along the Hythe (town) frontage. This reduction in width reflects the change in land usage. The line of the coast between Hythe and Folkestone has been 'fixed' by seawalls for more than a century, whereas the beach that fronts the ranges functions more freely.

Shingle ridges are backed by low-lying alluvium hinterland, the landward limit of which is delineated by the Royal Military Canal. Landwards of the Canal the land rises rapidly to the Neolithic cliff that encircles Romney Marsh, outcropping at Cliff End in the west and meeting the sea in the east at Sandgate. The low-lying hinterland is widest to the west of the frontage and decreases in an eastward direction towards Sandgate.

There is a general lack of contemporary sediment input to this frontage, which increases the likelihood of barrier breakdown; conversely the movement of material out of this frontage to downdrift locations is also small. The potential net transport rate at Hythe, is in an eastwards direction and ranges between 4000m^3/year (HR Wallingford, 1999) and 15,000m^3/per year (Halcrow, 2002).

Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that between Dungeness and Folkestone, the sub-tidal fluxes are lower in magnitude and there is no definite transport trend.

Movement:

Accumulation of shingle occurred along this frontage following the natural re-routing of the former course of the River Rother and the subsequent sealing of its mouth.

The old masonry and vertical concrete seawalls from Hythe to Sandgate are fronted by a newly created shingle beach, held in place by two large rock groynes built in 1995. Near Coastguard Cottages, Sandgate, four rock groynes, built in 1991 are now virtually covered by shingle. This has occurred as a result of the artificial re-nourishment operations completed by 1996.

At Hythe, erosion has the potential to occur at a rate of 1.5 to 2m/year (HR Wallingford, 1999b). The present seawall precludes the natural responses of this frontage, by maintaining a fixed plan-form position of the shoreline; it has increased the tendency for lowering of the existing foreshore. It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and / or update the quantative estimates stipulated.

The shingle beach between Hythe and Sandgate has recently (1996) been re-nourished with sand and shingle. This supply is now gradually filtering through from west to east and has now affected the beach as far as Sandgate Memorial. As a result of this lack of supply together with a changing coastline alignment, the shingle beach, which is narrow on the Sandgate frontage, virtually disappears at Mill Point, Folkestone.

Predictions of shoreline evolution:

The shingle ridge will roll-back, across the low lying hinterland, in response to sea level rise. The landward transgression is more likely to be achieved in the east due to the frontage being narrower but it will be restricted due to the presence of a fossil cliff line. Ultimately the ridge would 'meet' the fossil cliff line, enabling marine action to re-activate processes of recession within these features. Sediment supplied from cliff recession will be dispersed directly onto the beach before being transported alongshore to neighbouring units.

LOCAL SCALE: HYTHE RANGES TO LITTLESTONE-ON-SEA

Interactions:

This section of the frontage is dominated by a series of shingle ridges; constructed from material transported alongshore. The backshore is low-lying alluvium hinterland, the majority of which has been developed, with the exception of Romney Warren, north of Littlestone-on-Sea, where a series of sand dunes have developed and are believed to date back to 6,000 years B.P, making them older than those at Camber Sands.

The feed of sediment to this frontage from updrift sources is now relatively small, due to the lack of contemporary material entering the system together with the effects of shingle recycling. The consequence of this is that movement of material, out of this frontage to downdrift locations, is also low. To combat this there has in the past been some (un-quantified) beach recharge, which has brought material to the Hythe Ranges frontage. Sediment transportation along this frontage is small-scale i.e. the net annual rate is approximately 1300 to 1400m^3/year and moves in an eastward direction along this frontage, decreasing slightly towards Hythe Ranges. Continued development of Dungeness has further interrupted sediment supply and exposed Dymchurch to erosion.

Movement:

Following the onset of the formation of Dungeness, the frontage began to experience reduced sediment input and consequently beach levels fell. Consequently erosion of the foreshore and reworking of the sediment stored within the shingle ridges occurs due to the limited contemporary sediment supply.

On this section of the frontage a localised drift reversal, which transports material in the opposite direction, exists. This may be due to a convergence zone that extends across the channel from Hythe to Boulogne.

A concrete seawall at Dymchurch is constraining the idealised landward transgression of the shoreline and is squeezing the foreshore between rising sea levels and a static backshore line (Futurecoast, 2002).

Predictions of shoreline evolution:

Initially the shoreline between Dymchurch and Hythe would continue to progressively narrow and deepen in plan form. With the predicted effects of sea level rise and increased storminess the barrier will begin to experience roll back and consequently start to segment. Erosion of the foreshore shingle ridge would lead to re-working of the shingle stored within backshore ridges; thus specific areas are likely to come under attack from marine inundation. It is probable that a tidal inlet could be created along this frontage.

LOCAL SCALE: LITTLESTONE-ON-SEA TO DUNGENESS (PILOT PH)

Interactions:

The present storm ridge backs a sand and mud foreshore, which increases from a very narrow 'zone', immediately updrift of the Ness, to 1.2km at Greatstone-on-Sea before it tapers off at Littlestone-on-Sea. The coastal orientation changes on the leeward side of the Ness; as the shingle ridges lie sub-parallel to the shoreline, indicative of past environmental controls.

The eastern-facing shore is accreting because sediment is being transported alongshore from Lydd Ranges (on the southern shore of Dungeness) and around the nose. Once on the eastern shore the sediment can be distribution in both an east and west direction, due to the presence of a drift divide.

Using numerical modelling methods to assess potential sediment transport, HR Wallingford (1999) and Halcrow (2000a) found that on the eastern side of Dungeness Foreland, there is opposing sediment fluxes, nominally a drift divide at Greatstone-on-Sea. To combat this approximately 5,000m^3/year is taken from the 'borrow pit' and transported to Littlestone-on-Sea when deemed necessary (Halcrow 2000, p.26). Babtie (1994) proposed that there was a potential for sand-sized sediment to bypass Dungeness under strong eastward tidal and storm wave conditions. Sub-tidal modelling carried out by Halcrow (2000a) showed that offshore there are shore parallel flows that may be able to transport sand-sized material to localities at the eastern extremity of this unit and / or further east. HR Wallingford (1999) recognised that the drift regime immediately east of Dungeness is a complex one. Net annual alongshore sediment transport rate is in the region of 8300m^3 /year and there is predominance to the south (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and / or update the quantative estimates stipulated.

Movement:

The geomorphological evolution of the shoreline is linked to the Holocene marine transgression (10,000years to present) and the infilling of the open spit. Romney was a former embayment as well as the outlet for the River Rother but the record storm of 1287 breached the continuous shingle ridge and re-routed the course of the River Rother to Rye, its current location. More recently the beaches between Greatstone-on-Sea and St. Mary's Bay have been relatively stable, with less than 0.5m/year change in beach position, this being attributed to the presence of coastal defence structures.

Predictions of shoreline evolution:

It is likely that insufficient sediment will enter the system from updrift sources, to keep pace with sea level rise and increased storminess. Thus breaching of the natural foreshore beach would be instigated and lead to the (re)inundation of Romney Marsh with tidal waters. Such a breach would be likely to remain open rather than rapidly become sealed due to: (i) only a relatively small volume of longshore drift along this frontage; and (ii) the potential for the re-created inlet to have a relatively large tidal prism, enabling the creation of a hydraulic barrier. The creation of this feature would intercept longshore transport to neighbouring frontages.

LOCAL SCALE: DUNGENESS (NESS)

Interactions:

Dungeness is indicative of a high-energy sink for gravel throughout the late Holocene period (c.9000 years BP to present). The gravel is derived from longshore drift, 'cannibalisation' of the drift-aligned barrier between Jury's Gap and Denge Marsh Lookout and, more recently, shingle recycling.

There is considerable transport of shingle around the nose due to strong tidal currents as well as the possibility of shore-attached spit development and its subsequent re-attachment to the east-facing shore during different wave conditions. A localised drift reversal is evident immediately in the lee of the nose, caused by an anticlockwise sediment transport eddy; it is possible that some offshore loss of shingle occurs from the nose (Futurecoast, 2002).

Both mathematical modelling of residual currents (ABP and Associates, 1996) and analysis of admiralty charts (Halcrow, 2002a), confirm the presence of a strong south-east residual along the east side of Dungeness. Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that the sub-tidal sediment flux along this section increases eastwards but is not strong enough to transport anything other than sand sized material.

Approximately 60,000m^3/year of shingle is recycled from the eastern flanks of the Ness, an area referred to as the 'borrow pit' and transported by vehicles, west to Broomhill Sands and the western limits of the Dungeness Power Station and approximately 5000m^3/year is transported to Littlestone-on-Sea, in the east, when deemed necessary (Halcrow 2000, p.26).

Movement:

Dungeness is an example of a constructional shingle feature; being formed from a series of abandoned storm crests as longshore sediment transport converged (McFarland, 1999) and / or transported onshore, from the Channel, by rising sea levels during the Holocene Marine Transgression (c.10,000 years BP to the present). The nose of Dungeness is a control point, which represents the 'point' of no significant change in the contemporary sediment volume. Around this point the Ness re-orientates itself, thereby migrating in a northeast direction at an approximate rate of 10m per year.

The presence of Dungeness Nuclear Power Station fixes the plan position of the southern shoreline and a shingle-recycling scheme is in operation to assist this.

Halcrow (2003) assert between 1877 and 2001, at the Old Lifeboat Station, on the eastern flank of the Ness, that there was c. 420m accretion, this equates to approximately 3.4m/year. Should the recycling programme cease then it has been estimated (HR Wallingford, 1999b) that accretion may be in the region up to 4.5m/year on the eastern shore.

Predictions of shoreline evolution:

The foreland is undergoing large-scale re-alignment towards a more swash-aligned form in response to the comparative lack of contemporary sediment supply. This means that the southern-facing shore will continue to experience erosion in an attempt to minimise alongshore sediment transport through the creation of a swash-aligned embayment.

Further eastward extension of the foreland is limited by its present proximity to deep, fast-flowing water which acts to trim the nose. The eastern-facing shore is the beneficiary area of the large-scale re-orientation.

LOCAL SCALE: LYDD RANGES

Interactions:

Dungeness is the largest shingle foreland in Britain, composed of over 500 shingle ridges (Eddison, 1983), which reflect c.5000 years of coastal development and provide a record of Holocene coastal change (Halcrow, 2003). The shingle for these ridges originated mainly from glacial deposits on the seabed, supplemented with material derived from the erosion of flints from the chalk cliffs to the west.

The shingle foreshore fronts low-lying hinterland, the majority of which is reclaimed marshland. Moving east towards Denge Lookout shingle size increases slightly, this may be indicative of a higher energy environment.

Localised drift reversals are known to occur near Broomhill Sands. From a tidal flow model that assesses potential sediment transport; (Halcrow, 2000a) found that the sub-tidal sediment flux increased in an eastward direction.

Currently there is little to no input of shingle from Camber Sands, whilst east of Broomhill Sands transport rates increase significantly; so much so that the plan form of the beach is becoming progressively swash-aligned, instigating the re-activation and re-working of shingle stored within relict ridges (initially in the Broomhill and Jury's Gap area). This material is then transported alongshore; the rate at which this occurs is anticipated to reduce over time, as equilibrium with the contemporary sediment budget and forcing factors is reached.

Movement:

A spit developed between Rye Bay and Hythe c. 5,000years BP; this then progressed into a barrier which extended and infilled, in an eastward direction. Relict barrier beaches now protect the reclaimed marshes of Walland and Romney. Progradation was also influenced, at the time, by the nearshore wave climate and the presence of the River Rother, which was originally located at New Romney.

Historically this frontage has acted as a sediment sink for downdrift gravel sources, from as far west as Fairlight. More recently (c.3000 years BP to present) barrier break down has commenced and consequently the frontage has been experiencing erosion via cannibalisation, as the system tries to re-align to a swash-aligned coast.

East of Broomhill Sands there has been a trend for general erosion since 1872, due to the rapidly diminished supply of shingle to the area and the continued dominant easterly drift. At Lydd Ranges and Denge Marsh beach shoreline recession is occurring at an approximate rate of 1m/year (HR Wallingford, 1999b).

In a bid to slow this mechanism, shingle recycling is conducted by the Environment Agency. Approximately 60,000m^3/year of shingle is taken from the eastern flank of Dungeness and transported to Broomhill and to the western boundary of the Dungeness Power Station (HR Wallingford, 1999b).

At Broomhill recent changes in the shoreline position have been small and it is thought to be a combination of shingle recycling and that the sediment transport at this location is near zero (Halcrow, 2000 p.12).

Predictions of shoreline evolution:

Erosion of the southern facing shingle beach will continue, potentially at a slightly greater rate than that experienced, due to sea level rise, which could be in the region of 4 to 6mm / year (Defra, 2002). The low-lying areas of alluvium that intercept the shingle ridges will become periodically inundated with saline water and brackish environments will be created.

Little beach building material (shingle) will enter the system from updrift locations, i.e. Rye Harbour East, the shingle barrier will therefore cannibalise sediment 'in situ', to attain a position that is more commensurate with shoreline energy i.e. 'swash-alignment'.

LOCAL SCALE: RYE HARBOUR EAST

Interactions:

A sandy foreshore with active dunes characterises the area from the eastern harbour arm to the eastern extremity of Camber. The Camber Sands dune system rises to approximately 8m OD, which makes them larger than those at Romney Sands on the adjacent (east) coast (Halcrow, 2000a).

The terminal groyne, updrift at Rye, exerts a significant control over the development of the Camber Sands frontage. Although the harbour arm has the beneficial effect of affording a degree of protection to this frontage against waves from certain approach angles and allowing sand to bypass, it also almost completely severs any input of shingle (Futurecoast, 2002). HR Wallingford (1999b) proposes that less than 1,000m^3 of shingle bypasses Rye terminal groyne each year, which is confirmed by the very small amount of shingle present on Camber Sands.

Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that the sub-tidal sediment flux along the eastern extremity of this section increases towards Broomhill Sands. Whilst a predominant eastward drift exists here, a localised drift reversal can occur between Camber Sands and Broomhill Sands, which have led to the more variable beach trends over recent historic timescales.

Movement:

Rapid accretion of the sand beach and dunes was apparently observed throughout the late 16th and early 17th Centuries. This trend continued, albeit at a slower rate, throughout the 18th and 19th Centuries, since the 20th Century however, more variable trends have been evident, nominally oscillations between accretion and erosion.

Predictions of shoreline evolution:

Failure of the terminal groyne at Rye will release material to downdrift locations i.e. Camber Sands and Broomhill. Sand will probably continue to accrete on the foreshore and in the dunes at Camber Sands; shingle would also accumulate in and around Camber but to a limited extent, as it would also be transported alongshore to feed Dungeness. Although such an input would largely be from a finite store of sediment immediately updrift of the Rye Harbour arm, it is highly probable that the store will be sufficient enough to feed potential transport pathways over the epoch.

Towards the close of the epoch there may be potential for barrier breaching, prompting tidal inundation east of Camber.

LOCAL SCALE: RYE HARBOUR

Interactions:

From Winchelsea Beach to Rye Harbour West a shingle barrier beach dominates the coast. The barrier overlies Holocene and Quaternary sands and silts (c.125, 000 BP to present) and fronts low lying hinterland, which is at risk from tidal inundation.

There is a wide beach either side of Rye harbour; on the western side it is shingle, whereas on the eastern side it is sand. This distinction is believed to be a direct consequence of the Rye terminal groyne, whereby sand manages to bypass the groyne but shingle does not.

The River Rother and the subsequent Rye Estuary ‘dissects’ the open coastline. A reduction of the former tidal prism of the River Rother occurred as a result of the draining and reclamation of intertidal marshes. This reduction in the hydraulic flushing power of the river led to increased longshore transport of sediment across the river mouth and consequently prompted the construction of the Rye terminal groyne in 1920.

Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that the sub-tidal sediment flux along this section increases in a eastward direction but a very weak westward drift also exist.

Alongshore transport is interrupted by the terminal groyne, which has resulted in significant progradation of the beach in this area (Halcrow, 2000a). Modelling showed that net annual alongshore sediment transport rate ranges from 20,000 to 25,000m^3/year in an eastwards direction along this frontage (the Shoreline Management Plan, 1996, suggests that the rate is of 4,600 to 4,700 m^3/year). Research and monitoring being conducted by the South East Regional Strategic Monitoring Programme will hopefully support and / or update the quantative estimates stipulated.

Movement:

The Fairlight to Hythe Holocene shingle barrier began to break down c.3, 000 years/BP; possible triggers for this include a fall in updrift sediment supply and/or a change in climate, for example increased storminess and/or acceleration in the rate of sea level rise (Halcrow, 2000, p.26).

Since the 14th Century coastal evolution has been one of progradation for the western Rye area; successive ridges building out in a more progressively south-facing alignment, resulting in a fan-like ridge complex (Halcrow, 2000a). Evidence of this progradation includes Camber Castle, which was built on the advancing shingle spit but is now an isolated island as was Old Winchelsea but fell victim to the 13th Century storms and was lost to the sea (Halcrow, 2000 p.27).

Coastal sediment travelling eastwards along the frontage has accumulated on the western side Rye Estuary and Rye Harbour Arm, which has accelerated the progradation of the shoreline on the western side of the Rother. Between 1930 and 1960 there was a seaward progradation of c.150m, relative to the Camber Sands shoreline east of the river. Currently the shoreline is displaced by approximately 0.5km either side of the River Rother inlet, as a consequence there has been a reduction in sediment transport to the east, nominally to the Dungeness frontage.

Predictions of shoreline evolution:

Material west of the river entrance will continue to move progressively alongshore to Camber Sands. The development of a spit is anticipated and eventually it will block the entrance of the River Rother. As a consequence the mouth of the river may migrate in an easterly direction (Futurecoast, 2002).

With the failure of the Rye terminal groyne it is anticipated that the frontage will undergo the transition from a ‘sink’ to a ‘source’. Re-working of the beach material will actively commence along the entire frontage but it is believed that there is a sufficient store of sediment within these ridges that any threat of breaching and inundation of the hinterland would be localised.

LOCAL SCALE: WINCHELSEA BEACH TO CLIFF END

Interactions:

This section is characterised by a shingle ridge which fronts a large proportion of low-lying land which is at risk from tidal inundation. Holocene (c.10, 000 years BP to present) alluvium deposits are protected by a shingle ridge, which rests upon a sand and mud foreshore.

This frontage is supplied with relatively low volumes of fine sediment released from the cliffs between Fairlight and Cliff End. As this material is too fine to be of beach building use, a shingle recycling programme (Halcrow, 2000 p.11) has been implemented.

Using a tidal flow model to assess potential sediment transport, Halcrow (2000a) found that the sub-tidal sediment flux between Cliff End and Rye increases to the east. Modelling (Halcrow, 2000) showed that the net annual alongshore shingle transport rate, between Cliff End and Rye harbour, is in the region of 20,000 to 25,000m^3/year and in an eastwards direction. (This section of the frontage is groyned there is therefore a potential for greater transportation rates under a no active intervention scenario).

Movement:

The shingle barrier that fronts the alluvium hinterland began to break down c. 3,000 years BP. Possible triggers for this include a fall in updrift sediment supply and/or a change in climate, for example increased storminess and/or acceleration in the rate of sea level rise (Halcrow, 2000, p.26). The past tendency for barrier progradation (10,000 years BP to 2,000 years BP) has been and continues to be in a west to east direction along the frontage. Since 2,000 years BP however, the barrier has been ‘breaking down’ due to a diminishing supply of shingle entering the system. This has resulted in rollback, periodic inundation and subsequent cannibalisation of the more landward ridges.

Anthropogenic modifications have affected the development of this area and they are believed to have commenced at least as far back as the 8th Century with the impoundment of the marshes. Further modifications were experienced when artificial watercourses were constructed c. 1268 A.D.

The shingle beach experienced significant cut back between 1872 and 1950 (up to 200m immediately downdrift of Cliff End) and this may have been at least partly caused by the defence works updrift at Hastings.

Currently the shingle ridge is ‘held’ in an artificial position with the aid of groynes and a seawall and assisted with recycling from the area adjacent to Rye terminal groyne. The seawall along this section of the frontage prevents the natural roll back of the shingle barrier in response to controlling factors like sea level rise.

Predictions of shoreline evolution:

Continued roll back and possible eventual breaching of the shingle barrier in response to sea level rise is expected. The rate of roll back would depend on the rate of sea level rise, the inertia of the barrier and the topography of the low-lying hinterland. Breaching of the barrier would result in inundation of the backshore and over the long-term, the creation of a new tidal inlet (Futurecoast, 2002). Cannibalisation of barrier material would result in re-alignment and in the long term (+100 years), a bay shape may develop.

C1.5 CLIFF END TO BEACHY HEAD

REGIONAL SCALE: CLIFF END TO BEACHY HEAD

The landscape comprises moderately resistant Chalk cliffs at Beachy Head, low-lying shingle and alluvial areas at Pevensey and Hooe Levels, and much faulted (and thus unstable) Cretaceous Ashdown Sands and Fairlight / Wadhurst Clay cliffs from the outskirts of Bexhill through to Cliff End.

The shingle foreland of Langney Point and the Crumbles, in Pevensey Bay, developed upon a foundation of Gault and Wealden mudstones. It is a comparatively modern feature, in geological terms (c.3000 years BP – present), that probably originated as a bar or spit. Fine sand to grey clays has been accumulating in the lee of the coastal shingle barrier, for thousands of years, to form tidal flats and saltmarsh deposits. Historically material from the Crumbles has been moved along the coast, in an eastwards direction, towards Hastings and Dungeness; the contemporary shingle store is therefore not as significant as it once was.

The offshore wave data (Babtie Dobbie and HR Wallingford, 1991) shows that the majority of waves and storms are from the southwest, thereby resulting in the west to east transportation of sediment along the frontage.

Anthropogenic constraints have greatly influenced coastal evolution. The construction of groynes has reduced and finally halted erosion along the Beachy Head to Norman's Bay area of the coastline. The first groyne system is evident on the 1875 edition of the Ordnance Survey, since their construction this section of the coastline has remained reasonably stable with the exception for occasional local erosion during the winter storms (Halcrow, 2000, p.24). Frontages between Bexhill and Hastings are heavily managed; defences hold the plan position of the shoreline, this artificial alignment gives way to natural/semi-natural coastal processes between Fairlight Cove and Cliff End.

Location	Author	Net Drift (m^3/ year)	Notes
Beachy Head	Posford (1999)		Annual shingle supply c.5,000m3/year
Eastbourne	Posford Duvivier (1992)	0 to 90,000 (E)	Considered both shingle and sand components.
The Crumbles	Posford		Annual shingle supply c.5,000m3/year
Crumbles foreland	Ove Arup	15,000 to 40,000 (E)	
Langney Point to Cooden	Babtie (1997)	30,000 (E)	Based on physical modelling by HR for an un-groyned beach.
Langney Point to Cooden	Halcrow	20,000 (E) with groynes 50,000 (E) without groynes	
Bexhill to Hastings	Babtie (1994)	15,000 (E)	Analysis of the ABMS data
Cliff End to Rye Harbour	Halcrow (1998)	30,000 to 45,000 with groynes 100,000 without groynes	BPSM used and calibrated against 20 years of beach recycling data, aerial photographs and ABMS data.

Source: Beachy Head to Rye Harbour Strategy Study (Halcrow, 2002)

Although the cliffed sections of this section of coast are retreating at a reasonably consistent rate the intermittent low-lying areas are extremely dynamic and respond quite rapidly to changes in forcing factors. In essence this is not a static coastline; cliffs are eroding, low-lying areas are vulnerable to flooding and sediment is constantly being transported alongshore, in an eastwards direction, as the Table below demonstrates, despite the frontage being heavily defended and managed.

LOCAL SCALE: CLIFF END TO FAIRLIGHT COVE EAST

Interactions:

The presence of clays and faults within the geological sequence, of the cliffs between Fairlight Cove and Cliff End, promotes landsliding, which releases sediment to the sand and shingle foreshore. Cliff recession will provide 'localised' material but the volume this is anticipated to yield, is likely to be small and primarily fine material.

Estimations of sediment transport have been calculated by various parties utilising a suite of numerical models (Halcrow, 2000a), which have determined that shingle transport along this frontage is minimal. Sand transport is predicted to be in the region of 3400 to 3500 m^3/year and drift along this frontage is eastwards.

Movement:

The cliffs fronting the coastline from Fairlight Cove to Cliff End are actively retreating but at different rates, due to the nature of the geology. For example the retreat rates in the Ashdown Sandstones are 0.4m/year whereas at Cliff End the rate is 1.08m.year. As a consequence a headland between Fairlight Cove and Cliff End is forming (Halcrow, 2000 p.65).

Any material released from the cliffs will periodically rest on the shore platform below and offer a certain degree of protection before being transported alongshore to downdrift locations, nominally Cliff End and/or be deposited in the inter-tidal and sub-tidal zones. This sediment is too fine to be beach building material.

Predictions of shoreline evolution:

Cliff erosion will continue at a greater rate than that experienced historically because sea level rise and increased storminess will prompt further cliff instability as well as lowering and narrowing of the foreshore. Any material that does accumulate at the toe of the cliffs will be moved east by longshore sediment transport processes.

LOCAL SCALE: FAIRLIGHT COVE EAST

Interactions:

Fairlight Cove East sits between two reversed faults (Haddock and Fairlight Reserved Fault respectively). The cliffs are composed of Middle Ashdown Beds and expose alternating thin layers of sandstone, sandy shales, silts and sandy clays; it is the clay basal layer that promotes block failure. The cliffs are fronted by a wave cut platform and a sand and gravel foreshore.

Sandstone is the main input, into this system, from the cliffs but this input will undoubtedly be very localised and too fine to be beach building material. Updrift developments and structures are considered responsible for depleting the shingle supply.

Site observations have identified a bar of shingle moving across the beach at Fairlight, in front of the defensive rock bund. This shingle has probably leaked around from Hastings and it is possible that over time it will migrate to Cliff End. Some material does not however enter the system due to the influence of updrift developments, nominally the breakwaters at Hastings, which are deemed responsible for depleting beach material supply. Net alongshore sediment transport is in an eastward direction and in the region of 2, 400 m^3/year (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and / or update the quantative estimates stipulated.

Movement:

In the 1980's the cliffs protecting the eastern section began to erode quite rapidly. To combat this a rock bund was constructed, in 1990, at the 'toe' of the cliffs (c.40m offshore). The cliffs are however, still susceptible to some wave erosion as well as sub-aerial weathering. As the cliffs along this section of the frontage are eroding at a slower rate, than those along the previous frontage, a headland has begun to develop.

Erosion rates are up to 2m/year (through block failure associated with a clay band) whereas at Fairlight headland lower rates of retreat are being experienced, within the region of 0.7m/year (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and / or update the quantative estimates stipulated.

Predictions of shoreline evolution:

Evolution of the site is dependent on cliff retreat; currently cliff retreat is protected by the rock bund, along the eastern section; however it is predicted that erosion will occur at a rate greater than that experienced historically due to the impact of sea level rise and increased storminess. Landsliding tendencies would therefore be initiated and dominate this section of the cliffline, as clays are present within the structure. This would yield sand and silt to the foreshore, which would 'collect' at the rear of the bund. From here the material and beach shingle would be moved along the foreshore by longshore processes, onto downdrift locations (Futurecoast, 2002).

LOCAL SCALE: FAIRLIGHT COVE CENTRAL

Interactions:

Fairlight Cove Central also sits between two reversed faults (Haddock and Fairlight Reserved Fault respectively). The cliffs are composed of Middle Ashdown Beds and expose alternating thin layers of sandstone, sandy shales, silts and sandy clays; it is the clay basal layer that promotes block failure. The cliffs are fronted by a wave cut platform and a sand and gravel foreshore.

Sandstone from the cliffs is the main input into this system, but this input will undoubtedly be very localised and too fine to be beach building material. Updrift developments and structures are considered responsible for depleting the shingle supply.

Net alongshore sediment transport is in the region of 2400 m^3/year, is in an easterly direction (South Foreland to Beachy Head SMP, 1996). It is hoped that research being conducted by the South East Regional Strategic Monitoring Programme will support and / or update the quantative estimates stipulated.

Movement:

This section of Fairlight comprises active landsliding cliffs. Recently there has been rapid retreat of the clifftop, adjacent to Rockmead Road, due to a landslide event which is now settling. Retreat is projected to return to the slower historic rates in the coming years (historic erosion rates are up to 2m/year through block failure associated with the clay band). Landslides are *high magnitude/ low frequency events;* the cause of this landslide has been attributed to the combined effects of elevated ground water and cliff toe erosion. Therefore, despite things settling at the toe, the cliffs are still susceptible to sub-aerial weathering.

Predictions of Shoreline Evolution:

There is significant uncertainty regarding the future recession potential of the clifftop on this frontage due to recent landslide events. There have been a large number of estimates made regarding long-term recession rates, which range from low (0.5m/yr), medium (1.0m/year) and high (2.0m/year). Findings from the most recent study (which draws in evidence from those sites with similar characteristics to that of Fairlight Cove) propose the higher rate (2.0m/yr), which includes climate change plus increased recession of softer cliff material. Due to the dynamic nature of this frontage, predictions regarding shoreline change and shoreline dynamics have been split into three epochs:

Short Term:
It is predicted that as a maximum, the zone of disturbed ground and ground of incipient failure will be lost within the next 10 years. (Given the observed post-1997 average rate of cliff top recession of 8.5m/ yr, the 15m wide “Tension Zone” and 34m wide “Nascent Zone” could be eroded in 5 years)[3].

Medium Term:
In the short term, the cliff slope processes are thought to dominate behaviour. However, in the medium and long-term, sea erosion will become more prevalent. Climate change is likely to have an impact during this epoch and rates of erosion could be in the region of 1.5m-2m/year (this rate allows for climate change and increasing geological weakness).

Long Term:
Continued sea erosion will steepen the cliffs with time. A critical inclination will then be reached at which the next episode of cliff regression is triggered. The cycle of cliff toe erosion and cliff failure will be repeated. The long-term average rate of cliff regression is likely to be in the region of 2.0m/year.

Any erosion (be it toe or sub-aerial) will yield sand and silt to the foreshore. From here the material would be moved alongshore to downdrift locations (Futurecoast, 2002).

[3] Terry Oakes Associates, 2005

LOCAL SCALE: FAIRLIGHT COVE WEST TO HASTINGS CLIFFS

Interactions:

The cliffs are formed in the much faulted and southwest dipping Ashdown Sands and Fairlight Clays. The Hasting Cliffs are susceptible to weathering and sub-aerial erosion, which releases sandstone material to the beach below (Halcrow 2000a), although this contribution is not large. The unprotected cliffs along the eastern coastline (East Cliff to Fairlight Cove) have been experiencing erosion for many years because of the geology.

The alongshore transportation of shingle is restricted by the defence works at Hastings and the presence of the cliffs. Potential net drift along this frontage ranges between 1,000 and 5,000m^3/year, there are however higher rates of potential movement along the eastern half, especially near Hastings Cliffs, where net annual rates of transport can increase up to 10,000m^3/year, a direct consequence of weathering. Drift is predominantly easterly, with a net annual alongshore sediment transport in the region of 3100 m^3/year (South Foreland to Beachy Head SMP, 1996).

Movement:

The shoreline is eroding into the hanging valleys of Ecclesbourne, Fairlight and Warren's Glen. Further along the coast the cliffs between Fairlight Cove and Cliff End (proceeding 'units') are eroding at a slower rate and consequently a headland has started to develop. Inconsistent erosion is due to cliff geology; retreat rates at Fairlight Glen (Hastings Bed Clays) are in the region of 1.43m/year (South Foreland to Beachy Head SMP, 1996) and erosion is directed predominantly at the undercliff due to continued toe erosion, which provides material, predominantly sand, into the system. Research and monitoring being conducted by the South East Regional Strategic Monitoring Programme will hopefully support and / or update the quantative estimates stipulated.

Predictions of Shoreline Evolution:

Cliff erosion is anticipated to continue at a slightly higher rate than that experienced historically due to sea level rise, which will facilitate two mechanisms: greater toe erosion and the progressive removal of foreshore sediment, which work to increase the vulnerability of the backing sea cliffs.

Despite an increase in cliff erosion, very little additional beach building material will be provided to the foreshore and to down drift frontages i.e. Fairlight Cove and what it does yield will be transported alongshore at a fairly rapid rate.

LOCAL SCALE: HASTINGS

Interactions:

Hastings Pier represents the backshore boundary between Tunbridge Wells Sands and Ashdown Sands. The foreshore comprises a shingle beach that has a steep profile. St. Leonard's and White Rock headlands have experienced continued erosion, which has aided the 'smoothing' of the plan shape of the coastline; making sand and shingle available to the sediment budget (Halcrow, 2000 p.25). This retreat has permitted the amalgamation of two or more independent longshore drift currents; so that increasing lengths of the coastline come under influence from one dominant drift, transporting sediment in an eastward direction.

The comparative lack of contemporary sediment sources to this frontage has resulted in the diminishing stock of available foreshore sediments. The net annual alongshore sediment transport rate, is 4500 to 5000 m^3/year and in an eastward direction (South Foreland to Beachy Head SMP, 1996).

Movement:

The Saxon town of Hastings was built on low-lying land and sat on the western side of the 'Priory Valley'. Its original location became uninhabitable by the end of the 13th Century and citizens relocated to Bourne Valley, in the east, to avoid wave attack. The 14th Century breakwater and harbour created an accretion zone, which promoted land reclamation in the lee of the breakwater and by the late 17th Century the 'new' Hastings began to spread in a westerly direction.

Small side valleys in Hastings were once tidal inlets, but became blocked by drifting shingle by the late 16th early 17th Century. Following these events there has been a long-term history of recession. Over at least the past two centuries, however, the shoreline plan-form position has been fixed by protection measures. Thus since the 1870's the general trend at Hastings has been one of accretion caused by the construction of groynes which have significantly reduced the alongshore drift to the east (Halcrow, 2000, p.11).

The straight sea front of Hastings is a relatively recent 'characteristic'; originally the coast was more indented, with headlands providing shelter from the prevailing south-westerly waves for bays in the east. (Halcrow, 2000, p.63)

Predictions of Shoreline Evolution:

Erosion of the relict cliff line will be activated early on and it could be in the region of 40 to 50m by 2105. Material eroded from the cliffs will provide foreshore sediment but with sea level rise, the input will not be sufficient enough to build beaches.

The frontage has begun to experience retreat at its western extremity and it is likely that a breach may occur and eventually inundate the frontage (Futurecoast, 2002). A small sand beach may be all that remains, along the Hastings 'front', maintained by local feed from the cliffs.

LOCAL SCALE: BEXHILL EAST

Interactions:

There is a shingle and sand foreshore with shore platform bedrock comprising Tunbridge Wells silts and sandstone, which frequently outcrop along this frontage. The outcrop, across the inter-tidal zone, acts as a natural groyne to the longshore transportation of material.

Groynes punctuate the updrift frontages and extend as far westwards as Eastbourne. They include the marina breakwaters which reduce the transport of the limited available sediment to this frontage, necessitating the construction of similar defences which, in turn, deprive frontages further downdrift of sediment input (Futurecoast, 2002).

Modelling confirmed that there are high potential rates of movement along this section of the frontage, particularly in front of Hastings Cliffs, where potentially the net annual rate can be as low as 4700 m3/year (South Foreland to Beachy Head SMP, 1996) or up to 10,000 m^3/year, which suggests that this stretch of the coastline is vulnerable to erosion (Halcrow, 2000, p.25).

The eastern extremity comprises a shingle and sand foreshore that fronts the low-lying alluvial area of Combe Haven and the Bulverhythe Valley. There is a comparative lack of contemporary sediment input to this frontage has resulted in the diminishing stock of available foreshore sediments. Updrift developments are responsible for the interruption of sediment and despite recharge schemes; the shingle beach at Bulverhythe has suffered an overall loss of material since 1973. The significant landward movement of the Low Water Mark means that a steeper foreshore has developed. Consequently exposure has increased which has resulted in an accentuation of drift and erosive potential. (Halcrow, 2000, p.63) Drift is predominantly in an eastward direction, with the net annual alongshore sediment transport rate being approximately 5000 m^3/year (South Foreland to Beachy Head SMP, 1996).

Movement:

The comparative lack of contemporary sediment input to this frontage has resulted in the diminishing stock of available foreshore sediments and a related reduction in the degree of natural foreshore protection afforded to the low cliffs. Geological controls exert an influence on localised sea cliff behaviour, primarily due to the presence of clay within the cliffs (Futurecoast, 2002).

Over the past century the tendency has been for cliff line recession, with particular events occurring primarily where the less durable Fairlight Clay is present.

The Coombe Haven inlet was blocked by drifting shingle in the 16th and 17th Century, since then the frontage has become recessional, in response to sea level rise. At Bulverhythe there has been erosion since 1872, some of which may be due to large quantities of ballast being removed from the beach, for industrial purposes.

Predictions of Shoreline Evolution:

It is likely that there will be a continued denudation of presently available foreshore sediments in response to sea level rise. This would result in progressively increased vulnerability of the backshore slope and low sea cliffs, leading to a tendency for episodic landsliding in the clayey layers of the low cliff; this will, however, yield only a relatively small volume in terms of fresh sediment input (Futurecoast, 2002). Inundation of the low-lying valley of Bulverhythe will become a regular occurrence, which will result in a widening of the river mouth. If this were to occur then alongshore transport would be interrupted.

A landward transgression of foreshore sediment is currently occurring in response to rising sea levels. In the future it is likely that the foreshore would migrate landwards in response to rising sea levels with potential, due to the limited available sediment supply, for segmentation and ultimate breaching. Breaching of the foreshore would result in inundation of the Bulverhythe Valley and the re-formation of a tidal inlet (Futurecoast, 2002).

LOCAL SCALE: BEXHILL WEST

Interactions:

At the western end of Bexhill, the flat marshland of the Hooe Levels gives way to Cooden Cliffs. These cliffs are predominantly Cretaceous (144 - 66.4 million years ago) and consist of thin shale, clay and sandstone. The foreshore is composed of shingle and sand and the shore platform bedrock, comprising Tunbridge Wells silts and sandstones, is occasionally exposed.

It is well established that this frontage receives its supply of beach material from the west. The comparative lack of contemporary sediment input to this frontage, due to the presence of defences and updrift structures, has resulted in the diminishing stock of available foreshore sediments and a related reduction in the degree of natural foreshore protection afforded to the backing slope and low cliffs. Net annual alongshore sediment transport rate 4200m3 / year eastwards (South Foreland to Beachy Head SMP, 1996).

Movement:

Between 1872 and 1950 the frontage experienced some erosion, the formerly eroding cliffs (average rates of erosion since 1930 = 0.35-0.7m/year) are now largely protected and generally the area appears to be quite stable. There has however been localised foreshore erosion, which can be quite severe i.e. at some locations along the Bexhill frontage some locations were suffering foreshore erosion at an alarming rate of up to 9m/year (Halcrow, 2000).

Predictions of Shoreline Evolution:

Up on the failure of defences, erosion of the beach and the cliffs at Cooden would be initiated. Rates of retreat would be in the order of 50 to 60m by 2105, which would be exacerbated by sea level rise. Cliff erosion would yield sands and silts to the foreshore but would only release a small amount of 'beach building' material (shingle) to the system. Localised mixed beaches are likely to be maintained (Futurecoast, 2002)

LOCAL SCALE: COODEN TO NORMAN'S BAY

Interactions

Norman's Bay is an area of low-lying shoreline, which is fronted by a single continuous shingle ridge, which extends along the length of its frontage. The low-lying alluvial meadows of Hooe Level join those of Pevensey and are both vulnerable to flooding.

There are a number of potential shingle sources; much of it is re-worked from relict deposits on the floor of the English Channel (Halcrow, 2000 p.ii), the supply of which may now be cut off. Contemporary shingle inputs occur through cliff erosion at Beachy Head but this is believed to be insufficient. Transport of shingle takes place in a north-eastwards direction. Outside the shelter of 'The Crumbles' the shoreline becomes increasingly exposed to wave attack at the eastern section of this frontage.

Movement:

The lowland areas have undergone enormous change over past centuries. The present levels at Hooe used to be an estuary in Norman times but through a combination of shingle development, deposition and alluvial and estuarine infill, have transformed into wetlands (Halcrow, 2000). The majority of the land has been claimed, which has affected tidal flushing and consequently affected the tidal system.

The beach along this stretch is currently held in place by a series of groynes, which act to inhibit shingle movement. Net transport rates were found to be eastwards and very small (less than 1, 000 m^3/year). Modelling suggests that up to 6,000m^3/year of sediment leaves this stretch of coast every year and is transported eastwards (Halcrow, 2000, p.24).

Predictions of Shoreline Evolution:

The shingle ridge, across Norman's Bay and the Levels, would attempt to roll back with sea level rise. This, combined with the comparative lack of contemporary sediment supply, would induce the segmentation of the ridge and its eventual breaching. The longer-term prognosis for this frontage would be one of full-scale breaching and tidal inundation of reclaimed low-lying land, resulting in the formation of a tidal inlet with associated flats and marshes (Futurecoast, 2002).

LOCAL SCALE: NORMAN'S BAY TO PEVENSEY BAY

Interactions

The Pevensey Levels form a wide tract of land below normal tide levels that interconnect with East Langney, Mountney and Manxey Levels to form an expanse of habitats characterised by tidal flats and salt-marshes, fronted by a continuous shingle ridge. The Pevensey Levels were claimed from the sea in the mid 1300s by strengthening the natural shingle ridge. There is a long history of flooding in the area, due to the hinterland being low-lying. The level of protection provided by the shingle bank has deteriorated during the 20th Century due to a reduction in shingle supply from the west (Halcrow, 2000, p.62). As such, the hinterland is now vulnerable to flood inundation.

Drift is predominantly in an eastward direction from the Crumbles, investigations do however indicate a trend for a localised drift reversal, immediately in the lee of the Crumbles, caused by wave diffraction around the small foreland. The construction of Sovereign Harbour in 1992 has significantly affected shingle movement, to the east of Pevensey Bay (Halcrow, 2000, p.61), as it intercepts sediment movement.

Problems within this area have predominantly been caused by the interruption of alongshore drift by groynes updrift. They were first built in 1907, at the western end of the bay, the central section was groyned between 1952 and 1962 and Norman's Bay was groyned between 1962 and 1967. Consequently beach recycling schemes are currently in operation along this frontage (PFI Project).

Various sediment transport estimations have been made, utilising a suite of numerical models (Halcrow, 2000a). Net transport rates, of shingle, were found to be very small (less than 1,000m^3/ year) and eastwards, the results however indicate that a potential 6,000m^3/year leaves this stretch of coastline, being transported eastwards. In the absence of groynes, the potential sediment transport could be in the region of 30,000m^3/year.

Movement:

Historically the Pevensey Levels were a tidal inlet, which became sealed by the alongshore movement of shingle forming a barrier across the bay and leading to the development of the Crumbles cuspate foreland. Following barrier formation, extensive alluvium deposition occurred in the Levels, which induced agricultural reclamation. Following this, the shoreline was predominantly accreting but a more recent tendency has been one of shingle ridge retreat, a process initiated by significant sediment starvation due to defence's updrift at Eastbourne and the Crumbles and a comparative lack contemporary sediment input. Thus between 1872 and 1950 net erosion, of the shoreline, occurred in the magnitude of 100m-150m, which equates to an approximate annual erosion rate of 1.5m/year (Halcrow, 2000, p.10).

Predictions of Shoreline Evolution:

The shingle ridge will try to roll landward as a consequence of sea level rise, increased storminess and sediment starvation from both alongshore and offshore sources. As a consequence segmentation of the shingle ridge and eventual breaching is highly probable. The longer-term prognosis for this frontage would be one of full-scale breaching and tidal inundation of reclaimed low-lying land, resulting in the formation of a tidal inlet with associated flats and marshes (Futurecoast, 2002).

LOCAL SCALE: EASTBOURNE EAST

Interactions

This section of the coast encompasses 'The Crumbles', a large accumulation of shingle deposited in front of Willingdon Levels (originally tidal flats and saltmarsh).

The alongshore transport of shingle, from the Redoubt to Sovereign Harbour takes place in a north-eastwards direction and comes to rest on the western side of the harbour arm, where a shingle beach has been increasingly accreting. On the downdrift side of the harbour the beaches have however, been eroding due to the harbour arms interrupting feed. With rising sea levels there has been a landward migration of the beach across the backshore slope, although the rate at which this occurs has been constrained by the presence of current defences.

Movement:

Between 1100 A.D. and 1600 A.D. 'The Crumbles' experienced growth due to the onshore migration of a shingle bar. Longshore drift enabled the extensive shingle bar to extend eastwards and in the process it enclosed the Willingdon, Pevensey and Hooe Levels. Thereafter the barrier has eroded quite rapidly, c.1-m/year, which suggests a reduction in shingle source and insufficient alongshore supply. Since 1884 the coast has become relatively stable, due to the construction of groynes, which has restricted the longshore transport of sand and shingle.

Defence management practices fix the plan-form of the beach, which restricts natural response and consequently the beach is being held seawards of its natural alignment. The detrimental impact of this is prevalent at Langney Point, which is eroding due to the direct impact of defence works updrift, nominally along Eastbourne's frontage, which interrupts sediment movement.

Predictions of Shoreline Evolution:

As a consequence of sea level rise, the potential for increased storminess and sediment starvation from both alongshore and offshore sources the shoreline position of the Crumbles is anticipated to migrate landwards (Futurecoast, 2002). To achieve natural coastal processes and shoreline alignment, re-working of the shingle beach and backshore ridges would need to be instigated. As defences fail it is anticipated that erosion would initially increase, but this will reduce once a position (swash aligned) more commensurate with the shoreline energy has been attained. It is anticipated that shingle would continue to be transported in an eastwards direction, released initially into the harbour before moving onto downdrift frontages, nominally Pevensey and Hooe Levels) and may, in time, encourage the development of a spit (Futurecoast, 2002).

LOCAL SCALE: EASTBOURNE

Interactions

Beachy Head is largely controlled by its local geology; it is moderately resistant along the southwest face; but less so along its faulted southern-most section and weaker' within the Gault clay southeast facing section (Futurecoast, 2002).

Eastbourne's beaches have historically relied on the supply of sediment from the west. Man-made structures interfere with the natural sediment supply west of Beachy Head. Consequently records indicate that the quantity of shingle entering Holywell has fluctuated significantly (Halcrow, 2000 p.60). Erosion of the sea cliffs is largely via landsliding; especially along the southeast facing shore. This provides a contemporary input of sediment to the foreshore, which is then entrained and incorporated into the littoral transport regime. The coarse material being transported eastwards and fines transported offshore via suspension.

Using a tidal flow model, to determine potential patterns of sediment transport, Halcrow (2000a) found that the greatest rates of transport occurred around Beachy Head with a potential offshore transport of sand at this location. The modelling also indicated a local net drift reversal present between Eastbourne and Bexhill. Not surprisingly tidal flow modelling also showed that the greatest movement occurred under storm conditions.

Estimations of sediment transport have been calculated in various studies using a variety of numerical models; i.e. Halcrow (2000a). The potential longshore sediment movement between Beachy Head and Eastbourne varies within the region of 6,000 and 16,000m^3/year; although the greatest rates are recorded along the Eastbourne frontage. Modelling suggests that there is a potential net drift of material in the region of 2,000-7,000m^3/year out of this stretch and eastwards towards the Crumbles and Pevensey Bay.

Shoreline Movement:

The past tendency, at Beachy Head, has been for modest rates of cliff recession and platform lowering along the southwest facing cliffs. Towards the most southern point of the headland, the cliff top is actively receding, due to the presence of faults and along the east-facing cliffs there is a tendency for landsliding due to the presence of Gault Clay (Futurecoast, 2002). Mapping the shoreline position (MHW) between Beachy Head and Eastbourne, using Ordnance Survey Maps, dated 1872 to

1990, illustrates that there has been little change. Defence works and beach management have increased beach levels by approximately 2.4m since 1972 (Halcrow, 2000b).

Thus the shoreline between Holywell to the Wish Tower is eroding, the coastline between the Wish Tower and the Pier is accreting and little sediment transport takes place along Eastbourne Pier to Redoubt frontage.

Predictions of Shoreline Evolution:

Futurecoast (2002) predicts a continued lowering of the shore platform, which would prompt cliff falls and lead to a recession of the south west-facing Chalk cliffs. The Gault Clay cliffs on the south-east facing cliffs would be subject to continued landsliding; this is anticipated to increase its rate in response to sea level rise (Futurecoast, 2002). Additional fine sediment may enter the system as periodic slumps become more frequent. At Eastbourne a narrow but shallow shingle and sand beach will be maintained. Under a no active intervention scenario the back of beach position would retreat landwards, in the region of 30 to 50m by 2105.

LOCAL SCALE: EASTBOURNE TO BEACHY HEAD

Interactions

Beachy Head is largely controlled by its local geology; it is moderately resistant along the southwest face; but less so along its faulted southern-most section and weaker within the Gault clay southeast facing section (Futurecoast, 2002).

Historically shingle moved around Beachy Head to feed the beaches at Eastbourne. However, since the construction of updrift man-made structures (i.e. Newhaven Breakwater), natural sediment supply from the west has been impaired. Consequently, records indicate that the quantity of shingle entering Holywell has fluctuated with each additional defence structure built (Halcrow, 2000 p.60). Erosion of the sea cliffs is largely via landsliding; especially along the southeast facing shore. This provides a contemporary input of sediment to the foreshore, which is then entrained and incorporated into the littoral transport regime. The coarse material being transported eastwards and fines transported offshore via suspension.

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C2 Defence Data

The Tables overleaf provide a summary of the existing defences along the SMP frontage together with an assessment of their residual life. An assessment of residual life under a ‘no active intervention’ policy was undertaken using the condition data together with NADNAC *condition deterioration curves* (CDC), using the Table below (Defra, 2006) as a guide.

Defence Description	**Estimate of residual life (years) under NAI policy**				
	Existing Defence Condition Grade				
	Grade 1	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
Seawall (concrete/ masonry)	25 to 35	15 to 25	10 to 15	5 to 7	0
Revetment (concrete/ rock)	25 to 35	15 to 25	10 to 15	5 to 7	0
Timber groynes and other timber structures (e.g. breastwork/ revetments)	15 to 25	10 to 20	8 to 12	2 to 7	0
Gabion	10 to 25	6 to 10	4 to 7	1 to 3	0
Note: Grade 5 is not used in the CPSE, but is included here as a measure of failure.					

Source: Defra, 2006 (Shoreline Management Plan guidance Vol. 2 Appendices, March 2006)

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
South Foreland Chainage: 106940m to 110600 Defence Length Codes: CPSE: 573/4615[part] SDS: none	*1980s:* Timber groyne field with concrete infill and concrete seawall at St Margaret's-at-Cliffe (to the north and outside of study area). The updrift development of Dover Harbour has decreased sediment supply to the area.	The shoreline is largely undefended although natural cliff falls offer a measure of shoreline protection.	Chalk cliffs run from the eastern end of Dover harbour to the western end of St. Margaret's Bay, rising up to 150m in height The foreshore comprises a chalk wave cut platform with varying accumulations of cliff fall debris.
Dover Harbour Chainage: 102530m to 106940m Defence Length Codes: CPSE: 573/4628[part], 4627-4615[part] SDS: none	Dover harbour has been protected since the *15th Century* with the development of the harbour arms. *1847*: Construction of Admiralty Pier (changed area from eroding to accreting). *1910*: Block Wall Admiralty Pier constructed. *1924*: Sea wall west of Admiralty Pier constructed to protect new railway infrastructure. Existing breakwaters have been constructed over the last 2 centuries. - 1920: Harbour arm constructed of masonry blocks; maintained by regular maintenance. - 1930: Concrete wall constructed stretching from cliffs in front of Shakespeare Tunnel forming harbour arm. - 1950's - 1970's & 1993: Various upgrades to harbour in form of concrete wall constructions forming inner walls and terminal groynes.	Main protection to outer harbour is provided by masonry breakwater arms, with predominantly steel sheet piled jetties on inner harbour walls. Within the harbour area is a series of walls, many with concrete aprons or toe piling, fronted in places with shingle of varying widths and groynes in some areas. Shingle beach at west end of unit was historically accreting, but is presently retreating Residual Life Seawall inside harbour c20yrs Groynes <15yrs Sheet piling: <15yrs Harbour Arm c20yrs, <35-40yrs.	The chalk cliff line is intersected at Dover Harbour by the steep sided valley of the River Dour. The 'natural' foreshore is located to the west of Admiralty Pier and the beach located between the East and West Docks is predominantly shingle. (The remaining foreshore has been fully developed for shipping activities).
Shakespeare Cliff Chainage: 101390m to 102530m Defence Length Codes:	1930s: masonry/concrete retaining wall to railway tracks at the eastern entrance to Shakespeare's tunnel.	Undeveloped coastline is unprotected other than by a short section of wall. Natural shoreline protection is provided by the cliff fall debris and the shore platform. Shingle beach at east end of unit is low and wall needs	Backshore of cliffs composed of Lower and Middle Chalk, rising to over 90m The foreshore comprises Lower Chalk bedrock outcrops with

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
CPSE: 573/4629[part], 4628[part] SDS: none		replacing. <u>Residual Life</u> Wall <5-10yrs	occasional ‘aprons’ of cliff debris and boulders.
Samphire Hoe Chainage: 99890m to 101390m Defence Length Codes: CPSE: 573/4629 SDS: none	*1843:* Cliffs partially artificially profiled through blasting for railway line. Short section of the platform length was protected. *1992:* Concrete wall with splash wall, apron and steel toe piling constructed to form Samphire Hoe. Block and rock revetment and rock armour placed as scour protection. Shingle recharge to west.	Artificial platform with no intertidal zone composed of 5 million cubic metres of reclaimed ‘soil’ (mud/clay) from Eurotunnel spoil within a protective seawall. <u>Residual Life</u> All elements <35-40yrs, <50yrs	Extension of Abbot’s Cliff area, but covered with artificial platform. No intertidal zone; entire littoral zone covered by spoil platform.
Abbot’s Cliff Chainage: 98115m to 99890m Defence Length Codes: CPSE: 573/4629 SDS: None	*1992*: Shingle recharge to beach in front of concrete wall at east end of unit. Ongoing: Proposals to extend existing rock revetment at Folkestone Warren to east (into Abbot’s Cliff defence length) and monitoring/maintenance works by Railtrack.	Largely undefended other than by natural toe protection afforded by boulder spreads derived from cliff falls. The embankment at the eastern limit of the unit forms the western end of the channel tunnel site and provides a spending beach against the sheet piling.	Eroding 140m high cliffs composed of Lower and Middle Chalk. The cliffs are subject to falls and the material forms wide aprons of debris (boulders and chalk rubble) on the foreshore.
Folkestone Warren Chainage: 94970m to 98115m Defence Length Codes: CPSE: 573/4503-4501, 4634-4632, 4631[part] SDS: None	*1938-1948*: Timber groynes constructed from edge of Copt Point. *1948*: section of concrete wall constructed along the main slippage zones. Some of these walls such as those at west and east ends of unit have concrete splash walls and apron. 1996/1997: 2 sections of rock revetment in front of seawall at east end of unit approx 150m long each. Ongoing: Proposals to extend rock revetment to east and west and monitoring/maintenance works by Railtrack.	Cliffs are a major slippage zone and subsequent to major failures protection is through seawall with concrete apron in places at the toe of the undercliff. Timber groynes are largely in a poor condition, but have a concrete buttress at their landward end. <u>Residual Life</u> Central section of concrete wall < 5-10yrs Remainder of Concrete wall <15yrs, c20yrs Rock revetment c20yrs, <35-40 yrs Timber Groynes – western half of groynes <5-10yrs, eastern half of groynes <15yrs	Chalk and Gault Clay sea cliffs highly susceptible to major and classic landsliding characteristics. The sea cliffs are up to 160m high, comprising Chalk overlying Gault Clay. A narrow sand and shingle foreshore.

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
Copt Point Chainage: 94070m to 94970m Defence Length Codes: CPSE573/5404 SDS: None	Depletion of shingle supply by the development of the Main Folkestone Harbour Arm has influenced the lack of beach material and rate of toe removal.	No defences, line of unprotected eroding cliffs with natural toe protection of slipped material.	Sea cliffs along the backshore that are highly susceptible to major and classic landsliding characteristics. The cliffs are up to 160m high and are composed of Chalk and Gault Clay. A sand and shingle foreshore
Hythe to Folkestone Harbour Chainage: 84964m to 94070m Defence Length Codes: CPSE: 573/4521[part], 4520-4504 SDS: 073/5230d, 5232d	Historically defended since 1861 *1807:* Work commenced on Folkestone Harbour *1860:* Harbour extension *1905*: Harbour extension *1930-1970's*: Seawall construction with early wall segments mostly of rock / masonry and later concrete upgrades with splash walls. Timber groynes constructed over unit *1991*: Four rock groynes constructed near coastguard cottages, Sandgate. *1992*: Two rock groynes replaced old timber groynes midway between Mill Point and Folkestone and beach re-nourished. *1995:* Two rock groynes constructed at Hythe-Sandgate *1996*: Re-nourish beach between Hythe and Sandgate with sand and shingle. *2004:* Three large rock headlands constructed at Mill Point to replace the fishtail groynes built in 1992. A further two rock groynes constructed between Mill Point and Hythe. Beach renourishment and seawall raising also carried out. Updrift defences have severely restricted sediment supply.	The shingle ridge narrows rapidly along the Hythe to Sandgate frontage. The masonry and concrete seawalls are fronted by newly created shingle beach held in place by two rock groynes. The rock groynes near Coastguard Cottages are covered by shingle from the latest artificial recharge. The three large rock headlands at Mill Point, Folkestone maintain two stable bays. An additional rock groyne along with the recent beach renourishment maintains a wide shingle beach between Sandgate and Folkestone. The beach formed against the western arm of Folkestone Harbour is accreting as a result of shingle supply from the west. Folkestone Harbour includes breakwater arms and harbour quays. East of the harbour the concrete promenade wall has a series of arches with concrete decking, in poor condition. East of the promenade there is a short length of retaining wall with a cliff face which suffers from localised slippages. East of the retaining wall concrete has been poured onto the cliff face to prevent outflanking. Residual Life 60 years (providing regular beach maintenance)	This frontage is backed by a low-lying alluvium hinterland, which rises to Greensand cliff line in the east. Shingle ridges front the alluvium backshore. A seawall precludes the natural response of this frontage, by maintaining a fixed plan-form position of the shoreline.

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
	Other Coastal Structures include an outfall and Martello Towers.		
Hythe Ranges Chainage: 81980m to 84969m Defence Length Codes: 573/4521[part] SDS: 073/5220[part]	Dates of original construction unknown. Maintenance and emergency works to revetment. Gravel extraction has taken place at Pennypot (NW of the frontage) Other coastal structures include an outfall and Martello Towers	Shingle ridge protected by a rock armour revetment that extends from Dymchurch Redoubt to the west end of Fisherman's Beach. Sand lower foreshore is narrow and flat with a steep and extensively groyned shingle upper foreshore. The westernmost (partly collapsed) Martello Tower is situated seaward of the rock armour revetment. The easternmost two Martello Towers are protected by rock armour. Rock protection added on ad-hoc basis to areas which appear vulnerable to flooding, with some poor grading of stones, steep slopes and localised collapse of toe. Beach recharge currently undertaken. <u>Residual Life</u> Revetment (east) <5-10yrs Revetment (west) <15yrs Timber Groynes <5-10yrs	A low-lying alluvium hinterland fronts a fossil cliff line. A series of shingle ridges front the alluvial hinterland. The low-lying foreshore is widest in the west and decreases towards Sandgate.
Hythe Ranges to Littlestone-On-Sea Chainage: 72631m to 81980m Defence Length Codes: CPSE: 573/4521[part] SDS: 073/5202[part], 5203-5218, 5220m[part]	Seawall running along an old line established in the 13th Century. *1980*: Timber groynes, breastwork and rock revetment constructed along frontage to MOD site. *1990's*: Strengthening of seawall western section Wall at St Mary's Bay is of very recent construction. Other Coastal Structures include the outfall at St Mary's Bay and 2 others, plus Martello towers	Mass concrete seawalls extend from Littlestone-on-sea to St Mary's Bay with vertical or stepped front face, horizontal apron and rear wall. This length is also subject to periodic shingle re-nourishment, the long timber groynes are partly-buried and the lower ends are in a semi-derelict state. From Dymchurch Village to Dymchurch Redoubt defences are older. The original clay embankments were clad on the seaward face, protected on the crest and have had rear wave return walls added at various dates. The sloping front aprons have had to be extended	The backshore is low-lying alluvium hinterland, the majority of which has been developed, with the exception of Romney Warren – here a series of sand dunes developed c.6000yrs BP. The underlying sand on the foreshore has the affect of reducing the permeability of the shingle and therefore beaches are less steep than those associated with pure shingle. The present storm ridge backs a

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
		and patched with concrete. Defences need frequent maintenance and upgrading. The field of timber groynes extend from St Mary's Bay northwards with occasional gaps and is largely derelict, but with sound timber structures in the heavily groyned area near Willop Basin. Small section of rock revetment defending MOD site (very east end of unit). Controlled development to Dungeness foreland has interrupted sediment supply resulting in coastal erosion exposing wall. Prone to flooding and overtopping. Residual Life Concrete wall (south) <15yrs, c20yrs Concrete wall (north) <5-10yrs Timber Groynes <5-10yrs Rock revetment (east) <35-40yrs	sand and mud foreshore, which increases from a very narrow 'zone', immediately updrift of the Ness, to 1.2km at Greatstone-on-Sea, it tapers off at Littlestone-on-Sea. Offshore: A periodic drift reversal exists between Lydd-on-Sea and Greatstone-on-Sea.
Littlestone on Sea to Dungeness Chainage: 63928m to 72631m Defence Length Codes: 573/4523[part], 4522 SDS: 073/5004[part], 5102[part], 5005, 5201, 5202[part]		Natural defence largely provided by shingle ridges fronted by an increasingly wide tidal foreshore of sand and mud. At Greatstone-on-Sea narrow sand dunes form the first line of defence. At the northern end of the frontage the beach is groyned, but the timber groynes are largely buried and partly derelict. Residual Life Groynes <5-10yrs	Backshore consists of low-lying hinterland composed of over 500 shingle ridges/recurves. The foreshore comprises thick shingle, which rests on pure sand. A wide sand shoreline is prominent.
Dungeness Power Station Chainage: 62200m to 63928m Defence Length Codes:	Shingle has been recycled from east to west 'for many years'. 1996 strategy plan indicated recycling at rate of 39,000m3/yr to maintain the shingle bank. Net drift of shingle is eastward to zone of	No hard defences. Mechanically profiled & nourished high shingle bank landward of a natural shingle beach crest and backed by a low level of concrete road.	Backshore consists of low-lying hinterland composed of over 500 shingle ridges/recurves. The null point for the development of the shingle 'ness' is located on this section of the foreshore. A

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
CPSE: 573/4523 SDS: 073/5003[part], 5102,073/5004[part]	accretion north of Dungeness Point		steep intertidal shingle profile drops off into naturally deep water. Offshore: Large pocket of gravel (deposition).
Lydd Ranges Chainage: 54097m to 62200m Defence Length Codes: CPSE: 573/4523[part] SDS: 074/5108[part], 074/5109, 5001-5002, 5003[part], 5102[part]	Ancient 2nd defence line of the Green Wall *1970*: Timber Groynes (west end of unit) Other structures include the South Brooks outfall, protected by small rock revetment.	No hard defences exist. A continuous shingle ridge maintained by recycling and beach re-grading (following storms) forms the first line of defence. A secondary defence line is formed by the Green Wall (clay embankment) which runs landwards at a shallow angle and stops short of the eastern boundary. From the western boundary for 2km the Green Wall embankment is paved, but the slabs are extensively cracked and the crest is undulating. East of the Galloway's the embankment is in very poor condition, is overgrown and unsafe to walk on. Timber groynes are maintained across the boundary of units 14 and 15. Eastern section is undefended other than re-profiling to ensure power stations are not outflanked. <u>Residual Life</u> Groynes <5-10yrs (older), <15yrs (new) Green Wall <15yrs	Low-lying hinterland composed of over 500-shingle ridge, intersected by 'strips' of alluvium. Foreshore consists of a continuous shingle ridge, with a narrow intertidal zone which declines towards the east.
Camber Sands to Rye Harbour East- Chainage: 49390 to 54097 Defence Length Codes: CPSE: 574/4402-4401 SDS: 074/5102-5107, 5108[part]	Since 13th Century, successive canalisation of Rother has prevented shingle migration west to east across the Rother River. Nourishment has been taking places since late *1950*s *1963:* Timber Groynes (east end of unit) *1970*: Timber Groynes (west end of unit) *Ongoing:* Groyne repair and recharge	There are no current defences other than sand dunes between the harbour entrance and Camber. The narrow dune belt immediately east of the car park gives way to a shingle ridge. Between The Suttons and Jury's Gap the narrow backshore is protected by a concrete seawall at both ends of the frontage and a shingle bank along the whole length with timber groynes. There is an ongoing programme of groyne repair and recycling on this frontage	A sandy foreshore with active dunes and a transition towards gravels at Jury's Gut. A drift divide exists at Broomhill Sands. If the terminal groyne to the west of Camber were to be removed, shingle would be likely to form single or series of shingle ridges covering the mouth of the river.

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
		Residual Life Older groynes <5-10yrs. New groynes <15yrs Seawall 5-15yrs	
Rye Harbour West Chainage: 45927m to 49390m Defence Length Codes: CPSE: None SDS: 074/5010[part], 5011-5012, 5101	Construction dates not found. Without recycling the western harbour arm would be overtopped and shingle would obstruct the harbour entrance.	The Rye Harbour East Pier and Terminal Groyne interrupt the easterly longshore drift and results in shingle accretion to the west, which is recycled for use in unit 12. The East Pier (training wall) consists seaward of a section of concrete wall covered on its east face by sheet piling (poor condition) and further seaward, a section of double sheet piling, which is submerged at high tide. Applications to undertake works as part of Pett Frontage Sea Defence Project have been submitted. These will include upgrade of terminal groynes and river training wall, construction of temporary extraction pocket groyne and upgrade of existing groynes along Winchelsea Beach to Cliff end along with beach recharge fed from shingle extraction pocket adjacent to terminal groyne. Residual Life East pier <5-10yrs, <15yrs	Backshore is low lying land which is at risk from tidal inundation. From Winchelsea Beach to Rye Harbour West the foreshore is dominated by a storm ridge deposition over Holocene and Quaternary sands and silts. Accreting shoreline has high conservation value for shingle, dune and brackish and freshwater habitats.
Winchelsea Beach to Cliff End Chainage: 41167 to 45927 Defence Length Codes: CPSE: 574/4404[part], 574/4403 SDS: 074/5007-5009, 5010[part]	*1949-50*: Concrete revetment - east section of unit *1975*: Timber groynes constructed *1980*: Concrete revetment – west end of unit. *1982*: Concrete wall and apron (Cliff End), rubble and breastwork.	At Cliff End the low level promenade is fronted by concrete rubble, timber breastwork and three timber groynes, (all in poor condition). East of the rubble protection, but still local to Cliff End is a concrete seawall and splash wall, with patterned concrete block apron. The seawall defence is maintained by artificial beach feeding, held in position by groynes. Applications to undertake works as part of Pett	The Wadhurst Clay Cliffs give way to a low-lying alluvial coastline, a large proportion of which is below MHWM. A shingle ridge rests upon a sand and mud foreshore.

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
		Frontage Sea Defence Project have been submitted. These will include upgrade of terminal groynes and river training wall, construction of temporary extraction pocket groyne and upgrade of existing groynes along Winchelsea Beach to Cliff end along with beach recharge fed from shingle extraction pocket adjacent to terminal groyne. Residual Life Timber groynes <5-10yrs East concrete revetment <5-10yrs West concrete revetment, wall and apron <15yrs, c20yrs	
Cliff End to Fairlight Cove Chainage: 40313m to 41167m Defence Length Codes: CPSE: 574/4405[part], 4404[part]	*1960s:* Timber groynes constructed at Cliff End. *1982:* Armour rubble placed and timber breastwork constructed at Cliff End. *1988:* Rock bund constructed at toe of cliff to retain longshore drift and protect base of cliff from erosion. Bund has reduced rates of erosion.	Continuation of rock toe bund from previous unit at western limit. Other than this, no hard defences in front of cliffs. Shoreline is unprotected as natural defences are formed by the wave cut platform and Greensand Reef. Natural accumulation provides a measure of toe erosion control. At Cliff End the low level promenade is fronted by concrete rubble, timber breastwork and three timber groynes, all in poor condition. Residual Life Rock Bund <50yrs, >50yrs Timber groyne and breastwork <5-10yrs Rubble Armour < 5-10yrs	Steep cliffed zone rises to 145m on undeveloped coastline. Foreshore is of sand and shingle with collapsed cliff material. To the east the foreshore is of mud and sand.
Fairlight Cove Chainage: 33970m to 38637m Defence Length Codes: CPSE: 574/4405	*1988:* Rock bund constructed at toe of cliff to retain longshore drift and protect base of cliff from erosion. Bund has reduced rates of erosion.	Eroding sandstone cliffs up to 145m high. At the east end of the unit the toe of the cliff is protected by a rock bund. In recent years considerable shingle has accumulated on the landward side of the bund, increasing	An eroding sandstone cliff with a clay basal layer, promoting block failure. A wave cut platform with sand and gravel foreshore, composed of material derived from

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
SDS: None		protection to the cliff toe. Several properties on the cliff top are still vulnerable to potential cliff erosion (land drainage issue). Residual Life Rock Bund <50yrs, >50yrs	cliff falls. Erosion determined by cliff collapse and toe material removal (up to 2m/yr).
Fairlight Cove to Hastings Cliff Chainage: 33970 to 38673 Defence Length Codes: CPSE & SDS: None	Retreat rates at Fairlight Glen in the Hastings bed clays are 1.43m/yr	Unprotected other than by natural cliff collapse material protecting the toe of the slumped cliffs. No man-made defences.	Unprotected cliffs formed in the much faulted Ashdown Sands and Fairlight Clays. The undercliffs are prone to marine erosion and continued slippage. Variety of cliff profiles and erosion rates, but generally highest where clays are exposed at sea level.
Hastings East Chainage: 31869 to 33970 Defence Length Codes: CPSE: 574/4307[part], 4306-4301 SDS: None	Coastline has been protected since the 14th century. *Early 1800s:* Easterly breakwaters constructed. *1900:* Westerly breakwater developed to protect shore based fishing fleet. *1930s:* Easterly breakwaters rebuilt and concrete seawall at Castle Rock *1950/1960s*: Timber groynes constructed. *Late 1980's-early 1990's*: Groynes east of pier encased. Concrete groyne constructed at very east of unit fronting the fishing fleet *1993*: concrete masonry wall constructed just east of pier due to large-scale erosion. Recharge accompanied seawall upgrade Other structures include storm water outfalls	To the east of the Pier, the concrete wall and promenade is fronted by timber groynes and a shingle beach (largely lost at Carlisle Parade, which has a history of flooding). Timber groynes are dilapidated and not effective. Hastings Harbour is at the eastern end of the unit. Substantial beach area between harbour arm and groyne 1, which is used to store fishing boats. Residual Life Timber (encased) groynes <15yrs Concrete groynes to east <15yrs/ c20yrs Groyne No 1 c 20yrs Hastings Harbour Arm c20yrs Seawall <15yrs, c20yrs	Historically accreting, the western end of the unit is presently retreating. Drift is easterly and the breakwater and harbour created an accretion zone updrift of the breakwater arm, which promoted land reclamation behind the breakwater.
Hastings West	Protected since the late 1800's following	East of Glyne Gap a small outcrop of eroding	Gravel foreshore with sand at low

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
Chainage: 27694 to 31860 Defence Length Codes: CPSE: 574/4315-4306, 4307[part] SDS: 074/3405[part], 3406[part], 3407,3410d	erosional losses in St. Leonard's. *1930s*: Concrete wall between White Rock and Goat Ledge. Late 1950's / early 1960's: Installation of groyne fields Late 1980s/early 1990s: Reconstruction of western section of 1930s concrete wall and extension eastwards past the Pier. Encasement/reconstruction of groyne field and beach nourishment. Other coastal structures include Hastings Pier and a number of outfalls, SWS Bulverhythe Tower MTW long outfall, Coombe Haven MTW long outfalls, Bo Peep and Warrior Sq. Overflows.	clay cliffs is protected by a series of rock groynes and the toe of the cliff is protected by a rock toe bund positioned some distance beyond the toe of the cliff. Beach material has infilled the area between the toe bund and the cliffs. History of flooding at West Marina. Hastings West Marina to the Pier consists of a shingle beach fronting a concrete seawall forming a two-tiered promenade and a series of timber and concrete groynes. Rock has been placed at various erosion "hot-spots". <u>Residual Life</u> Rock groynes and toe protection <50yrs Timber groynes <5-10yrs/ <15yrs Concrete groynes <35-40yrs, <50yrs Concrete wall <15yrs, c20yrs (undermining)	water with increasing bedrock exposure to the east. West Pier may be responsible for interruption of sediment transfer within the unit. Shingle fronts a low-lying, alluvial area of Coombe Haven, which gives way to the headlands of St. Leonard's and White Rock. In the zone offshore of St Leonards is a submerged forest.
Bexhill East Chainage: 24309m to 27694m Defence Length Codes: CPSE: 574/4410-4406 SDS: 074/34013404, 3405[part], 3406[part]	*Circa 1930*: Masonry wall constructed at west end of unit (My Lords Rock). *1950-1960*: Wall extended (in concrete) eastwards up to Galley Hill. *1980's*: Groyne field constructed along entire frontage and concrete wall extended through Galley Hill. Other structures include storm water outfalls to the sea.	A shingle beach partially constrained by a series of timber groynes, which are at the end of their design lives. The frontage has a wall at the back of the beach, although the form of this structure varies along the length. The eroding clay cliff situated at the back of the beach at Galley Hill has largely been stabilised by the construction of the wall. History of flooding at Bulverhythe. <u>Residual Life</u> Timber groynes <5-10yrs Seawall <5-10yrs/ <15yrs (undermining)	The foreshore is of shingle storm gravels with sands and exposures on the lower shores. Bedrock is Tunbridge Wells sandstone and siltstones in the west.
Bexhill West	*Circa 1960*: Vertical concrete wall	Shingle and sand beach with groyne field along	Flat marshland at the western end

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
Chainage: 21004m to 24809m Defence Length Codes: CPSE: 574/4414-12, 4411[part] SDS: 074/3304[part]	constructed at De La Warr. *1976:* Approx 1.4km of recurve wall constructed along West Parade. *1980*: Timber groynes constructed along majority of frontage. *1985*: Approx 1.3km of concrete recurve wall constructed at Cooden, forming a promenade along the frontage. Timber groynes constructed in front of new wall.	entire length. At the western limit (Cooden) the wide beach ridge is backed in places by a grass embankment. Moving eastwards the shingle ridge narrows and is backed by a promenade with a splash wall (Cooden to West Parade). Directly behind the promenade and embankment there is urban development. Further east of Cooden towards De La Warr there is a near-vertical concrete wall at the back of the beach with promenade on top. Again this provides protection to residential properties. Residual Life: Groynes at Western limit of Cooden <5-10 yrs Groynes along remainder of frontage <5-10yrs/ <15yrs Seawall west (at rear of beach) <15yrs, c20yrs Seawall east (at rear of beach) <5-10yrs/ <15yrs	of Bexhill, rising eastwards to Cooden Cliffs (Cretaceous). Shingle and sand foreshore with intermittent exposure of bedrock (Tunbridge Wells Silts and Sandstones).
Norman's Bay Chainage: 17023m to 21004m Defence Length Codes: CPSE: None SDS: 074/3302[part], 3303, 3304[part]	*1900s*: Timber groynes constructed to retain beach. *2001 onwards*: Regular beach recycling under PFI project. Other structures include Martello Towers (Scheduled Ancient Monuments).	Groynes retaining shingle embankment with some timber breastwork. Shingle ridge is extensive in places. Short stretches of concrete seawall, apron and revetment at rear of beach. Condition of groynes varies across length, from poor at western limit (less than 50% of planking remaining) to good at the eastern limit. Residual Life Timber groynes <5-10 yrs at western end, <15yrs at eastern end. Concrete seawall (at rear of beach where present) c20yrs, <35-40yrs (depending on present beach condition)	Backshore consists of low-lying alluvial meadows (Hooe Levels) which join the Pevensey Levels. Length is fronted by a single continuous shingle ridge, which extends for the entire frontage.

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
Pevensey Bay Chainage: 13622m to 17023m Defence Length Codes: CPSE: none SDS: 074/3302	*Mid to late 1900's:* Timber groynes constructed to retain beach. *2001 onwards*: regular beach recycling under PFI project (although infrequent beach recycling took place prior to this). Other structures include Martello Towers (Scheduled Ancient Monuments).	Groynes retaining shingle embankment with some timber breastwork. A short stretch of concrete seawall at rear of beach. Groynes have most planks remaining and are in fair condition. Residual Life Timber groynes <5-10 yrs/ <15yrs	**Backshore:** Tidal flats and saltmarsh (Manxey Levels) **Foreshore:** One continuous shingle ridge, which fronts the low-lying hinterland. Historically accreting, but decline in sediment supply may affect this.
Eastbourne East (The Crumbles) Chainage: 9323m to 13622m Defence Length Codes: CPSE: 4201-4204, 4205[part] SDS: 3210D[part], 3211D, 3201, 3220D, 3301-02	*Circa 1900/1930*: Timber groynes constructed to retain beach. *1907*: Langley Point Outfall Constructed *Circa 1970*: Concrete wall at The Redoubt. *1992*: Sovereign Harbour Breakwater arm constructed. *1993*: extension of concrete wall near Harbour arm. Works on northern rock breakwaters. *1995-1999*: Existing groynes between The Redoubt and Langley Point replaced with 36 nr new timber groynes with beach recharge. Rock revetment at Crumbles Outfall and either side of Langley Point Outfall. Future monitoring and maintenance (inc beach recharge) planned. *2001*: 440m rock revetment east of Sovereign harbour to rear of beach. Groynes in area partially removed. Other structures include Martello Towers (Scheduled Ancient Monument), sewers and long sea outfall at Langney Point.	West of Sovereign Harbour a shingle beach with 90m-long timber groynes at 60-70m spacing, protecting dense urban area. Concrete wall along back of beach at western limit. Breakwaters, quay wall and revetment at Sovereign Harbour. Material accumulating at the western (S) breakwater is being bypassed to the north-east of the harbour. Rock revetment north-east of Sovereign Harbour partially buried in Shingle bank. Groynes have been removed over 440m length. Further north-east Residual Life Groynes (west of Langley Point) c20 yrs Groynes (east of Sovereign Harbour) <5-10yrs, <15yrs Sovereign Harbour breakwaters c50yrs Rock Revetment <35-40 yrs	Low-lying area, composed of tidal flats and saltmarsh being rapidly developed. Foreshore developed through reclamation of land closed shingle ridge The Crumbles has a large accumulation of shingle deposits, which fronts the low-lying Willingdon Levels. Since construction of Sovereign Harbour, frontage east of the harbour is now eroding. Crumbles outfall and Langley Point Outfall particularly volatile areas of frontage.
Eastbourne West Chainage: 5700m to	*Circa 1900/1930*: Seawalls and timber groynes constructed	Rock revetment at base of cliff at Holywell. Shingle beach with 90m-long timber groynes at	Low chalk cliffs declining eastwards from Holywell to low-lying land at

Location	Defence History (optional)	Present Defences & Residual Life	Natural Features
9323m Defence Length Codes: CPSE: 574/4205 [part]-4206 [part] SDS: 074/3210D [part]	*1995-1999*: Existing groynes from Holywell eastwards replaced with 54 nr new timber groynes with beach recharge and secondary splash wall between Pier and The Redoubt. Future monitoring and maintenance (inc beach recharge) planned. *2001*: 75m rock revetment constructed at base of cliffs at Holywell to protect water source. Other structures include Eastbourne Pier.	60-70m spacing, protecting dense urban area. Concrete wall along back of beach for majority of length. <u>Residual Life</u> Groynes c20 yrs Seawall (at rear of beach) <35-40 yrs Rock revetment <50yrs, >50yrs	Redoubt. Rock platform underlies beach. Longshore transport rates estimated at 4,000-8,000 m^3/yr easterly (higher immediately after recharge) (Posford Duvier 1999). Offshore zone wide and shallow with potential offshore sources of gravel.
Beachy Head	The shoreline is undefended although natural cliff falls offer a measure of shoreline protection.	The shoreline is undefended although natural cliff falls offer a measure of shoreline protection.	The shoreline is undefended although natural cliff falls offer a measure of shoreline protection.

C3 Climate Change and Sea Level Rise

Introduction

The global climate is constantly changing, but it is generally recognised that we are entering a period of change, particularly with respect to rising sea levels and the anticipated implications of climate change and sea level rise present a significant challenge to future coastal management. Over the last few decades, there have been numerous studies into the impact of potential changes in the future, however, there remains considerable uncertainty both within the science of future climate modelling and associated with future global development patterns.

Sea level rise

The South coast is believed to be still responding to changes during the last 10,000 years when sea levels rose rapidly, flooding the North Sea Basin and Solent area, but there is now concern over human-induced acceleration in sea level rise due to climate change. Relative sea level change depends upon changes in global sea level (eustatic change) and in land-level (isostatic change).

Isostatic change is the change in land level as the crust slowly readjusts to unloading of the weight of the ice since the last Ice Age c.125, 000 years BP (this phenomenon is also known as crustal forebulge). Therefore, areas which were covered by ice, i.e. northern England and Scotland, have been experiencing a rise in land levels over the last few thousand years, whereas the south-east coast of England has been subsiding at a rate of 0.9mm/year (regional isostatic subsidence: UKCIP, 2002), in specific locations though this has been as high as 1 to 2mm / year (Dungeness Foreland, for the last 4,000 years BP, Long & Shennan, 1993).

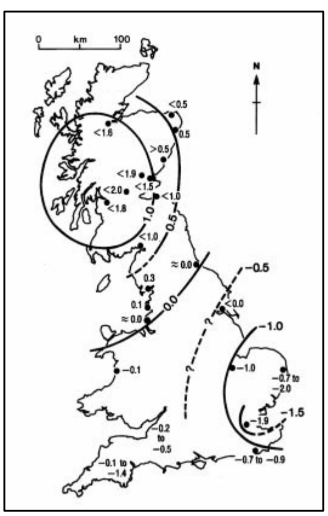

Figure 3.1 Estimates of relative land changes (mm/yr): positive values indicate relative land uplift; negative values are relative land subsidence. Effects of sediment consolidation are not included [Source: Ian Shennan, 1989].

Eustatic change can be influenced by climatic changes (e.g. increased temperature causes an increased volume of water through thermal expansion and melting ice). Evidence suggests that global-average sea level rose by about 1.5mm/year during the twentieth century; this is believed to be due to a number of factors including thermal expansion of warming ocean waters and the melting of land (alpine) glaciers[4], but after adjustment for natural land movements, it has been calculated that the average rate of sea-level rise during the last century around the UK coastline was approximately 1 mm/year[4].

Predictions of sea level change have been developed by the UK Climate Impacts Programme (UKCIP, 2002) for four possible future climate scenarios: Low, Low-Medium, Medium-High and High; these span a range of emissions scenarios and different climate sensitivities.[5] The Table below presents the current UKCIP (2002) estimates of future sea level change for Southern England under four scenarios that range from low to high emissions. The Table also includes the Defra 2003 recommendation for consideration of sea level rise, which has been used in the SMP assessments.

Regional Isostatic Subsidence	UKCIP Net Sea-level Change 2080s (relative to 1961-90)				Defra recommendation for Southern Region (2003)
	Low Emissions scenario	Low-Medium Emissions Scenario	Medium-High Emissions Scenario	High Emissions scenario	
0.9 mm/yr	330mm (190-580mm)	360mm (210-640mm)	400mm (230-690mm)	460 mm (260-790mm)	6mm/year
(Data from Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report) (data available from website: *www.ukcip.org.uk*). Figures represent the mean rate of sea level change, low and high figures are presented below these figures, in the brackets)					

Storminess

It has been postulated that climate change may increase storminess around the UK, but although the UKCIP02) studies indicate some increase in storminess, there is a high degree of uncertainty and little agreement between models, regarding changes in mid-latitude storm intensity, frequency and variability. Therefore although this is recognised as an uncertainty within the predictions, no detailed analysis of potential impacts has been undertaken.

Precipitation

In addition to sea level rise and storminess, the other climate change factor that is important to coastal evolution is precipitation. UKCIP02 predictions suggest that winters will become wetter but summers may become drier throughout the UK. However, there is potential for heavy winter precipitation to become more frequent. This may have an impact on the soft cliffs along this coastline could increase the likelihood of large-scale slope failures, but although this is recognised as an uncertainty this has not been directly taken into account in the shoreline evolution predictions, as effects are likely to be

[4] Hulme,M., Jenkins,G.J., Lu,X., Turnpenny,J.R.,Mitchell,T.D., Jones,R.G., Lowe,J., Murphy,J.M., Hassell,D., Boorman,P., McDonald,R. and Hill,S. (2002) Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK. 120pp

[5] Refer to www.ukcip.org.uk

localised, but where large-scale failure are a potential hazard this has been recognised in the scenario assessments.

C4 Baseline Case 1 – No Active Intervention (NAI)

C4.1 INTRODUCTION

This report provides analysis of shoreline response conducted for the scenario of "No Active Intervention". This has considered that there is no expenditure on maintaining/ improving defences and that therefore defences will fail at a time dependent upon their residual life[6] and the condition of the beaches.

The analysis has been developed using the understanding of coastal behaviour from both Futurecoast (2002) and the baseline understanding report produced[7], existing coastal change data[8] and information on the nature and condition of existing coastal defences. In addition to this report, maps illustrating this are included at the end of this Appendix.

C4.2 SUMMARY

The following text provides a summary of the analysis of shoreline response with details specific to each location and epoch contained within the Scenario Assessment Table.

Epoch 0-20 years (to 2025)

During this period there will be increased pressure on the coastline, with continued diminishing beaches along much of the shoreline.

Substantial defences such as seawalls, rock groynes and structures like harbour arms, will remain along the majority of frontages however, timber groynes and defences with a low residual life will fail, allowing the beach and its sediment to move freely. At these locations, erosion will initially accelerate and specific beaches are anticipated to reduce significantly as a consequence e.g. Bexhill. The lack of foreshore material will, in turn, put increased stress on the more substantial defences.

Where defences remain, the ability of the shoreline to adapt to rising sea levels will be restricted and it is likely that the beach will narrow, which will put increased pressure on the defences. These areas will increasingly become promontories as adjacent undefended areas retreat.

Cessation of beach recycling and re-nourishment will have an immediate impact on shoreline stability and position, resulting in beach narrowing and retreat at locations such as Pevensey Bay, Cliff End and on the southern shore of Dungeness (Lydd Ranges). Conversely in areas where shingle is extracted from i.e. the 'borrow pit' on the north-eastern nose of Dungeness, this will result in accretion.

The undefended cliff frontages will continue to erode at a rate similar to the historic one. There are not likely to be significant increases in the frequency of flood inundation during this period, but locations where the beach narrows will become increasing susceptible, such as at Bulverhythe and Jury's Gap. Littoral transport will continue to be dominant in an eastward direction and there is likely to be little net change to the sediment budget although the volume may be slightly less due the cessation of recharged material.

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[6] Refer to Section C2
[7] Refer to Section C1
[8] Refer to Section C4.4

Epoch 20-50 years (to 2055)
Accelerating sea level rise and the potential for increased storminess will put increased pressure on the coastal system. During this period, the majority of the remaining seawalls and revetments will fail, exacerbated by the narrow beaches and increased exposure. Where the shoreline position has been held seaward of its natural alignment for more than 100 years, there will be a period of relatively rapid erosion, which will last until a natural equilibrium in shoreline dynamics is attained. This could be between 5 and 20 years after defence failure.

Under these increased pressures, and with the lack of management, specific beaches will denude rapidly such as Eastbourne, Bexhill and Hythe Ranges, as well as specific areas being at risk from flood inundation e.g. Bulverhythe.

There will be a landward transgression of the, now unconstrained, barrier beaches due to sea level rise, which may result in reworking (or cannibalisation) of the shingle area behind (e.g. Lydd Ranges, Dungeness).

Along sections where cliffs were previously defended, erosion will be reactivated, which will initially result in high levels of instability via toe erosion. There will be increased input of sediment into the system, but it is expected that this will mainly result in maintaining rather than building beaches. Undefended cliffs will continue to retreat, at a rate slightly higher than that at present, due to sea level rise.

Generally, the shoreline will start to develop and respond more naturally, with coastal processes only being interrupted a small number of locations, where major structures remain in place, i.e. the harbour structures at Sovereign Harbour, Rye, Folkestone and Dover.

Epoch 50-100 years (to 2105)
All defences will have failed or become ineffective by the end of this period i.e. some of the rock bund structures will still exist but their effectiveness in reducing wave energy, at the shoreline, will be minimal due to cliffs or the back of beach being in a retreated, and largely detached position.

Where defences have remained up to the start of this period, the shoreline may be protruding several tens of metres seaward of the adjacent shoreline, therefore as these defended sections fail, there will be a rapid recession, as the shoreline attains a position more commensurate with shoreline energy. Along undefended stretches cliff erosion will continue at accelerated rates due to sea level rise. The input of debris will only be sufficient enough to allow narrow beaches to be maintained at the cliff toe.

At Dungeness, the central low-lying area, along the South Foreland to Beachy Head coastline, there will be a continued landward transgression of the southern barrier beaches, as a more ‘swash-aligned’ position is formed. This will be achieved via ‘cannibilisation’ of the back barrier and alongshore transportation. The shingle bund will fail during this epoch, allowing the ‘ness’ to migrate in a reasonably unconstrained manner i.e. to migrate north-eastwards. The presence of the reactor buildings will however, exert an influence on the position of the coastline, holding it temporarily static. North of the ness the shingle beach will continue to accrete, especially the area around Lydd-on-Sea and Lade, tapering towards Romney Sands.

The long-term picture is one of a more connected coastline, in a position more commensurate with shoreline energy. Along most of the shoreline there will be a more naturally functioning sediment transport system. There will however, still be continued shoreline retreat, in response to sea level rise, as sediment input, from cliff retreat, will not be sufficient to build beaches. At some locations, beaches may narrow where cliff retreat is slower than the advancing sea level.

This picture will only be disrupted where the barrier-beaches fronting low-lying areas i.e. Pevensey Levels, Bulverhythe, Lydd Ranges, become periodically breached, allowing semi-permanent brackish lagoons to form, (which may, in the future, lead to the formation of tidal inlets.)

Although there are obvious uncertainties over the final morphology of the Beachy Head to South Foreland shoreline, it is highly probable that where there are cliffs, the position of the shoreline will be more seaward than the low-lying sections. The large plan form changes, in position, that are likely are the deepening of the bays between Beachy Head and Bexhill, nominally Pevensey Bay and Norman’s Bay, a more south-westerly alignment (i.e. facing dominant waves) of the southern shore of Dungeness and deepening between Romney Sands and Hythe.

C4.3 NAI SCENARIO ASSESSMENT TABLE

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
South Foreland	**Timber Groynes at St. Margaret's will fail early on during this epoch**	**No Defences / Management**	
	The chalk cliffs will continue to erode at a rate similar to historic. Susceptible to sub-aerial weathering, periodic slumps and block failures, large falls from the cliff face are likely. This will induce the formation of debris boulder and chalk rubble 'aprons', providing temporary protection to the cliff toe. The chalk shore platform that fronts this section of the coast is covered with very little foreshore sediment. There exists potential for the eastwards movement of foreshore sediment across, and beyond, the frontage.	Cliff recession (due to both marine and sub-aerial processes) and platform lowering will continue at rate similar to that experienced historically. Recession of the chalk cliffs yields minimal flinty shingle to the foreshore. Any chalk rubble released will initially accumulate at the toe until it becomes broken down and transported alongshore (in an eastwards direction). There is a general lack of contemporary shingle and sand supply to the frontage, tending to result in only limited protection offered by the natural shingle foreshore and, consequently, a propensity for continued cliff recession.	Cliff recession and platform lowering is likely to increase throughout this epoch due to sea level rise. Wave attack will be concentrated at the toe, prompting further instability i.e. periodic slumps and block failure. Any chalk rubble released will accumulate at the toe until it becomes broken down and transported alongshore (in an eastwards direction). Recession of the chalk cliffs will continue to yield flinty shingle to the foreshore, which can be transported eastwards by longshore drift.
Dover Harbour	**Groynes will fail half through this epoch. Concrete Seawall will remain. Breakwater / Harbour Arms will remain.** **(Dover Harbour will remain 'protected', within the confines of the harbour arms, due to its economical importance).**	**Concrete Seawall either side of the harbour arms will fail early on during this epoch but within the confines of the harbour it will be maintained.** **Breakwater / Harbour Arms will remain**	**Breakwater / Harbour Arms will remain** **Seawall will remain within the harbour**

Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	The western pier has trapped alongshore material, resulting in beaches accreting on the western side. To the east of the harbour though the beaches will continue to narrow due no other local supply of sediment being available. The present management practises at Dover Harbour prevents inundation of the River Dour valley from the sea. It has been assumed that this will continue to be the case in the future.	The concrete seawall on the flanks of the harbour will fail and a landwards transgression of the shoreline will commence. It is likely that the harbour arm on the west side of the harbour will continue intercepting alongshore transport and artificially the beach here will continue to accrete, albeit at a very small rate, as little sediment will be entering the system. Sea level rise and increased storminess will start to have an impact on the coast and narrowing of the shingle beach within the confines of the harbour and adjacent beaches will be at risk.	Accelerated sea level rise will continue to put 'stress' on the resources and defences within the confines of the harbour and they might need to be strengthened as a consequence. The shingle beach within the harbours arms is likely to be lost, as are the beaches either side of it.
Shakespeare Cliff	**No Defences / Management**		
	There is a general lack of contemporary sediment entering this frontage, due to updrift defences and features like Samphire Hoe, which restrict sediment movement. The shingle foreshore therefore offers limited protection. The cliffs and the shore platform will continued to recede, at a rate similar to that experienced historically and any periodic slump and block failures will result in the formation of wide aprons of debris containing boulders and chalk rubble at the cliff toe. Here it will be broken down and transported alongshore, in an eastwards direction.	Rates of natural cliff recession and shore platform lowering are likely to continue at a slightly greater rate than that experienced historically. Chalk rubble released will initially accumulate at the cliff toe, before being transported alongshore by marine processes. There is a general lack of contemporary shingle supply throughout this frontage, tending to result in limited toe protection. Sea level rise and increased storminess will aggravate the situation.	The chalk cliffs will continue to actively recede during this epoch, with the rate increasing in response to sea level rise, sub-aerial weathering and adjacent cliff instability. Despite a pulse of fine material entering the system, the shingle beach will narrow. The chalk platform will become increasingly redundant in response to sea level rise, which will further encourage cliff erosion. Chalk rubble released will be broken down and transported alongshore.

Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
Samphire Hoe	**Concrete Apron Wall will remain** **Block and Rock Revetment will remain** **Rock Armour will remain**	**Concrete Apron Wall will fail towards the end of this epoch** **Block and Rock Revetment will fail towards the end of this epoch** **Rock Armour will fail towards the end of this epoch**	**No Defences / Management**
	The construction of Samphire Hoe, an artificial seaward-extended platform, from depositional spoil from the Channel Tunnel and its containment within a protective seawall, affords substantial protection to the backing chalk cliffs. There will therefore be no change in cliff line position during this epoch. The artificially seaward alignment of Samphire Hoe might interrupt sediment movement alongshore.	Up until the defences fail, very little change, in the position of the shoreline / cliff line, will occur along this frontage. However, as defences are likely to fail towards the latter end of this epoch, it will initially result in the 'spoil' being released into the system and transported alongshore. Marine processes at the toe of Abbots Cliff will be re-activated at the latter end of this epoch.	With the loss of Samphire Hoe, erosion of Abbots Cliffs will be re-activated and instability prompted. Any slumping would release chalk rubble to the toe and here it will be broken down and transported alongshore (to Shakespeare's Cliffs) or offshore, by marine processes. The cliffs will erode at a similar rate to what they did prior to defences being constructed. The rate of recession will probably be in the region 20 to 50m by 2105.
Abbot's Cliff	**No Defences / Management**		
	The 140m high chalk cliffs will continue to erode at a similar rate to that experienced historically, which will be in the region of 5m to 10m by 2025. Slow rates of platform lowering are anticipated during this epoch and therefore toe protection and stability will continue. Material released will be predominantly fines and therefore not provide localised and downdrift beach building material.	The chalk cliffs will continue to erode, at a potentially higher rate than it has done historically, due to sea level rise and adjacent cliff instability, retreat could therefore be in the region of 10 to 25m by 2055. Rates of platform lowering are also likely to be slightly higher due to sea level rise. Any chalk rubble released, from rock falls, will initially accumulate at the toe of the cliffs until it becomes broken down and transported alongshore by marine processes	Chalk cliff recession will continue to increase throughout this epoch due to sea level rise, increased sub-aerial weathering and adjacent cliff instability. Retreat could therefore be in the region of 20 to 60m by 2105. Any chalk rubble released will initially accumulate at the toe until it is broken down and transported alongshore to Samphire Hoe.

<table>
<tr><th rowspan="2">Location</th><th colspan="3">Predicted Change for</th></tr>
<tr><th>Years 0 – 20 (2025)</th><th>Years 20 – 50 (2055)</th><th>Years 50 – 100 (2105)</th></tr>
<tr><td rowspan="2">Folkestone Warren</td><td>Timber Groynes will fail early on along the western frontage whereas along the eastern section they will fail towards the end of the epoch
Concrete Seawall and rock armouring will start to reduce in efficiency.</td><td colspan="2">Concrete seawall and rock armouring will become increasingly ineffective throughout the 20 – 100 year epoch resulting in minimal protection.
The lower slope, fronting the chalk back scarp, will start to become mobile which may induce periodic failure of the backing cliffs.</td></tr>
<tr><td>The seawall will continue to prevent cliff retreat throughout the majority of this epoch however upon failure the cliffs erosion will be re-activated. ‘The Warren’ cliffs exhibit classic rotational landslips and material released can result in the sudden influx of considerable volumes of predominantly fine sediment to the foreshore. The debris will provide limited protection to the toe, but once removed downdrift and offshore, further episodic landsliding events will be prompted.
Generally there is a lack of contemporary sediment input to the frontage from updrift sources, tending to result in only limited protection offered by the natural shingle foreshore.</td><td>There will be continued cliff erosion, providing localised protection to the toe before being transported alongshore.
With the updrift failure of Folkestone’s harbour arm it is likely that the foreshore will receive a ‘pulse’ of material (shingle) from the west. The volume would however be insufficient to alter the overall trend of foreshore denudation.
As a result of reducing natural foreshore protection, the stability of the sea cliff complex would decrease further and encourage more frequent landslide events.</td><td>‘The Warren’ cliffline will probably retreat at a rate greater than that experienced historically due to a lack of defences, the sea level rise and limited material at the cliff toe. This combination will prompt further instability with a potential recession rate of in the region of 50 to 100m by the end of the epoch.
Debris from cliff failure will be transported alongshore but the nature of this material will not be appropriate to build beaches with.</td></tr>
<tr><td>Folkestone:
(Copt Point to Sandgate)</td><td><u>To the west:</u>
Beach Recharge will terminate immediately
Concrete and Timber Groynes and seawall will fail early on
Concrete Breakwater
<u>To the east (Copt Point):</u>
No Defences / Management</td><td>Rock groynes may begin to fail towards the end of this period
Concrete Breakwater / Harbour arm may fail towards the end of this period</td><td>No Defences / Management</td></tr>
</table>

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	At the western end the cliffs are fronted by limited foreshore deposits, which make this section of the beach vulnerable to erosion. At the eastern end (Copt Point) the cliffs are fronted by a shore platform, erosion is therefore lower. Rates along this section will continue to be similar to that experienced historically i.e. localised large-scale rotational landsliding, which may cause up to 10m of retreat in a single event. Any debris material will rest temporarily at the toe before being transported alongshore (to Folkestone Warren) and offshore. The harbour arms, located at the extreme eastern end of this frontage, will continue to act as terminal groynes, trapping material moving alongshore, this will continue to build Rotunda Beach but erode downdrift sections such as Coronation Parade.	With the failure of the seawall in the previous epoch, erosion and landsliding of the unprotected cliffs will commence, resulting in large slabs of mudstone (fines) being deposited onto the foreshore. As there will be a general lack of contemporary shingle entering the frontage; the amount of toe protection will be limited. This, along with a rise in sea level will accelerate cliff recession. Debris material, will offer some localised protection but it will be transported alongshore relatively rapidly due to a lack of defences that used to hold the material in place. The failure of the harbour arm, towards the end of this epoch, will release a ‘pulse’ of material (nominally shingle) to downdrift locations (Folkestone Warren).	With the cliffs being unprotected and sea level rising, it is likely that the cliff erosion will increase, as wave attack focuses additional energy at the cliff toe. Little if any shingle beach is anticipated to remain along the western front and what debris fronts the cliffs will be very narrow and readily transportable, therefore offering very little protection to the toe. The shore platform, at the toe of the cliffs, along the eastern section, may continue to reduce the impact of wave attack but the efficiency at which it does this may reduce during the course of this period, as a consequence of sea level rise, which could be in the region of up to 4mm to 6mm /annum.
Sandgate to Hythe	**Timber groynes will fail early on** **Concrete Seawall (at Hythe) will fail towards the end** **Rock Revetment will remain** **Rock groynes will remain**	**Rock Revetment will fail early on** **Rock groynes will fail towards the end**	**No Defences/Management**

Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	A shingle beach, with low-lying hinterland separates a fossil cliff line along the western section of the frontage. The beach is widest to the west of the frontage and decreases towards Sandgate, where the cliffs become active sea cliffs and are subject to marine erosion. There is a low sediment transport rate along this frontage due to a lack of contemporary sediment entering the system. The beach is likely to diminish in volume as sediment continues to be transported alongshore (to Folkestone). The rock groynes will continue to add stability to the beach during the majority of this epoch and the seawall will ensure that the backshore position does not change. However as the seawall is anticipated to fail, by the end of this epoch, the shoreline will roll back, across the low-lying hinterland. The rate of roll back is controlled by material availability, rate of sea level rise, and backshore gradient.	Rock groynes along the front will continue to retain some of the beach but as they fail, towards the end of the epoch, the retained beach material will become released. The beach will respond by narrowing in width and lowering in height. With failure of the seawall, at the end of the previous epoch, the landward transgression of the shingle barrier will commence. This will be restricted along the eastern section by cliffs. During this epoch the shingle beach that fronts them will roll back, to the toe, to re-activate the erosion process. Failure at the cliff toe will provide some localised material but it will not be significant to build beaches.	The shingle barrier beach, along the western section of this frontage, will continue to rollback, across the low-lying hinterland, in response to sea level rise. Contemporary shingle input into this system will decrease with time. The beach will respond by narrowing and eventually segmenting. Reactivation of the cliffs at the eastern end of this frontage will become more significant during this epoch, especially at Sandgate and Encombe, which will have a ‘knock-on’ effect downdrift by accelerating the failure of adjacent sections. Any sediment supplied from cliff erosion will be localised and provide some toe protection. Any fines released will be dispersed alongshore to downdrift units i.e. Folkestone.
Hythe Ranges to Romney Sands	**Concrete Seawall will fail towards the end of this period** **Timber Groynes will fail early on in this epoch** **Rock Revetment (Hythe Ranges)**	**Rock Revetment (Hythe Ranges) will fail by the end of the epoch.**	**No Defences / Management**

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	A shingle and sand beach fronts the low-lying alluvial hinterland of Romney Marsh. Groynes will continue to hold this barrier initially but as they fail, which will occur at an early stage in this epoch, longshore drift along this frontage will increase. The seawall at Dymchurch is expected to fail towards the latter part of this epoch, resulting in erosion of the beach and periodic flooding of the low-lying hinterland.	With no defences in place to hold the beach seaward of its natural alignment, retreat during this epoch is anticipated to be quite rapid. The plan position of the shoreline will start to become embayed, especially in between St. Mary's and Dymchurch. This metamorphism will be exacerbated by sea level rise and a lack of contemporary feed (shingle) from updrift sources. In response to this the shingle ridge may roll back but if it struggles to keep pace with sea level rise, especially as the epoch draws to a close, then in places there could be the potential for barrier segmentation. Due to an apparent lack of shingle entering the system a predominantly thin, sandy beach is anticipated along this frontage.	The shoreline between Dymchurch and Hythe will continue to progressively narrow and deepen in plan form. The shoreline will experience roll back and consequently the shingle barrier will start to segment throughout the epoch and breach on a regular basis. Erosion of the foreshore would lead to the re-working of the sediment stored within the backshore ridges. Specific areas are likely to come under attack from marine inundation, nominally St. Mary's and Dymchurch. Minimal beach building material is likely to enter the frontage from updrift sources, which will encourage the development of a swash-aligned form.
Dungeness East (Romney Sands to The Pilot)	**Timber Groynes will fail early on**	**No Defences / Management**	
	The shingle beach that fronts relict shingle ridges will continue to accrete throughout this epoch. This may be at a slightly accelerated rate than the current one, due to the failure and termination of updrift defence and management practises along with the cessation of shingle extraction from the borrow pit area. Inputs and outputs of alongshore shingle transport are anticipated to increase slightly, redistributing sediment in a predominantly northwards direction, which will reduce towards Romney Sands, where a null point and a fairly stable sand dune system exists.	Despite sea level rise, which could be in the region of 4 to 6mm / per year, the shingle beach on the frontage between The Pilot and Lade will continue to accrete. Alongshore feed, from updrift sources i.e. Lydd Ranges and Dungeness South may be slightly greater than what it currently is due to updrift defence failure, management cessation and the shingle barrier updrift aligning to a position more commensurate with shoreline energy. Shingle feed (transportation) and beach width will taper towards Romney Sands, which is likely to remain the null point along this section of the coast.	The shingle beach between the Pilot and Lade will be substantial enough to provide protection against a rise in sea level and a potential increase in storminess. At Romney Sands it is likely that the effects of sea level rise and greater wave attack will threaten dune integrity. Erosion may start off in the form of 'blow-outs' and extend with time. The shingle barrier at Greatstone-on-Sea, in between Lade and Romney Sands, may start to experience periodic inundation of the hinterland (Romney Marsh), creating a semi-brackish environment towards the end of the epoch.

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Dungeness South (Reactor to The Pilot)	**Shingle Bund** **Beach Recycling will terminate**	**Shingle Bund will experience erosion**	**No Defences / Management**
	As at Lydd Ranges, without shingle recharge there will be realignment of the coast, resulting in erosion of the southern shore. At Dungeness Power Station, the coastline is held seaward of its natural position, which results in this section experiencing greatest pressure therefore erosion of the shingle bund, is expected. The rapid transport rates along this frontage means it is unlikely that the beach along here will build. The 'nose' of Dungeness represents the point of no significant net contemporary change in sediment volume and this point migrates on a regular basis.	A potentially greater amount of shingle will enter the system from the west (Lydd Ranges) due to the updrift barrier realigning. Cannibalised material will hold the 'nose' to some degree but the majority of the material will be transported around the 'nose', coming to rest on the eastern shore. The north-eastwards migration of the Ness is anticipated to continue. The foundations of the nuclear reactor buildings may start to come under attack due to erosion of the shingle bund, especially under storm conditions and sea level rise.	The reactor buildings will 'hold' the shoreline for a period, which will prevent erosion in front of the power station, but cause outflanking especially on the western side. The reactor buildings will also act as a groyne, restricting the alongshore migration of shingle. Material will continue to move anti-clockwise around the 'ness.' The amount of shingle transport around the nose is likely to be quite considerable and it is possible that some offshore loss of shingle will occur from the nose. Eventually the reactor buildings will fail (+100 years) and the 'ness' will be able to migrate in an unconstrained manner.
Lydd Ranges (Broomhill to Dungeness Reactor)	**Beach Recycling will terminate immediately** **Storm Re-Profiling will cease immediately**	**No Defences / Management**	

Location	**Predicted Change for**		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The immediate cessation of shingle recycling and beach re-profiling would initiate a re-alignment of the shingle barrier beach, on the southern facing foreshore. The plan form would progressively move towards a swash-aligned coast. As a result there would be erosion of the front edge of the most seaward ridge. The areas of low-lying alluvium that intercept the shingle ridges would become increasingly susceptible to localised inundation, especially at the western section of the frontage, as the beach becomes re-aligned. Insufficient sediment is entering the frontage; due to updrift defence works and the influence of the drift divide at Broomhill, more material is anticipated to be leaving the system.	The plan form of the beach would become progressively swash-aligned, which will instigate the re-activation and re-working of shingle stored within relict ridges. This material will then be transported alongshore; the rate at which this occurs is anticipated to reduce over time, as a dynamic equilibrium is reached. The low-lying areas of alluvium that intercept the ridges will become (periodically) inundated Erosion will be most significant at the western end, near Jury's Lookout and during this epoch the Green Wall, a secondary clay bank defence, will be lost.	Erosion of the southern facing shingle beach will continue, potentially at a slightly greater rate than that experienced in the two previous epochs, due to sea level rise, which could be in the region of 4 to 6mm/year. As little beach building material (shingle) is entering the system from updrift locations, i.e. Rye Harbour East, the shingle barrier will cannibalise sediment 'in situ', distributing the material to a location that is more commensurate with shoreline energy.
Rye Harbour East (Camber Sands to Broomhill)	**Beach Recycling will terminate immediately** **Timber Groynes will fail early on Concrete Seawall will fail towards the end of this period** **River Training Wall will remain**	**River Training Wall will fail towards the end of this epoch**	**No Defences / Management**

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The western and central section of this frontage is dominated by sand dunes, which will continue to accrete throughout the entirety of this epoch, which may be related to the sheltering presence of Rye Harbour terminal groyne, which blocks shingle inputting this frontage and the river training wall. At the eastern end the sand dune system gives way to a mixed sand and shingle veneer beach. It is at this point (Broomhill) that a drift divide is believed to exist, because eastwards of here the mixed beach changes to shingle. The eastern section of this frontage is managed with groynes and a seawall. As soon as the groynes fail, which will occur early on in this epoch, transportation rates will increase, in an eastward direction. Within 10 years it is anticipated that the shingle beach level will be approximately 1m lower than what it currently is. The sea wall will become increasingly exposed to direct wave attack and undermining will commence, causing failure by the end of this epoch.	The shingle beach at Broomhill will recede rapidly, narrowing and lowering, in conjunction with failure of the groynes and seawall. Sea level rise will exacerbate the situation, which could be in the region of 4 to 6mm/year, prompting periodic flooding to low-lying areas, nominally Jury's Gap, Jury's Gut and the Broomhill Levels and erosion of the shoreline. To the west, at Camber Sands, no significant change is expected, due to the continued presence of downdrift structures such as Rye terminal groyne and the river training wall. However as they are anticipated to fail, by the end of the epoch and a pulse of shingle being released, which will move alongshore in an eastwards direction, their survival could be threatened.	A continued throughput of shingle from what is essentially a finite store (Winchelsea and Rye Harbour East) will accumulate in and around Camber. This may cause the River Rother to re-route, which could affect the integrity of the dunes. Shingle transportation, is anticipated to be restricted by the drift divide at Broomhill, therefore little material will pass this point. Consequently the backshore position of the beach will continue to migrate landwards. With the influence of sea level rise barrier breaching, prompting tidal inundation around the Broomhill area is highly likely.
Rye Harbour to Winchelsea	**Recycling license will not be renewed** **Terminal Groyne will remain**	**Terminal Groyne will fail in the latter stages on this epoch**	**No Defences / Management**

<table>
<tr><th rowspan="2">Location</th><th colspan="3">Predicted Change for</th></tr>
<tr><th>Years 0 – 20 (2025)</th><th>Years 20 – 50 (2055)</th><th>Years 50 – 100 (2105)</th></tr>
<tr><td></td><td>Relict shingle ridges back an active shingle barrier. The frontage will start to erode, at the western end, with the immediate cessation of shingle recycling combined with insufficient shingle entering the system. The shingle beach, at the eastern end, will continue to accrete due to the feed from alongshore transport but mainly due to the presence of Rye Harbour terminal groyne, which blocks shingle movement.</td><td>The shingle beach will continue to erode in the east and accrete at the west up until the terminal groyne fails, which is anticipated to occur by the end of this epoch. Upon failure a pulse of shingle will be released and transported in an eastwards direction across the mouth of the River Rother and on towards Camber Sands. During this epoch the unit will metamorphose from a ‘sink’ into a ‘source’ (which is what it used to be prior to the construction of the terminal groyne). Winchelsea to Rye Harbour is regarded as a sediment source because of the nature and volume of material that the hinterland is composed along with the local and regional wave climate.

The shingle barrier beach is likely to migrate landwards and as it does so align itself to a position more commensurate with shoreline energy and sea level rise, which may be in the region of 4 to 6mm/year.

Localised flooding, of the low-lying hinterland, may occur under storm conditions but the impact of this is not anticipated to be great due to the volume of material the hinterland stores</td><td>Material will continue to be progressively moved alongshore, in an eastward direction to Camber Sands. The transferral of shingle may start to block the mouth of the River Rother and towards the end of the epoch it could force the river to re-route, in an eastwards direction.

Cannibalised material will be transported alongshore to feed neighbouring units, nominally Rye Harbour East.

During this epoch it is probable that the frontage will have fully undergone the transition from a ‘sink’ to a ‘source’ and re-working of the backshore material would actively be underway. It is believed, however, that there is a sufficient store of sediment, that any threat of breaching and inundation of the hinterland, in response to sea level rise, would be localised.

Volumes of material (shingle) entering the system is likely to be comparable to volumes of shingle leaving the system. Sand will also be transported alongshore, in and eastwards direction, coming to rest in Rye Bay.</td></tr>
<tr><td>Winchelsea Beach to Cliff End</td><td>Concrete Seawall will fail towards the end

Concrete Revetment will fail early on

Timber Groynes will fail early on

Beach Recharge will terminate immediately</td><td colspan="2">No Defences / Management</td></tr>
</table>

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	There is restricted and limited feed into this area therefore, with the termination of shingle recharge the wide, shingle beach, that overlies a sandy foreshore, will start to reduce in volume immediately. As a consequence the shingle beach will start to lower, putting both the groynes and concrete seawall under increased wave attack from wave. The groynes will fail early on whereas the wall will fail by the end of the epoch. With defence failure alongshore processes will transport the shingle in an eastward direction; the vulnerability of this location will increase as a result, with the low-lying hinterland at risk from flooding. Due to defence failure and beach management cessation more material will output from this system than what enters it; Winchelsea will benefit from this.	With no sea defences in place, the shingle barrier will start to segment; resulting in periodic inundation of the low-lying hinterland. Due to a lack of contemporary sediment entering the system and sea level rise (4 to 6mm/year) the barrier will roll back. As the barrier beach migrates landwards, re-alignment would be instigated, to achieve a position more commensurate with shoreline energy. Any material re-worked within this system would be transported alongshore and on into the neighbouring downdrift 'units'.	The shingle barrier beach would continue to roll back across the low-lying hinterland in response to sea level rise and a lack of sediment entering the system. The rate at which this occurs is, however, dependant on the rate of sea level rise, the indolence of the barrier and the topography of the hinterland. This frontage would receive minimal sediment from updrift frontages, and what it does i.e. from the Fairlight complex, would be insufficient to build beaches, as the cliffs would yield mainly fines. There would, however, continue to be the longshore drift of 'cannibalised' material from this frontage, which would feed downdrift units. Cannibalisation of the barrier would result in re-alignment and in the long term (+100 years) a bay shape may develop. Breaching of the barrier and inundation of the low-lying hinterland would become more frequent and intense during this epoch, which would lead to brackish environments forming and in the future the potential for the creation of a tidal inlet.
Cliff End to	**No Defences / Management**		

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Fairlight Cove	Cliff erosion will continue at similar rates to that experienced historically. Net retreat is anticipated to be in the region of 10 to 20m by 2025. Sediment ‘released’ from the cliffs, which will be mainly fines, will be transported alongshore to the Rye Bay sink or offshore. Any shingle released will temporarily rest on the shore platform and offer short-term protection before being transported, to downdrift to locations i.e. Cliff End. Very little change to the sediment budget is anticipated, with a continuum of transport eastwards.	Cliff erosion will continue at a slightly greater rate than that experienced historically. It could be as high as 40 to 60m by 2055 due to geological composition and the effects of sea level rise. Material from the cliffs will continue to ‘rest’ on the foreshore but it is unlikely to be sufficient enough to keep pace with sea level rise, which could be in the region of 4 to 6mm/year and inadequate to build beaches. Material accumulating at the toe of the cliffs will continue to be, depending on its nature, moved eastwards by longshore processes or offshore. Very little material will be entering and exiting this system.	Cliff erosion will continue at a greater rate than that experienced historically, anticipated at being in the region of 100m by 2105, due to the impacts of sea level rise. The recession will provide predominantly ‘localised’ fine material to the foreshore and sediment budget. The volume of material cliff recession is anticipated to yield, is likely to be small, which will be insufficient to build a beaches with. Any material accumulated at the cliff toe will be transported eastwards by longshore processes, to either Cliff End or to the Rye Bay sink, although the amount is likely to be very small.
Fairlight Cove	**Sea Road Rock Toe Bund will remain – its effectiveness will reduce over time. No defences to central and west Fairlight.**		

Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
(East, Central and West)	In the east, cliff erosion will continue at a similar rate to that experienced since the construction of the rock bund (which will continue to effectively protect the cliff toe). Small quantities of shingle from updrift sources will continue to accumulate in front of the bund, providing additional protection to the cliffs and the durability of the bund. In the centre, erosion rates are expected to be higher than the historic average. The disturbed material around the cliff will slip quickly into the sea, with the results that the cliff slope will recede towards the equilibrium angle. Given the observed post-1997 average rate of cliff top recession of 8.5m/ yr, the 15m wide “Tension Zone” and 34m wide “Nascent Zone” could be eroded in 5 years. Therefore, recession to the equilibrium profile is expected within the next 4 to 10 years. In the west, erosion rates will be similar to that experienced historically. The beach that fronts the cliffs will not alter in any significant way as no significant change in sediment input, from updrift sources, is expected during this epoch.	In the east, cliff erosion will continue at a potentially greater rate than that experienced since the construction of the rock bund, due to the impact of sea level rise, which may be in the region of 4 to 6mm/year. During this epoch the rock bund will begin to reduce in effectiveness and as a consequence the toe of the cliffs will come under increased wave attack. In the central section continued sea erosion will steepen the cliffs with the passage of time, until a critical inclination is reached, at which point the next episode of cliff regression is triggered. Landsliding tendencies dominate this section, as clays are present within the cliff geology. Debris will accumulate at the toe of the cliffs, yielding small quantities of sand and silt to the foreshore. Some shingle will enter the system due to defence failure from updrift frontages, although it is more likely that a sandy beach will be more prevalent on the foreshore (due to debris from cliff erosion). It is anticipated that this beach will be narrow. Very little sediment is anticipated to exit this system.	In the east and west sections, cliff erosion will continue at a greater rate than that experienced historically due to the impact of sea level rise and increased storminess. By 2105 this could be in the region of 50-60m. The rate of erosion in the centre will also be greater than that experienced historically (prior to the most recent landslide). Rates could be as high as 2m/annum. This rate does, however, accommodate climate change (i.e. heavier winter rainfall, increased storminess, reduced summer rainfall) as well as allowing for increased recession of softer cliff material . The combination of no management and sea level rise will reduce the effectiveness of the bund along the eastern frontage. This will result in greater wave attack at the toe of the cliffs, which will prompt further cliff instability. Landsliding tendencies will therefore dominate this section, as well as the central section, as clays are a major component of the cliffs geology. The landslides will, however, yield sand and silt to the foreshore. An insufficient supply of shingle will continue to enter, as well as leave, the system.
Fairlight Cove to	**No Defences / Management**		

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Hastings Harbour	Cliff erosion will continue at similar rates to that experienced historically, with landslips as the key failure mechanism. The potential drift rate, along this frontage, is also relatively high, as there are no defence structures to interrupt movement, with beach material being transported in an eastward direction. Little input from updrift units due to the continued presence of Hastings Harbour Arm.	Cliff erosion will continue at a slightly greater rate to that experienced historically, due to the impact of sea level rise. Estimated retreat will therefore be in the region of 30 to 40m by 2055. Shingle will enter the system, due to the updrift failure of Hasting Harbour Arm, providing cover at the toe of the cliffs. Longshore transport, to the east, combined with sea level rise, will however, lead to the progressive removal of the shingle, thus increasing the vulnerability of the cliffs. The shingle will be transported along to Fairlight Cove; the volume will probably be insufficient to build beaches and thus make a difference.	Cliff erosion will continue at a slightly greater rate to that experienced historically due to the impact of sea level rise. Estimated retreat by 2105 could be as high as 110 to 130m. Despite an increase in cliff erosion, very little additional beach building material will be provided to the foreshore and to down drift frontages i.e. Fairlight Cove and what it does yield will be transported alongshore at a fairly rapid rate. This, combined with the effects of sea level rise, will increase the vulnerability of the cliff toe.
Hastings (East) ***Hastings Pier to Hastings Harbour Groynes***	**Timber Groynes will fail towards the end of this epoch** **Concrete Groynes will fail towards the end of this epoch** **Concrete Blockwork Seawall will fail towards the end of this epoch**	**Concrete Harbour Arm will fail very early on during this epoch.**	**No Defences / Management**

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	There will be no change to the position of the relict cliffline, as a series of defences, and the presence of a shingle beach, will continue to protect it throughout the majority of this epoch. A mobile shingle ridge fronts a concrete seawall. At the western end of the frontage the shingle beach is extremely narrow and as soon as the groynes fail, which is anticipated to occur towards the end of the epoch, very little, if any shingle beach will remain at specific locations like Carlisle Parade. Although the shingle beach widens to the east, this is merely a consequence of defence structures i.e. concrete groynes and harbour arms. As the concrete groynes are expected to fail by the end of this epoch this will increase beach vulnerability. As the beach narrows, considerable overtopping and flooding, along the front, will occur. The seawall will be undermined and fail by the end of this period. The harbour structures at the eastern end of Hastings will continue to trap shingle, restricting longshore feed to downdrift areas.	The harbour arm is anticipated to fail relatively early on in this epoch, releasing a significant amount of shingle. This will increase sediment throughput to the east, feeding the cliffs east of Hastings and potentially Fairlight Cove. Beaches updrift of the harbour arm will narrow, due to increased sediment transport rates, related to defence failure. Consequently the shingle beach along this section will narrow and lower.	With the loss of sea defences comes the re-activation of the cliffs especially along the eastern section of this frontage, Hastings Old Town. With sea level rise, the potential for increased storminess and a lack of contemporary material entering the frontage, the probability of a shingle beach remaining, at this location is unlikely. A small sand beach may be all that remains, maintained by local feed from the cliffs. The inputs and outputs of the sediment budget are likely to be very minimal, by this period, with any material being transported in an eastward direction.
Hastings (West) West Marina to Hastings Pier	**Timber Groynes will fail early on in this period** **Concrete Seawall with apron will fail towards the end of this epoch**	**No Defences / Management**	

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The timber groynes will fail early on in this epoch and mobilise the shingle beach. Upon failure the shingle beach is likely to narrow, as material is transported, in an eastwards direction, alongshore. The seawall will begin to experience increased exposure to wave attack. Towards the end of the epoch the wall will start to be undermined and eventually fail. Any feed into the system, due to failure of defences from updrift frontages i.e. Bexhill, will be offset by material exiting the system. Therefore no significant change in transported volume is anticipated during this epoch.	As there will be no significant increase in sediment input, beaches will continue to reduce in volume and narrow, eating into the frontage along Hastings West, with the assistance of sea level rise and the potential for increased storminess. The shingle beach will continue to lower and narrow, in conjunction with sea level rise and an insufficient contemporary sediment supply. Sediment movement is in an eastward direction along this section of the frontage. Periodic flooding updrift, of Coombe Haven, has the potential to restrict sediment movement to this frontage	Erosion of the relict cliff line will be activated early on within this epoch and is anticipated to be in the region of 40 to 50m by 2105. Material eroded from the cliffs will provide foreshore sediment but with sea level rise, the input will not be sufficient enough to build beaches. Frequent flooding and inundation of the Coombe Haven valley (updrift) will continue to influence sediment inputs to this frontage. Sediment movement, along this frontage, will continue to be transported in an eastward direction.
Bexhill (East)	**Timber Groynes will fail** **Masonry Blockwork Seawall will fail**	**No Defences / Management**	

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	There will be little change to the position of the cliffline, at the western section of this frontage, as the seawall will continue to protect it however, upon failure the cliffs will start to erode at similar, or slightly greater rates, than that experienced historically, prior to defence construction, due to the shoreline being held seaward of its natural alignment. The narrow, shingle beach along the eastern section of this frontage will become mobile as soon as the groynes fail and as this is anticipated to occur at a relatively early stage, the shingle beach will narrow further by the end of this epoch. This will result in greater exposure of the seawall to wave attack and its subsequent failure. With no defences in place and a low crest level, the shingle beach will be susceptible to overtopping during storm conditions. Specific areas, that are low-lying, will become increasingly susceptible to flooding i.e. Bulverhythe and the Coombe Haven Valley. The inputs and outputs of the sediment budget are anticipated to be similar to what they currently are.	The exposed cliff line will become susceptible to cliff slippage. Rates of retreat will vary locally but the effects will be greater around Galley Hill, due to much-faulted geology. By 2055 it is likely that the cliffline will have retreated by 15 to 25m. The low-lying valley of Bulverhythe will become more frequently inundated and consequently the mouth of the river may widen, interrupting alongshore sediment transport. When this occurs the shingle beach, at the eastern extremity of Bulverhythe, is likely to experience additional narrowing and lowering, in conjunction with sea level rise.	The exposed cliff line will become increasingly susceptible to cliff slippage. Sea level rise, sub aerial weathering and the potential for increased storminess will exacerbate the situation. By 2105 it is likely that the cliffline will have retreated by 40 to 50m. Inundation of the low-lying valley of Bulverhythe will become a regular occurrence, which will result in a widening of the river mouth. If this were to occur then alongshore transport would be interrupted. Cliff erosion will provide some material to the foreshore but it is likely that the amount yielded will not be sufficient to build an adequate beach. East of Bulverhythe very little, if any, beach will remain due to an extended river mouth interrupting sediment movement alongshore
Bexhill (West) ***Includes Cooden***	**Timber Groynes will fail early on** **Concrete Wall will fail towards the end of this period**	**No Defences / Management**	

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	A concrete promenade and splash wall will continue to hold the grass embankment in place thereby deferring erosion in the short-term. The wide shingle beach, in front of the embankment and concrete wall, will be held until the groynes fail, which is anticipated to occur approximately half way through the epoch. Upon failure the shingle beach will narrow and lower, as material is transported eastwards and insufficient quantity of contemporary, beach building material will be enter the system. As the shingle beach denudes, the seawall, will be subjected to undermining and eventually fail towards the end of the epoch. With no defences in place to hold the 'plan-position' of the coastline and an increase in wave attack due to sea level rise and increased storminess, erosion of the backshore slope will be initiated.	With no defences in place to hold the 'plan-position' of the coastline and an increase in wave attack due to sea level rise and increased storminess, erosion of the backshore slope will continue. This erosion will be exacerbated by a drop in beach levels; a result of limited longshore input. Erosion of the slope and cliffs will not provide a significant input of beach building material, to this frontage and those updrift, due to the nature of the cliff's geology. The beach will therefore denude.	Erosion of the backshore slope and low cliffs will continue. Sea level rise and increased storminess will exacerbate the situation; with retreat anticipated to be in the order of 50-60m by 2105. Cliff erosion will yield small quantities of sand and silt to the foreshore and although updrift sources will supply some shingle and sand, from the failure of the Sovereign Harbour Arm and cannibalisation of Pevensey and Norman's Bay, it is unlikely that anything other than a small mixed beach will be retained along this frontage.
Pevensey and Hooe Levels	**Beach Recycling will terminate immediately** **Timber Groynes will fail early on** **Shingle Ridge (Natural)**	**No Defences / Management**	

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The shingle ridge, which fronts low-lying fluvial and estuarine alluvium, will migrate landwards as the timber groynes, which fix the beach, fail and beach recycling ceases. Because the groynes along this section of the frontage are in poor condition, failure is anticipated to occur relatively early on. Erosion of the beach crest during storm events will put specific areas at significant risk from flooding, nominally Norman's Bay to Culver Croft Bank as well as a short section east of Beachlands. Flooding will become a more regular event due to failure of the beach crest and a lack of contemporary beach building material entering the system. The net alongshore drift is eastwards, however feed is intercepted by updrift structures such as Sovereign Harbour arm (Eastbourne East).	Roll back of the shingle barrier would continue with sea level rise, increased storminess and a lack of contemporary material. There could be segmentation and barrier breakdown, resulting in inundation of the low-lying hinterland. Very little sediment is likely to enter this system due to the updrift resilience of the Sovereign Harbour arms. Erosion, along this frontage, is anticipated to be greater than what it currently is, as the barrier struggles to keep pace with sea level rise. Any shingle reworked would be transported in an eastwards direction.	Roll back of the shingle barrier would continue due to sea level rise. This would prompt cannibalisation of relict shingle ridges. Although an influx of updrift material will enter the system, due to the failure of the Sovereign Harbour arms, it is unlikely that the volume of material will be sufficient to keep pace with sea level rise and prevent breaching. Accelerated segmentation and barrier breakdown is anticipated throughout this epoch; as a result the low-lying hinterland would, periodically and then more regularly be inundated with marine water. In the very latter stages the formation of an inlet may occur, which would intercept both alongshore and cross-shore sediment movement.
Eastbourne East (Redoubt to Sovereign Harbour)	**Timber Groynes will fail half way through this period** **Rock Revetment** **Rock Breakwaters/Harbour arms**	**Rock Revetment will fail towards the end of this epoch**	**Harbour arms will fail early on**

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The backshore beach at The Redoubt is set back and significantly wider, than that at 'Eastbourne'. The beach narrows towards Langney Point / Sovereign Harbour and this will continue to be the case up until groyne failure, which is anticipated to occur half way through the epoch. Upon failure, material will still move alongshore, in an eastwards direction, but at a greater rate. It will come to rest on the western side of Sovereign Harbour arms and the beach will extend as a result. Although material moving alongshore, within the confines of the unit, will increase slightly, beaches updrift and downdrift of Sovereign Harbour i.e. will either be denuded or starved of shingle, which will result in foreshore lowering.	With lower beach levels and an increase in sea level rise the rock revetment, which restricts movement along the back of beach, will come under increased wave attack and fail by the end of the epoch. Reworking of the backshore ridges is anticipated to commence, to attain a position more commensurate with the shoreline energy triggering re-alignment of the coast; nominally erosion up until Langney Point, due to defence failure releasing sediment and accretion thereafter, due to the presence of Sovereign Harbour. It is likely that the frontage will start to become at risk from flooding due to the effects of sea level rise. Although more material will enter the system, because of a lack of defences updrift (Eastbourne), it is in transit and therefore unlikely to build beaches. It will eventually come to rest on the western arm of Sovereign Harbour.	The Sovereign Harbour arms are expected to fail relatively early on during this epoch. Material (shingle and sand) resting here will be released into the harbour and onto downdrift frontages (Hooe and Pevensey Levels). In the western section i.e. around The Redoubt, re-working of relict backshore beach would be prevalent, to attain a position more commensurate with the shoreline energy, due to a lack of contemporary material entering the system. Any shingle reworked would be transported in an eastward direction and with no defence structures to restrict movement, transported onto Pevensey and Norman's Bay. The frontage will continue to be at risk from flooding due to an insufficient amount of contemporary sediment entering the system combined with the effects of sea-level rise, which could be as much as 6mm/year 2105.
Eastbourne	**Beach recharge will terminate immediately** **Timber Groynes** **Concrete Seawall** **Rock revetment (Holywell Cliffs)**	**Timber Groynes will fail very early on Seawall will fail towards the end of this epoch** **Rock Revetment will become less effective**	**Rock revetment will become less effective**

Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	There will be no change in the position of the cliffline at the western section of this frontage, as a series of defences will continue to protect it. Along Eastbourne's front the seawall will continue to hold the backshore of the shingle beach, in its current position. With however, the termination of shingle recharge and low sediment feed from the west, the artificially wide, mobile shingle beach, that overlies a sandy foreshore, along the central and eastern sections of the frontage, will start to narrow and lower. Failure of the timber groynes would be a staggered event but it is highly probable that a number, at the western end of the frontage, will be lost by Year 20. This would result in shingle being transported alongshore, to the eastern section of this frontage, where the more durable groynes remain. At the western end foreshore lowering would commence, which will undermine the concrete seawall that fixes the plan position of the cliffs. Material will continue to move in an eastward direction. As groynes fail this will increase feed within the confines of this unit.	The remaining timber groynes will fail early on in this epoch, releasing beach material, from the central and eastern areas, that it previously 'held' in place. This will provide a 'pulse' of material to the east i.e. 'Eastbourne East'. Loss of beach material will result in greater exposure of the sea wall to wave attack. The situation will be exacerbated by sea level rise along with the potential for increased storminess. Consequently the seawall will fail by the end of this epoch. It is anticipated that a greater volume of shingle will leave this system, moving alongshore to 'Eastbourne East', than enter it. This will result in the beach, along the entire frontage, narrowing and lowering.	Erosion of the cliffs to the west and beach to the east will commence due to failure of the seawall. The landward transgression, along the cliffed section is anticipated to be less than that along the beach i.e. Eastbourne's front. Retreat is anticipated to be in the region of 30 to 50m by 2105. Eastbourne will manage to maintain a very narrow and shallow shingle/sand beach, which will be maintained via a small amount of feed from updrift sources along with local material (fines) from Holywell cliffs, as the effectiveness of the rock revetment continually reduces, due to sea level rise. Very little 'fresh' sediment will enter or exit the system, as the 'pulse' took place in the previous epoch. But any that does will be transported alongshore to Eastbourne East.
Beachy Head	**No Defences / Management**		

Location	Predicted Change for		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	Cliff erosion will continue at similar rates to that experienced historically, which will be in the region of 10m by 2025. Erosion is related to geology: the southwest facing sea cliffs will recede at modest rates whereas the southeast facing cliffs have the potential to landslide. The fronting shore platform, at the toe of the cliffs, is of variable width and it will continue to reduce the impact of wave attack, against the cliff base. Any fallen rock will come to rest at the base of the cliffs, to form small ‘pocket’ beaches. Here it will be broken down in-situ, with a residence time of anything between 5 and 50 years (Shoreham to Beachy Head Sediment Transport Study). Alongshore sediment transport into and out of the system is in an eastward direction. It provides small quantities of gravel, in transit from updrift sources that are subject to temporary storage in the ‘pocket’ beaches, which has the potential to provide temporary ‘pulses’, to downdrift frontages (Eastbourne). Input from the cliffs would be minimal and consist predominantly of fines. Predicting quantities is difficult but no significant change to the inputs and outputs of the sediment budget are anticipated.	Cliff erosion will continue at similar rates to that experienced historically, with moderate retreat being in the region of 20 to 30m, by 2055 and mainly via periodic slides. The shore platform, at the toe of the cliffs, combined with any eroded debris, will continue to reduce the impact of wave attack. The efficiency at which it does this may reduce during the course of this period, as a consequence of sea level rise, which could be in the region of up to 4 to 6mm/year. With a rise in sea level, shingle entering the system, may have greater potential to bypass the Beachy Head headland but again actual or potential quantities are difficult to estimate. No significant change to the sediment inputs and outputs are anticipated during this epoch.	Cliff erosion will continue at a rate greater than that previously experienced as a consequence of sea level rise, increased sub-aerial weathering. Rates of retreat are anticipated to be in the region of 50 to 60m by 2105. Rising sea levels will force the rocky platform, fronting the cliffs to become increasing less effective, which will increase pressure on the cliff toe. It is unlikely that cliff retreat will keep pace with sea level rise. Erosion at the toe of the cliffs will trigger instability, providing sediment to the system as periodic slumps become more frequent. This will initially be in the form of foreshore ‘cover’ before the fines are dispersed downdrift and offshore. Despite an increase in cliff erosion, very little additional beach building material will enter or leave the system; there will therefore be little change in feed to downdrift beaches (Eastbourne).

C4.4 NAI DATA INTERPRETATION

Introduction

A number of data sets were used in the predictions of future shoreline response and evolution under the scenario of no active intervention, these included:

- Futurecoast historical shoreline change data (reported in the assessment of shoreline dynamics report (Section C1)).
- Other historical change data sets: e.g. at some locations cliff position data sets are available (reported in the assessment of shoreline dynamics report (Section C1)).
- Futurecoast predictions of future shoreline change under an ‘unconstrained’ scenario: this assumed that all defence structures were removed and other coastal defence management interventions ceased therefore is not directly comparable to a ‘no active intervention’ scenario.
- Environment Agency beach profile data: this data is only relevant for specific locations and restricted to specific time frames i.e. twenty years.
- Prediction of future shoreline response under a ‘Do Nothing’ scenario from first SMP.
- Other predictions of future shoreline response under no active intervention (or ‘do nothing’) scenario, e.g. from strategy studies completed since the first SMP.

Data Assessments (NAI):

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
South Foreland	Historical data suggests a retreat rate of 0.4m/year (1878-2002)	Moderate (40 to 50m) Recession potential of a single landslide event: <10m	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section. 5-20m is however most prevalent.	No defences Assumed similar rates to those experienced over last 20 years will continue, therefore used average of Futurecoast historic data.	No defences Assumed similar rates to those experienced historically plus SLR component - used Futurecoast MLW data plus the SLR multiplier	No defences Assumed similar rates to those experienced historically plus SLR component - used Futurecoast MLW data plus the SLR multiplier	Futurecoast score: very low Tendency for simple failure, a single event could result in <10m of erosion.
Dover	No NAI cliff data available as the coastal position defended for much/all of the record.	Moderate to High (50-100m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section. 5-20m and 20-50m is most prevalent, therefore a rate of 15-35m has been assumed.	0-20 Defences remain	20-50 Defences remain	50-100 Defences remain	Futurecoast score: very low Defences remain
				No change in cliff position due to the frontage being heavily defended	No change in cliff position due to the frontage being heavily defended Assumed a net steepening of foreshore, but backshore position fixed SLR component included	No change in cliff position due to the frontage being heavily defended Assumed a net steepening of foreshore, but backshore position fixed. SLR component included	
Shakespeare Cliffs	Net retreat of cliffs: range of 0.5 to	Moderate (40 to 50m)	**SMP1 (2080):** Predicted a minimum of <-5m	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low

[9] Futurecoast predictions did not consider an acceleration of sea level rise.

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	1m/yr.	Recession potential of a single landslide event: <10m	and a maximum of 50m shoreline alignment for this section. 5-20m is however most prevalent.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Tendency for simple failure, a single event could result in <10m of erosion.
Samphire Hoe	Net retreat of cliffs: Assumed similar rates as Abbots Cliff = 0.06m/yr.	Moderate to High (50-100m)	**SMP1 (2080):** Predicted a minimum of -5m and a maximum of 100m shoreline alignment for this section. 20-50m is however most prevalent.	0-20 Defences in place	20-50 Defences start to fail	50-100 No defences	**Futurecoast score: low**
				No change in cliff position due to the frontage being heavily defended Used Futurecoast cliff data	Revetment expected to fail at some time during the latter stages of this epoch. Assumed that revetment stopped erosion by c. a third for last c.25 years. Rapid readjustment anticipated when defences fall to ascertain an equilibrium Futurecoast cliff data and EA data used to determine likely rate, plus SLR component.	Linear retreat of cliff assumed Used Futurecoast cliff data and EA data to determine likely rate, plus SLR component. Also assumed that re-activation of landslide events may occur.	Tendency for simple failure, a single event could result in 10 to 50m erosion.
Abbots Cliff	Net retreat of cliffs: 0.06m/year	Moderate (50m)	**SMP1 (2080):** Predicted a minimum of -5m	0-20 No defences	20-50 No defences	50-100 No defences	**Futurecoast score: low**

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
		Recession potential of a single landslide event: <10m	and a maximum of 100m shoreline alignment for this section. 20-50m is most prevalent.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Tendency for simple failure, a single event could result in <10m erosion.
Folkestone Warren	No NAI cliff data available as the coastal position defended for much of record. Seawall fixes the plan-form position and reduces sediment input from (now) relict landslides making retreat static	High (75-100m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section, with 20-50m of change being most prevalent.	0-20 Defences in place No change in cliff position due to defences, but historical evidence suggests foreshore will continue to steepen and narrow.	20-50 No defences Rapid initial rate of foreshore erosion expected to exceed historical rates, Taking Futurecoast MLW/ plus SLR multiplier Also considered a large single cliff top failure event occurring in this period.	50-100 No defences Linear retreat of cliff assumed, used historic Futurecoast cliff data to determine likely rate, plus SLR component. Landslide event(s) anticipated and some feed from the west. Assumed net affect would be smoothing of coast.	Futurecoast score: high Little data available pre-defences. Complex failure mechanism therefore during a single event could result in +30m
Folkestone (Copt Point to Sandgate)	Average cliff retreat of 0.5-1m/year but coast defended for some of period.	Moderate to High (50-100m) Recession potential of a single landslide event: 10-50m (0.2-1ha)	**SMP1 (2080):** Predicted a minimum of -5m and a maximum of 100m shoreline alignment for this section. In the urbanised areas 5-20m is most frequent; this changes, in the cliffed section, to 20-50m.	0-20 Defences in place Beach recharge will immediately cease, groynes and seawall will fail early on resulting in an initial surge as coast held for last 100 or so years. Therefore used Futurecoast to calculate 'catch-up' and to predict erosion after initial surge.	20-50 Defences start to fail Remainder of groynes and breakwater will fail allowing the coast and cliffs to function freely. Historic Futurecoast rates used plus SLR component.	50-100 No defences Cliff erosion assumed to adopt a linear fashion. Futurecoast rates plus SLR component used.	Futurecoast score: medium Little data relating to the undefended coast.
Sandgate to Hythe	Very little change in shoreline position	High (75-100m)	**SMP1 (2080):** Predicted a minimum of -5m	0-20 Defences in place	20-50 Defences start to fail	50-100 No defences	Futurecoast score: medium

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	due to the frontage being defended historically		and a maximum of 100m shoreline alignment for this section.	Timber groynes and seawall will fail early on putting pressure on the remaining defences but no significant change in the shoreline position is expected. Used combination of Futurecoast and EA data.	Rock groynes and revetment will fail resulting in a surge of shoreline change. Used Futurecoast pre-defence rates plus SLR component.	Re-activation of the cliffs at Sandgate and roll back of the barrier along the western section anticipated. Used Futurecoast pre-defence rates plus SLR component.	Limited data relating to the undefended coast.
Hythe Ranges to Romney Sands	First defences c.1900. Beach narrow by c.50m since that period	High (75-100m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. 5-20m of change is most prevalent	0-20 Defences in place Used combination of Futurecoast and EA data.	20-50 Defences fail Assumed the revetment will fail during this epoch Used Futurecoast pre-defence rates plus SLR component.	50-100 No defences Assumed feed from updrift frontages will counter some SLR impacts but not enough to counter roll back of the shingle barrier Used Futurecoast pre-defence rates plus SLR component.	Futurecoast score: medium Although this section has sustained itself historically the ability to continue doing this remains unclear
Dungeness East (Romney Sands to The Pilot)	Net accretion / retreat of: 1.0m/yr	High (50-100m)	**Environment Agency:** Data reliable despite there being a drift divide at this location **SMP1 (2080):** Predicted predominantly <-5m of shoreline alignment for this section.	0-20 Defences start to fail	50-100 No defences Used combination of Futurecoast and South Foreland Sea Defence Scheme rates.	50-100 No defences Assumed feed from updrift frontages will have a positive impact on this frontage. Used combination of Futurecoast rates and predictions made by Dungeness Foreland Sea Defence Scheme.	Futurecoast score: low to medium Change will be influenced by feed, hydro-dynamics plus SLR. Uncertainty will increase towards Romney Sands

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
Dungeness South (The Pilot to the Reactor)	Defended since 1961 (coastal position held for the past 40+ years). Prior to this 0.02m/year (1877-1944) of erosion	Very High (100m) with rapid realignment	**Environment Agency:** Data very reliable: 0-20 years = 0.4m, 20-50 years = 1m and 50-100 years = 2m of erosion **SMP1 (2080):** Predicted predominantly 50-100m of shoreline alignment for this section.	0-20 years Defence and management practise sustained	20-50 years Defence and management practise sustained	50-100 years Defence and management practise sustained	Futurecoast score: very low Shoreline position will be maintained.
				Along the length of this frontage a combination of EA and Power Station data used. It was assumed that the safety case requirements will be maintained and thus the shoreline will be held seaward of its natural alignment.	Assumed that the safety case requirements will continue to be met. Assumed as well that feed from Lydd Ranges will start to have a positive impact on this frontage, despite SLR (used Defra's rates)	Assumed that the safety case requirements will continue to be met. Feed from Lydd Ranges and other updrift frontages will continue to have a positive impact on this frontage. Aware that the mobility of the ness will not cease (as this is the very nature of this feature) Incorporated SLR component.	
Lydd Ranges	Average trend of net retreat = 1.5-2m/yr. Cannibalisation of the southern foreland is natural.	Very High (150-180m)	**Environment Agency:** Data very reliable: 0-20 years = 30-40m, 20-50 years = 80-100m, 50-100 years = 150-180m **SMP1 (2080):** Predicted a minimum of 100m and a maximum of 200m shoreline alignment for this section, the higher figure being most prevalent through this section.	0-20 Management practises cease	20-50 No defences	50-100 No defences	Futurecoast score: medium to high Uncertainty over alignment and full extent of inundation
				Used EA (scheme) rates and included additional realignment probability with the cessation of shingle recycling. Breach potential identified	Assumed continued realignment of the foreland. Used Futurecoast MLW rates, aerial photographs and historic maps to estimate change also added SLR component and took into consideration a small amount of updrift feed.	Assumed continued foreland realignment Feed from the west will increase (due to updrift defence failure and management cessation) but will be countered by SLR (used Defra's rates)	

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
Rye Harbour East (Broomhill to Camber Sands)	Coastline held historically (since the Napoleonic period as a minimum).	Moderate to High (50-100m)	**Environment Agency:** Accretion will continue at Camber (1.9m year) and the foreshore will continue to narrow at Broomhill: 0-20 years = 10m, 20-50 years = 50m (min), 50-100 years = 80m (min) **SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. <-5m is however most prevalent throughout this section.	0-20 Defences / management in place Sea wall assumed to remain therefore no change in backshore position, but foreshore expected to narrow at the western end but continue accreting to the east. Dune response assessed through geomorphological knowledge and input from CHaMP. Breach potential highly likely	20-50 Defences start to fail Sea wall will fail and rapid inundation will follow, resulting in erosion of low-lying land behind (for SMP purposes assumed to be to extent of EA IFM). Erosion of dunes expected to continue – EA data used together with Futurecoast data plus SLR component	50-100 No defences Continual breaches expected (for SMP purposes assumed to be to extent of EA IFM).	Futurecoast score: high Limited data relating to the undefended coast therefore uncertainty of coastal response post defence failure and uncertainty regarding dune survival.
River Rother	Defended since 1910	Moderate	**Environment Agency**: Data generally quite good but as the river has been defended current rates/ trends are distorted.	0-20 Defences / management in place The current course of the river will be held.	20-50 Defences start to fail Assumed terminal groyne will fail by the end of this epoch, releasing a mass of sediments, as well as inducing fluvial morphological change.	50-100 No defences Large scale inundation identified Re-routing of the river anticipated (after current river mouth becomes blocked with sediments due to terminal groyne failure)	Futurecoast score: high Uncertainty of coastal / fluvial response post defence failure.
River Rother to Winchelsea	1.2m/yr for back of beach position (1878-1899).	High (100m)	**Environment Agency**: Data for this frontage is plentiful but distorted due to downdrift	0-20 Defences / management in place	20-50 Defences start to fail	50-100 No defences	Futurecoast score: medium Some uncertainty

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	Downdrift defence structures have influenced the nature of this frontage since 1910 (turning a source into a sink)		defence structure. **SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. <-5m is however most prevalent throughout this section.	Accretion expected to continue at the eastern end of the frontage due to the continued presence of the terminal groyne.	Accretion assumed to continue until the terminal groyne fails. Thereafter the beach will erode and realign. Incorporated into this Futurecoast data plus Defra's SLR component.	Assumed a lack of feed from east and no defences will lead to breach potentials to the west and beach erosion to the east. Estimate based on historic rates from Futurecoast plus SLR component.	over response and evolution of the coast: mainly due to failure of the terminal groyne
Winchelsea to Cliff End	Average retreat rate of -0.5-0.75m/yr.	Very High (100m)	**SMP1 (2080):** Predicted a minimum of 50m and a maximum of 200m shoreline alignment for this section.	Beach management ceases and defences fail	No defences	No defences	Futurecoast score: medium to high Limited data relating to the undefended coast therefore uncertainty regarding the extent and rate of inundation
				Assumed beach erosion will increase with the cessation of beach recycling Data from EA (scheme) data with Futurecoast used.	Breach potential identified	Total loss of beach anticipated based on an EA and Futurecoast understanding plus SLR component.	
Cliff End to Fairlight Cove	Average retreat rate (similar to historic) 0.5-1m/year From old maps and records dating back to 1873, the erosion of the cliffs has been relatively modest.	Moderate to high (50-100m)	**SMP1 (2080):** Predicted 20-100m of shoreline alignment for the cliffed sections and 100-200m for the low lying land.	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low No significant change anticipated
					Futurecoast and SMP1 data used plus SLR component	Cliff erosion expected to continue at a slightly greater rate than that experienced historically Rates based on Futurecoast data plus SLR component	

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
Fairlight Cove (includes East, Central and West sections).	Average retreat rate 0.08m/year (1878-2001) These cliffs are undefended except for a 0.5 km length below Sea Road which is protected by a rock bund constructed in 1990 to prevent further undercutting of the cliff along this length	High (80-100m)	**SMP1 (2080):** Predicted that the shoreline alignment would be 50-100m SMP2: Assumed that at the eastern section, under a scenario of NAI, the bund would become increasingly ineffective thus erosion in the latter epoch would return to the pre-bund rate. In the central section it was assumed that once the landslide had settled, rates of erosion would return to a slightly higher rate than that experienced historically. It was also assumed that the western section would continue to erode at a slightly higher rate than that experienced historically. Drawing on Futurecoast data a rate of 1.0m-1.5m was stipulated for Fairlight Cove. Terry Oakes Associates (2005) suggest that rates of erosion could be as high as 2m/year. This rate includes cliff top and toe erosion, climate change and increased recession of softer cliff material. **Moore (1984, 1986)** reported rates of 0.5-1.4m/year at Fairlight Glen. **Landslip Inspection, Halcrow (2004):** 17m maximum short-term recession rate between 1998 and 2003.	0-20 Defence in place (at the eastern end) Assumed the coast will erode in a similar manner to what it has done in the recent past.	20-50 Defence effectiveness reduces Assumed cliff retreat will continue at a slightly greater rate than the recent past due to SLR.	50-100 Defence effectiveness reduces Assumed SLR will render the bund ineffective, cliff erosion anticipated to increase. Rates based on Futurecoast and Halcrow (2004) plus SLR component.	Futurecoast score: medium Complex failure mechanism during a single event c.30m of the cliffs is likely to occur
Fairlight Cove to Hastings	From old maps and records dating back	Moderate (50 m)	**SMP1 (2080):** Predicts a shoreline alignment	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	to 1873, the erosion of the cliffs has been relatively modest.		projection that ranges between 5-100m. 20-50m and 50-100m are most prevalent therefore a rate of 35-75m has been assumed.	Assumed coastline position (cliffs) will continue to retreat laterally at a similar rate to that experienced historically.	Due to SLR assumed that net retreat will increase slightly.	Assumed that retreat will continue, increasing slightly due to SLR.	Little change and variance is anticipated for this unit
Hastings (includes the harbour)	Frontage defended for most of period, therefore little data available and little change in cliff and beach position.	Moderate to High (50-100m)	**SMP1 (2080):** Shoreline alignment is projected predominantly at <-5m	0-20 Some defences will fail	20-50 Remaining defences will fail	50-100 No defences	Futurecoast score: medium
				During this epoch the groynes and seawall will fail. Assumed that there will be a surge in shoreline realignment (but the harbour arm will continue to arrest alongshore movement).	Assumed harbour arm will fail towards start of period, releasing beach material that has been previously held for c.100+years. Initial surge in realignment anticipated Used Futurecoast cliff retreat rates plus SLR component to calculate initial surge and then assumed rates to be uniform for rest of period.	Assumed that there will be a re-activation of cliff erosion (to the east). Smoothing and retreat of the shoreline anticipated Futurecoast rates plus SLR component	Uncertainty due to the shoreline being defended historically
Bulverhythe and Glyne Gap	Defended since 1899	Moderate to High (50-	**SMP1 (2080):** Predicts a shoreline alignment	0-20 Defences will fail	20-50 No defences	50-100 No defences	Futurecoast score: medium

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	Foreshore shows a steepening and narrowing (c.80m) trend.	100m)	projection that ranges between 20-200m, with 50-100m being the most prevalent shoreline projection	Assumed that defences will fail and that initially the shoreline will dramatically readjust. Assumed that the defences have reduced erosion by a third for 100 years. After surge a more uniform rate of retreat is reached: used Futurecoast and SS data.	Assumed cliffs will be vulnerable to land slips and the low lying land vulnerable to inundation. Futurecoast data and SLR component used	Assumed cliffs will be vulnerable to land slips and the low lying land vulnerable to inundation. Futurecoast cliff retreat and SLR component used	Uncertainty over how active the faulted geology would become and the degree of inundation.
Bexhill and Cooden	Defended since 1935 Historic rate of erosion = 0.5m/year (1878-1910) Foreshore shows a steepening trend.	Moderate to High (50-100m)	**Strategy Study:** Analysis of the last 30 years of Annual Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 22,000 m³ per year. **SMP1 (2080):** Predicts a shoreline alignment projection that ranges between 20-200m, with 50-100m being the most prevalent shoreline projection	0-20 Defences will fail Assumed that initially the shoreline will continue to be held. Upon defence failure the shoreline will rapidly adjust, having been held for c.70 years. A more stable rate of retreat is assumed after the initial surge. Used Futurecoast and SS data.	20-50 No defences Assumed a uniform rate of retreat. Inundation anticipated Used Futurecoast data plus SLR component.	50-100 No defences Assumed a uniform rate of retreat and further inundation anticipated. Assumed feed from 'The Crumbles' will counter a limited amount of SLR Used Futurecoast data plus SLR component	Futurecoast score: medium Uncertainty regarding the degree of inundation (therefore assumed EA IFM limits)
Hooe and Pevensey Levels	Prior to the construction of defences (1961)	High to Very High (150-200m). This is	**Strategy Study:** Under a 'do-nothing' approach it is estimated that the	**0-20** **Defences / management practises fail**	**20-50** **No defences**	**50-100** **No defences**	Futurecoast score: medium to high

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
	MHW and MLW oscillated greatly. A more stable trend has been prevalent since that date. 0.07-0.1m/year (To the east of Sovereign Harbour a storm on 24th October 1999 damaged more than 50 crest-top properties. Strategy Study)	a hotspot area	defences in the Agency frontage would be permanently breached within 2 years resulting in uncontrolled flooding and land and property loss. Analysis of the last 30 years of Annual Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 22,000 m³ per year. **SMP1 (2080):** Predicts that there will be a combination of accretion (<-5m) and erosion (20-50m) zones along the frontage. The figures presented are the zones most prevalent.	Assumed beach recycling will cease immediately and the timber groynes will fail, prompting a 'shoreline rectification' phase, countering 40+ years of beach management. Used Futurecoast data.	Assumed the barrier will roll back and that there will be some segmentation. Futurecoast data and SLR component used. Assumed that there will be no significant feed from the west.	Assumed feed from 'The Crumbles' will counter some effects of SLR. Futurecoast and SS data and SLR component.	Uncertainty regarding the degree of inundation (assumed EA IFM limits)
Sovereign Harbour	Historic accretion rate = 1m/year (1879-2001) due predominantly to the presence of the harbour	High (50-100m of change) *Note this does not necessarily mean the beach will accrete but the feature will be mobile	**SMP1 (2080):** The main rate for shoreline projection along this frontage is 50-100m	**0-20 years** **Some defences will fail** Assumed coastline position (shingle beach) will continue to be held seawards of its natural alignment, despite some defences failing.	**20-50 years** **More defences will fail** Assumed the revetment will fail at the start of the epoch resulting in an initial period of 'rectification', resulting in retreat of the shoreline.	**50-100 years** **Remaining defences will fail** Assumed harbour arm failure at the start of the epoch will initiate full rectification (SLR component built into this equation)	Futurecoast score: medium Uncertainty over the response of The Crumbles
Eastbourne (Defended since 1878)	No significant change, apart from	High (50-100m of	**Strategy Study:** Analysis of the last 30 years of Annual	0-20 Defences in place	20-50 Defences start to fail	50-100 No defences	**Futurecoast score: medium**

Location	Futurecoast data		Other	Prediction of shoreline change for NAI			Uncertainty
	Historical	Prediction[9]		0-20	20-50	50-100	
(The most recent major beach erosion event at Eastbourne predates the existing defence scheme. On February 17th 1990, the defence line was breached and shingle spilled onto the road when 100mph winds coincided with a high tide. Strategy Study))	MLW falling c.40m due to the shoreline being held by the defences.	shoreline change)	Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 7,000 m³ per year The predicted erosion rate, from historical analysis, is 1m/yr with no defence in place, i.e. at the end of the residual lives of the groynes (Year 23). **SMP1 (2080):** predicted that some sections would erode 20-50m and others 50-100m. Therefore a generic figure of 35-75m has been assumed	Assumed coastline position (shingle beach) will be held seawards of its natural alignment by the defences. No significant change anticipated during this epoch.	Assumed shoreline retreat will commence as soon as the defences fail, resulting in a rapid rectification, as the shoreline has been held seawards of its natural alignment for c.125yrs. Futurecoast data plus SLR component used.	Assumed shoreline erosion will continue (used combination of EA and Futurecoast data plus SLR rise component). Retreat rate assumed to be consistent once rectification has taken place	Uncertainty over impact of no defences (as this frontage has been defended historically)
Beachy Head	Net retreat of cliffs 0.4m/yr (1878-2002)	Moderate (50m) 0.5m/year	**Strategy Study:** The cliffs will continue to erode	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low Little change and variance is anticipated
				Assumed uniform rate of cliff retreat similar to that experienced historically	Assumed uniform rate of cliff retreat similar to that experienced historically plus incorporated sea level rise (using Futurecoast MLW)	Assumed uniform rate of cliff retreat similar to that experienced historically plus incorporated sea level rise (using Futurecoast MLW)	

C5 Baseline Case 2 – With Present Management (WPM)

C5.1 INTRODUCTION

This report provides analysis of shoreline response conducted for the scenario of “With Present Management”. This has considered that all existing defence practices are continued, accepting that in some cases this will require considerable improvement to present defences to maintain their integrity and effectiveness and has taken account of the fact that some presently redundant structures do not form part of this existing defence management.[10]

The analysis has been developed using the understanding of coastal behaviour from Futurecoast and the baseline understanding report produced,[11] existing coastal change data[12] and information on the nature and condition of existing coastal defences. In addition to this report, maps illustrating this are included at the end of this Appendix.

C5.2 SUMMARY

The following text provides a summary of the analysis of shoreline response with details specific to each location and epoch contained within the Scenario Assessment Table.

Epoch 0-20 years (to 2025)

Overall the picture is one of increased stress on the shoreline, with diminishing beaches and higher exposure to wave activity.

There will be a continuation of present day trends throughout the SMP area. As sea levels continue to rise, this will squeeze the intertidal zone as nearshore areas deepen and defences prevent natural landward movement of the shoreline. Stress on the coast will be greatest where there are seawalls, elsewhere other structures such as groynes and rock bunds work to limit the rate of cliff and shoreline retreat. These will exacerbate the problem by continuing to reduce the natural input of sediment to the beaches.

Groynes will continue to intercept the alongshore movement of beach material through the frontage, with a similar effectiveness to today.

On the undefended sections of the coast, cliff erosion is anticipated to continue at similar rates to that experienced over recent years. Significant breaches and tidal inundation on low-lying frontages would be averted under this scenario, through the continuation of existing defence practices.

The presence of harbour arms, river training walls and breakwaters has created zones of accretion, most notably at Sovereign Harbour, Hastings, Rye Harbour (west), Folkestone Harbour and Dover harbour and this trend will continue throughout the epoch. Correspondingly, there will continue to be a deficit of material downdrift of these structures.

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[10] Refer to Section C2 (Defence Assessment)
[11] Refer to Section C1
[12] Refer to Section C5.4

Epoch 20-50 years (to 2055)

Accelerating sea level rise and the potential for increased storminess will put increased pressure on the coastal system. During this period, the majority of the remaining seawalls and revetments will fail, exacerbated by the narrow beaches and increased exposure. Where the shoreline position has been held seaward of its natural alignment for more than 100 years, there will be a period of relatively rapid erosion, which will last until a natural equilibrium in shoreline dynamics is attained. This could be between 5 and 20 years after defence failure.

Under these increased pressures, and with the lack of management, specific beaches will denude rapidly such as Eastbourne, Bexhill and Hythe Ranges, as well as specific areas being at risk from flood inundation e.g. Bulverhythe.

There will be a landward transgression of the, now unconstrained, barrier beaches due to sea level rise, which may result in reworking (or cannibalisation) of the shingle area behind (e.g. Lydd Ranges, Dungeness).

Along sections where cliffs were previously defended, erosion will be reactivated, which will initially result in high levels of instability via toe erosion. There will be increased input of sediment into the system, but it is expected that this will mainly result in maintaining rather than building beaches. Undefended cliffs will continue to retreat, at a rate slightly higher than that at present, due to sea level rise.

Generally, the shoreline will start to develop and respond more naturally, with coastal processes only being interrupted a small number of locations, where major structures remain in place, i.e. the harbour structures at Sovereign Harbour, Rye, Folkestone and Dover.

Epoch 50-100 years (to 2105)

The long-term picture is one of a very fragmented shoreline, characterised by a series of concreted headlands and embayments. The natural movement of sand and shingle sediment will have been seriously interrupted and there is potential for more of this beach-building material to be washed offshore.

The presence of seawalls will create local promontories and the artificially seaward position of the shoreline will result in increased exposure to deeper water and greater wave attack, consequently much more substantial defences will be required. Some of these defences may also need to be extended to prevent any outflanking. The hard defences, and cross-shore structures, will serve to effectively eliminate the exchange of sand and shingle throughout large proportions of the SMP coastline, in a similar way to existing harbour arms and breakwaters.

There will be no beaches present on frontages held seaward of their natural alignment by hard defences and groynes along these frontages are likely to become redundant with time, mainly due to the impact of sea level rise.

The rate of cliff retreat along the undefended sections is also anticipated to increase with sea level rise, providing material to the immediate foreshore, although the amounts it will yield will not be significant to build beaches.

Permanent breaches and tidal inundation of low lying areas would continue to be averted under this scenario, but as for 20-50 years, the frequency and magnitude of storm failures of the barrier beaches will increase, as the beaches narrow, with flooding of the backing areas. Much more substantial preventative measures would be required to prevent this flooding occurring.

C5.3 WPM SCENARIO ASSESSMENT TABLE

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
South Foreland	No Defences / Management Practices		
	The chalk cliffs will continue to erode at a rate similar to what it has done historically, resulting in retreat, somewhere in the region of 10m by 2025. Susceptible to sub-aerial weathering, periodic slumps and block failures, large falls from the cliff face are likely. This will induce the formation of debris boulder and chalk rubble 'aprons', providing temporary protection to the cliff toe. The chalk shore platform that fronts this section of the coast is covered with very little foreshore sediment. There exists potential for the eastwards movement of foreshore sediment across, and beyond, the frontage.	The backshore cliffs will continue to erode slowly, at a rate similar to that at present, resulting in retreat of 30m by 2055. Recession of the chalk cliffs yields minimal flinty shingle to the foreshore. Any chalk rubble released will initially accumulate at the toe until it becomes broken down and transported alongshore (in an eastwards direction). There is a general lack of contemporary shingle and sand supply to the frontage, tending to result in only limited protection offered by the natural shingle foreshore and, consequently, a propensity for continued cliff recession.	Cliff recession and platform lowering is likely to increase throughout this epoch due to sea level rise. Wave attack will be concentrated at the toe, prompting further instability i.e. periodic slumps and block failure; retreat could be in the region 60m by 2105. Any chalk rubble released will accumulate at the toe until it becomes broken down and transported alongshore (in an eastwards direction). Recession of the chalk cliffs will continue to yield flinty shingle to the foreshore, which can be transported eastwards by longshore drift Sediment supply beyond this frontage will probably continue.
Dover Harbour	Concrete seawall, breakwater, harbour arms and groynes **(Dover Harbour will remain 'protected', within the confines of the harbour arms, due to its economical importance).**		
	The seawall will prevent any erosion of the shoreline, with the western pier, continuing to trap material moving alongshore, resulting in a continuation of accretion on the western side. To the east of the harbour the beaches will continue to narrow. The transportation of material will be affected by the presence of the harbour arms.	The seawall will prevent any erosion or inundation of the hinterland. There will be some foreshore narrowing as sea levels rise and the sediment supply regime alters. Substantial works may be required to the seawall in places to maintain its integrity as a defence. There will be some feed of material from the west, transported by alongshore processes, although rates are likely to be low. Consequently the groynes will be unlikely to retain a beach.	The seawall will prevent any erosion or inundation of the hinterland. There will be further foreshore narrowing as sea levels rise and the sediment supply from the west reduces, the beach is expected to disappear within the confines of the harbour. Substantial works may be required to the seawall in places to maintain integrity. Rates of transport are likely to remain low, although these might have increased over time with increased sea levels and wave exposure.

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Shakespeare Cliff	No Defences / Management Practices		
	The backshore cliffs and fronting shore platform will continue to erode at a rate similar to that at present, resulting in retreat of 10m by 2025. However some stability will be provided to the cliffs by the controlling influence of the seawall, which will prevent retreat at the eastern extremity. The extent to which a beach is retained in front of the cliffs depends upon the extent of erosion but at best it is likely to be very narrow.	The backshore cliffs will continue to erode slowly, at a rate similar to that at present, resulting in retreat of 30m by 2025. The seawall will prevent retreat of the backshore. Beach narrowing and steepening will occur, as a result of sea level rise and diminished alongshore sediment supply.	The backshore cliffs will continue to erode slowly, at a rate similar to that at present, resulting in retreat of 60m by 2025. The seawall will prevent retreat of the backshore. Increased exposure due to rising sea levels will diminish beach retention capability and potential reduction in sediment supply means that there will no longer be a beach in front of the wall. Substantial works may be required to maintain the integrity of this defence. Sediment transport, if any at all, is likely to take place in west to east direction.
Samphire Hoe	Concrete apron seawall fronted with a block and rock revetment and rock armour.		
	There will be no change to the backshore position due to the heavily managed coastline. As there is no beach, erosion will be concentrated at the toe of the seawall. Samphire Hoe restricts sediment movement due to it being an artificial promontory.	The backshore will remain in its present position due to the heavily managed coastline. Sea level rise and increased storminess will attack the sea wall. Sediment transport along the frontage will be restricted, as Samphire Hoe becomes a more defined promontory.	The backshore will be held in the same position as at present, forming a more defined promontory. Pressure of rising sea levels, the promontory will come under increased wave attack and therefore will need substantial amounts of maintenance to sustain integrity. Sediment movement will continue to be restricted along this frontage, the eastern section being particularly vulnerable.
Folkestone Warren	Concrete sea wall and timber groynes along the warren frontage and shingle recharge at the eastern extremity of Abbots Cliff. (Retreating at a rate of 0.25 –0.5m / year)		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	The backshore cliffs will continue to erode slowly, at a rate similar to that at present, resulting in retreat of 10m by 2025. The beach in front of the seawall will be maintained via sediment recharge. Some of this sediment will, despite the presence of groynes, move alongshore onto frontages downdrift (Samphire Hoe).	Erosion of the cliffs will increase in frequency as sea levels rise and the defences are more regularly overtopped. This will produce a retreat of 30m by 2055. The beach in front of the seawall will continue to be maintained via sediment recharge, although the rate and volume will need to be increased during this epoch. Some of this sediment will, despite the presence of groynes, move alongshore onto frontages downdrift (Samphire Hoe).	Cliff (toe) erosion will remain restricted by the defence but would continue to occur with greater frequency as exposure levels increase. The clifftop position is expected to have retreated by 60m by 2105. There will be no beach in front of the structure but material eroded from the cliffs will be retained behind the structure. Sediment entering the frontage will continue to be restricted due to the continued presence of Folkestone harbour arms and other updrift defence structures.
Copt Point	No defences		
	Cliff erosion would continue at similar rates to those experienced historically. It would be in the region of 5 to 10m by 2025. The beach will also experience some retreat, similar to the historic trend, probably due to the presence of the harbour arm (updrift), which prevents alongshore transport. The limited erosion of the cliffs will provide minimal / localised material, the majority of which will, however, be fines.	The cliffs will continue to erode at a rate slightly greater to that at present, resulting in retreat of 10 to 25m by 2025. Sediment feed into the system would continue to be limited due to the presence of updrift structures like Folkestone harbour arms. Thus the amount of material exiting the system (in an eastwards direction) will be low. The beach in front of the cliffs would narrow under the influence of sea level rise and limited sediment supply.	Cliff erosion is likely to increase due to sea level rise, and the reduced amount of sediment arriving from the west, due to the presence of a fragmented coastline and anthropogenic structures like Folkestone harbour arm. The clifftop position is expected to have retreated some 40 to 50m by 2105 The beach in front of the cliffs would narrow under the influence of sea level rise and limited sediment supply.
Folkestone	Seawall fronted by a recharged shingle beach and held in place by rock groynes. At Folkestone Harbour there are breakwaters and quays.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
(Copt Point to Sandgate)	There would be little change to the position of the backshore beach, as the concrete seawall will prevent a landward transgression of the shoreline. Sediment volumes transported along the frontage will not differ too greatly from the present regime.	The seawall will continue to hold the back of the beach in its current position and consequently the entire length of shoreline at Folkestone would start to form a slight promontory. The limited natural sediment feed to this area will not be sufficient to maintain adequate beach volumes, therefore present recharge rates would need to be increased.	The entire length of shoreline at Folkestone would continue to form a promontory, as the seawall continues to hold the shoreline seaward of its natural alignment. To maintain a shingle beach along this frontage, recharge will need to be increased, as will the height of the seawall and the rock groynes. Frontages and structures updrift will have also developed into promontories this will therefore have restricted sediment supply to this frontage.
Sandgate to Hythe	Rock groynes, rock revetment, and a concrete seawall		
	The seawall will continue to hold the shoreline in its present position. The shingle beach would begin to experience some reduction in volume. The form of the beach would not be too dissimilar from that at present due to the presence of rock groynes along the frontage. Sediment transported along the frontage will not differ too greatly from the present regime.	The seawall will continue to hold the backshore in its current position. The effectiveness of the rock revetment will start to reduce throughout the epoch and the shingle beach will denude due to a rise in sea level The rock groynes would retain some shingle but the beach would be narrower due to sea level rise and prevention of the back of the beach being held seaward of its natural alignment.	The backshore will be held in its present position by the seawall and to some degree by the presence of the rock revetment. It is likely though that significant work will be required to ensure the integrity of these coastal defences. The rock groynes will continue to trap a limited amount of shingle; elsewhere the beach is expected to narrow. It is probable that there will be little / no shingle beach along this frontage, as the retention potential will have reduced significantly due to greater exposure from wave attack. Sand however, arriving on this frontage is likely to be transported alongshore or possibly offshore.
Hythe Ranges to	At the southern end of the frontage the beach is groyned A concrete seawall extends from Littlestone-on-Sea to St. Mary's Bay, periodic shingle re-nourishment and timber groynes. A rock revetment defends the MoD at Hythe.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Romney Sands	The seawall will fix the position of the sand and shingle beach, which will hold the beach seawards of its natural alignment, by preventing a landward transgression, thus prompting greater exposure to wave attack. A shingle and sand beach fronts the low-lying alluvial hinterland of Romney Marsh. Groynes will continue to hold the shingle and mixed beach in place but they will need regular maintenance and beach levels will need to be monitored.	The seawall will hold the backshore in its present position, although this will become increasingly difficult at places like Dymchurch, which is more exposed to wave attack and it at such locations, it is possible that very little beach will be left, which will result in undermining the foundations of the seawall. The beach is likely to reduce in volume as a result of increasing sea levels and decreasing sediment supply. This will need to be supplemented with additional re-nourishment and by potentially raising the height of the groynes.	Significant work is likely to be required, along this frontage, to ensure the integrity of the seawall. During this epoch the shingle beach is likely to be non-existent and the volume of sand to have diminished quite considerably. The current re-nourishment quantities will be insufficient to withstand the increased volatility and exposure resulting from sea level rise and would therefore need to be increased. Any sediment stripped from this frontage will be transported alongshore (eastwards) towards Hythe.
Dungeness East (Romney Sands to the The Pilot)	No Defences / Management		
	The shingle beach that fronts relict shingle ridges will continue to accrete throughout this epoch. This will be at rate similar to the current i.e.50 to 60m by 2025. Inputs and outputs of alongshore shingle transport are anticipated to decrease slightly, sediment will be redistributed in a predominantly northwards direction, tapering towards Romney Sands, where a null point and a fairly stable sand dune system will continue to exist. Little change in the position of the backshore dunes is anticipated.	The beaches at the southern end of the frontage i.e. from The Pilot to Lade will not be unduly affected by sea level and will continue to accrete, albeit at a lower rate than the current one, which could be in the region of 100 to 125m by 2055. The mixed shingle and sand beaches, from Greatstone-on-Sea to Romney Sands, will however start to lower and narrow, due an insufficient supply of sediment, related to defences and shingle extraction updrift, along with sea level rise. This may prompt the need for some engineering works along this section of the frontage and/or potentially dune management.	The shingle beach between the Pilot and Lade will remain substantial enough to provide protection against sea level rise. However the shingle barrier beach at Greatstone-on-Sea, in between Lade and Romney Sands, will start to experience periodic breaching, resulting in inundation of the hinterland (Romney Marsh), if engineering structures are not implemented. At Romney Sands it is likely that the effects of sea level rise and increased wave attack will be threatening dune integrity and without management or some form of engineering, erosion will increase with time and with increasing risk of inundation of the low-lying hinterland.
Dungeness	Mechanically profiled and nourished shingle bund		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
South (The Pilot to the Reactor)	Although there is a degree of uncertainty attached to the evolution and processes at Dungeness. It is highly likely that the southern shore of the ness will continue to hold its current position due to the presence of the shingle bund and recycling activities present on this section of the frontage.	The shingle beach and bund will be exactly how it currently is, maintained by shingle recycling and mechanical profiling, although the volume and frequency of this operation will need to increase during this epoch to keep pace with sea level rise. The bund will start to form a slight promontory, with outflanking starting to cut back on its updrift edge, which may lead to vulnerable areas developing. During this epoch the 'form/profile' of the bund will become harder to maintain, as a result of sea level rise and the migration tendency of the ness, which will want to alter the position and width of the bund. There will be continued transport of shingle and sand anti-clockwise around the ness.	It is uncertain as to how the Ness may behave over this timescale. Erosional tendencies are likely on the southern shore and therefore the bund will need additional maintenance, potentially extending to prevent outflanking or alternative engineering options and management practices may have to be sought. There will be continued transport of shingle and sand anti-clockwise around the ness (some material will be transported offshore before being bought back onshore, at Dungeness East, under storm conditions).
Lydd	Shingle recycling and beach recharging along the frontage. A secondary defence is formed by the 'Green Wall' (clay embankment).		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
Ranges (Dungeness Reactor to Broomhill)	The management practices are expected to have a very limited impact and the barrier beach is likely to continue to experience erosion, as the shoreline wants to move towards a position commensurate with shoreline energy. The beach ridge is expected to retreat approximately 30m during this epoch, eroding the extreme western section of the 'Green Wall' (secondary defence).	The management practices are expected to have very limited impact on the sustainability of the barrier beach. It is likely to continue to retreat and realign, via 'cannibalisation', eroding up to 60m by the end of this epoch. Any material eroded will be rapidly transported alongshore and onto Dungeness South and East. The western end of the frontage, which is particularly vulnerable, will experience regular inundation. To prevent these alternative engineering options would need to be implemented.	Despite shingle recycling the plan form of the barrier beach would progressively move towards a swash-aligned coast (which would achieve equilibrium to the limited amount of sediment entering the system by altering the plan position of the coastline and reducing the amount of alongshore transport). To achieve this, it is anticipated that initially erosion of the active and relict shingle ridges, via rollback of the shingle ridge, would increase dramatically. Realignment of the coastline is anticipated to be in the region of c.150m by 2105. The low-lying areas of alluvium that intercept the shingle ridges may become at greater risk from inundation due to limited protection provided by the shingle ridge combined with the impact of sea level rise. Long term (+100 years) this shoreline will begin, to some degree, to stabilize, as erosion will begin to slow.
Rye Harbour East	Concrete seawall fronted with timber groynes between The Sutton's and Jury's Gap. Shingle recycling on this frontage along the eastern end. There are no defences / management at Camber Sands.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
(Broomhill to Camber Sands)	The sand dune complex at Camber Sands will remain reasonably healthy due to the shelter afforded by the Rye terminal groyne and the presence of a drift divide around Broomhill Sands area. The concrete seawall and timber groynes, along the central and eastern section will continue to hold the back of the shingle and sand beach in its current position. The groynes will continue to trap some of the limited beach building material supplied from the west, which combined with shingle recycling, will maintain a similar form (beach profile) to that at present.	The concrete seawall will need to be strengthened quite considerably to continue holding the line and to prevent flooding and overtopping. The Broomhill to Jury's Gap section will be most vulnerable to wave attack therefore shingle recycling might need to increase in volume and frequency along this section. Some beach material (mainly fines) will continue to be supplied from the west, but this will be transported alongshore in an eastwards direction to the Lydd Ranges. At the eastern boundary of the frontage, there is a switch in management practice and it is at this location i.e. Jury's Gap Lookout that the potential for outflanking is imminent. Consequently the seawall may have to be extended to combat flood propagation. Although the beach along this entire frontage will be held in place, by the seawall, they will be narrower and steeper in form due to the effects of sea level rise.	The integrity of the sand dunes will come under attack with the effects of sea level rise. Without management or potentially some form of engineering, erosion is inevitable, which may lead to inundation of the low-lying hinterland Unless supplemented by substantial amounts of shingle, beach levels along this frontage will fall due to sea level rise, updrift structures that restrict sediment movement and an insufficient amount of contemporary sediment available to the system. Lowering of the shingle beach will threaten the integrity of the seawall; to combat this additional maintenance will be necessary. Increasing the volume of shingle, extracted from the borrow pit area; on the eastern flanks of the Ness will not necessarily be beneficial to this frontage during this epoch. With the shoreline position being held seawards of its natural alignment and a rise in sea level, which combined both increase exposure to wave attack, it will be extremely difficult to retain any beach along the central and eastern section of this frontage.
Rye Harbour	Rye harbour terminal groyne, east pier training wall, recycling scheme		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
to Winchelsea	Shingle will continue to be supplied to this area from updrift frontages to the west, and will be arrested by the presence of the terminal groyne, which will continue to retain a significant amount of beach material. The shingle beach along this front is likely to be slightly lower and narrower than what it is at present.	Limited shingle will continue to enter this area from updrift frontages from the west but will not be able to move alongshore (on into Camber) due to presence of the terminal groyne. The shingle beach is likely to be lower and narrower than what it currently is due to the supply being finite and updrift structures that limit feed. The position of the shoreline will migrate landwards, despite beach recycling, due to the impact of sea level rise. At this location there is a substantial amount of back barrier deposits to prevent inundation the shingle beach will therefore 'roll-back'.	Continued maintenance of the Rye Harbour arm will lead to continued accretion on the westward side. Material (shingle) accreted here would continue to provide a source of material for the recycling operations along the Pett Levels frontage but the volume would probably be insufficient to keep beach levels at a suitable crest height with a rise in sea level. Sea level rise will produce higher water levels and higher waves, and conditions that are more volatile and less conducive to beach stability.
Winchelsea to Cliff End	Concrete rubble, timber breastwork and a few timber groynes at Cliff End gives way to a concrete seawall, fronted by an apron and groynes. Supplemented with beach feeding.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	Sediment recycling operations and the presence of a seawall / breastwork will continue to effectively fix the present plan-form position of the shoreline and prevent the shingle barrier beach from rolling back. The groynes would continue to trap the limited material supplied from the west, to maintain a beach similar to that at present. To sustain the correct crest height this would be supplemented with beach recharge.	The timber breastwork will provide some protection to the western section, but will not halt erosion. The rate of retreat is likely to increase as a result of sea level rise and could be in the region of 10 to 20 by 2055. Consequently the timber breastwork may need to be located landwards of its current position or raised to keep pace with the retreated position. A nominal amount of beach material (fines) will continue to be supplied to and transported along this frontage. The beaches are expected to be narrower than those at present and occupy a slightly retreated position.	Sediment feed into this frontage from the west will be minimal. Despite erosion from the cliffs updrift, the shingle beach is likely to have dropped in height and narrowed significantly. This could: 1) Further necessitate the creation and maintenance (increase beach feed volumes) of an artificially over steepened barrier profile to prevent flooding. However, this could increase vulnerability to major crest collapse through over washing processes that are likely to occur with increased frequency as sea levels continue to rise. Timber breastwork and groynes will experience greater exposure and will need regular maintenance. 2) Lead to the hard defences (seawalls) being significantly lengthened and strengthened to prevent a landwards migration of the shoreline, as sea level rise produces higher waves and more volatile conditions.
Cliff End to	No Defences / Management		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
Fairlight Cove	Cliff erosion will continue at a rate similar to that experienced historically. By 2025, it is anticipated that the cliffs will have eroded by 10 to 20m. Material eroded from the cliffs erosion will be predominantly fines and therefore it will be either lost offshore or transported alongshore to feed units downdrift (eastwards). The beach fronting the cliffs will not look too dissimilar than currently.	Cliff erosion will continue at a slightly greater rate than that experienced historically. It could be as high as 40 to 60m by 2055 due to the geological composition of the cliffs, along with the effects of sea level rise. Material from the cliffs will continue to temporarily 'rest' on the foreshore but it is unlikely to be sufficient enough to keep pace with sea level rise, which could be in the region of 4 to 6mm/year and adequate enough to build beaches with. Material accumulating at the toe of the cliffs will continue to be transported eastwards by longshore processes or alternatively offshore. Very little material will enter or exit this system.	Cliff erosion will continue at a greater rate than that experienced historically, and could be in the region of 100m by 2105, due to the impacts of sea level rise. The recession will provide predominantly 'localised' fine material to the foreshore, which will be small in volume and therefore insufficient to build beaches with. Should any material accumulate at the cliff toe, it will be transported eastwards by longshore processes, to either Cliff End or to the Rye Bay sink.
Fairlight	Rock bund at toe of the cliffs. (At the eastern extremity of Cliff End there is concrete rubble, timber breastwork and a few timber groynes)		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Cove East	Cliff erosion will continue at similar rates to that experienced since the construction and implementation of the rock bund. The bund is designed to reduce but not prevent erosion, thus it will continue to effectively reduce wave attack at the cliff toe. Small quantities of shingle, from updrift sources, may continue to accumulate in front of the bund, providing additional protection to the cliffs and the durability of the bund. The sand beach that fronts the cliffs will not alter in any significant way as no significant change in sediment input, from updrift sources and outputs, to downdrift frontages, are expected during this epoch.	Cliff erosion will continue at a potentially greater rate than that experienced since the construction of the rock bund, due to the impact of sea level rise (c.4 to 6mm/year), which will reduce the effectiveness of the bund and. To combat toe erosion the bund may need maintenance work. Although the rock bund will reduce toe erosion, a landward movement in the cliff top position will still occur, which could be in the region of 10 to 20m by 2055. The beach in front of the bund will narrow due to sea level rise and a lack of contemporary beach building material entering the system.	Erosion rates, at the cliff toe, will continue to be restricted due to the presence of the rock bund, but in order for the bund to remain as effective as what it currently is, it will need maintenance (extending), to keep pace with cliff top erosion, which could be in the region of c.40m by 2105 and sea level rise, which could be as great as 4 to 6mm/year. If the bund is not upgraded then landsliding tendencies are expected to dominate this section, due groundwater processes and clays being present within the cliff's geology. Erosional debris will accumulate at the cliff toe, yielding small quantities of sand and silt to the foreshore
Fairlight Cove Central	**Predicted Change for 'With Present Management':**		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	Toe protection works and / or drainage works constructed and / or slope re-profiling conducted in this first epoch	Defence works maintained	Defences removed or allowed to fail

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
	Given the nature of this landslide and the timescales involved in implementing a scheme, it is inevitable that there will be further loss of clifftop properties, located within the 'slippage zone', in the short term, even if works were implemented. Terry Oakes (2005) stated that the observed post-1997 average rate of cliff top recession was 8.5m/ yr, and that within the next 5 years the 15m wide "Tension Zone" and 34m wide "Nascent Zone" could be eroded. Therefore, recession to the equilibrium profile is expected within the next 4 to 10 years, thereafter the long term erosion rate (plus the potential impact of climate change) would be resumed (1.5-2m/year).	During this epoch the cliff is expected to have reached its equilibrium profile and experiencing annual erosion. The rate of erosion is predicted to be higher than the historic rate (prior to the landslide) due to the affects of climate change. Thus rates of 1.5-2m / per annum are predicted. Material derived from cliff erosion will be mainly fines and this is expected to rest initially at the cliff toe before being moved alongshore to downdrift frontages. Should engineering works, at the cliff toe, take place then toe erosion would be reduced and thus feed to the system altered. Initially alongshore sediment transportation of coarse material may be affected, however this is deemed as being temporary and 'normal' conditions will resume thereafter..	During this epoch the cliff is expected to continue eroding at a rate of 1.5-2m/year. However, the impact of sea level rise, which will become increasingly prevalent during this epoch, may trigger further cliff instability resulting in periodic landslides (the scale of which can not be predicted). If however an engineering structure resides at the cliff toe then the rate of cliff toe erosion is expected to be very low. However it is predicted that with a rise in sea level and a predicted increased in winter rainfall the rate of cliff erosion is likely to increase. With time a landslide event could be initiated due to the nature of the cliff's geology. Any erosion (be it annual or via a landslide event) would release mainly fine sediment to the foreshore and into the system.
Fairlight Cove (West) to Hastings Harbour	No management practices.		
	Cliff erosion would continue, via marine and sub-aerial processes, at a rate similar to that experienced historically. By 2025, it is anticipated that the cliffs will have eroded by 10 to 20m. Material released from cliff erosion along this section will be either: 1) lost offshore, 2) retained on the local beach affording some protection to the toe or 3) transported alongshore, in an eastwards direction. The shoreline will not look too dissimilar to what it currently is.	Cliff erosion will continue at a slightly greater rate to that experienced historically, due to the effects of sea level rise. Estimated retreat will be in the region of 30 to 40m by 2055. Hastings harbour arm will continue to restrict feed to this frontage and alongshore transport, combined with sea level rise, will lead to the progressive removal of any cliff debris and shingle that rests at the cliff toe, which will increase cliff vulnerability. Any material transported alongshore, to Fairlight Cove, will however be insufficient to build beaches.	Erosion of the cliffs is anticipated to be in the region of 110-130m by 2105. Some material released from the cliffs will maintain a very narrow beach similar, at the cliff toe, whilst the remainder will be rapidly transported eastwards. Despite an increase in cliff erosion, very little additional beach building material will be provided to the foreshore and to down drift frontages i.e. Fairlight Cove, as there are no defences in place. This combined with the effects of sea level rise, will increase the vulnerability of the cliff toe to wave attack.

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
Hastings East (Hastings Harbour to Hastings Pier)	Timber groynes front a concrete seawall with Hastings harbour arm at the eastern extremity of the frontage.		
	The shingle beach, which fronts the concrete seawall, will continue to be 'held' in place by a series of timber and concrete groynes. There will therefore be no change in shoreline position. The harbour arm, at the eastern extremity of the frontage will continue to 'trap' sediment, thus restricting alongshore transport to the east.	The seawall will continue to hold the shoreline in its present position, although as this area becomes more prominent, it is probable that much more substantial structures would be required to sustain defences integrity. It is probable that shingle beach width will narrow as sediment supply, from updrift sources becomes increasingly restricted, due to promontories and defence works updrift i.e. Bexhill and Hastings West. Groynes will try to trap sediment, but what material it does retain at this frontage results in frontages downdrift suffering. Cutback will be more apparent at eastern end of this frontage, downdrift of the harbour arms, due to sediment movement being to this location.	The concrete sea wall will continue to fix the plan position of the shoreline but it is highly probable that there will be little beach material entering the system from the west. A small beach may be retained updrift of the harbour arms but little if any is anticipated along the eastern extremity, downdrift of the harbour arm, which will aggravate erosion at Hastings Cliffs. Sea level rise, which could be in the region of 4 to 6mm /year will exacerbate the situation.
Hastings	Concrete seawall fronted by rock and timber groynes. Rock toe bund located in front of the clay cliffs, east of Glyne Gap.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	**Years 20 – 50 (2055)**	**Years 50 – 100 (2105)**
West (Hastings Pier to West Marina)	A reasonably healthy shingle beach fronts a concrete seawall (with a sloping apron) this is 'held' in place by a series of timber and concrete groynes. The shingle beach will not change a great deal from its current state, although it may slightly narrow. The clay cliffs, east of Glyne Gap, will continue to retreat at a rate slower than what it would naturally due to the presence of the rock bund.	The seawall will continue to hold the backshore position of the beach, although as it is being held seaward of its natural alignment, it is probable that more substantial structures would be required to sustain defence integrity. As the shoreline is being held seaward of its natural alignment, it will become increasingly exposed to wave attack. Groynes throughout the frontage will temporarily succeed in trapping material to retain a shingle beach the longevity of this by the limited availability of contemporary sediment input to the frontage. Nonetheless a narrow shingle beach is likely to remain during this epoch, which will offer some protection to the defences against wave attack.	The seawall will hold the shoreline in its present position; maintenance will however be necessary to maintain defence integrity. This may include laterally extending the seawall to front of the clay cliffs. The prominence of this frontage (and subsequent updrift frontages) will mean that it is highly probable that there will be no beach present, as the majority of the limited sediment supply from the west, will have been cut off due to the formation of updrift promontories i.e. Eastbourne, and Bexhill. Increased wave exposure, a consequence of sea level rise, will exert additional pressure on the seawall and as there is no or very little beach is likely to remain, the groynes will become redundant.
Bexhill East	Timber groynes along entire frontage. Concrete sea wall up to Galley Hill.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	The seawall will continue to fix the position of the sand and shingle beach, which restricts the natural landward transgression. The groynes will continue to retain a shingle beach, similar in form to those of today, but may slightly narrower and lower. Any material not held by the groynes will be transported downdrift (Hastings West).	The seawall will continue to fix the position of the sand and shingle beach, restricting a natural landward transgression. A small promontory will begin to form, which may temporarily inhibit sediment bypassing along the frontage. As the plan position is being held seaward of its natural alignment, the present defences may have to increase in proportions and strength, to continue holding the shoreline's position and in trapping beach material. The shingle beach will steepen and narrow throughout this epoch.	The seawall will continue to prevent a landward movement of the shoreline in response to sea level rise, but will enhance the potential for foreshore lowering. If the groynes are not heightened they could, under the worst-case scenario, become redundant as a consequence of sea level rise 'stripping' away beach material. It is anticipated that less material will enter the frontage throughout this epoch, which will exacerbate the problem. Sea level rise will produce higher water levels and higher waves, and conditions that are more volatile and less conducive to beach stability. If any beach is retained by the end of this epoch then it will be very narrow and very steep.
Bexhill West	Concrete seawall / promenade and timber groynes		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
(Includes Cooden)	The seawall will fix the position of the sand and shingle beach, along the western section of the frontage to its present position, as well as restricting inundation of the flat marshland. To the east the seawall will hold the cliffs in their present position. The shingle beach is expected to be slightly narrower and lower than what it currently is due to the store being finite. Any material entering the system will be 'trapped' by groynes, but as this interrupts alongshore transport there will be adverse effects downdrift.	The seawall present along the frontage will preclude a landward movement of the shoreline in response to sea level rise, but will enhance the potential for foreshore lowering. Groynes, which will need regular maintenance, along the frontage may temporarily succeed in trapping material to form a protective natural foreshore; they do not, however, solve the longer-term recessional tendency along this frontage, which is intrinsically related to the limited availability of contemporary sediment input and compounded by sea level rise. The shoreline at the western extremity of the frontage would start to experience cutback as a hard defence meets a 'softer' engineering option updrift. This may result in this section being more susceptible to wave attack.	The seawall, if maintained will continue to prevent a landward movement of the shoreline, which could result in inter-tidal squeeze, due to sea level rise. This section of frontage is likely to form a slight promontory, towards the end of the epoch, which may or may not be fronted by a shingle beach by the end of the epoch. If the latter is the case then the groynes will become redundant (and therefore will need to be removed) and substantial work will be required to maintain the integrity of the seawall. Sea level rise will increase exposure to greater wave activity, which will exert additional pressure on the current management practices along this section of the coastline.
Pevensey	Timber and rock revetment with timber groynes and rock breakwaters		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
and Hooe Levels	Where timber and rock revetments protect the shingle beach, there will be limited change in the plan position of the shoreline. There will also be very little change in the supply of shingle and sand to and from adjacent frontage due to groynes restricting alongshore sediment movement.	The position of shingle beach may have 'rolled back' slightly landwards, under the impact of sea level rise. To combat this and associated flooding and overtopping, the timber and rock revetment will need to be strengthened. There will be little sediment input from updrift frontages due to the heavily managed frontage at Eastbourne and at Eastbourne East, due primarily to the presence of the harbour arms at Sovereign Harbour. With a sufficient lack of contemporary material entering the system, combined with sea level rise beach volumes will start to decrease, resulting in an increased denudation of the foreshore sediments and a greater propensity for foreshore lowering.	The shingle beach will continually narrow because the timber and rock revetment reduces a natural landward migration. This puts great pressure on the revetment and it may result in the structures being strengthened or relocated. The groynes along this frontage may have to be lengthened or raised to retain a shingle beach. Whilst this approach is temporarily successful, in providing a semi-natural protective foreshore, they do not solve the longer-term recessional tendency of this frontage, which is intrinsically linked to the limited availability of contemporary sediment and sea level rise.
Eastbourne East	The seawall along the eastern section is a low concrete structure, which serves to reduce the rate of erosion rather than provide full protection. Timber groynes exist along this frontage.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	The seawall will continue to hold the shoreline in its present position, although the ability at which it achieves this will decrease with time, if the structure is not strengthened. The shingle beach will begin to reduce in volume but generally the profile should not be too dissimilar from that at present, due to the 'trapping mechanism' of the groynes.	The seawall will need to be significantly strengthened and potentially lengthened, if the position of the shoreline is to be held. The shingle beach will continue to reduce in volume, continually narrowing and lowering in front of the concrete wall, in response to sea level rise and a lack of contemporary sediment entering the system. This will however, further undermine the integrity of the seawall and the groynes, the latter of which will need regular maintenance throughout this epoch. Beach material draw down is likely to be transported alongshore, in an eastwards direction, to provide feed to beaches downdrift. The volume of material would not be sufficient to maintain a 'protective' beach crest at this frontage or indeed downdrift.	The plan-form position of the beach (The Crumbles) will continue to be fixed by the seawall, which precludes the shingle barriers natural migration tendency. Stress would therefore be exerted on the shoreline and sea level rise would compound the problem. The foreshore could narrow some 10 to 20m by 2105 and although this releases sand and shingle to beaches downdrift, it also results in the toe of the seawall becoming increasingly exposed. Denudation of the foreshore will be greatest downdrift of Sovereign Harbour, due to the trapping nature of this structure. Sea level rise will be in the region of 4 to 6mm/year and propagate higher waves and more volatile conditions.
Eastbourne	A vertically faced concrete seawall and promenade, with timber groynes along the frontage. Capital beach recharge occurs on a periodic basis, this may need to increase with time.		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	The seawall and rock revetment will continue to hold the cliffs, to the west and the shingle beach along the central and eastern section of this frontage, in its present position. The shingle beach will begin to reduce in volume. There would be continued, low sediment feed into this area from the updrift sources (Beachy Head), which will not be sufficient enough to sustain the current beach levels; therefore capital beach recharge will be needed. It is anticipated that the volume of shingle material being transported to the east will not be significantly different from present rates, due to the continued presence of groynes.	The seawall and rock revetment (along the western section) will continue to hold the shoreline in a fixed position, seaward of its natural alignment. Insufficient feed from updrift sources and a rise in sea level will result in a fall in beach levels along the front. Therefore the volume and frequency of capital recharge will need to be increased. The groynes will continue to retain some littoral drift but the retention of this material will become increasingly difficult due to sea level rise, which will produce conditions that are more volatile and less conducive to beach stability.	To continue holding the shoreline in its present position the seawall and rock revetment will need to be strengthened substantially. As the shoreline is held seaward of its natural alignment it exacerbates the tendency for foreshore lowering, which results in removal of beach material (shingle) and platform lowering (Holywell Cliffs) in response to wave action. This threatens the integrity of the defences and therefore requires further maintenance and management of the frontage, to retain a shingle beach, under a sea level rise scenario. The volume of recharge will need to be increased; otherwise there is a danger of no beach being present. Due to hard defences being present, Eastbourne will form a slight promontory.
Beachy Head	No Management Practises / Defences		

Location	Predicted Change for 'With Present Management':		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
	Cliff erosion would continue at similar rates to those experienced historically. It would be in the region of 10m by 2025. The rocky foreshore will also experience retreat at a rate similar to the historic trend. Limited erosion of the cliffs will provide minimal, localised beach building material, the majority of which will mainly be fines. Alongshore sediment transport is in an eastward direction. It provides small quantities of shingle, in transit from updrift sources that are subject to temporary storage in 'pocket' beaches. The limited quantity of shingle will provide temporary 'pulses', to downdrift frontages.	There would be continued cliff erosion and shoreline retreat, with up to 20 to 30m . The cliffs will continue to supply limited material, which will come initially rest on the rock platform at the cliff toe. Sea level rise may increase wave energy at the toe of the chalk cliffs as well as stripping debris away from the rocky platform. Although an increase in sea level might initiate sediment supply, which can then be transported alongshore, in an eastwards direction, it will do so at the detriment of the cliffs.	There would be continued cliff erosion, which could be in the region of 50 to 60m by 2105. Whilst the cliffs will continue to supply some material to the rocky platform below, it is likely to be insufficient to maintain any degree of toe protection. Sea level rise and the potential for increased storminess are likely to increase wave energy at the base of the cliffs, which will trigger instability. Despite an increase in cliff erosion, very little additional beach building material will enter or leave the system; there will therefore be little change in feed to downdrift beaches (Eastbourne).

C5.4 WPM DATA INTERPRETATION

Introduction

A number of data sets were used in the predictions of future shoreline response and evolution under the scenario of ‘with present management’, these included:

- Futurecoast historical shoreline change data (reported in the assessment of shoreline dynamics report (Section C1): primarily focussed on changes post-defences.
- Other historical change data sets: e.g. at some locations cliff position data sets are available (reported in the assessment of shoreline dynamics report (Section C1).
- Futurecoast predictions of future shoreline change under a ‘with present management practices’ scenario: this assumed that all present management practices were to continue.
- Environment Agency beach profile data: this data is only relevant for specific locations and restricted to specific time frames i.e. twenty years.

The affect of accelerating sea level rise was also taken into account (see Section C3).

Data Assessments (WPM)

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
South Foreland	Historical data suggests a retreat rate of 0.4m/year (1878-2002)	Moderate (40-50m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section. 5-20m is however most prevalent.	No defences Assumed similar rates to those experienced over last 20 years will continue, therefore used average of Futurecoast historic data.	No defences Assumed similar rates to those experienced historically plus SLR component - used Futurecoast MLW data plus the SLR multiplier	No defences Assumed similar rates to those experienced historically plus SLR component - used Futurecoast MLW data plus the SLR multiplier	Futurecoast score: very low Tendency for simple failure, a single event could result in 10 to 50m erosion.
Dover	No NAI cliff data available as the coastal position defended for much/all of the record.	High (50-100m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section. 5-20m and 20-50m is most prevalent, therefore a rate of 15-35m has been assumed.	0-20 Defences remain No change in cliff position due to the frontage being heavily defended	20-50 Defences remain No change in cliff position due to the frontage being heavily defended Assumed a net steepening of foreshore, but backshore position fixed SLR component included	50-100 Defences remain No change in cliff position due to the frontage being heavily defended Assumed a net steepening of foreshore, but backshore position fixed. SLR component included	Futurecoast score: very low Defences remain
Shakespeare Cliffs	Net retreat of cliffs: range of 0.5 to 1m/yr.	Moderate (40 to 50m) Recession potential of a single landslide event: <10m	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 50m shoreline alignment for this section. 5-20m is however most prevalent.	0-20 No defences Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate.	20-50 No defences Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	50-100 No defences Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Futurecoast score: low Tendency for simple failure, a single event could result in 10 to 50m erosion.

[13] Note: Futurecoast predictions did not consider an acceleration of sea level rise.

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
Samphire Hoe	Net retreat of cliffs: Assumed similar rates as Abbots Cliff = 0.06m/yr.	High (50-100m)	**SMP1 (2080):** Predicted a minimum of -5m and a maximum of 100m shoreline alignment for this section. 20-50m is however most prevalent.	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: low
				No change in cliff position due to the frontage being heavily defended Used Futurecoast cliff data	No change in cliff position due to the frontage being heavily defended Futurecoast cliff data and EA data used plus SLR component.	No change in cliff position due to the frontage being heavily defended Futurecoast cliff data and EA data used plus SLR component.	Tendency for simple failure, a single event could result in 10 to 50m erosion.
Abbots Cliff	Net retreat of cliffs: 0.06m/year	Moderate (40 to 50m) Recession potential of a single landslide event: <10m	**SMP1 (2080):** Predicted a minimum of -5m and a maximum of 100m shoreline alignment for this section. 20-50m is most prevalent.	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low
				Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Linear retreat of cliff assumed – used Futurecoast cliff data and EA data to determine likely rate, plus SLR component.	Tendency for simple failure, a single event could result in 10 to 50m erosion.
Folkestone Warren	No NAI cliff data	Moderate (50m)	**SMP1 (2080):** Predicted a minimum	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: medium

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	available as the coastal position defended for much of record. Seawall fixes the plan-form position and reduces sediment input from (now) relict landslides making retreat static		of <-5m and a maximum of 50m shoreline alignment for this section, with 20-50m of change being most prevalent.	No change in cliff position due to defences, but historical evidence suggests foreshore will continue to steepen and narrow.	No change in baseline cliff position due to defences, but historical evidence suggests foreshore will continue to steepen and narrow. Taken Futurecoast plus SLR multiplier. Also considered a large single cliff top failure event occurring in this period.	No change in baseline cliff position due to defences, but historical evidence suggests foreshore will continue to steepen and narrow. Taken Futurecoast plus SLR multiplier. Also considered a large single cliff top failure event	Sufficient data available of the defended coastline. Complex failure mechanism therefore during a single event could have over 30m
Folkestone (Copt Point to Sandgate)	Average cliff retreat of 0.5-1m/year but coast defended for some of that period.	High (50-100m)	**SMP1 (2080):** Predicted a minimum of -5m and a maximum of 100m shoreline alignment for this section. In the urbanised areas 5-20m is most frequent; this changes, in the cliffed section, to 20-50m.	0-20 Defences in place Little change in the position of the backshore. Foreshore likely to narrow and steepen	20-50 Defences in place Little change in the position of the backshore. Foreshore likely to narrow and steepen Historic Futurecoast rates used plus SLR component.	50-100 Defences in place Little change in the position of the backshore. Foreshore likely to narrow and steepen Historic Futurecoast rates used plus SLR component	Futurecoast score: Low Sufficient data relating to the defended coast.
Sandgate to Hythe	Very little change in	High (50-100m)	**SMP1 (2080):** Predicted a minimum	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: low

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	shoreline position due to the frontage being defended historically		of -5m and a maximum of 100m shoreline alignment for this section.	No significant change in the shoreline position is anticipated. Used combination of Futurecoast and EA data.	No significant change in the shoreline position is anticipated. Assumed foreshore will narrow and steepen Used Futurecoast rates plus SLR component.	No significant change in the shoreline position is anticipated. Assumed foreshore will narrow and steepen Used Futurecoast rates plus SLR component.	Sufficient data relating to the defended coast.
Hythe Ranges to Romney Sands	First defences c.1900. Beach narrow by c.50m since that period	High (50-100m)	**SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. 5-20m of change is most prevalent	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: low
				No significant change in the shoreline position is anticipated. Used combination of Futurecoast and EA data.	No significant change in the shoreline position is anticipated. Assumed foreshore will narrow and steepen further Used Futurecoast rates plus SLR component.	Assumed foreshore will disappear Breach potential Used Futurecoast rates plus SLR component.	Sufficient data relating to the defended coast.
Dungeness East (Romney Sands to The Pilot)	Net accretion / retreat of: 1.0m/yr	High (50-100m)	**Environment Agency:** Data reliable despite there being a drift divide at this location **SMP1 (2080):** Predicted predominantly <-5m of shoreline alignment for this section.	0-20 No defences	50-100 No defences	50-100 No defences	Futurecoast score: low to medium
				The beach will continue to accrete	Used combination of Futurecoast and South Foreland Sea Defence Scheme rates.	Assumed feed from updrift frontages will continue to reach this frontage. Used combination of Futurecoast rates and predictions made by Dungeness Foreland Sea Defence Scheme.	Change will be influenced by feed, hydro-dynamics plus SLR Uncertainty increases towards Romney Sands
Dungeness South (The Pilot to the Reactor)	Defended since 1961 (coastal position held	Low	**Environment Agency:** Data very reliable: 0-20 years = 0.4m, 20-50 years =	0-20 years Defence and management practise sustained	20-50 years Defence and management practise sustained	50-100 years Defence and management practise sustained	Futurecoast score: very low

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	for the past 40+ years). Prior to this 0.02m/year (1877-1944) of erosion		1m and 50-100 years = 2m of erosion **SMP1 (2080):** Predicted predominantly 50-100m of shoreline alignment for this section.	Along the length of this frontage a combination of EA and Power Station data used. It was assumed that the safety case requirements will be maintained and thus the shoreline will be held seaward of its natural alignment.	Assumed that the safety case requirements will continue to be met. Assumed as well that feed from Lydd Ranges will start to have a positive impact on this frontage, despite SLR (used Defra's rates)	Assumed that the safety case requirements will continue to be met. Feed from Lydd Ranges and other updrift frontages will continue to have a positive impact on this frontage. Aware that the mobility of the ness will not cease (as this is the very nature of this feature) Incorporated SLR component.	Shoreline position will be maintained.
Lydd Ranges	Average trend of net retreat = 1.5-2m/yr. Cannibalisation of the southern foreland is natural.	Very High (150-180m)	**Environment Agency:** Data very reliable: 0-20 years = 30-40m, 20-50 years = 80-100m, 50-100 years = 150-180m **SMP1 (2080):** Predicted a minimum of 100m and a maximum of 200m shoreline alignment for this section, the higher figure being most prevalent through this section.	0-20 Management practises continue Used EA (scheme) rates and assumed alignment would continue despite shingle recycling.	20-50 Management practises continue Used EA (scheme) rates and assumed alignment would continue, at a greater rate due to SLR, despite shingle recycling. Breach potential	50-100 Management practises continue Used EA (scheme) rates and assumed alignment would continue, at a greater rate due to SLR, despite shingle recycling. Breach potential increases	Futurecoast score: low to medium The shoreline will continue to retreat but in a managed fashion, similar to what it has done historically.
Rye Harbour East (Broomhill to	Coastline held historically (since the	High (50-100m)	**Environment Agency:** Accretion will continue at Camber (1.9m year)	0-20 Defences / beach management sustained	20-50 Defences / beach management sustained	50-100 Defences / beach management sustained	Futurecoast score: Low Uncertainty of

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
Camber Sands)	Napoleonic period as a minimum).		and the foreshore will continue to narrow at Broomhill: 0-20 years = 10m, 20-50 years = 50m (min), 50-100 years = 80m (min) **SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. <-5m is however most prevalent throughout this section.	Sea wall assumed to remain therefore no change in backshore position, but assumed the foreshore will accrete at the western end and erode at the east. Dune response assessed through geomorphological knowledge and input from CHaMP.	Sea wall will hold the backshore in its current position. Breach potential likely at Broomhill EA data used together with Futurecoast data plus SLR component	Assumed breach susceptibility will increase Also assumed that there will be some erosion of the dunes at Camber Sands. EA data used together with Futurecoast data plus SLR component	sustainability of sand dune complex in response to SLR – if they do erode then an alternative defence option will be implemented
River Rother	Defended since 1910	Low	**Environment Agency**: Data generally quite good but as the river has been defended current rates/ trends are distorted.	0-20 Defences in place The current course of the river will be held.	20-50 Defences in place The current course of the river will be held.	50-100 Defences in place The current course of the river will be held.	Futurecoast score: low Fluvial morphology will be held in its current form.
River Rother to Winchelsea	1.2m/yr for back of beach position	Low to medium (20 - 50m)	**Environment Agency**: Data for this frontage is plentiful but distorted due to	0-20 Defences / beach management sustained	20-50 Defences / beach management sustained	50-100 Defences / beach management sustained	Futurecoast score: low Some uncertainty over

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	(1878-1899): Downdrift defence structures have influenced the nature of this frontage since 1910 (turning a source into a sink)		downdrift defence structure. **SMP1 (2080):** Predicted a minimum of <-5m and a maximum of 100m shoreline alignment for this section. <-5m is however most prevalent throughout this section.	Accretion expected to continue at the eastern end of the frontage due to the presence of the terminal groyne. Data from EA (scheme) and Futurecoast used.	Assumed accretion will continue at the eastern end of the frontage (despite material being extracted from this location). Foreshore likely to narrow to the west despite beach recycling programme. Futurecoast data plus Defra's SLR component.	Assumed accretion will continue at the eastern end and foreshore narrowing to the west. Breach potential at the western end of the frontage despite a continuation in beach recycling. Estimate based on historic rates from Futurecoast plus SLR component.	response and evolution of the coast at the western end of the frontage but assumed this will be resolved via alternative beach management / defence options.
Winchelsea to Cliff End	Average retreat rate of -0.5-0.75m/yr.	High (50-100m)	**SMP1 (2080):** Predicted a minimum of 50m and a maximum of 200m shoreline alignment for this section.	0-20 Defences / beach management sustained	0-20 Defences / beach management sustained	0-20 Defences / beach management sustained	Futurecoast score: medium Some uncertainty over response and evolution of the coast to SLR but assumed this will be resolved via alternative beach management / defence options.
				Assumed the foreshore will narrow slightly despite the beach recycling programme in place. Defences will hold the shoreline in its current position Data from EA (scheme) and Futurecoast used.	Defences will continue to hold the shoreline in its current position Foreshore will continue to narrow across the entire frontage Data from EA (scheme) and Futurecoast used.	Defences will continue to hold the shoreline in its current position Foreshore will continue to narrow across the entire frontage EA and Futurecoast understanding plus SLR component.	
Cliff End to Fairlight	Average retreat rate	High (50-100m)	**SMP1 (2080):** Predicted 20-100m of	0-20 No defences	20-50 No defences	50-100 No defences	Futurecoast score: low

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
Cove	(similar to historic) 0.5-1m/year		shoreline alignment for the cliffed sections and 100-200m for the low lying land.	Cliff erosion expected to continue at a similar rate to that experienced historically	Cliff erosion expected to continue at a slightly greater rate to that experienced historically. Futurecoast and SMP1 data used plus SLR component	Cliff erosion expected to continue at a greater rate than that experienced historically. Rates based on Futurecoast data plus SLR component	No significant change anticipated
Fairlight Cove (includes East and Central section)	Average retreat rate of 0.5 to 1m/year. c.0.08m/year (1878-2001)	High (80-100m)	**SMP1 (2080):** Predicted that the shoreline alignment would be 50-100m Assumed that the bund would become increasingly ineffective. **Moore (1984, 1986)** reported rates of 0.5-1.4m/year at Fairlight Glen. **Landslip Inspection, Halcrow (2004):** 17m maximum recession rate between 1998 and 2003. **SMP2:** Assumed that	0-20 Defence in place (at the eastern end) Assumed the coast will erode in a similar manner to what it has done in the recent past. Rates based on Futurecoast and Halcrow (2003 and 2004) plus SLR component.	20-50 Defence in place (at the eastern end) Assumed cliff retreat will continue at a slightly greater rate than the recent past due to SLR. Rates based on Futurecoast and Halcrow (2003 and 2004) plus SLR component.	50-100 Defence in place (at the eastern end) Cliff erosion anticipated to increase. Assumed landslide events will become more frequent Rates based on Futurecoast and Halcrow (2003 and 2004) plus SLR component.	Futurecoast score: medium Complex failure mechanism during a single event c.30m of the cliff is still likely to occur regardless of any engineering solution

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
			the bund (Fairlight East) would not be maintained beyond its design life. Investigated protection works to Fairlight Central – assumed that some retreat would continue in the first epoch (due to stabilisation reasons), that minimal erosion would occur in the medium term and that erosion would be instigated in the long term (due to the nature of the cliff's geology)				
Fairlight Cove West to Hastings	From old maps and records dating back to 1873, the erosion of the cliffs has been relatively modest.	Fluctuations in shoreline position between 0 and 50 m	**SMP1 (2080):** Predicts a shoreline alignment projection that ranges between 5-100m. 20-50m and 50-100m are most prevalent therefore a rate of 35-75m has been assumed.	0-20 No defences Assumed coastline position (cliffs) will continue to retreat laterally at a similar rate to that experienced historically.	20-50 No defences Due to SLR assumed that net retreat will increase slightly.	50-100 No defences Assumed that retreat will continue, increasing slightly due to SLR.	Futurecoast score: low Tendency for simple failure, a single event could result in 10 to 50m erosion.
Hastings (includes the	Frontage defended for	High (50-100m)	EA data shows erosion of beach and	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: low

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
harbour)	most of period, little change in cliff and beach position.		retreat of MSL at rate between 2.8 and 3.5m/yr.	Assumed that the shoreline will be held in its current position. The harbour arm will continue to arrest alongshore movement.	Assumed that the shoreline will continue to be held in its current position and that the harbour arm will continue arresting the alongshore movement of material. Assumed that the foreshore will narrow except at the eastern end (by the harbour arm) Used Futurecoast rates plus SLR component	Assumed that the shoreline will continue to be held in its current position and that the harbour arm will continue arresting the alongshore movement of material. Assumed that the foreshore will have narrowed dramatically Futurecoast rates plus SLR component	Shoreline position will be maintained.
Bulverhythe and Glyne Gap	Defended since 1899 Foreshore shows a steepening trend.	Moderate (50m)	**SMP1 (2080):** Predicts a shoreline alignment projection that ranges between 20-200m, with 50-100m being the most prevalent shoreline projection	0-20 Defences in place Assumed that defences will continue to hold the shoreline in its current position. Not too much change anticipated during this epoch	20-50 Defences in place Assumed that defences will continue to hold the shoreline in its current position. Also assumed that the foreshore will narrow as a consequence of SLR and lack of feed. Futurecoast data and SLR component used	50-100 Defences in place Assumed that defences will continue to hold the shoreline in its current position. Assumed that the foreshore will continue to narrow due to SLR and a lack of feed. Futurecoast data and SLR component used	Futurecoast score: low to medium Uncertainty how much the foreshore will narrow in response to SLR
Bexhill and Cooden	Defended since 1935	Moderate (50m)	**Strategy Study:** Analysis of the last 30	0-20 Defences in place	20-50 Defences in place	50-100 Defences in place	Futurecoast score: low to medium

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	Foreshore shows a steepening trend.		years of Annual Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 22,000 m^3 per year. **SMP1 (2080):** Predicts a shoreline alignment projection that ranges between 20-200m, with 50-100m being the most prevalent shoreline projection	Assumed that the shoreline will continue to be held. Very little change is anticipated during this epoch Used Futurecoast and Strategy Study data.	Assumed that defences will continue to hold the shoreline in its current position. Also assumed that the foreshore will narrow as a consequence of SLR and lack of feed. Used Futurecoast data plus SLR component.	Assumed that defences will continue to hold the shoreline in its current position. Assumed that the foreshore will continue to narrow due to SLR and a lack of feed. Used Futurecoast data plus SLR component	Uncertainty regarding the degree of foreshore narrowing
Hooe and Pevensey Levels	Defended since 1961	Moderate: roll back of the shingle barrier will continue	**Strategy Study:** Under a 'do-nothing' approach it is estimated that the	**0-20** **Defence and management practises sustained**	**20-50** **Defence and management practises sustained**	**50-100** **Defence and management practises sustained**	Futurecoast score: medium

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	Historic rate of retreat: 0.07-0.1m/year	up to the defence line, thereafter the foreshore will narrow (50m).	defences in the Agency frontage would be permanently breached within 2 years resulting in uncontrolled flooding and land and property loss. Analysis of the last 30 years of Annual Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 22,000 m^3 per year. **SMP1 (2080):** Predicts that there will be a combination of accretion (<-5m) and erosion (20-50m) zones along the frontage. The figures presented are the zones most prevalent.	Limited change in the plan position of the shoreline The foreshore will roll back at a similar rate to that experienced in the recent past. Used Futurecoast (2002) data.	Assumed some alignment of the foreshore would continue, perhaps at a greater rate, despite shingle recycling, due to SLR. The potential for breach will increase towards the end of this epoch. Futurecoast data and SLR component used.	Foreshore will narrow significantly but the backshore position will be held by the defences. Assumed feed from 'The Crumbles' will continue to be interrupted by defences downdrift. Futurecoast and SS data and SLR component.	Uncertainty regarding the durability of the foreshore in response to foreshore narrowing
Sovereign Harbour	Historic accretion	High (50-100m of change)	**SMP1 (2080):** The main rate for	**0-20 years** Defences in place	**20-50 years** Defences in place	**50-100 years** Defences in place	Futurecoast score: low

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
	rate = 1m/year (1879-2001)	*Note this does not necessarily mean the beach will accrete more that the feature will become mobile and move.	shoreline projection along this frontage is 50-100m	Assumed coastline position (shingle beach) will continue to be held seawards of its natural alignment by the defences and that the form will not look too dissimilar to what it currently is. Used Futurecoast and Strategy data.	In response to SLR and limited feed the foreshore along the majority of the frontage is anticipated to narrow and lower, with the exception of the beach immediately downdrift of the harbour arm, which will continue to accrete. Futurecoast and SS data and SLR component.	The plan position of the shoreline will remain fixed but the foreshore will continue to narrow and lower in response to SLR (potentially this could include the beach downdrift of the harbour arm) Futurecoast and SS data and SLR component.	Shoreline will be held in its current position and remain heavily defended
Eastbourne (Defended since 1878)	No significant change, apart from MLW falling c.40m due to the shoreline being held by the defences	Low	**Strategy Study:** Analysis of the last 30 years of Annual Beach Monitoring Surveys and recharge schemes shows an average shingle loss from the study frontage of 7,000 m³ per year The predicted erosion rate, from historical analysis, is 1m/yr with no defence in place, i.e. at the end of the residual lives of the groynes (Year 23). **SMP1 (2080):** predicted that some sections would erode 20-50m and others 50-100m. Therefore a generic figure of 35-75m has been assumed	0-20 Defences in place Assumed coastline position (shingle beach) will be held seawards of its natural alignment by the defences. No significant change anticipated during this epoch.	20-50 Defences in place Assumed the foreshore will retreat in response to SLR and limited feed. The plan position of the shoreline will however remain fixed due to the defences. Futurecoast data plus SLR component used.	50-100 Defences in place Assumed erosion of the foreshore will continue, despite beach management practises in place but that the plan position will continue to be held. Used combination of EA and Futurecoast data plus SLR rise component.	Futurecoast score: low Historically this frontage has been defended The shoreline will continue to be held in its current position

Location	Futurecoast data		Other	Prediction of shoreline change for WPM			Uncertainty
	Historical	Prediction[13]		0-20	20-50	50-100	
Beachy Head	Net retreat of MLW and cliffs 0.4m/yr.	Moderate (50m) 0.5m/year	**Strategy Study:** The cliffs will continue to erode	No defences Assumed uniform rate of cliff retreat similar to that experienced historically	No defences Assumed uniform rate of cliff retreat similar to that experienced historically plus incorporated sea level rise (using Futurecoast MLW)	No defences Assumed uniform rate of cliff retreat similar to that experienced historically plus incorporated sea level rise (using Futurecoast MLW)	Futurecoast score: low No significant change anticipated

C6 Maps (NAI and WPM)