Regional Beach Management Plan 2015:
Graveney to Northern Sea Wall

Report – ENVIMSE100035/R-01

Final Report, February 2017

This series of regional Beach Management Plans for Southeast England are dedicated to the memory of Andy Bradbury.

The data that has been used to compile them is only available due to Andy’s vision and drive for better coastal monitoring data to inform beach management.

Regional Beach Management Plan 2015

Graveney to Northern Sea Wall

Main Report

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EXECUTIVE SUMMARY

This Beach Management Plan (BMP) has been prepared by **Canterbury City Council** on behalf of **Canterbury City Council and the Environment Agency**. The BMP sets out the implementation approaches for intervention and monitoring to maintain the beach where it provides an integral part of the sea defences between Graveney and Northern Sea Wall. The aim of the BMP is to inform, guide and assist these responsible authorities and organisations in managing the beach, and to ensure that the beach management continues to manage the risk of coastal flooding and erosion.

> *Beach Management Plans provide an accountable and transparent methodology for managing beaches as coastal defence assets based on risk information that derives from scheme design, monitoring and scientific/research input with the aim of managing the frontage in a sustainable way that enhances vegetated shingle habitats.*

To this effect the BMP contains the evidence base that has led to the management options. To achieve this aim of accountability and transparency, all source data, documents and methods are appended to this report in the Appendices and in digital form in the enclosed DVD.

The entire frontage, except for the Nothern Sea Wall, covered by this beach management plan is characterised by low rates of longshore sediment transport (generally <1,000m^3 per year) and beach volumes well in excess of what is needed to provide the required standard of protection. Management requirements are therefore low and focussed on local hot spots. The BMP proposes the following activities:

- Continued monitoring as part of the Regional Coastal Monitoring Programme.
- Managing authorities to continue to monitor the management hotspots identified in Chapter 8.
- Maintain opening for river mouth at Long Rock (long term solution under investigation)
- Biannual recycling at Lane End and inside the Harbour, Herne Bay. Approximately 2,000m^2 of shingle per year.
- At Northern Sea Wall; recycle from Minnis Bay on an ad-hoc basis and recharge from St. Augustine's Bank into sections C-E.

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1 INTRODUCTION

1-1 PRESENT SITUATION

1-1-1 SMP AND OTHER STRATEGY POLICY

The coastline between Graveney and Northern Sea Wall falls within the coastal frontage of the Isle of Grain to South Foreland Shoreline Management Plan (Halcrow, 2010) including parts of policy units 4c07A (Faversham Creek to the Sportsman Pub) to 4a14 (Reculver Towers to Minnis Bay), Table 1-1. The frontage is managed under the responsibility of the organisations shown in Figure 1-1 overleaf.

TABLE 1-1 SMP POLICIES WITHIN THE BMP

POLICY UNIT	DESCRIPTION	SEDIMENT TYPE	SHORT TERM	MEDIUM TERM	LONG TERM
4A07A	FAVERSHAM CREEK TO THE SPORTSMAN PUB	SHINGLE	HTL	MR	MR
4A07B	THE SPORTSMAN PUB TO SEASALTER	SHINGLE	HTL	HTL	MR
4A08	SEASALTER TO WHITSTABLE TOWN (GOLF COURSE	SHINGLE	HTL	HTL	HTL
4A09	WHITSTABLE TOWN (GOLF COURSE) TO WHITSTABLE HARBOUR	SHINGLE	HTL	HTL	HTL
4A10	WHITSTABLE HARBOUR (EAST) TO SWALECLIFFE	SHINGLE	HTL	HTL	HTL
4A11	SWALECLIFFE TO HERNE BAY BREAKWATER	SHINGLE	HTL	HTL	HTL
4A12	HERNE BAY BREAKWATER TO BISHOPSTONE MANOR	SHINGLE	HTL	HTL	HTL
4A13	RECULVER COUNTRY PARK	SHINGLE	NAI	NAI	NAI
4A14	RECULVER TOWERS TO MINNIS BAY	SHINGLE	HTL	MR+HTL	MR+HTL

HTL – Hold the Line, NAI – No Active Intervention, MR – Managed Realignment

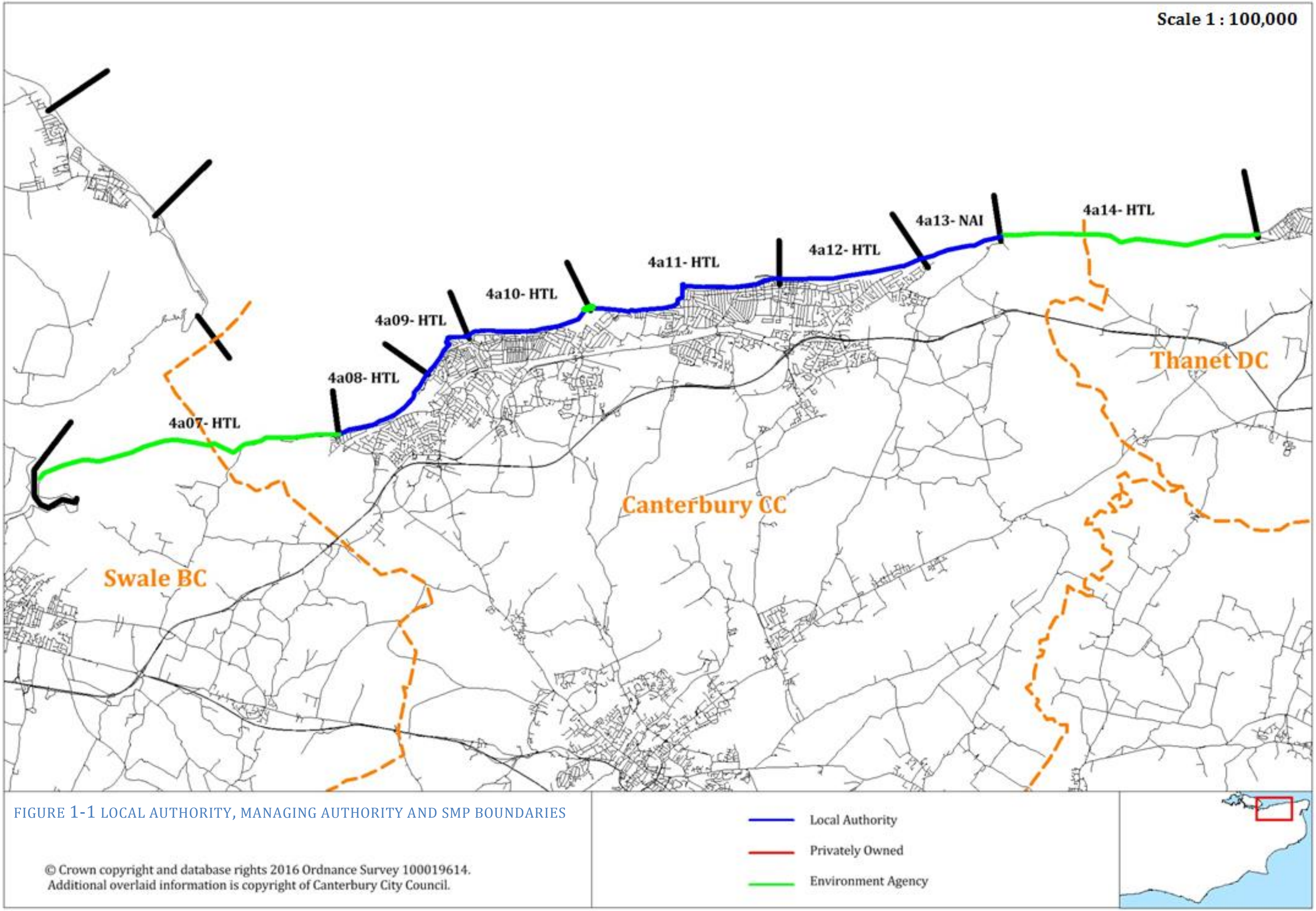

FIGURE 1-1 LOCAL AUTHORITY, MANAGING AUTHORITY AND SMP BOUNDARIES

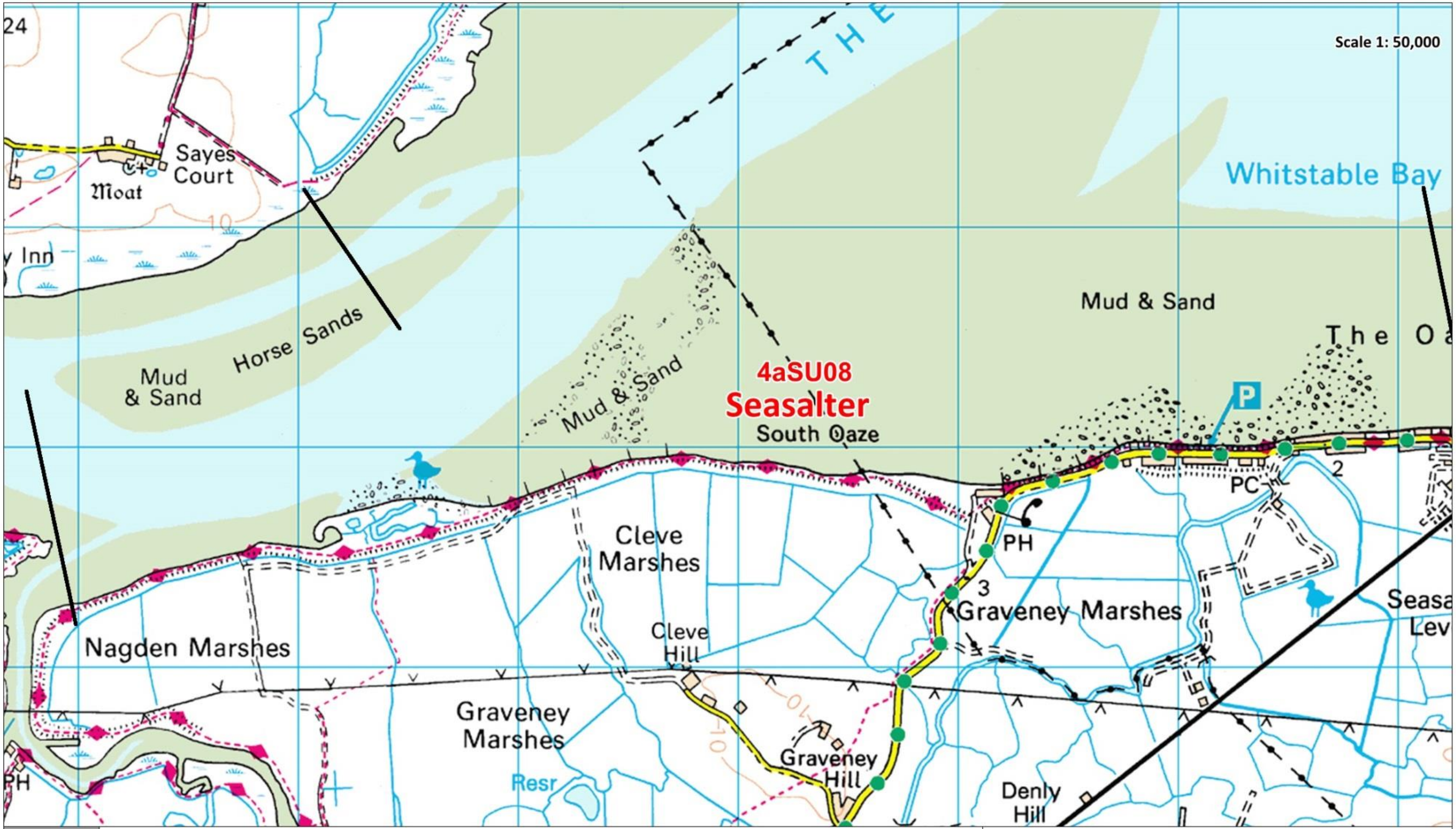

FIGURE 1-2 UNIT BOUNDARIES - SEASALTER

▬ **Policy Unit Boundary**

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FIGURE 1-3 UNIT BOUNDARIES - WHITSTABLE

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Policy Unit Boundary

CANTERBURY CITY COUNCIL

FIGURE 1-4 UNIT BOUNDARIES - TANKERTON

— Policy Unit Boundary

CANTERBURY CITY COUNCIL

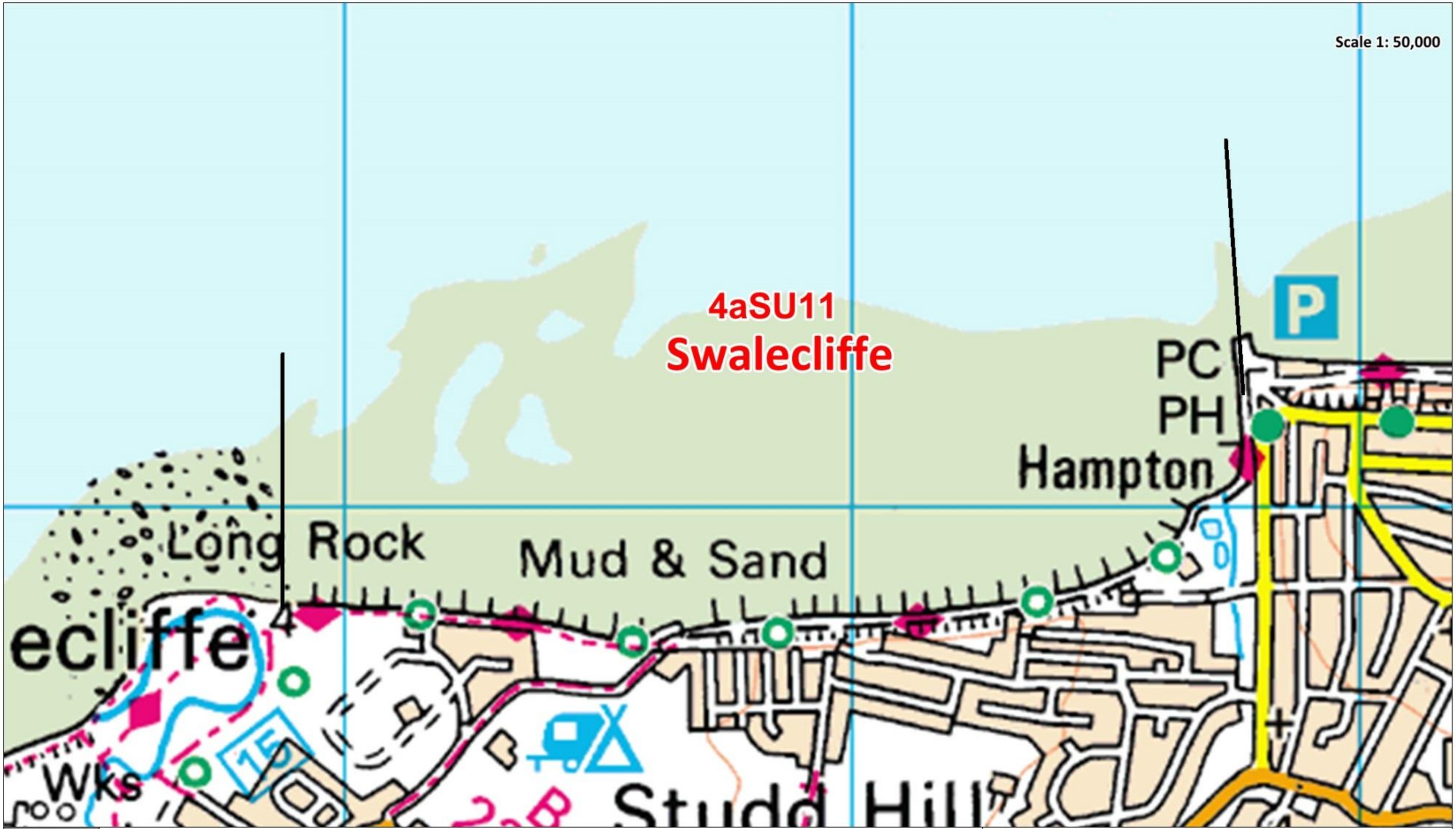

FIGURE 1-5 UNIT BOUNDARIES - SWALECLIFFE

N

Policy Unit Boundary

CANTERBURY CITY COUNCIL

FIGURE 1-6 UNIT BOUNDARIES – HERNE BAY

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▬ **Policy Unit Boundary**

CANTERBURY CITY COUNCIL

FIGURE 1-7 UNIT BOUNDARIES – RECULVER COUNTRY PARK

— Policy Unit Boundary

CANTERBURY CITY COUNCIL

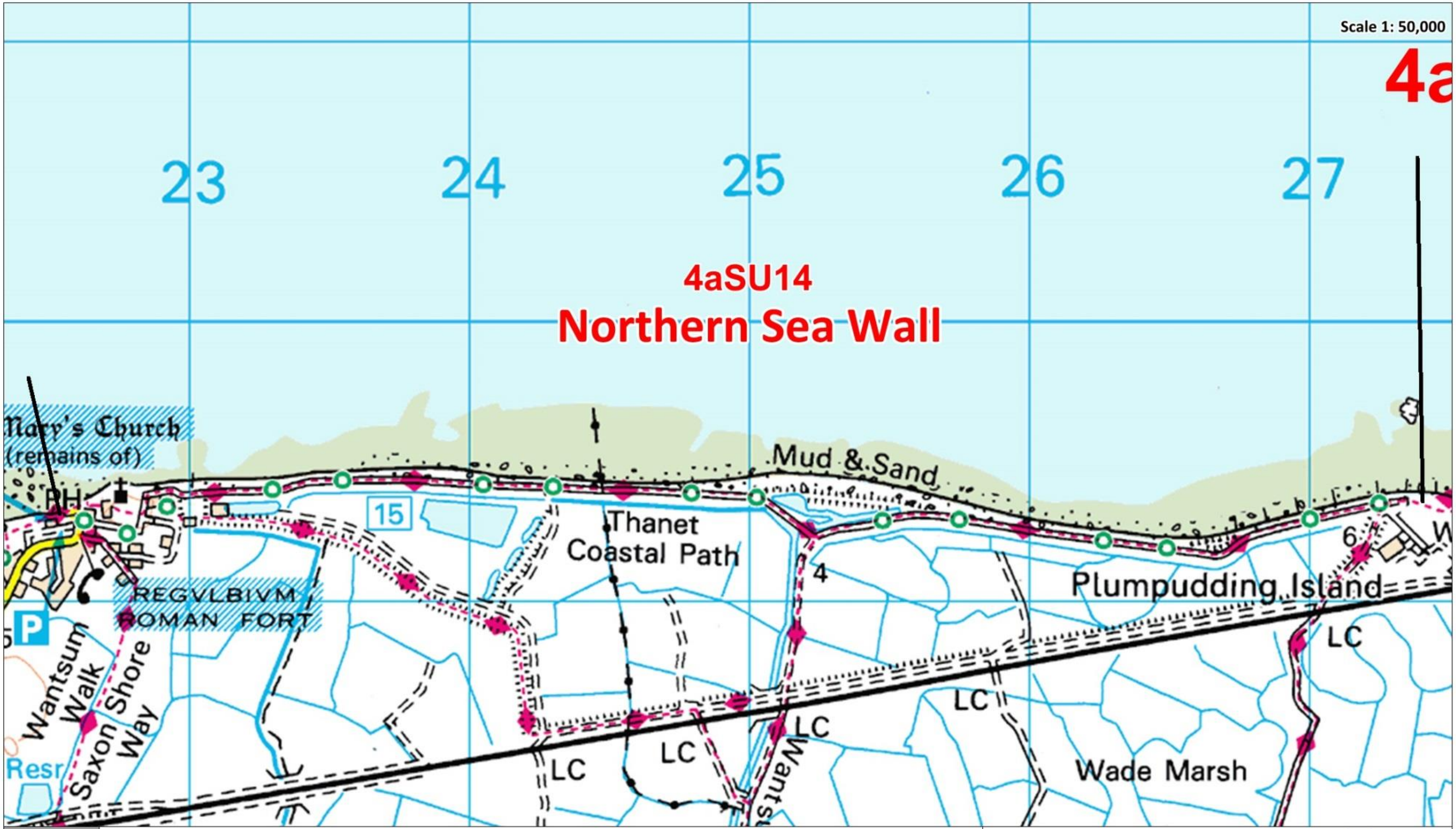


FIGURE 1-8 UNIT BOUNDARIES – NORTHERN SEA WALL

N

Policy Unit Boundary

CANTERBURY CITY COUNCIL

1-1-2 PHYSICAL CHARACTERISTICS AND COASTAL DEFENCES

The frontage encompasses a gently undulating clay cliff landscape, interspersed with low lying alluvial areas. The Seasalter and Graveney Marshes mark the western extent of the BMP area whilst the old Wantsum Delta defines the eastern boundary. Shingle deposits and controlling structures backed by hard defences occupy the majority of the frontage as erosion protection or flood defence.

Refer to Appendix A - Oblique Aerial Photography for place names and frontage overview.

GRAVENEY & SEASALTER

The Graveney and Seasalter frontage extends 6.5km, from Faversham Creek in the west to the Oyster Pearl (formerly the Blue Anchor) Public House in the east. A shingle sand composite beach, which becomes finer towards the west, is present with largely exposed mudflats in front of the sea wall. Seasalter is at the mouth of the Swale Estuary and the mud foreshore is much higher than the rest of the frontage in this BMP at +1.0mOD. It has a number of national and international conservation designations with the habitats on the seaward side providing a level of protection to the sea wall. These designations cover the marshes and hinterland.

The vast majority of this unit comprises low-lying agricultural land defended by a re-enforced clay embankment (crest levels between +6.0 and 6.5 mOD), built in 1954, that is generally in fair condition. Much of this hinterland consists of a marshland, below MHW (Mean high Water +2.21mOD), at a level of +2.0 mOD, which has been progressively drained and reclaimed over the centuries. The flood plain extends inland up to 4km behind the sea wall. The London to North Kent (Faversham to Thanet) main railway line and high voltage trunk power lines on pylons cross the flood plain.

Figure 1-9 shows a typical example with the concrete sea wall sitting on a clay bund with the seaward side protected by a block work apron. The wall itself has a wave return profile and is in fairly good condition, although short sections are affected by differential settling. At the Sportsman Pub the defence is a grass covered clay bund with a crest level of +5.7mOD that is set back but protected by a beach and high shingle ridge.

Further to the east the defence line moves to the landward side of Faversham Road and consists of a grassed clay bund at level +5.1mOD. At this location there are a number of houses situated in front of the defence. At the eastern end of the unit, there is a small length of concrete sea wall with a wave recurve (c.70m) in front of the Beach Court residential area, built to a level of +6.1mOD.

FIGURE 1-9 VEGETATED BLOCK WORK APRON AND WAVE RETURN PROFILE WALL ON CLAY BUND, BACKED BY GRAVENEY GRAZING MARSH (2008).

West of the Sportsman Pub to Faversham Creek, old timber groynes are intermittently placed along the length but in most cases these do little to control beach movement. The beach in front of the Sportsman is retained by three privately maintained groynes, fabricated from old railway sleepers, maintained by the Seasalter Chalet Owners Association. In the 1950's, 40 timber groynes were installed east of the Sportsman to the Red Sluice Outfall; in 2010 two of the groynes in front of the Sportsman PH received maintenance and nearly 3,000m^3 was deposited into these bays. No groynes exist between the Red Sluice outfall and the Oyster Pearl PH. In October 2010 Environment Agency maintenance works constructed two wooden groynes in front of the Oyster Pearl PH deposited 3,180 m^3 to the new groyne bays.

WHITSTABLE

The Whitstable frontage extends from Preston Parade in the west to the Harbour in the east, covering 3.3 km of coast. The frontage is extensively covered by a variety of sea walls (with a uniform height of +5.78 mOD) and a hardwood timber groyne field, spaced every 25-50m spacing and are between 30 and 60m in length. They are present along the whole frontage and are imperative to keeping the shingle beach stable (Figure 1-10) as the dominant drift direction of sediment is east to west and the design of the groyne field accommodates this: the groynes become smaller to the west, thereby reducing the 'terminal-groyne' effect.

The clay foreshore extends up to a kilometre offshore and this shallow intertidal area (+1.0mOD) supports mussels and shellfish banks. The beach between Admiralty Walk and the caravan site is dredged material, deposited in 2006. The beach between the caravan site and the harbour is dredged material deposited in 1989 and topped up in 2006, with a D_{50} of 10-15mm.

FIGURE 1-10 NEW TIMBER GROYNES AND BEACH REPLENISHMENT: THE 2006 CAPITAL SCHEME

Between Preston Parade, in the west, and the Golf course the hinterland is high (varying between +5.0 to +15.0mOD) due to the London Clay Cliffs. The sea wall fronting Admiralty Walk (+5.16 mOD) acts as a retaining wall for the clay slopes behind. The minor slope failures and landslides that are characteristic of this type of hillside have been largely alleviated by the provision of the sea wall and the regrading of the slopes and herringbone drainage. Further to the west approximately 150m of sea wall is managed by Network Rail as it forms part of the railway embankment. Here the defence is a sloping concrete wall, with a top level of +2.8mOD backed by a sloping clay railway embankment.

The majority of the frontage to the east of the Golf course is backed by a large flood basin which spans from the Golf Course in the south to the Harbour in the north. 110ha of low-lying land falls within the flood plain, comprising the town centre, the main commercial area of the town, the area around the harbour and the high density residential area. Parts of the town are as low as +2.4m OD (MHWS +2.66mOD). A population of approximately 9,000 live within the 1 in 200 year flood plain and a further 11,000 people live within the area that would be indirectly affected by any large flood event (South Quay PAR, 2015).

The harbour area covers approximately 4.3ha. The harbour quays themselves form part of the defences of the town, at +4.34mOD, and these are augmented by perimeter walls at a level of +5.8 to +6.3 mOD.

TANKERTON

Tankerton covers a 3.5km stretch from Whitstable Harbour up to and including Long Rock, a shingle spit at the mouth of the Swalecliffe Brook. A shingle beach is controlled by a dense timber groyne field of good condition, spaced as closely as 20m (80m in length) by Beach Walk, and 42m spacing along the main promenade (50m in length). The sea wall design is consistent throughout this section and the majority of this frontage is backed by regraded London clay cliffs. The foreshore consists of a weathered clay seabed covered with up to 300mm of fine sand and silt (CCC, 1988).

The sea wall extends from East Beach to Swalecliffe Brook and varies between + 4.6 to +5.8mOD with rear walls (between +5.5 and +6.7mOD) present in places. The wall was built in several phases over the last century hence slight variations in design. An unusual feature is "The Street"; a long narrow shingle ridge which is exposed at low tide and runs perpendicular to the coastline (Figure 1-11), see also Features of Interest in section 1.1.3.

FIGURE 1-11 THE STREET, TANKERTON

Between Beach Walk and the beach huts, inclusive, the sea wall is backed by a retaining wall for the Tankerton slopes. The clay cliffs are higher here than behind Admiralty Walk, ranging between +6.0 and +22.0 mOD, with the majority higher than +16.0m, falling to around +6.0m at the sea wall. Parts of these slopes have been regraded and herringbone drainage installed and they are generally turfed and mown. Other sections remain in their natural state and are generally hummocky and overgrown. Cracked and misaligned footpaths suggest slump and heave processes. The wide flat berm at the top of the slopes is 15m to 20m wide.

The beach at Swalecliffe Brook is backed by a clay embankment, at approximately +5.80 mOD. The clay embankment is set-back to accommodate the meandering brook. This brook is the main source for surface run-off for the town of Swalecliffe. The mouth of the brook discharges on the only open stretch of beach along the Tankerton and Swalecliffe coastline and is highly mobile which regularly causes the mouth to block. The set-back area, which is known as Long Rock, is fronted by a shingle ridge spit backed by small areas of scrub.

SWALECLIFFE

The frontage at Swalecliffe is predominantly low lying with the land rising to +17mOD at Studd Hill in the east. The beach is comprised of shingle sand composite at a 1 in 8 gradient with a mud and clay foreshore at -1mOD. The terminal structure, Hampton Pier, denotes the eastern boundary of this section. The total length of this frontage is 2.3km, and includes the residential areas of Swalecliffe and Studd Hill. The dominant drift direction is east to west; however, at the eastern end of the section, a drift reversal can occur close to Hampton Pier.

The current timber groynes were installed 1986 and 1990 creating a dense groyne field at 55m spacing. The concrete wave return wall and rear wall runs the whole length of the frontage. The western half of the wall, to the boat ramp (west of the caravan park) has a wave return wall (+5.18mOD) and rear wall (+6.7mOD) constructed in 1985 as an extension to the existing wall between the boat ramp and Hampton Pier. This wave return wall (+4.88mOD) was constructed in 1960 and rear wall (+5.33mOD) constructed in 1968. On the western face of the Hampton Pier a granite sett and stepped apron is now partially covered in beach material.

HERNE BAY

Herne Bay extends for 5.6km between Hampton Pier in the west to the rock revetment at Bishopstone Glen to the east. A shingle sand composite beach runs the entire length of this coast with a mud deposits on the foreshore at the west and centre and a gradually firmer sandy foreshore towards the east all with underlying London clay; the foreshore level ranges between -1.5 to -2.2 mOD, with the lowest foreshore in the centre, only exposing on low spring tides.

The dominant sediment drift direction is east to west; however the drift direction between Hampton Pier and a rock groyne at Herne Bay Pier alternates as it is a closed sediment cell. A dense groyne field (c.20-30m spacing) covers the whole frontage which maintains the beach between a 1 in 5 and a 1 in 8 gradient. The terminal structure at the west of the section, Hampton Pier, was constructed in 1900 and has received little maintenance. There is a natural accumulation of shingle on its eastern side due to the direction of longshore drift.

Herne Bay Pier does not hinder sediment movement as the steel piles allow sediment to pass underneath. East of Herne Bay Pier 'Neptune's Arm', a rock breakwater, provides a flood defence for the town and creates a small harbour in between the Pier and the breakwater. East of the Neptune Arm is a relatively narrow beach which stretches to the unprotected cliffs at Reculver.

There is no sea wall between Hampton Pier and Lane End, only a concrete promenade which is used to provide access to the beach huts (Canterbury City Council, 1988). Between Selsea Avenue and Lane End a 310m sea wall was constructed between 1905 and 1930, exact date unknown.

Over the 2012/13 winter the sea wall between Herne Bay Pier and Neptune Arm was raised by 225-300mm and where no wall was present, the wall was extended to join the wall just west of Neptune Arm, all at +6.1mOD. Three timber groynes were installed within the harbour to pacify a scour zone. Later, in 2015, the wall, between Herne Bay Pier and Lane End was also raised by 225-300mm to increase the wall to +6.1mOD.

The sea wall between the Kings Hall and Bishopstone Glen is consistently at +4.8mOD, albeit with varying substructures and varying construction dates. The main function of the rear wall is to stabilize the regraded slopes behind and ranges from +6.3mOD to +7.4mOD.

The London Clay cliffs at both Hampton and East Cliff are artificially managed and have previously undergone regrading and the installation of herringbone drainage (1930s and 1970s), to meet a 1 in 4 slope. Toe weighting is present at the base of the Miramar slip circle, towards Bishopstone.

RECULVER COUNTRY PARK

Reculver Country Park extends from Bishopstone Glen in the west to Reculver Towers in the east. The whole stretch is characterised by 25m high predominantly unprotected sandstone cliffs. A 330m rock revetment constructed on the western extent of the Reculver country park was constructed in 1986 to reduce erosion and possible cut back of the cliffs where they meet the Herne Bay sea wall.

A narrow shingle sand composite beach lies at the base of the cliffs with a sand and rock debris foreshore (Figure 1-12), rising from +1.7mOD in the west too -1m OD at Reculver Towers. This frontage is “No Active Intervention” under the Shoreline Management Plan.

To the west of Reculver Towers a second rock revetment provides protection to the sea wall and 30m wide concrete apron that at the base of Reculver Towers; a prominent headland and ancient monument.

FIGURE 1-12 SANDSTONE CLIFFS AND ROCK DEBRIS FORESHORE

NORTHERN SEA WALL

The Northern Sea Wall stretches from Reculver Towers to Minnis Bay and is 5km in length. The shingle sand beach has been artificially enlarged through beach nourishment to a 1 in 7 gradient to the mud and sand foreshore; at the western end the foreshore is underlain with clay. The frontage has 15no. rock groynes which are spaced every 200-300m to the west and every 900-1000m in front of the lagoons. There are a few timber groynes present along this stretch but they are not maintained. Historically, the beach had undergone annual reprofiling to maintain a design profile.

The sea wall comprises mass concrete units and is founded directly onto the shingle/ sandstone at the top of the beach and behind the sea wall the soil is loosely cemented fine sandstone (Canterbury City Council, 1996). The whole of the sea wall is very similar due to the fact it was constructed at the same time and consists of a castellated concrete sea wall backed by a promenade.

The sea wall is situated immediately behind the beach for the majority of the frontage with the exception of the Wantsum Delta, also known as Cold Harbour Lagoon, and St Augustine's Bank (Figure 1-13). At these locations, the wall is set back due to the presence of two saline lagoons. In front of these lagoons is a shingle ridge which reduces any salt water intrusion to occasional spray and percolation through the shingle bank.

FIGURE 1-13 SALINE LAGOON BEHIND SHINGLE RIDGE AT THE WANTSUM DELTA

The low lying area behind the Northern Sea Wall only has sparse residential settlement, the majority of which is within the Reculver locality on higher ground. An oyster hatchery is situated to the east of the Reculver Towers behind the sea wall. This area also includes the main railway line linking Faversham and Thanet which runs on a substantial embankment, along with the Thanet Way (A299) main road well landward of the railway line.

1-1-3 GEOLOGY

TOPOGRAPHY

The study area is bound by two low-lying plains; the Seasalter marshes and the relict Wantsum Delta. The central region of the study area is generally higher and gently undulates between +3.0 to +20 mOD (Figure 1-10). Although relatively open, the coastline forms part of both the greater Thames and Swale estuaries, hence the sea is relatively shallow and contains several sand banks.

Local elevation anomalies include the salt work cotterals at Seasalter, road and rail networks and the glen at Bishopstone. Bishopstone Glen is a short steep-sided valley cut through the clays and sands of Reculver Country Park and is the only feature of its kind on the North Kent Coast (CCC, 1996). In terms of coastal landforms two shingle spits exist: Coot Castle Spit at Nagden Marsh and Long Rock Spit where Swalecliffe brook meets the sea. The origins of the Street, a shingle barrier beach which protrudes 1 mile out at a right angle to the shoreline at Whitstable, are unknown (CCC, 1988).

BEDROCK

Figure 1-11 is an illustration of the rock that would be exposed if the surface, e.g. soils, vegetation, buildings etc., were removed. Eocene London Clay dominates the study area, extending from past Beacon's Hill in Herne Bay westwards to Seasalter and Graveney. The cliffs between Bishopstone and Reculver are and outcrop of much older Paleocene formations; the Harwich formation, the Lambeth group and the Thanet formation (Figure 1-14, Geoconservation Kent, n.d.). Margate chalk member is found at the very eastern end of Northern Sea Wall. Although extensive geological studies have been undertaken on land, less is known about the sea.

The London Clay formation was deposited approximately 55 million years ago under a shallow tropical sea, bordering mangroves. This is supported by the associated fossil of shark, turtle, sea snake, Stemless palm and seeds/fruits of types now found in Malaysia. Five stages of deposition have been recorded followed by a marine transgression, i.e. the lowering of sea level. Ferrous disulphide (pyrite) can be found on the foreshore from the clay layer; this was important in the 15th and 16th centuries when the copperas industry (black ink) relied on the processing of these nodules. The properties of clay have several important implications for engineering design in the coastal zone.

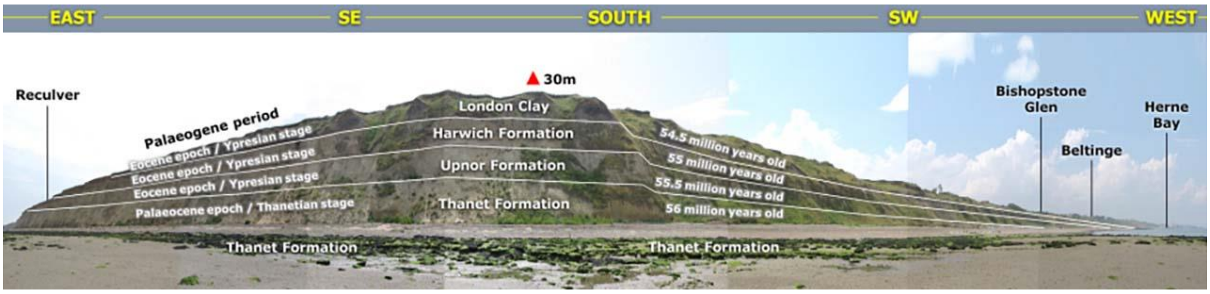


FIGURE 1-14 ROCK EXPOSURES AT BISHOPSTONE ©DISCOVERINGFOSSILS.CO.UK

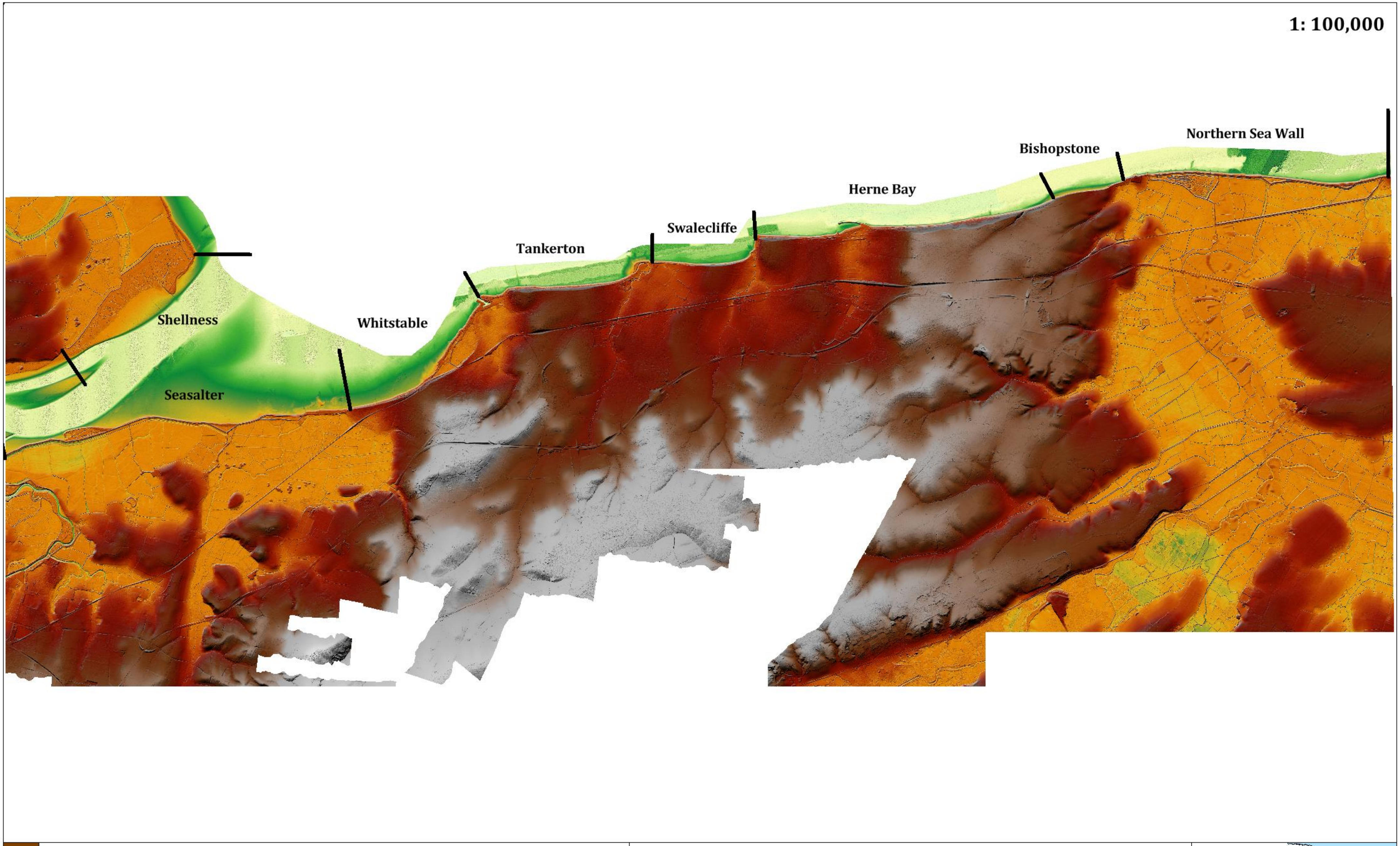
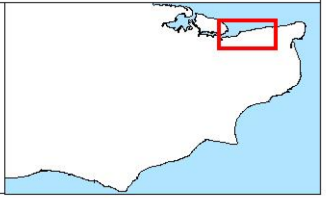


FIGURE 1-15 GEOLOGY - TOPOGRAPHY



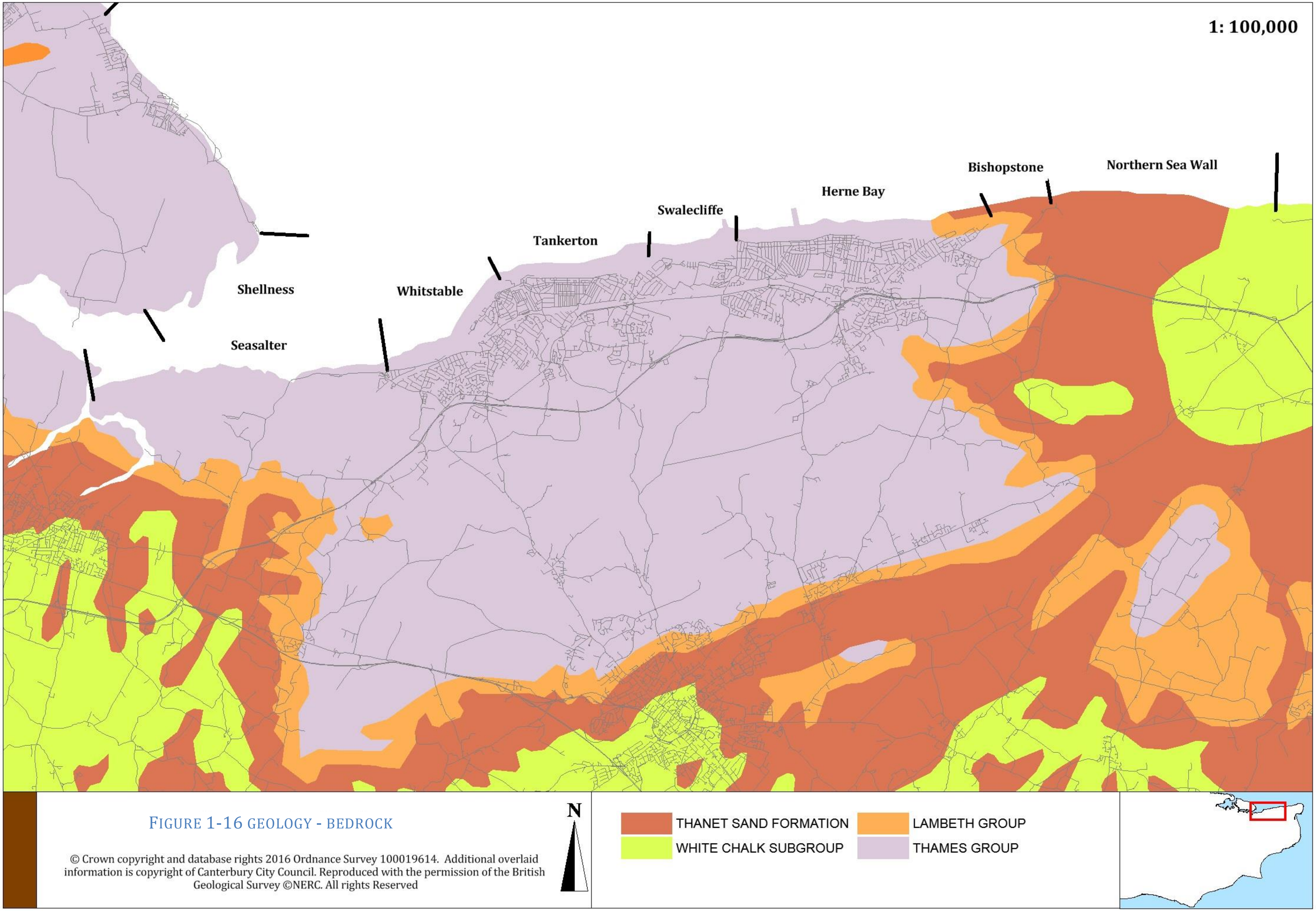


FIGURE 1-16 GEOLOGY - BEDROCK

The older sand and gravel beds which lie beneath the London Clay are exposed in the cliffs at Bishopstone and Reculver. In places it is possible to see all three beds at once (Kent Wildlife Trust, CCC & English Heritage, n.d.). The Harwich formation underlies the London Clay and sits on top of the Lambeth group. In Kent (the formation varies regionally), the Harwich formation is characterised by "glauconitic [derived from the mica group] silty or sandy clays, silts and fine- to coarse-grained glauconitic sands, some gravelly, varying to flint gravel beds. Thin beds of grey clay occur in some parts, as do shell-rich beds and thin beds of argillaceous limestone. Volcanic ash is a significant minor component in some parts of Kent and southern Essex. The Harwich Formation commonly includes a shelly marine fauna but locally a brackish water fauna," British Geological Survey (2015).

Underlying the Harwich formation lays the Lambeth group. The British Geological Society defines this formation as "vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional sandstone and conglomerate." Below this layer is the Thanet Beds.

The Thanet Beds comprise fine grained clayey sands and coarser shelly sands. There are occasional bands of harder calcareous cemented sands (doggers) exposed in the cliff section and on the foreshore, which distinguishes the Thanet Sands from the overlying Lambeth group.

All the cliff exposures are very soft and easily eroded by wind or by water with the clayey silts and the hard cemented doggers offering most resistance. The loosely compacted material is of ecological significance as it is home to the UK's largest sand martin colony.

Margate Chalk Member, the oldest rock in the study area is from the late Cretaceous, dating between 83 and 65 million years ago. The smooth white chalk is marl-free and contains little flint. Occasionally weakly developed indurated iron-stained sponge beds are found interleaved within the chalk. This rock is the top layer of bedrock in the eastern end of Northern Sea Wall, making up less than 5% of the entire frontage.

SUPERFICIAL DEPOSITS

Figure 1-12 shows the superficial deposits found within the study area. Superficial deposits are typically formed by the breakdown of bedrock by natural processed and form at an accelerated rate during glacial and subsequent melting events. For instance, the majority of shingle systems in the UK were formed by about 4,000 BP, geomorphological processes at the coast reworking and depositing shingle during periods of lower sea level.

There is a variety of deposits distributed about the study area, most importantly, sand and gravel along all areas of coastline. These deposits were provided by a fossil resource and there is now *no natural replenishment* of these sources. There are also head deposits between the east end of Tankerton to Reculver Country Park and the tidal flat deposits found within the relict Wantsum Channel. The presence of unconsolidated material is an important factor relating to land use

Intertidal flats extend approximately 1.5km seawards, covered by a thin layer of fine grained ripple shell sand lying directly on top of weathered London Clay surface. Less is known about the deposits offshore. Natural England (1997) conceded this overview of the offshore region of the North Kent coastline:

> "Offshore, a sedimentary regime prevails in this, the outermost part of the estuary of the River Thames. Deposits of sand and, especially to the west, mud cover much of the bedrock. As a result of the moderately strong tidal streams, the sand deposits around Thanet are quite mobile. The sea is nowhere very deep and locally sand banks are exposed at low tide, as at the Margate Hook off Minnis Bay. The waters off North Kent are extremely turbid, with visibility rarely exceeding two or three metres. Locally, the under-lying Chalk or London Clay is exposed as subtidal reefs and there are also areas of cobbles or pebbles which form a harder, more fixed, substrata on the sea bed."

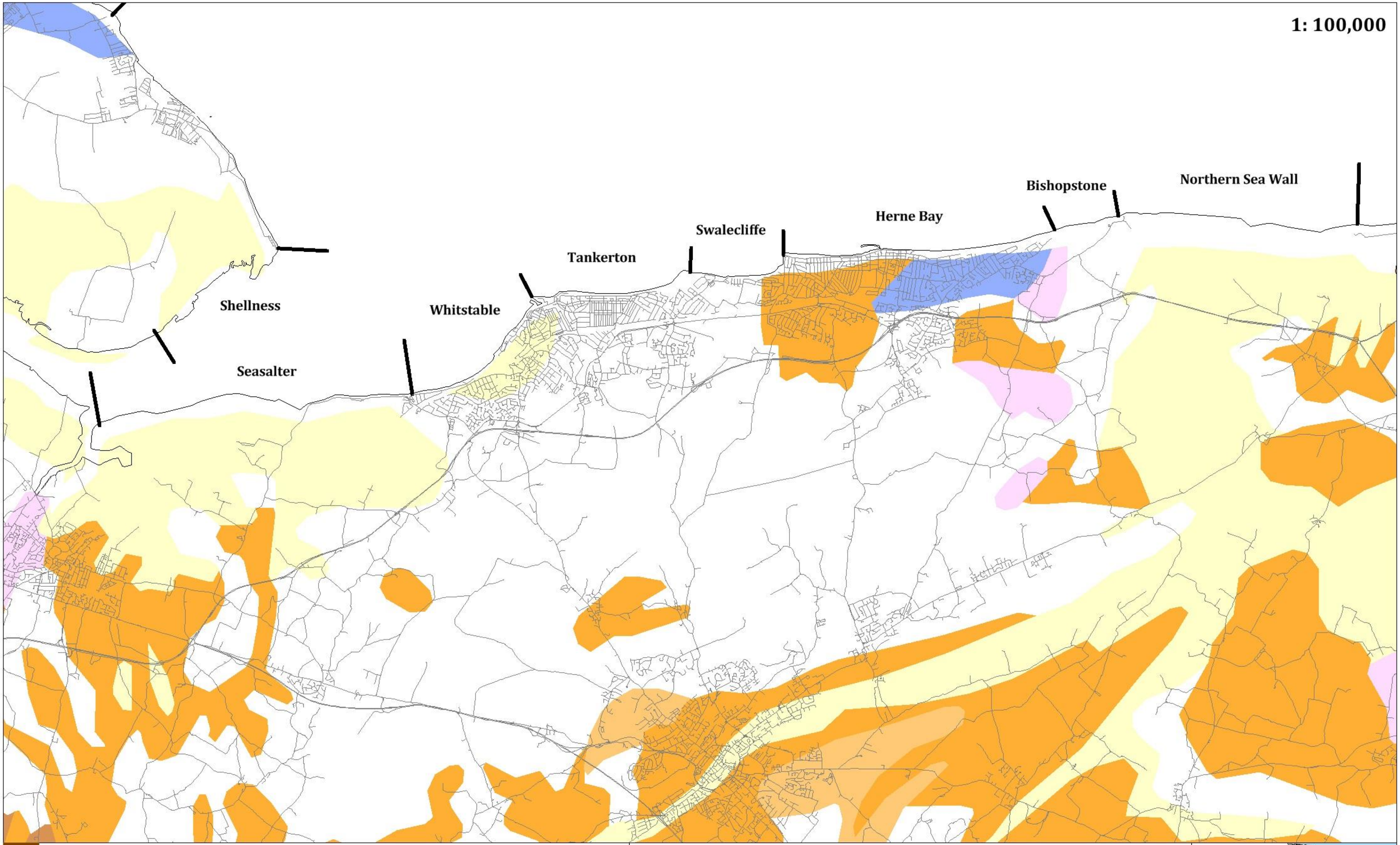


FIGURE 1-17 GEOLOGY - SUPERFICIAL

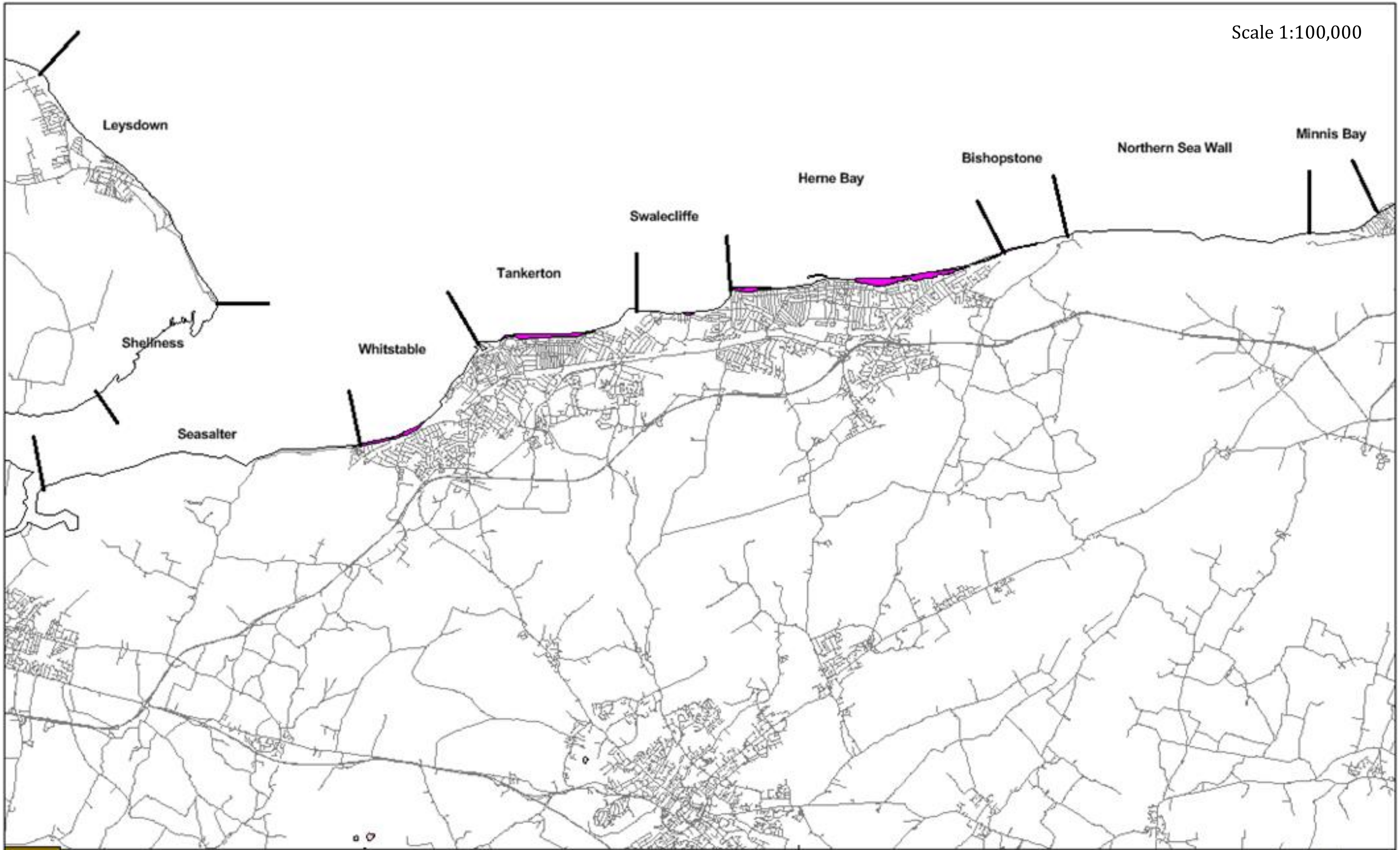


FIGURE 1-18 GEOLOGY – MASS MOVEMENT

🟪	CLAY, SILT AND SAND
—	UNIT BOUNDARY

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COASTAL EVOLUTION

The coastal area is defined by soft clay cliffs, interspersed with low lying areas covered in fine grained sediment deposits. The behavior of the coastline is strongly related to the underlying geology.

LAND RECLAMATION

A wide sea strait, the Wantsum Channel, occupied what are now the Wantsum and lower Stour valleys . Gradually the strait silted up, but it remained navigable until at least the tenth century, possibly even the fifteenth century (CCC, 1996). As with the Swale, once the channel had begun to silt up land was reclaimed by man, who converted the flat to arable land. This practice began in Roman times in the South East and continued into the 19th century (Woodrow, 1984). The reclamation of land cut off the tidal creeks and imposed an artificial straight coastline. Despite this it is still possible to see relict dendritic creeks from aerial photography (Figure 1-19).

FIGURE 1-19 AERIAL PHOTOGRAPHY OF SEASALTER SHOWING RELICT TIDAL CREEKS ©CHANNEL COASTAL OBSERVATORY

Today, almost all the low lying intertidal areas have been reclaimed and turned to freshwater grazing marsh with the exception of St. Augustine's Bank Lagoon, Coldharbour Lagoon (both at Northern Sea Wall) and Coot Castle spit. The decline in saltmarsh habitat is recorded in historic mapping. The 1872 OS map shows an expansive area of saltmarsh in the surrounds of Seasalter and a smaller stretch in front of West Beach, Whitstable. The extent of these salting's declined over the following 20 years. The loss of saltmarsh is significant to coastal evolution because saltmarsh dissipates wave energy (Möller & Spencer, 2002), which over a distance affects how much wave energy reaches the shore.

THE EROSIVE COASTLINE

The soft clay coastline has been eroding since Roman times. Historic maps suggest that the North Kent coastline was once much straighter than today (So. C, 1971). The earliest map considered to contain credible information is dated 1769 (held at Archives Library of Canterbury Cathedral). The map is at a scale of 2" to 1mile and it shows the road pattern of the day and Seasalter, Swalecliffe and Reculver churches. The coastline between Whitstable and Reculver is portrayed in nearly a straight line, which is not the case anymore. Figure 1-20 shows the view from the Reculver towers pre early 19th century when the towers were demolished. The view shows a very different picture from what you can see today.

FIGURE 1-20 RECULVER TOWERS, CIRCA 1800 AD.

Reculver is an area of historical and archaeological interest due to the Roman Fort and St Mary's Church which are now located directly on the cliff top (Figure 1-20). Wave action began to reach the walls of the fort and church in 1810 due to the erosion of the cliff face. Trinity house took action to protect the Towers so that they could remain as a reference point for mariners by building an apron constructed out of ragstone blocks and the first timber groynes (CCC, 1988).

A study by E. Bowler (1981) documented the evolution in coastline along the Canterbury frontage using historical Ordnance Survey mapping. Using the mean high water mark it was possible to see the recession of the coastline between the years 1872 – 1956/7. Key areas of coastal erosion were identified as Seasalter (>200m recession), West Beach Whitstable (30 m recession), the eastern ends of both Tankerton and Swalecliffe beaches (≤175 m) and Bishopstone cliffs (100m).

Man-made intervention has affected much of the North Kent Coast however none of the changes have been as drastic as those observed at Hampton Pier.

The construction of the original Hampton Pier in 1865, by the Herne Bay and Reculver oyster fisheries company, led to significant scour to the west of the structure (Figure 1-21). Concurrently beach growth occurred to the east of the structure. The structure was 1065ft long and built from wood and concrete. In total 175m of land was lost to the sea by 1921 as well the original fishing hamlet Hampton-on-Sea; two farmhouses, a beer house and a few cottages containing the Mount and Quick fishing families (Easdown, 2008). The pier was dilapidated by 1901 and a smaller pier (305ft long) was rebuilt in its place in 1905.

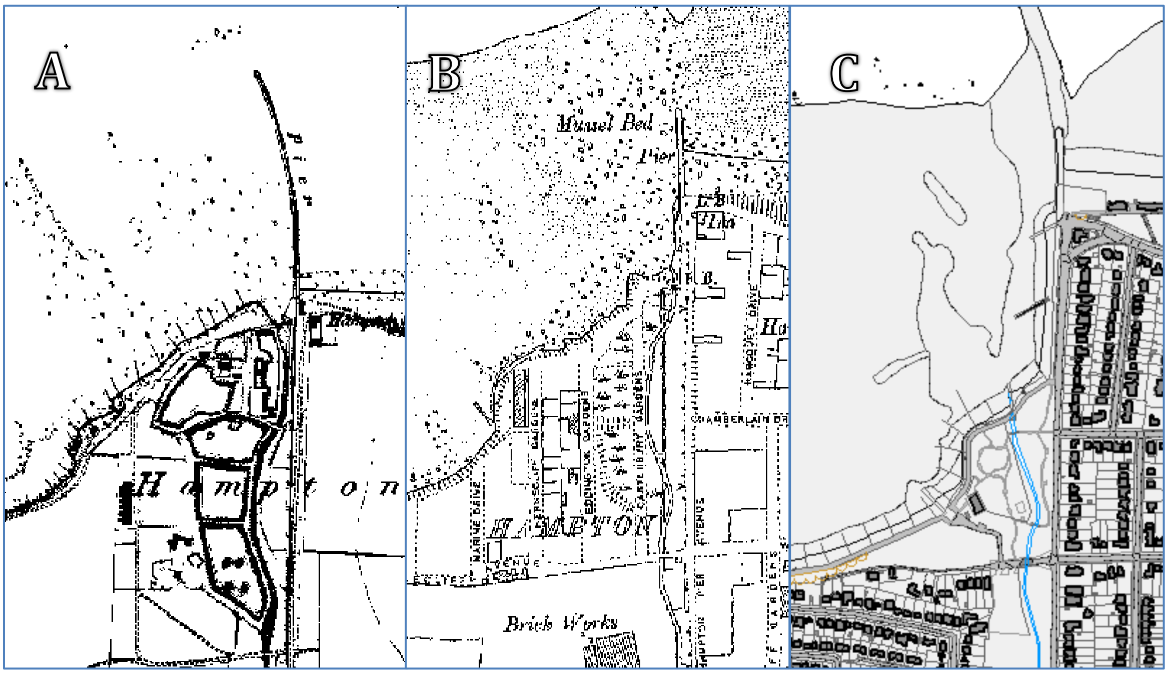

Figure 1-21 Erosion caused by the construction of Hampton Pier: A – Hampton in 1872, B – Hampton in 1910 and C – Hampton today

The Hampton Pier would have interrupted the sediment transport and this would have had knock on consequences. The scour which occurred to the west of the structure suggests that the predominant sediment drift was in the east to west direction. The lack of sediment feed into this area may have contributed to the erosion of the bays.

FEATURES OF INTEREST

CASTLE COOTE SPIT, GRAVENEY

Castle Coote spit is located approximately 1km east of Faversham Creek. The growth of the spit in recent years is attributable to increased alongshore transport resulting from progressive decay of the beach control structures to the west of the frontage (CCC, 2013).

SHINGLE BANK, SEASALTER

Since the 1970s, an offshore shingle bank has been forming between the Red Sluice and Preston Parade at Seasalter and has since been migrating landwards (Figure 1-22). In 2008 the RCMP topographic survey extended to cover this shingle bank. A perpendicular shingle ridge protruded on the south face until it reached the main beach in 2013 to form a tombolo. The ridge has been increasing in width and height and is now a prominent feature.

THE STREET, TANKERTON

A shingle bar perpendicular to the Tankerton coastline, locally known as The Street, is located near the western boundary of Tankerton, extending one kilometer offshore at Mean Low Water Springs (Canterbury City Council, 1996c) (Figure 1-11). In the Tankerton Study (1994), Delft Hydraulics concluded that the Street has only a very marginal influence on the coastal processes at Tankerton. A topographic survey of this feature is conducted every 2-3 years.

Since 2015 a second perpendicular shingle bar has been developing to the west.

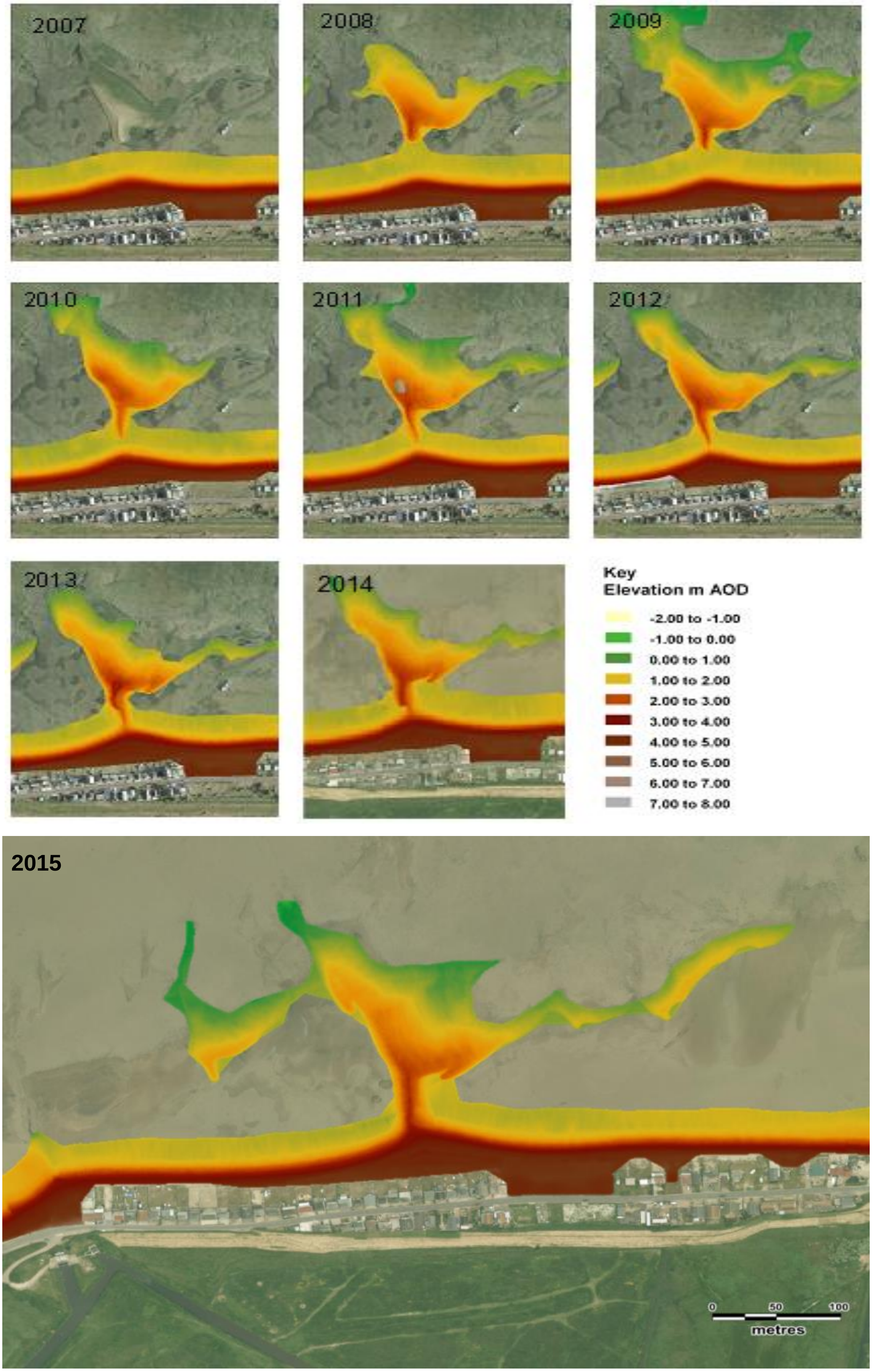

FIGURE 1-22 THE SHINGLE BANK AT SEASALTER

1-2 HISTORY OF THE FRONTAGE

Table 1-2 lists the flooding and storm events between Graveney and Northern Sea Wall and Table 1-3 list the erosion events. As these reports are typically in the mainstream press they frequently lack detail on the total number of properties affected and extent of damage, however this is sufficient to provide a threshold to aid validation of overtopping calculations. Photographic evidence of flood and erosion events is documented in Appendix J.

1-2-1 FLOODING EVENTS

The largest recorded flooding incident within living memory is the 1953 storm surge. Although estimates vary, it is believed to have a return period of 1 in 136 years (Canterbury City Council, 1988). Severe damages were caused to low lying Whitstable, Seasalter, Swalecliffe Herne Bay and Northern Sea Wall. The impacts of the event were greatest at Whitstable, where back door flooding led to flood waters 2m deep in the Gorrell Tank area, central Whitstable.

A smaller event occurred in 1978 (return period of 1 in 20 years). Despite a lower water level the waves exceeded that of 1953 due to a strong easterly wind. The Sea View Caravan and Chalet Park in Swalecliffe suffered considerable damages. At Seasalter the damages caused were far greater than that of the 1953 flood; an earth bund constructed behind the Faversham Road properties prevented water flowing out into the marshland behind. The majority of these properties were either destroyed or badly damaged, with flood waters reaching up to the mantel piece in some properties (Canterbury City Council, 1988).

The most recent flooding event was in 1996 when several houses were inundated at Seasalter. The storm was approximately a 1 in 10 year event. The damages caused to these properties by the floods were high. Since 1996, there has been no significant coastal flooding in the North Kent region.

On the 5th December 2013 the SWL rose to +4.1mOD with no wind or waves present. Faversham Road, Seasalter was evacuated as water lapped at the back doors of property, Whitstable Harbour flooded and water lapped at the top of the boat ramp in the Herne Bay harbour. One shed was moved from its base within Herne Bay harbour but otherwise there was no damage. If there had been any waves on top of the SWL it would have been the largest storm since 1996.

TABLE 1-2 COASTAL FLOODING AND STORM INCIDENTS

DATE	LOCATION	DAMAGE	REPAIR WORKS	SOURCE
1287	WHITSTABLE	UNKNOWN.	LED TO THE CONSTRUCTION OF THE FIRST SEA WALL (1290).	SUTTON, A. (1983)
1897	HERNE BAY	PIER WAS NEARLY DESTROYED		COASTAL MANAGEMENT HERNE BAY SEA DEFENCES (2007)
1949	WHITSTABLE	FLOODING WAS ALONG THE SEAFRONT BUT DID NOT EXTEND TOO FAR INTO THE MAIN TOWN		*WHITSTABLE SOUTH QUAY PAR (2015)*
1953	SEASALTER	FLOOD WATER PASSED THROUGH HOUSES INTO LOW LYING LAND BEHIND, LITTLE DAMAGE, MAIN RAILWAY LINE WAS BREACHED AT SEASALTER MARSHES	EARTH BUND RAISED BEHIND HOUSES TO PROTECT HINTERLAND.	PROPOSED COAST PROTECTION WORKS: BEACH RECHARGE AT PRESTON PARADE, KENT (CCC,1994)
1953	WHITSTABLE	DEFENCE FAILURE AT GOLF COURSE CAUSED BACK DOOR FLOODING OF THE TOWN. HIGHEST FLOOD WATERS RECORDED AT 2M DEPTH (AT THE GORRELL). SEVERE DAMAGE CAUSED	WHITSTABLE RAILWAY LINE RE OPENED TO AID EMERGENCY REPAIRS	WHITSTABLE SOUTH QUAY PAR 2015
1953	SWALECLIFFE	SEA DEFENCES BREACHED/ OVERTOPPED		SWALECLIFFE TO HAMPTON COASTAL DEFENCE STRATEGY PLAN (2010)
1953	HERNE BAY	SEA DEFENCES WERE BREACHED AND THE REMAINDER WERE OVERTOPPED, RAILWAY EAST OF HERNE BAY WAS BREACHED.		HAMPTON TO RECULVER COASTAL DEFENCE STRATEGY PLAN (2014)
1953	NORTHERN SEA WALL	CLAY BUND BREACHED IN THREE PLACES	CONSTRUCTION OF THE NORTHERN SEA WALL BEGAN THE FOLLOWING YEAR	APPENDIX C OF THE SMP
1978	SWALECLIFFE	CONSIDERABLE DAMAGE AT THE SEA VIEW CARAVAN AND CHALET PARK		HERNE BAY SUMMARY REPORT
1978	SEASALTER	FLOOD WATERS UP TO THE MANTEL PIECE IN SOME HOMES. NEW BUND PREVENTED WATER FLOWING TO LOW LYING LAND. MOST OF THE CHALETS ON THE SEAWARD		PROPOSED COAST PROTECTION WORKS: BEACH RECHARGE AT PRESTON PARADE, KENT (CCC,1994) FAVERSHAM CREEK TO WHITSTABLE HARBOUR

		SIDE OF FAVERSHAM ROAD WERE EITHER DESTROYED OR BADLY DAMAGED	COASTAL DEFENCE STRATEGY PLAN (2002)
1978	WHITSTABLE	MINOR FLOODING CAUSED BY OVERTOPPING TO AREAS ALONG THE SEAFRONT	WHITSTABLE PAR
1978	HERNE BAY	CONSIDERABLE DAMAGE ALONG THE FRONTAGE AND THE PIER WAS DESTROYED, CAUSED BY OVERTOPPING RATHER THAN BREACHING	HAMPTON TO RECULVER COASTAL DEFENCE STRATEGY PLAN (2014)
1990S	SEASALTER	VARIOUS SMALL FLOODING EVENTS DURING THE 1990S	
1996	SEASALTER	BADLY FLOODED HOUSES CAUSING DAMAGES	FAVERSHAM CREEK TO WHITSTABLE HARBOUR COASTAL DEFENCE STRATEGY PLAN (2002)

1-2-2 EROSION INCIDENTS

The shoreline of the North Kent Coast has been regressing since roman times. The underlying geology of London Clay is not resistant to erosion so without hard sea defences and the stabilisation of slopes the recession of this coastline would continue. Key erosion events which have shaped the coast we know today are described below.

Following the construction of Hampton Pier in 1864, the study area suffered considerable coastal erosion as the new pier cut off the natural flow of beach material (Canterbury City Council, 1988) transported along the coast by longshore drift from the east. Over a period of 94 years the average rate of coastal erosion was approximately 2m per annum (Canterbury City Council, 1988) which led to the reorientation of the coastline between Hampton Pier and Long Rock. By 1960 new sea defences, which halted the erosion, had been constructed along most of the study area frontage.

The 1996 storm caused major damage (Canterbury City Council, 1996) to parts of the sea defences along the North Kent coastline. This included collapse of sea walls at Reculver and some erosion of the land behind.

TABLE 1-3 EROSION INCIDENTS

DATE	LOCATION	DAMAGE	REPAIR WORKS	SOURCE
1800S	STUDD HILL	1872 – 1898 1.5M LOST		REPORT ON SLOPE STABILITY FOR TANKERTON COAST PROTECTION WORKS (CCC, 1995)
1900S	STUDD HILL	1898 – 1931 2.0M LOST 1931 – 1939 3.4M LOST 1939 – 1969 1.2M LOST		REPORT ON SLOPE STABILITY FOR TANKERTON COAST PROTECTION WORKS (CCC, 1995)
1905-1934	HAMPTON	1905- EROSION CAUSING HAMPTON GRAND PARADE AND HALF OF MARINE DRIVE TO BE LOST 1911- ALL 12 HOUSES OF HERNECLIFFE GARDENS TERRACE WERE ABANDONED AND THEN DEMOLISHED WITH THE SEA AT THE BACK DOORS. 1934- THE OLD FARMHOUSE WAS LOST TO THE SEA		HAMPTON TO RECULVER COASTAL DEFENCE STRATEGY PLAN (2014)
1950S	HERNE BAY EAST CLIFF	CLIFF SLOPE SLIPPAGE		HAMPTON TO RECULVER COASTAL DEFENCE STRATEGY PLAN (2014)
1950S	STUDD HILL	CLIFF SLOPE SLIPPAGE LEAVING HOUSES BEHIND DANGEROUSLY CLOSE TO THE EDGE	1952- SEA WALL CONSTRUCTED IN FRONT OF PROPERTIES	SWALECLIFFE TO HAMPTON COASTAL DEFENCE STRATEGY PLAN (2010)
1958	TANKERTON	LANDSLIDE CAUSING DAMAGES TO ALREADY TRIMMED AND DRAINED SLOPES		TANKERTON SLOPES, WHITSTABLE “REPORT OF THE CITY DIRECTOR” (CCC,1986)
1960	TANKERTON	FURTHER LANDSLIDES FROM THE 1958 EVENT, CAUSED BY PROLONGED PERIOD OF RAIN		TANKERTON SLOPES, WHITSTABLE “REPORT OF THE CITY DIRECTOR” (CCC,1986)
1967	TANKERTON	MAJOR LANDSLIDE ADJACENT TO ‘LOVERS WALK’ WOODLAND, CAUSED THE GROUND TO HEAVE IN THE GARDENS OF THE PROPERTIES KIORA AND BEACON HOUSE	BETWEEN 1960 & 1972 SECTIONS OF THE SLOPES REGRADED AND DRAINED WITH A HERRINGBONE DRAINAGE SYSTEM	TANKERTON SLOPES, WHITSTABLE “REPORT OF THE CITY DIRECTOR” (CCC,1986)
1996	NORTHERN SEA WALL	32M SECTION OF SEA WALL FAILED, WITH SOME EROSION OF THE LAND	EMERGENCY WORKS AND MAJOR REPAIRS	SEA WALL FAILURE EAST OF RECULVER TOWERS PRELIMINARY REPORT AND

		BEHIND	TO THE EXISTING STRUCTURE	DETAILS OF EMERGENCY WORKS, 1996
1996	TANKERTON	UNDERMINING OF PART OF THE SEA WALL AT TANKERTON		WHITSTABLE SOUTH QUAY PAR (2015)
1996	WHITSTABLE	ALTHOUGH NO FLOODING OR OVERTOPPING OCCURRED, THERE WAS SIGNIFICANT MOVEMENT OF BEACH MATERIAL WESTWARDS.	MUCH LATER SCHEME IN 2006	WHITSTABLE SOUTH QUAY PAR (2015)

1-3 HISTORY OF COASTAL MANAGEMENT

There has been a vast amount of documented engineering work undertaken on the north Kent coastline, including sea walls and controlling structures since the 1300's. More recently, several large capital schemes have reinstated concrete sea walls and renewed whole timber groyne fields since the 1950s. Figure 1-23 and 1-24 provide a summary of works and a detailed description of all works is listed in Appendix K.

	Seasalter	Whitstable	Tankerton
1800-1950		**1832** Whitstable Harbour opens. **1949** Railway concrete sea wall built.	**1911** Concrete sea wall constructed 975m long (Pre 1910 timber breastwork). **1922** Wall extended to priest and Sow Corner. **1928/29** Slope drainage. **1938 &1958** Raising, repairing and rebuilding parts of the sea wall (+5.18m OD). **1944** Slope drainage.
1950	**1953** Earth bund built behind Faversham Road. **1954** Sea wall built (+6.0-6.5 m OD).	**1950-1953** Construction of a uniform sea wall (+ 4.88 m OD) across Whitstable; West Beach, Wave Crest Marine Terrace, west Of Horse Bridge, Reeves Beach, Admiralty Walk (and concrete apron). **1954** groynes built at Admiralty Walk and Preston Parade east. **1955** All defences raised (+5.79 m OD) and new sea wall at Admiralty Walk.	**1950-60** Groynes built. **1958** & **1960** Landslips.
1960		**1963 &1965** Battery sea wall constructed. **1964 &1976** groyne construction at Preston Parade east. **1968** Sea wall built opp. St. Mary's Grove (+5.18 m OD).	**1960-1972** Slopes regraded and drained.
1970		**Early 1970's** beach recharge at Preston Parade east. **1976** Preston Parade east sea wall built (+5.18m OD). **1979** Raising and lengthening of groynes opp. golf course.	**1975-76** Wall partially restructured and concrete apron added at pinch point.
1980		**1982** New groynes and repair at Admiralty walk & beach recharge. **1987** Beach replenishment and groynes at Preston Parade. **1989** Beach recharge, groyne construction & sea wall imp. in central area.	**1985** Recharge at Tankerton West. **1986** Tankerton apron recharge. **1989** Recharge at harbour beach.
1990		**1992** Beach recharge, groyne construction & sea wall imp. at West Beach. **1994** Fisherman's Quay and South Quay reconstructed.	**1991** Recharge sailing club to long rock. **1999** Groyne replacement and beach recharge Phases I and Phase II. Boat Ramp replaced
2000		**2005** Whitstable Harbour East Quay replacement **2006** Sea wall imp. & groyne replacement at Preston Parade, Admiralty Walk & West Beach.	**2004** Groyne replacement and beach recharge Phase III
2010	**2010** Two timber groyne installed in front of Blue Anchor **2012** Timber boat ramp constructed in front of Seasalter Shellfish Ltd	**2011** Four timber groyne installed in front of Golf Course Wall	**2013** Swale Brook was redirected to exit the north of the beach

Figure 1-23 Coastal Defence Timeline 1 of 2

1800-1950
1950
1960
1970
1980
1990
2000
2010

Swalecliffe

- **1951** Wall constructed across the West Brook and in front of the boating pool
- **1955** Proposal for sea wall extension from Brook rejected by public inquiry
- **1959/59** At Studd Hill, groynes constructed at 25-20m centres and 25-30m long
- **1960** Wall from West Brook extended up to coastguard cottages +4.88m OD
- **1968** Permission to extend sea wall from Swalecliffe Brook—constructed 744m in length at a height of +5.18m OD
- **1983** Rear wave wall added on the wall across the West Brook
- **1985** Rear wave wall added to Swalecliffe Brook, construction of earth bund
- **1986** New groynes installed at Swalecliffe
- **1988** Swalecliffe mattresses constructed
- **1990** Additional short groynes built
- **2002** Improvement to Swalecliffe Sluice outfall

Herne Bay

- **1864** Construction of Hampton pier
- **1905-30** Sea wall constructed at Selsea avenue
- **1907** Timber breastwork was in existence between pier and clock tower jetty
- **1914** A sea wall existed between the pier and clock tower jetty
- **1930** Timber breastwork rebuilt in concrete& extended to bandstand
- **1938** regrading and drainage of the cliffs at East Cliff (1)
- **1955** Low concrete sea wall to the west of the pier in existence
- **1960s** Groynes implemented at Herne Bay central area, East cliff 1 and Hillborough cliff
- **1961** Rear wave wall added to the sea wall west of the pier
- **1968/69** 250m long temporary sea wall and shallow drainage system installed to stabilise the cliffs after they had been regraded
- **1980** A sea wall with sloping apron built between coopers hill and eastern extent of east cliff parade
- **1980s** Groynes implemented at Westcliffe, Coopers Hill and East Cliff 1&2
- **1983** Sea wall built at the extreme western end of Herne Bay
- **1987-1990** Permanent works to sea wall completed in front of cliffs
- **1990s** Scheme to raise and lengthen groynes
- **1992** Major capital scheme- Construction of Neptune's arm
- **1993** East cliff rock revetment toe waiting
- **1995** Toe piling, seawall coping, replacement of rear wall and flood gates just west of the Pier.
- **2012/13** Raising of the rear seawall within the harbour, construction of 3 timber groynes adjacent to the Pier (east) and new flood gates
- **2014** Raising of the rear seawall at Lane End and new floodgates

Bishopstone

- **1810** Ragstone Apron built
- **1867** first rock groynes
- **1956** Sea wall constructed east of the towers, extending for 200m
- **1970** Herringbone and brick rubble drainage implemented on top of cliffs
- **1978** Rock revetment in front and west of the sea wall constructed to reduce outflanking
- **1986** Rock revetment just east of Bishopstone Glen Installed
- **1994** West end of Bishopstone Glen revetment rebuilt, 1000t of additional rock added
- **1998/99** Repair works to the ragstone apron and voids under the apron filled with concrete

Northern Sea Wall

- **1954** Northern sea wall constructed after clay bund failed
- **1995** Northern Sea Wall project:
  Fourteen rock groynes added with pipes running underneath them from drains
  180,000m^3 of shingle imported. Rock revetment constructed
- **1996** Emergency works carried out after sea wall failure
  100m3 of pumped concrete and 90m2 of sprayed concrete (75mm thick) used to reface and strengthen the sea wall

FIGURE 1-24 COASTAL DEFENCE TIMELINE 2 OF 2

1-4 ENVIRONMENTAL OPPORTUNITIES AND CONSTRAINTS

The issues relating to the local environment are fully described in the Environmental Assessment in Appendix B of this report. The following section provides a brief overview of the key issues within the area, affecting coastal management, for protected sites, agriculture, infrastructure, tourism and recreation, culture and archaeology.

ENVIRONMENTAL RESTRICTIONS

The study area contains several sites which have been designated for their wildlife and geological value as protected sites with varying international, national and local significance. To retain the natural integrity of these sites certain activities are restricted and it may be necessary to contact Natural England before proceeding with any works. Figure 1-24 gives an overview of the areas with environmental designations. More detailed mapping is available within Appendix B.

Statutory designations

Sites protected by law within the study area:

- The Swale SSSI
- Thanet Coast SSSI
- Tankerton Slopes SSSI
- Swale Estuary MCZ
- The Swale SPA
- Thanet Coast & Sandwich Bay SPA
- Tankerton Slopes & Swalecliffe SAC
- Thanet Coast SPA
- Thanet Coast SAC
- The Swale Ramsar
- Thanet Coast and Sandwich Bay Ramsar

Natural England should be contacted for planning proposals that are likely to have a significant effect on a SSSI, MCZ, SAC, SPA or Ramsar site. For SAC or SPA sites a habitat regulations assessment may need to be carried out. Additionally, Natural England should also be consulted for planning proposals that require an Environmental Impact Assessment (Appendix B, Section 3).

The following activities within Table 1-4, which may affect coastal works, are prohibited within SSSI sites. For SSSI sites a letter of comfort must be obtained from Natural England via the Discretionary Advice Service to undertake certain activities. Depending on the type of works, this process can take several months so should be pursued within the early stages of the project.

TABLE 1-4 POTENTIAL RESTRICTIONS TO COASTAL WORKS

COASTAL WORKS IDENTIFIED BY NATURAL ENGLAND AS OPERATIONS WHICH MAY DAMAGE THE FEATURES OF INTEREST.
ERECTION AND REPAIR OF SEA DEFENCES OR COAST PROTECTION WORKS, INCLUDING CLIFF OR LANDSLIP DRAINAGE OR STABILISATION MEASURES
EXTRACTION OF MINERALS INCLUDING PEAT, SHINGLE, HARD ROCK, SAND AND GRAVEL, TOPSOIL, SUBSOIL, CHALK, SHELLS AND SPOIL.
DESTRUCTION, CONSTRUCTION, REMOVAL, REROUTING, OR RE GRADING OF ROADS, TRACKS, WALLS, FENCES, HARDSTANDS, BANKS, DITCHES OR OTHER EARTHWORKS, INCLUDING SOIL AND SOFT ROCK EXPOSURES OR THE LAYING, MAINTENANCE OR REMOVAL OF PIPELINES AND CABLES, ABOVE OR BELOW GROUND.
STORAGE OF MATERIALS.
ERECTION OF PERMANENT OR TEMPORARY STRUCTURES OR THE UNDERTAKING OF ENGINEERING WORKS, INCLUDING DRILLING.
MODIFICATION OF NATURAL OR MAN-MADE FEATURES
REMOVAL OF GEOLOGICAL SPECIMENS, INCLUDING ROCK SAMPLES, MINERALS AND FOSSILS.
USE OF VEHICLES OR CRAFT.
RECREATIONAL OR OTHER ACTIVITIES LIKELY TO DAMAGE OR DISTURB THE FEATURES OF SPECIAL INTEREST.

These restrictions do not apply for:

- emergency work, for example work to protect livestock during a flood or storm (Natural England must be notified as soon as possible afterwards)
- work with permission from the local council, attained through the planning application process
- work that has statutory permission for from a public body such as the Environment Agency or Forestry Commission (if they have consulted Natural England)

Additionally, all coastal works which extend below Mean High Water must receive a marine license which is provided by the Marine Management Organisation (MMO). If the project requires an Environmental Impact Assessment (EIA) the MMO must be consulted at the scoping stage; there are some exemptions, including beach recycling works, listed in Appendix H.

Non Statutory Designations

Sites with no legal protection in the study area:

- South Bank of the Swale LNR
- Bishopstone Cliffs LNR

It is important to consider those sites of local significance, i.e. LWS and LNR, by consulting with the land manager, e.g. Canterbury City Council, Environment Agency or Kent Wildlife Trust.

ENVIRONMENTAL OPPORTUNITIES

Three Biodiversity Opportunity Areas (BOA) exist within the study area (Figure 1-25). No statutory protection is afforded to these sites however it is in the best interest of sustainable development that these opportunities are considered and, potentially, integrated into any proposed scheme. More detail is given in Appendix B.

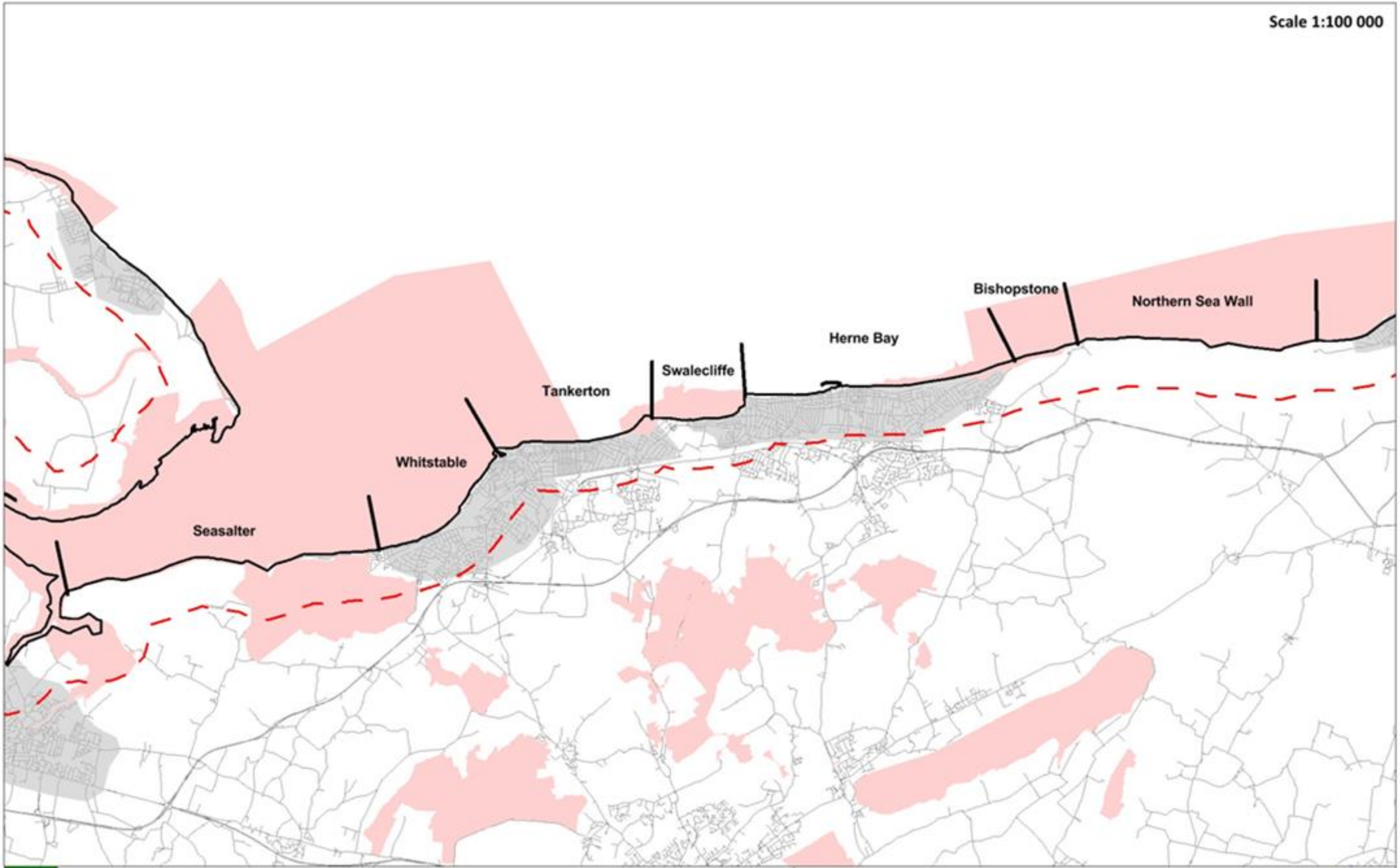

FIGURE 1-25 ENVIRONMENTAL RESTRICTIONS OVERVIEW MAP

N

🟥 **Restrictions may apply within this area.**
- - - **1km coastal buffer**
— **Unit boundaries**

CANTERBURY CITY COUNCIL

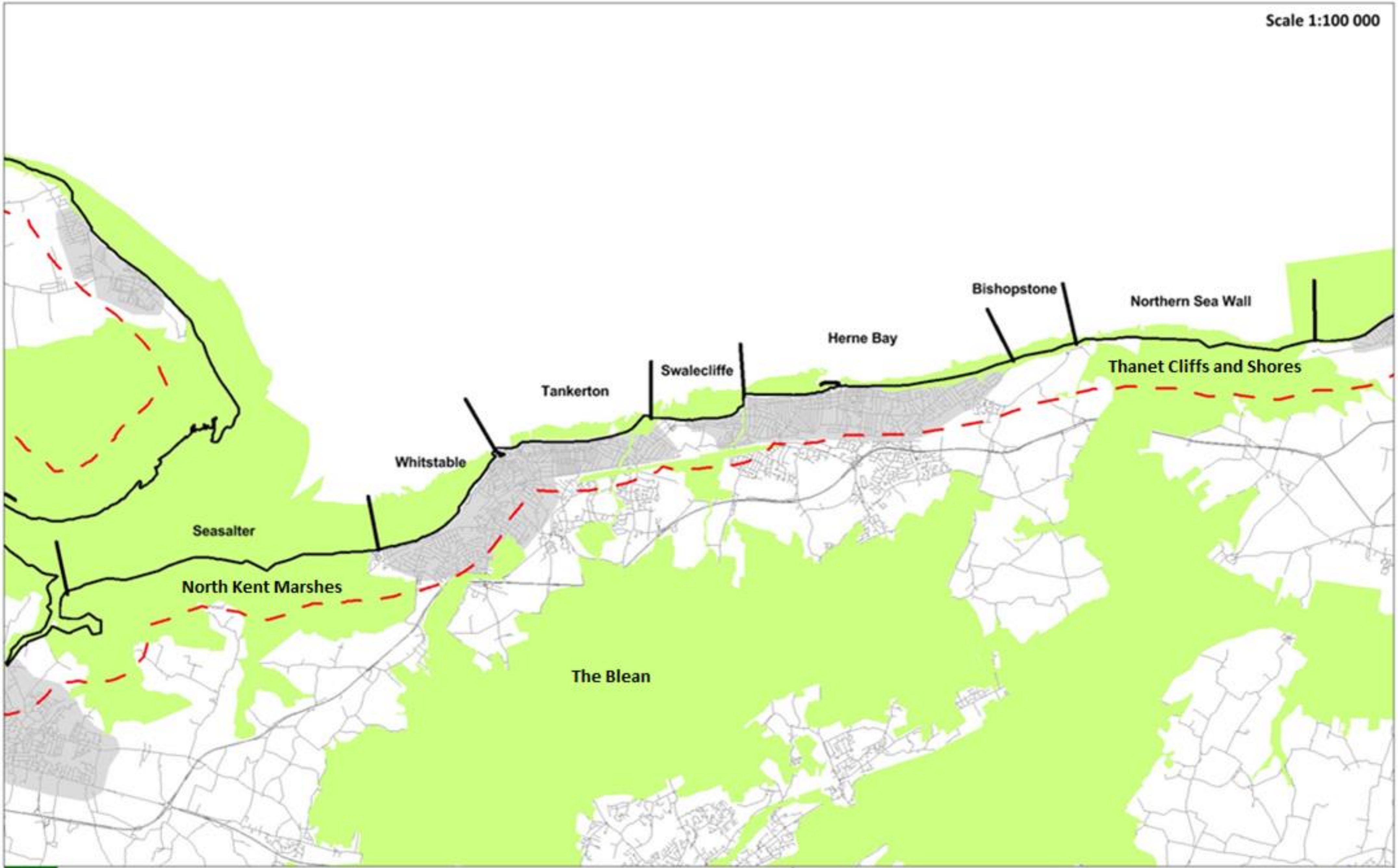

FIGURE 1-26 ENVIRONMENTAL OPPORTUNITIES OVERVIEW MAP

1-4-1 AGRICULTURE

Within the study site there are three key areas of agriculture: Graveney, the area between Faversham Creek and Whitstable; Swalecliffe, the green gap separating Tankerton and Hampton Pier and the undeveloped land which lies between Herne Bay and Northern Sea Wall.

The Agricultural Land Classification database (2002) shows that both Graveney and Swalecliffe are predominantly used as pasture, which is grazed by both cattle and sheep. The soil is classified as grade 3 agricultural land, i.e. land with good to moderate soils with a poor or more variable yield than grade 2. This land has been artificially drained and lies below sea level.

Most of the land behind Northern Sea Wall is cultivated for crops, such as oil seed rape, wheat, potatoes, peas and additional crops of cauliflower lettuce and onions (CCC, 1996). If coastal inundation should occur, saline deposits would permanently degrade the fertility of the arable ground.

1-4-2 INFRASTRUCTURE

The A299 is the only major road passing through the study area. This road is an extension of the M2 running from North Kent to Margate. Also known as Thanet Way the road diverges at Whitstable forming the A2990 which reconnects at Herne Bay. There are also a number of small coastal roads extending over the entire frontage at Herne Bay, parts of Whitstable and running parallel to the embankment at Seasalter.

Railway line, as part of the SouthEastern rail network and HighSpeed1 route, extends throughout the study area, running parallel to the coast. Some parts of the line exist in close proximity to the sea. At its smallest the distance between the railway line at Seasalter is less than 50m from the seafront. Should flooding occur, significant disturbance to commuters between Thanet and London would be felt.

The RNLI lifeboat station is situated at Whitstable. There are 18 commercial fishing vessels in Whitstable harbour. Private yachts and motor boats can be found in within Herne Bay harbour and beach launching occurs at Seasalter, Swalecliffe and Herne Bay beaches.

1-4-3 ARCHAOLOGY & CULTURAL HERITAGE

When sites of high archaeological and cultural value have been identified, they are assessed and recommendations are put forward. In England, three statutes provide protection for archaeological sites and their settings:

- *Ancient Monuments and Archaeological Areas Act (AMAA) 1979*;

- *Town and Country Planning (Listed Buildings and Conservation Areas) Act 1990*;

- *Protection of Wrecks Act 1973.*

The Reculver Saxon Shore Fort, Anglo-Saxon monastery and associated remains are designated as a Scheduled Monument, as are a group of ring ditches at Brookend, near Birchington (Historic England, 2016). The erosion of the alluvial deposits along the study area's foreshore at Studd Hill and Seasalter has revealed a wealth of archaeological and paleontological finds, including a bronze age mixed oak woodland. Large timber structures are also abundant in the area – Thorn the old fishing port at Faversham, as well as numerous fishing weirs and sea defences. Onshore, two large old salt works (cotterells) are found at Seasalter and finds of interest have been discovered in the church yards of Graveney and Seasalter churches. Remains of the Copperas Industry are found hidden under the shingle beach at Tankerton – one of three sites in the UK, dating to c.1538 (Godsall, 1956).

There are 119 listed properties within Whitstable, 54 in Herne Bay and a further 9 which fall within the 1km coastal buffer study area. Furthermore seven Conservation Areas fall within the study area.

There are no protected wrecks within the study area.

2 CURRENT RISK

An essential part of this BMP is to consider the purpose of each beach to determine the standard of protection required. The purpose of the beach is graded against four categories; protection from still water flooding, protection against overtopping, erosion and structures. The coastline has assessed against the four hazards summarised below. Appendix C provides detailed mapping of impacts under the following four classifications.

2-1 FLOODING

Coastal flooding can be highly destructive, damaging buildings and affecting the fertility of land. For the beach to exist for the protection from flooding the beach is reducing damage to property through flying shingle, overtopping and over wash, ponding, partial breach and full breach are considered as the main impacts of flooding. The disruption following coastal flooding can be extensive to the public, transport and agriculture. The salinity of the water can also cause issues, leading to farmland becoming infertile and upsetting natural freshwater habitats. Graveney, Whitstable, Swalecliffe and Herne Bay could be affected by overtopping as they all have properties in close proximity to the sea walls. Figures 2-1 to 2-3 show the areas below the 1 in 200 year still water level contour.

2-2 OVERTOPPING

Overtopping is classed as a danger to pedestrians on the beach, promenade and road and vehicles on the road; the larger the beach the lower the overtopping. Graveney, Whitstable, Swalecliffe, Herne Bay and Northern Sea Wall all have potential for overtopping, with the impact dependent on the topography and infrastructure behind the defence. Herne Bay promenade, by the King's Hall is particularly prone to overtopping with shingle regularly covering the promenade.

2-3 EROSION

Damage to slopes and cliffs, property on top of the slopes and cliffs and damage to property through loss of beach are all reduced by the presence of a shingle beach. Reculver Country Park is the only undefended cliff section along this frontage and is prone to landslides, however there are no properties as of yet that are at risk of being lost to the sea.

2-4 STRUCTURES

The beach reduces damage to structures preventing undermining and material washout from behind the wall, damage to the sea wall face and crown, promenade, splash and retaining walls, revetments and lastly, damage to drainage outfalls, harbour arms and rock revetments, rock groynes and timber groynes. Extensive networks of coastal defences protect Graveney to Northern Sea Wall, with a short stretch at Reculver Country Park being the exception.

2-5 AMENITY

Amenity impacts include damage to the amenity which is not infrastructure, for example reduction in beach width. Each beach has been given a score out of 100 to determine the level of amenity at risk within a 1km buffer of the coastline. Appendix C indicates the methodology, criteria is listed in Table 2-1 and a summary of the results are in Table 2-2 and Figure 2-4.

TABLE 2-1 CRITERIA FOR AMENITY SCALE

SCALE	POINTS	DESCRIPTION
1 – 2	0-20	THE BEACH IS NOT EASILY ACCESSED, NO CAR PARKING, NO FACILITIES, LITTLE USAGE.
3 – 4	21-40	THE BEACH IS ACCESSIBLE, NO CAR PARKING, MINIMAL FACILITIES, LITTLE USAGE.
5 – 6	41-60	THE BEACH HAS EASY ACCESS, CAR PARKING, SOME FACILITIES AND REGULAR USAGE – MAINLY DOG WALKERS.
7 – 8	61-80	THE BEACH HAS EASY ACCESS, AMPLE CAR PARKING, GOOD FACILITIES, WELL USED, GENERATES SOME INCOME TO THE AREA.
9 – 10	81-100	THE BEACH HAS EASY ACCESS, AMPLE CAR PARKING, AND GOOD FACILITIES, IS A MAIN ATTRACTION FOR TOURISTS, HEAVILY USED, LIFEGUARDED AND RELIED ON FOR INCOME THOUGH HOTELS.

TABLE 2-2 AMENITY SCORES

LOCATION	SUB CELL	SCORE /100
SEASALTER TO GRAVENEY	FAVERSHAM CREEK TO THE SPORTSMAN	2
	THE SPORTSMAN TO THE OYSTER PEARL	7.5
WHITSTABLE	OYSTER PEARL TO THE RAILWAY EMBANKMENT	17.5
	WHITSTABLE BAY	58.5
	WHITSTABLE HARBOUR	56.5
TANKERTON	PROMENADE	49.5
	LONG ROCK	5
SWALECLIFFE		12
HERNE BAY	HAMPTON PIER TO LANE END	40
	LANE END TO KINGS HALL	56
	EAST CLIFF	22.5
RECULVER COUNTRY PARK		7.5
NORTHERN SEA WALL		22

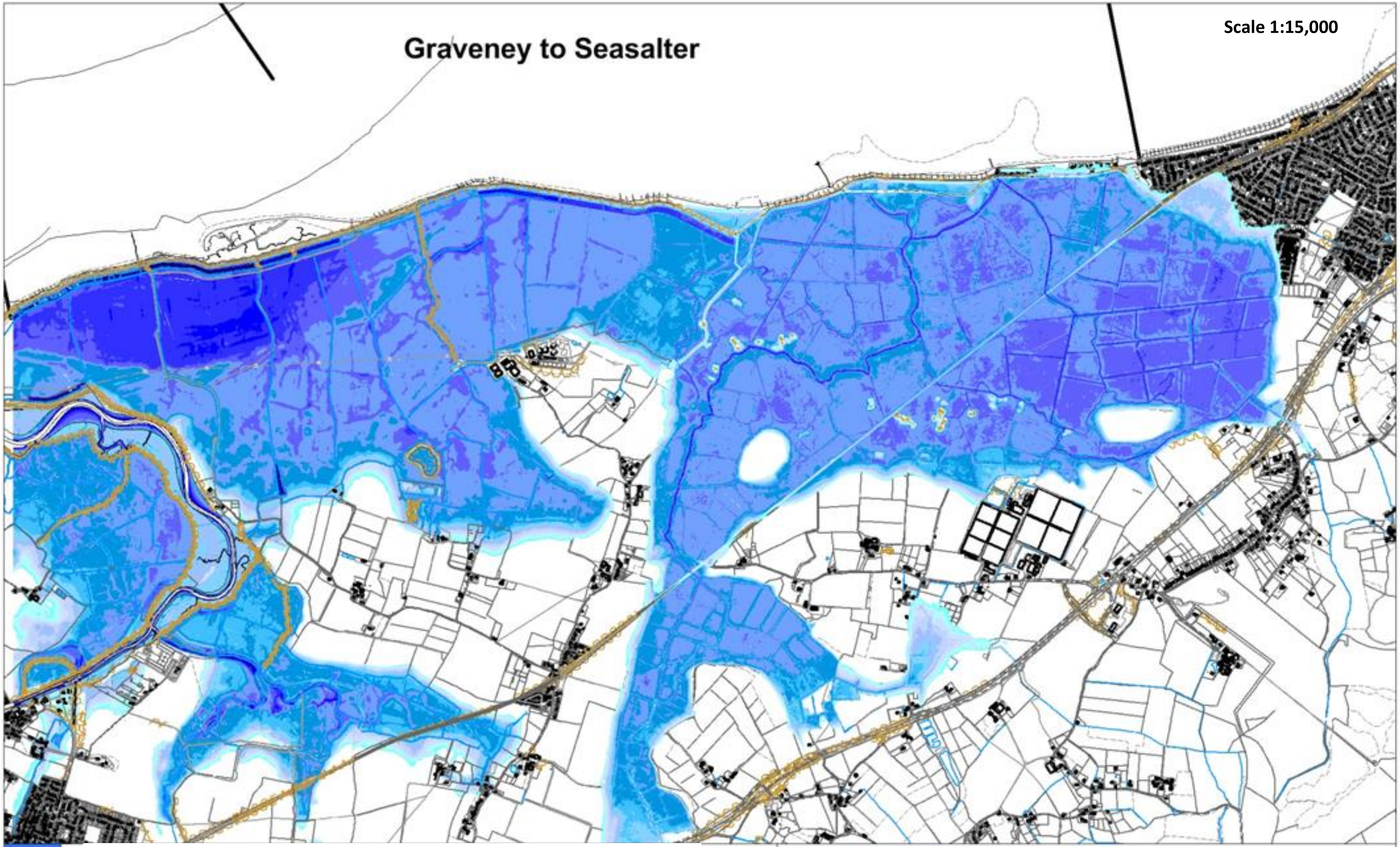

Figure 2-1 Graveney to Seasalter flood depth for 1 in 200 year still water level (planar flood map)

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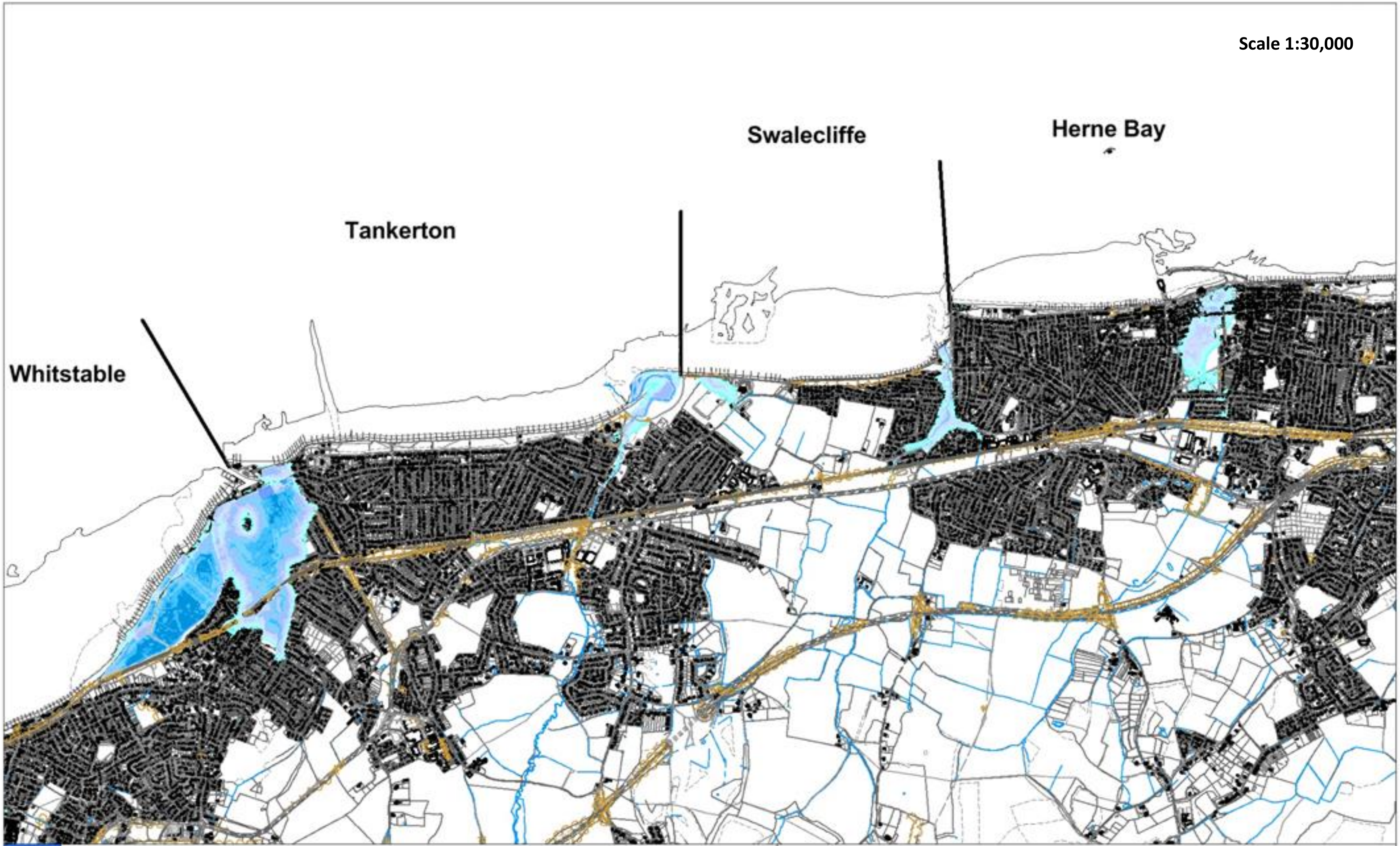

FIGURE 2-2 WHITSTABLE TO HERNE BAY FLOOD DEPTH FOR 1 IN 200 YEAR STILL WATER LEVEL (PLANAR FLOOD MAP)

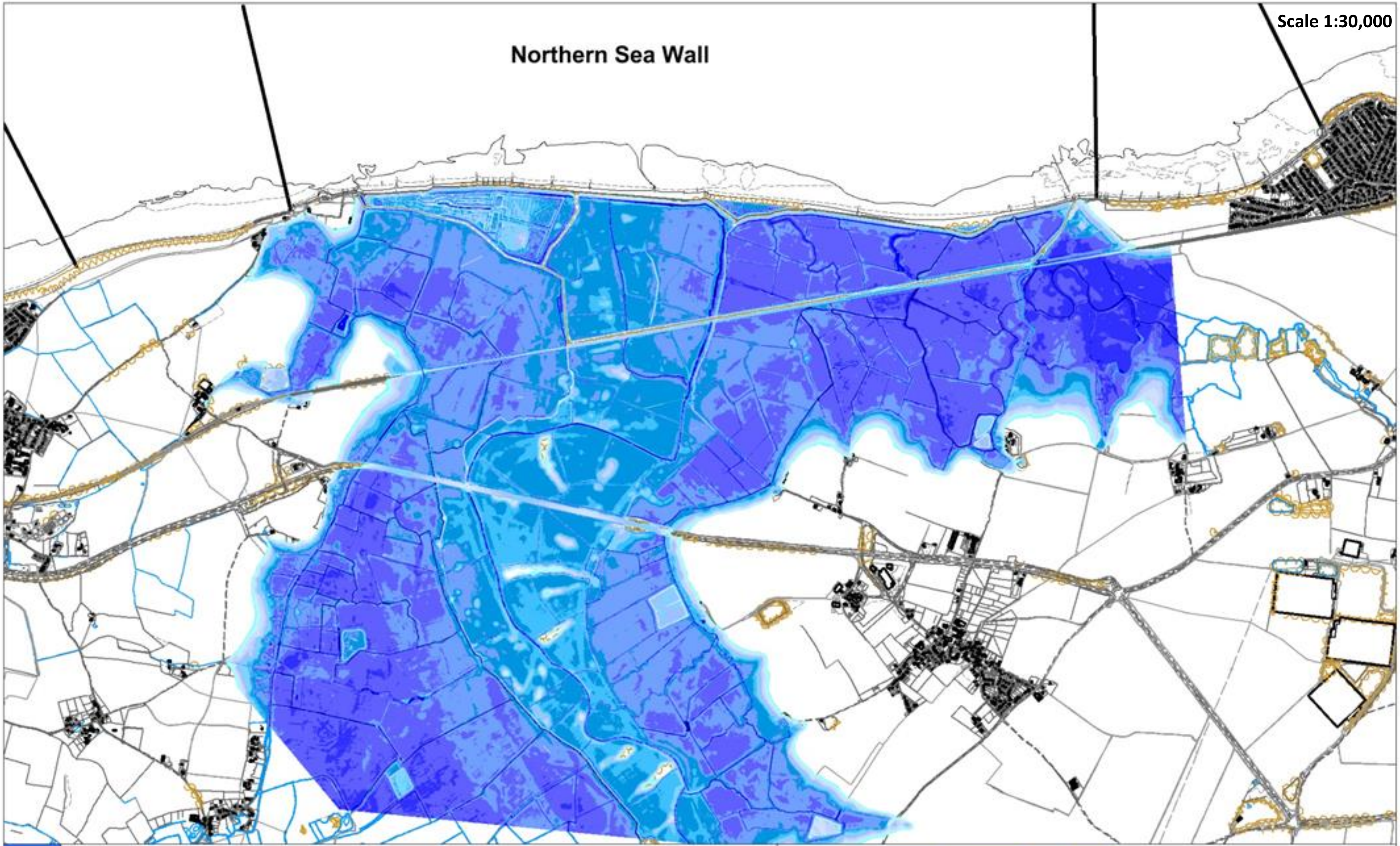

Figure 2-3 northern sea wall bay flood depth for 1 in 200 year still water level (planar flood map)

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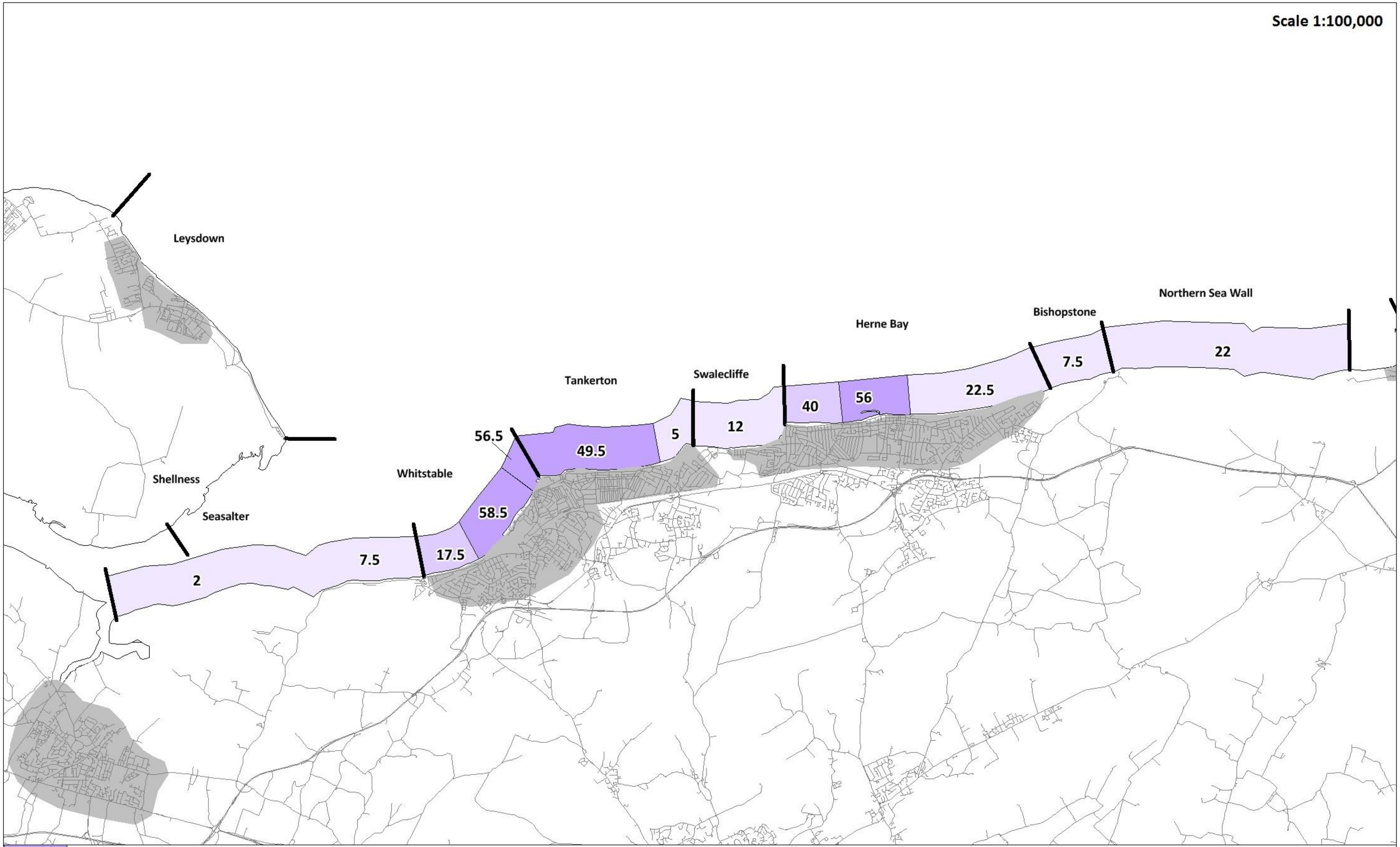

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FIGURE 2-4 AMENITY VALUE SCORES FOR THE GRAVENEY TO NORTHERN SEA WALL FRONTAGE

▨ 0 - 20
▨ 21 - 40
▨ 41 - 60
▨ 61 - 80
▨ 81 - 100
— Unit boundary

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3 PHYSICAL INPUTS

3-1 WATER LEVELS

3-1-1 TIDAL WATER LEVELS

This frontage has a tidal range of 2.8m during a mean neap and 4.9m during a mean spring tide (Admiralty Tide Tables).

3-1-2 EXTREME WATER LEVELS

Extreme water levels were derived from the results of *Coastal flood boundary conditions for UK mainland and islands* (Environment Agency, 2011). Results for four locations along the study area, as depicted in Figure 3-1, are provided in Table 3-1.

TABLE 3-1 EXTREME WATER LEVELS (+MOD) AND RETURN PERIODS

RETURN PERIOD (1 IN X YEARS)	A WHITSTABLE	B SWALECLIFFE	C HERNE BAY	D NORTHERN SEA WALL	UNCERTAINTY VALUES
1 IN 1	3.43	3.38	3.35	3.3	0.2
1 IN 5	3.74	3.69	3.66	3.62	0.2
1 IN 10	3.89	3.84	3.81	3.77	0.2
1 IN 25	4.07	4.02	3.99	3.95	0.2
1 IN 50	4.21	4.15	4.12	4.08	0.2
1 IN 100	4.35	4.29	4.26	4.22	0.3
1 IN 200	4.5	4.42	4.4	4.36	0.3

Values taken from Coastal flood boundary conditions for UK mainland and islands (Environment Agency, 2011)

The primary data source within the study area is the Herne Bay Etrometer Step Gauge. Sheerness tide gauge is also situated nearby however historical secondary tide data is limited. As a result the outputs are heavily reliant on the modeling and interpolation between nodes. Tidal predictions vary between software packages, namely POLTIPS (Proudman Oceanography Laboratory) and Admiralty TOTALTIDE (UK Hydrographic Office), and this may translate into uncertainty with regards the extreme sea levels.

Comparison with other studies (JBA, 2004; Bugonović, 2003; Canterbury City Council, 1993) that the results are consistent for higher return periods (1 in 200 years). Given this is the baseline standard of protection used in this report, and there is not sufficient historical data to validate the results, they are considered the best available data at this time. It is however recommended that consideration should be given to installing a permanent tide gauge within the study area.

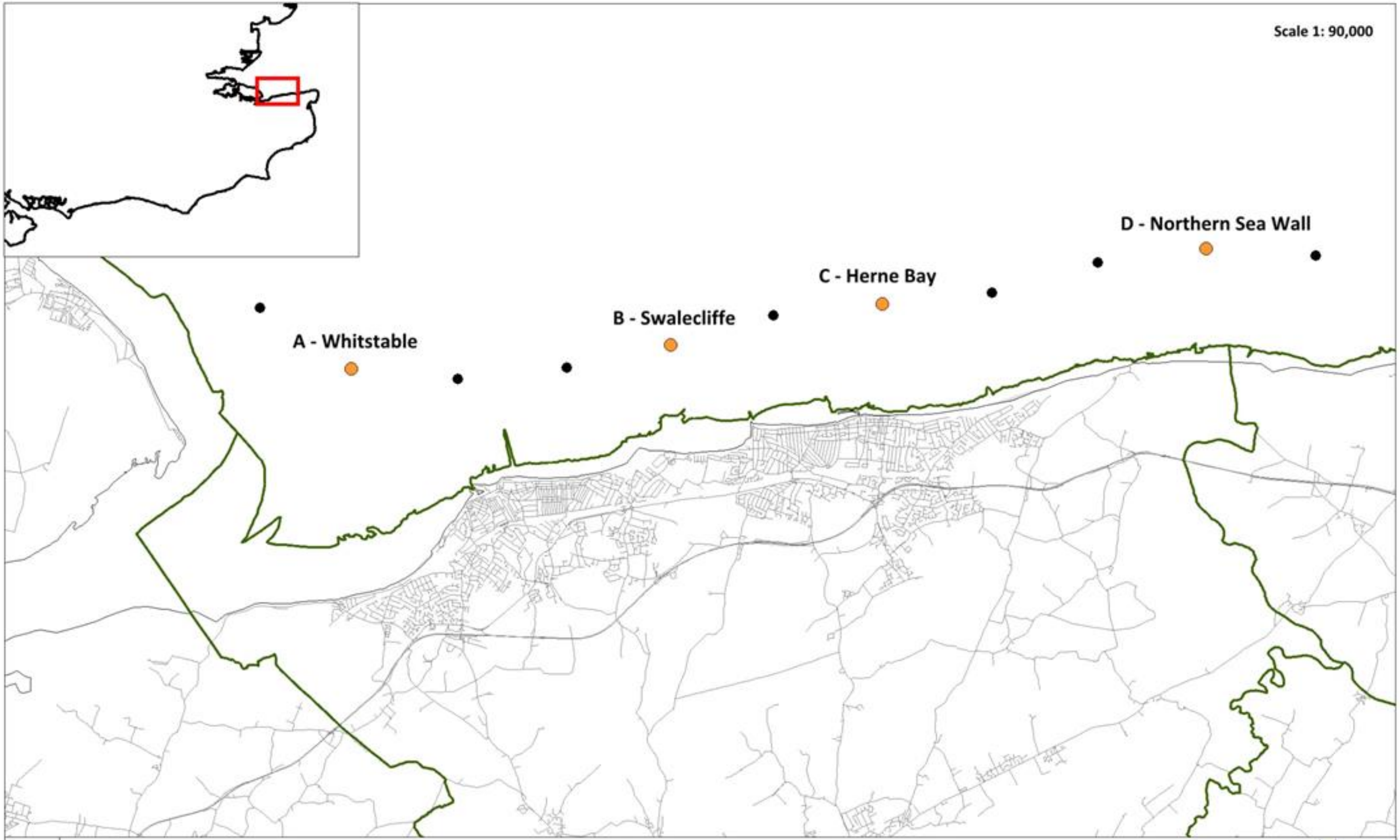

FIGURE 3-1 LOCATION OF THE 'EXTREME WATER LEVELS' AND EXAMPLE POINTS

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Water levels increase from East to West along the frontage with a typical difference in the region of 130mm between Whitstable and Northern Sea Wall.

3-1-3 WAVES

The wave climate is dominated by waves from the north east, resulting in an east to west drift of beach material along the whole frontage, excluding Northern Sea Wall. Waves from the north east are more frequent and typically larger in magnitude, but it should be recognised that periods of waves from the north west can result in a temporary reversal in the sediment drift direction.

Three sources of data have been used for this study, measured data from the Herne Bay Etrometer step gauge, wind data and Met Office Hindcast data that models 33 years of predicted wave conditions.

3-1-4 WAVE RECORDER

As part of the Regional Coastal Monitoring Programme an Etrometa Step Gauge is situated on the old pier head at Herne Bay, in approximately 9m of water (Figure 3-2). The gauge was installed in 2004.

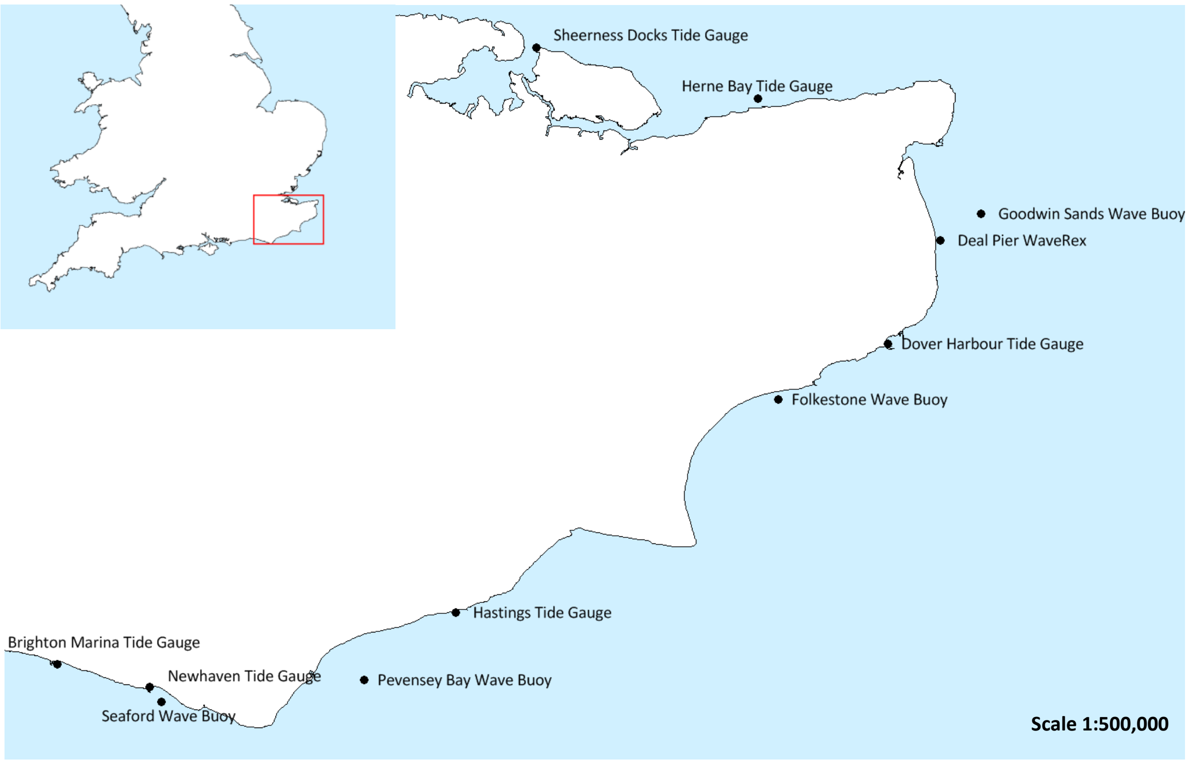

FIGURE 3-2 LOCATION OF ETROMETER STEP GAUGE

In addition to the wave recorder a wind recorder is also on site. As waves are generated by wind this offers insight into which direction waves are coming from and at what frequency. A summary of collected data is presented in the following wind rose, Figure 3-3.

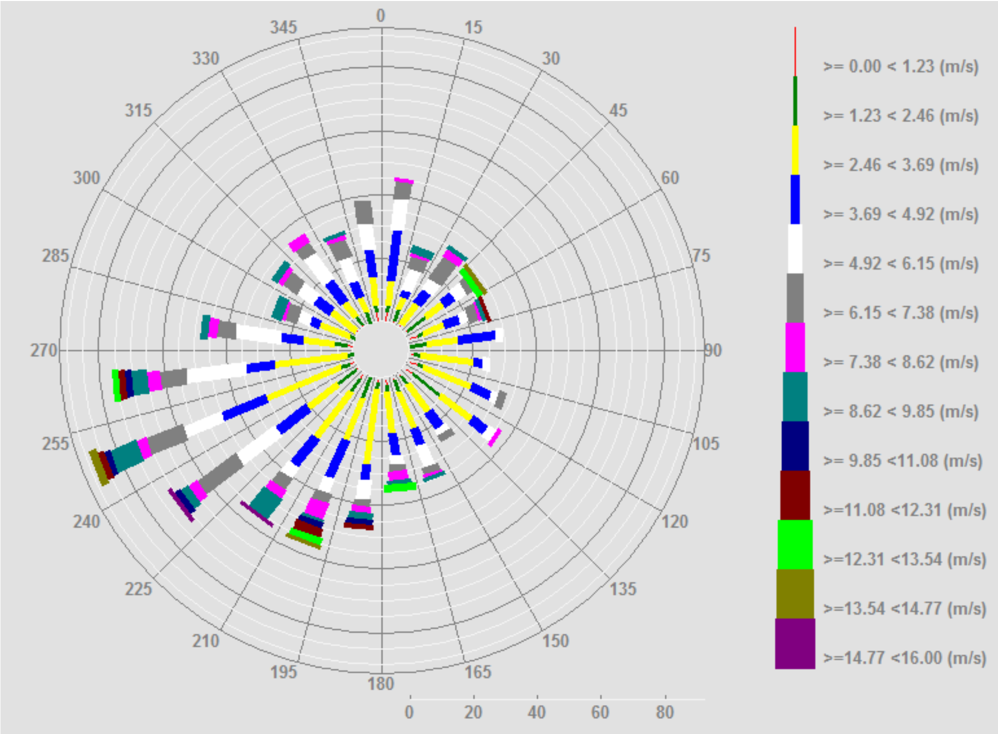

FIGURE 3-3 HERNE BAY WINDROSE: 01/01/2014 TO 01/01/2015

3-1-5 MET OFFICE HINDCAST

Using thirty-three years of Met Office Hindcast data for 52 nearshore locations at ~5km intervals (Figure 3-4) the Joint Return Probability for Beach Management study (Mason, 2014), calculated extreme return periods for each of these points.

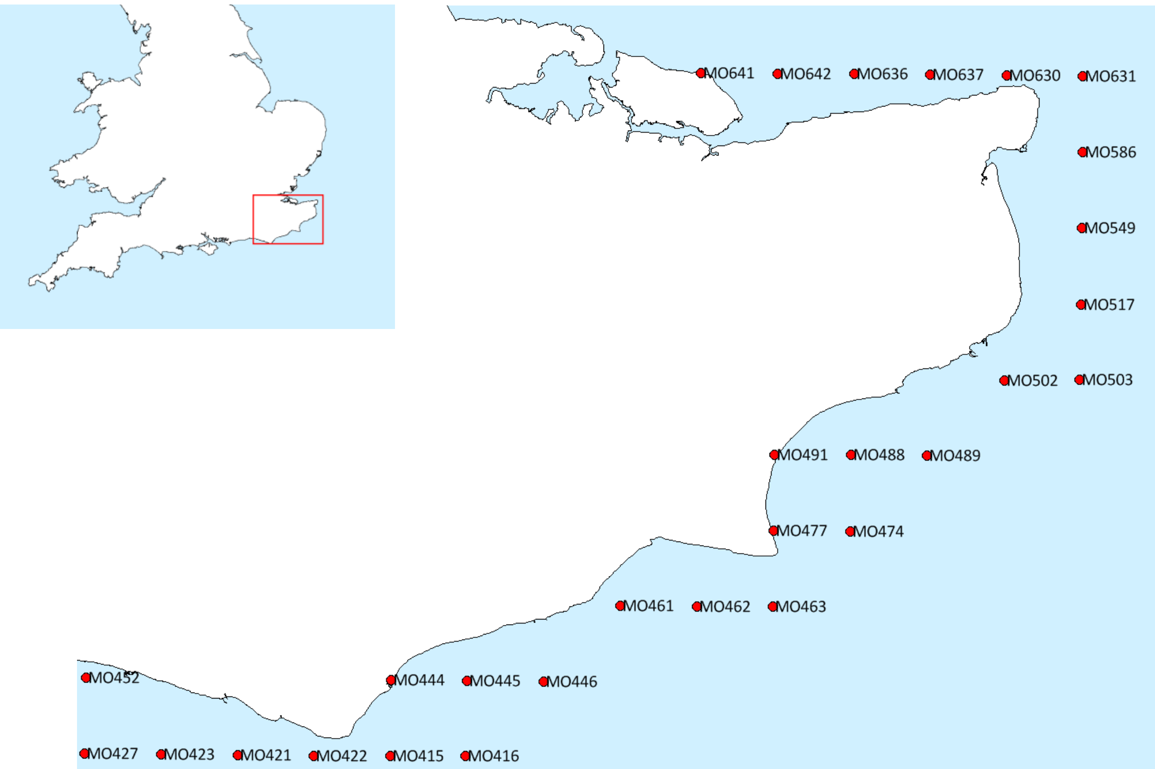

FIGURE 3-4 LOCATION OF MET OFFICE HINDCAST POINTS

Significant wave height return periods for Met Office points MO642, MO636 and MO637 are included for reference in Table 3-2. The methods employed to generate significant wave heights and their return periods do not take into consideration water depth and whether waves of that size could exist at that point given the effect of depth limitation. This is accounted for later in this report.

TABLE 3-2 SIGNIFICANT WAVE HEIGHT, HS (M) RETURN PERIODS FOR FOUR MET OFFICE HINDCAST POINTS; VALUES IN PARENTHESIS ARE THE WATER DEPTH AT THIS POINT

Return Period (1 in x years)	MO642 (3M)	MO636 (3M)	MO637 (4M)
1 in 1	**2.46**	**2.82**	**2.94**
1 in 5	**2.73**	**3.18**	**3.34**
1 in 10	**2.84**	**3.33**	**3.51**
1 in 20	**2.95**	**3.48**	**3.67**
1 in 50	**3.09**	**3.67**	**3.87**
1 in 100	**3.19**	**3.81**	**4.03**
1 in 200	**3.29**	**3.95**	**4.18**

Contours of the annual 0.05% wave height exceedance are illustrated in Figure 3-5 and show the geographical variability within the study area suggesting the western end of the study area is more sheltered than the eastern end.

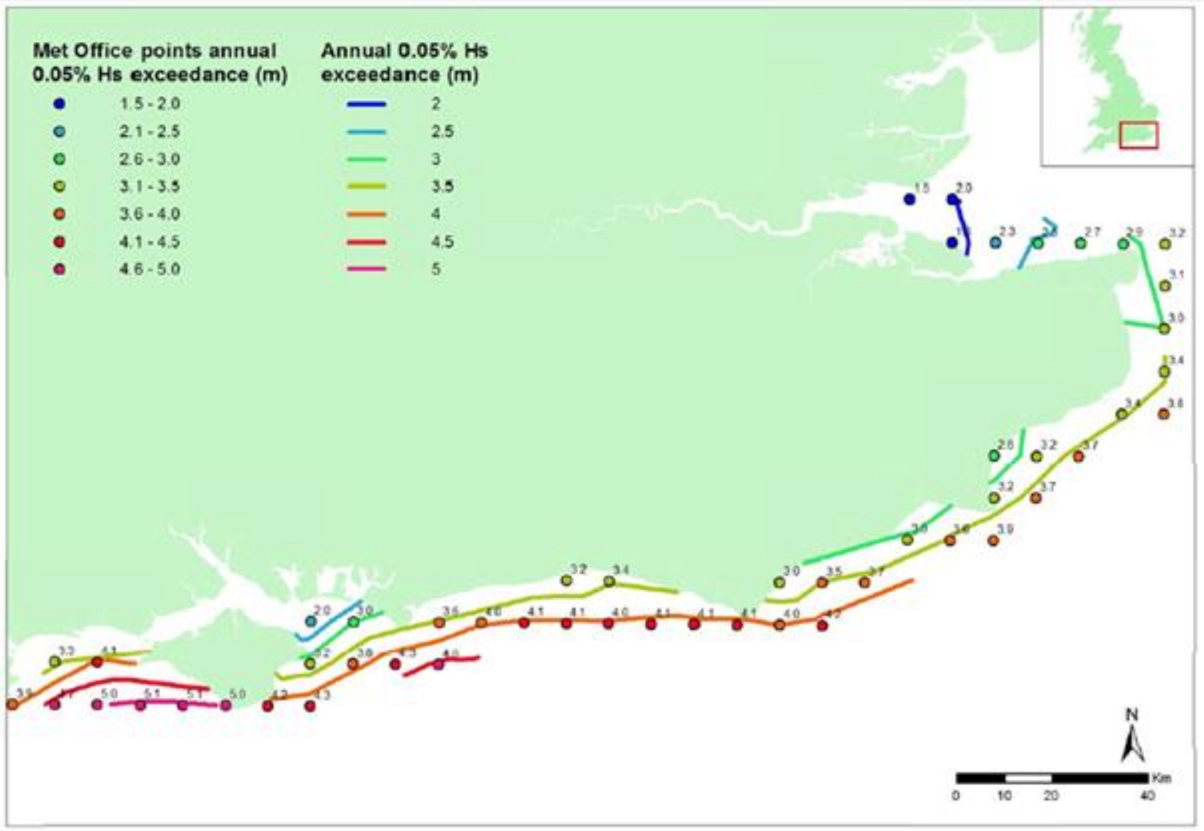

FIGURE 3-5 ANNUAL SIGNIFICANT WAVE HEIGHT (HS [M]) 0.05% EXCEEDANCE JOINT RETURN PROBABILITY FOR BEACH MANAGEMENT (MASON, 2014).

3-2 JOINT PROBABILITY ANALYSIS

Joint return periods were established using the 33 year Met Office Hindcast data and results from the EA water level boundary set as part of Mason, (2014). These were calculated for 1, 2, 5, 10, 20, 50, 100 and 200 year return periods, using the HR Wallingford TR2 SR653 desk calculator, for each Met Office point.

Results for Met office points MO642, MO636 and MO637 are presented graphically below, Figures 3-6 to 3-8. Note that the potential depth limitation is broadly calculated and included on the charts, but this is calculated more accurately under specific conditions later in the report.

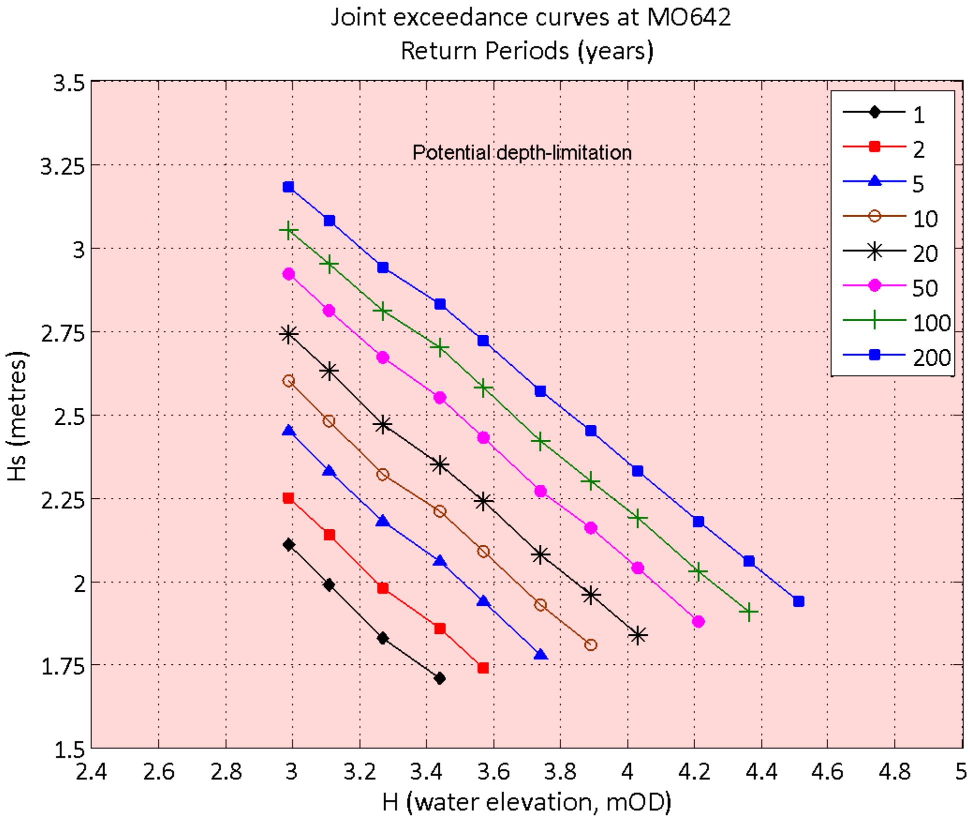

FIGURE 3-6 JOINT PROBABILITY EXCEEDANCE CURVES AT MO642, RETURN PERIOD (YEARS)

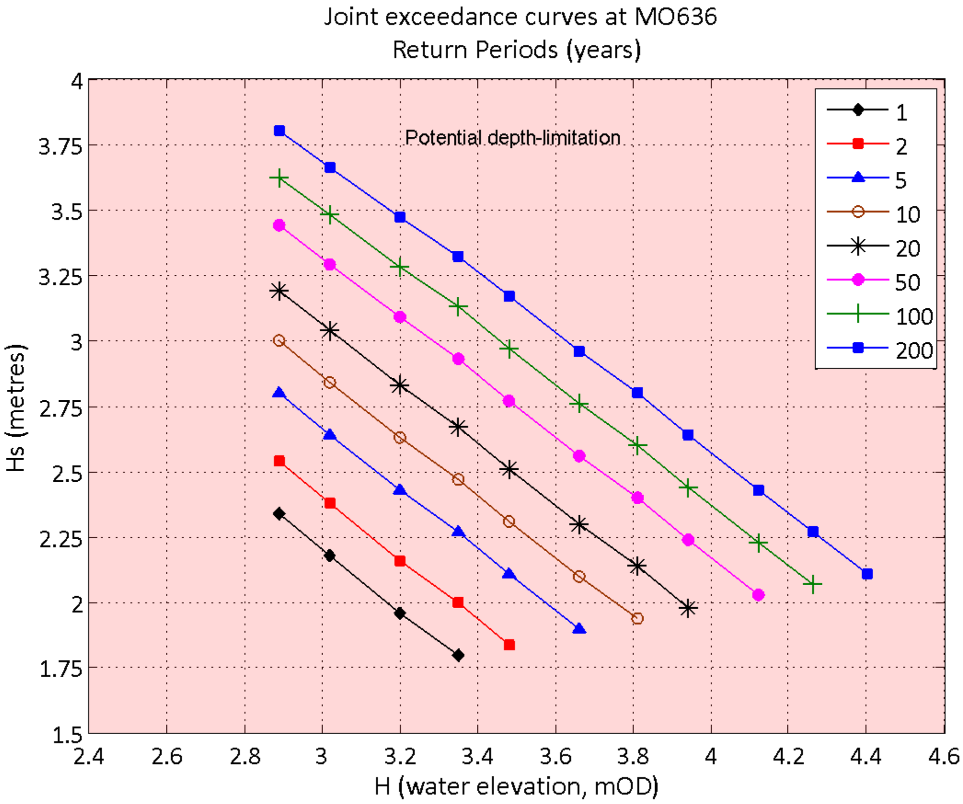

FIGURE 3-7 JOINT PROBABILITY EXCEEDANCE CURVES AT MO636, RETURN PERIOD (YEARS)

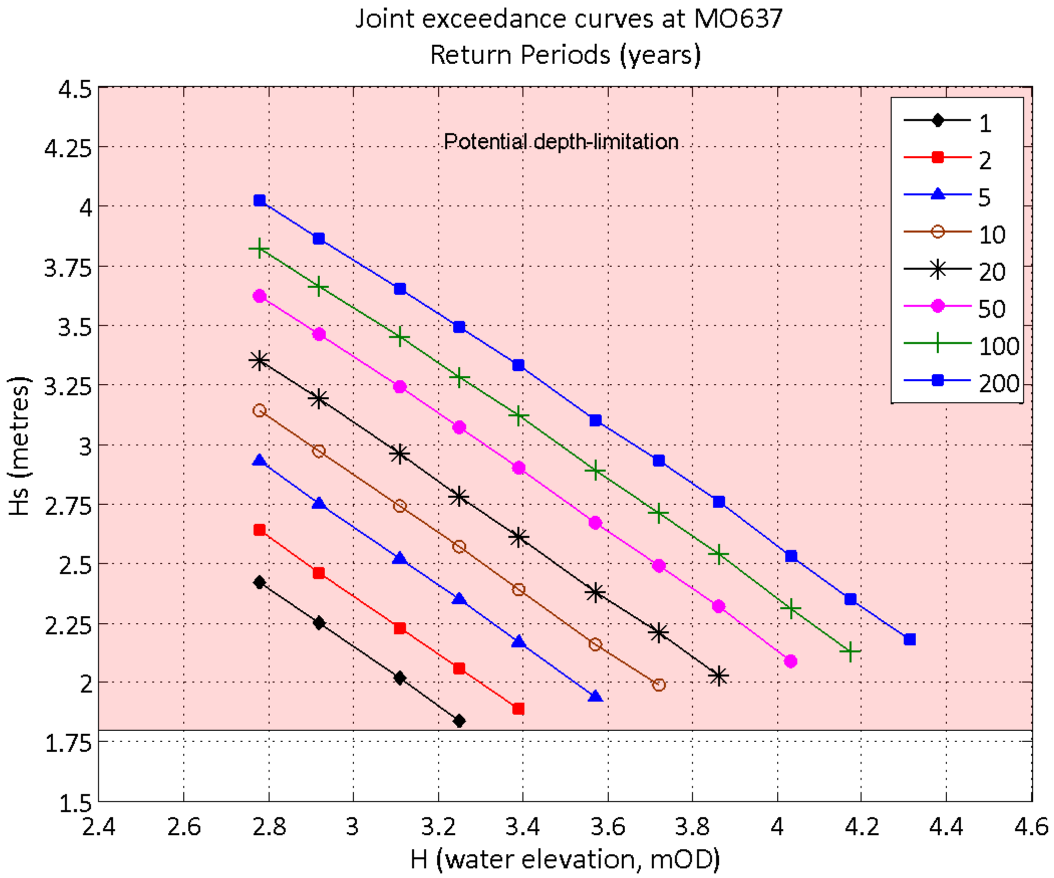

FIGURE 3-8 JOINT PROBABILITY EXCEEDANCE CURVES AT MO637, RETURN PERIOD (YEARS)

3-3 SEDIMENT CHARACTERISTICS

Sediment size and characteristics were obtained through previous studies undertaken by Canterbury City Council, and are summarised in the following table and illustrated on Figures 3-9 and 3-10. Sediment grading curves are included within Appendix E.

TABLE 3-3 SEDIMENT CHARACTERISTICS FOR THE NORTH KENT COAST DETERMINED FROM SEDIMENT SORTING MACHINE USING MATERIAL EXTRACTED FROM ALL LAYERS OF BEACH

LOCATION	BEACH SEDIMENT	FORESHORE SEDIMENT	D_{50} (MM)*
SEASALTER	SHINGLE	MUD/ CLAY	10
WHITSTABLE	SHINGLE	GRAVEL/MUD	8-10
TANKERTON	SHINGLE	SAND/ CLAY	8
SWALECLIFFE	SHINGLE	SAND/ CLAY	6-8
HERNE BAY	SHINGLE	SAND	6
RECULVER COUNTRY PARK	SHINGLE/ SAND	ROCK/ SAND	6
NORTHERN SEA WALL	SHINGLE	MUD/ SAND	4.6

**D50 is calculated from the whole sediment sample, including material below 2mm. This is based on the weight of the sample after it has been dried in an oven to remove most of the water content.*

FIGURE 3-9 AVERAGE GRAIN SIZE (D50) AT MEAN HIGH WATER SPRING, 1986

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FIGURE 3-10 AVERAGE GRAIN SIZE (D50) AT MEAN HIGH WATER NEAP, 1986

●	●	●	●	●
0.062 to 2 mm sand	2 - 4 mm v. fine pebbles	4 - 8 mm fine pebbles	8 - 16 mm medium pebbles	16 - 32 mm coarse pebbles

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Although these records are over 20 years old it is considered that the beach material has not changed significantly. The records show that the beaches are similar to other beaches within the southeast of England with a D50 of 10-14 mm.

It is good practice to ensure that the grading envelope of the replenished material is as close to the natural beach material as possible. Therefore it is recommended that a contract grading envelope is used for all works and that the delivered material is monitored to ensure it meets the specification and avoids performance issues associated with sub-standard finer material.

Sediment experiments at Tankerton in 2003 revealed that for mixed material beaches, the higher the fine/sand content the worse the beach performs in response to the North Kent wave climate. The experiment comprised of five adjacent groyne bays each filled with material with significantly different grading characteristics. Results showed that failure to meet the grading envelope due to an excessive amount of fine material was the causative factor for many problems including the increased erosion rates and increased amount of cliffing. This is due to the fact that the fines fill the interstitial voids; thereby reducing permeability and lowering the energy absorption of the waves by the beach. Beach permeability was also seriously impeded by the integration of replenishment material, reducing its ability to absorb wave energy and causing cliffing to occur.

Additionally, an experiment for ‘capping’ a groyne bay was undertaken. This involved the scraping and removing the top layer of the coarse, well sorted material from the indigenous beach and then filling the bay with finer dredged material. The well sorted material was then placed back in the bay, on top of the dredged material, as a ‘cap’. Results showed that initially the bay performed well, until the dredged material was exposed by the sea and then performance of the beach reduced. The conclusions were that the capping of the beached delayed the inevitable poor performance of the unsorted dredged material as beach fill.

3-4 BEACH GEOMETRY

Overall the study area is orientated along a WSW to ENE plane. The dominant drift direction is east to west direction.

The coastline between Seasalter and Northern Sea Wall is defined by several terminal structures and few headlands. As a result, the orientation varies within each sub cell, i.e. Seasalter splits into three sections and Whitstable into two.

Consequently, the orientation is a key factor affecting the rate of longshore transport as the dominant waves approach from the north east. Orientation between 30 and 60 degrees are geographically more vulnerable. Figure 3-11 identifies the orientation of the coastline in relation to due north.

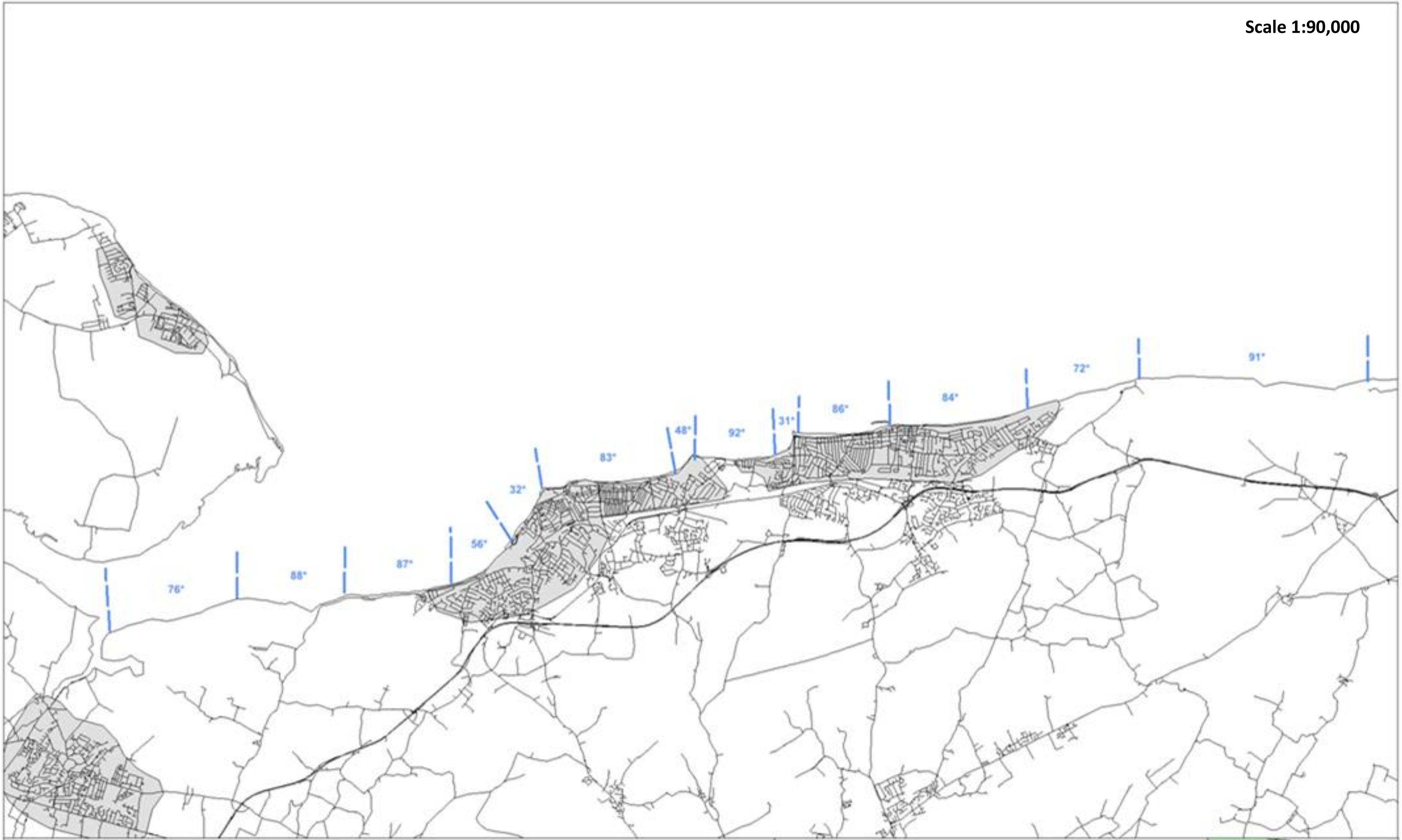

FIGURE 3-11 COASTAL ORIENTATION

4 HISTORICAL MONITORING

4-1 CONTROL NETWORK

A control network was set up by Longdin and Browning for the Regional Coastal Monitoring Programme (RCMP) in 2003, covering the coastline between Seasalter and Northern Sea Wall. It includes several E1 (surveyed for longer than 8 hours), E2 pins (surveyed for 6 to 8 hours) and E3 pins (surveyed for longer than 8 minutes) which are all suitable for leveling and GPS surveys; their location is shown on the Location Map of Survey Pins overleaf. GPS equipment has an accuracy of +/- 30mm in the vertical and +/- 30mm in the horizontal.

4-2 TOPOGRAPHIC SURVEYS

Coastal monitoring is undertaken annually through the Regional Coastal Monitoring Programme; its primary aim is to provide a repeatable and cost effective method of monitoring the English coastline. Following many years of *ad hoc* monitoring of coastal processes within the southeast, through local authorities and the Environment Agency, an extensive integrated survey programme was developed to cover approximately 1,000km of open coastline and estuaries between the Isle of Grain and Portland Bill. Data are collected by Local Authority in-house teams and are freely available via the Channel Coastal Observatory, which is based in Southampton.

4-2-1 GPS

The elevations of the beaches between Seasalter and Northern Sea Wall are surveyed with GPS equipment. GPS RTK methods are used to collect 2-D (profile method) or quasi 3-D (continuous method) representations of the volume of the beach. A beach profile is a cross section which starts are sea wall, or back of beach, and runs perpendicular to the coastline and ends at MHWS, a rock platform or if mud foreshore then 50m off the toe.

Linked to the Control Network, the GPS equipment has the ability to “stake-out” to the position of existing profile lines ensuring the same cross sections are surveyed every year. GPS equipment is mounted onto a detail pole at 1.8m and a new topographic point is taken at every significant change in elevation to produce a 2D replica of the beach face. Profiles are categorised as designated or intermediate lines. Designated profiles are representative of long stretches of coast, positioned along different orientations, different defence types or in areas of concern and can provide an overview of the beach. Intermediate profiles are spaced at 30-60m intervals between the designated profiles and provide a detailed coverage of the beach (Appendix D).

The continuous method produces blanket coverage of the beach. GPS equipment is mounted onto a rucksack or a quadbike and the surveyor walks (or drives) shore parallel lines along all changes of elevation, with points recorded every two seconds. This data is then post-processed in a GIS package to give the quasi 3-D model of the beach.

SPRING & AUTUMN SURVEYS

The designated profiles have been surveyed during the spring and autumn since 2003. Analysis is available for all profiles and is used to monitor beach response to wave conditions or replenishment schemes.

SUMMER SURVEYS

A full survey is conducted to provide a quasi 3D model of the beaches once every five years, unless the survey unit is a Beach Management Plan Site which would be surveyed annually. This comprises a full set of designated and intermediate profiles and a continuous dataset of the beach and foreshore.

POST STORM SURVEYS

Following a series of storm waves which exceed the storm threshold as set by Channel Coastal Observatory, post storm surveys may be conducted as an additional set of data. The surveys will only be conducted if the Local Authority or Environment Agency managers deem the beach to have had significant damage i.e. large losses or severe drawdown of material which will not return over the course of the next few tidal cycles.

Profiles will be concentrated in the areas of concern with a light coverage of the whole unit as these can inform emergency repair works.

IN/OUT SURVEYS

In and Out surveys refer to the pre and post work surveys respectively. The profiles and/or continuous is concentrated on those areas specified by the Local Authority or Environment Agency manager; usually the extraction and deposition sites.

Scale 1:100,000

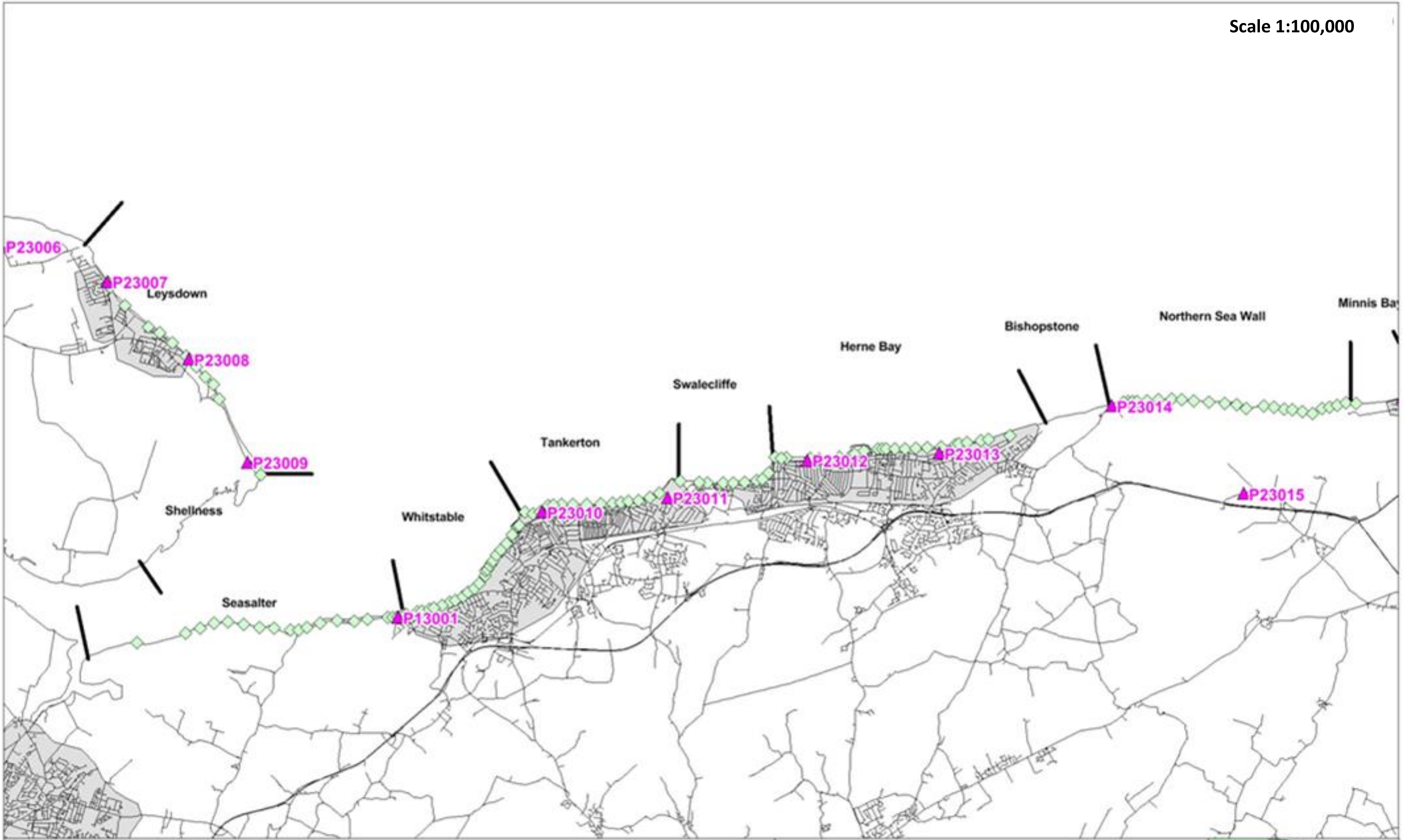

FIGURE 4-1 SURVEY CONTROL PINS LOCATION MAP

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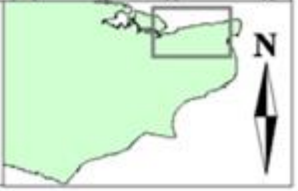
▲ E1- Surveyed by OS

◇ E3- Surveyed by SCRMP



4-2-2 HISTORIC

BEACH LEVELLING STATIONS

A system of beach monitoring originally commenced in 1975 after local government reorganization when the previous coastal authorities of Herne Bay and Whitstable became part of Canterbury City Council. These initial readings, although useful at the time, were not in any set format and were succeeded by the Beach Leveling Station (BLS) system. This was established between 1978 and 1980.

There were 46 stations originally rising to 71 as a result of the findings of the Beach Management Programme in 1992. Stations were spaced, on average at intervals of 225m along the coastline. Leveling surveys were undertaken at the BLS four times a year – February, May, August and November.

4-3 BATHYMETRIC SURVEYS

The most recent bathymetry data is the 2013 multi-beam survey. Single beam surveys of the study site were undertaken in 2007 and 2004.

4-4 BMP SITES

All beaches along this frontage are surveyed three times per year. Spring and autumn survey windows are February to March and October to November respectively. Summer surveys are undertaken between June and September. Each survey unit must have a minimum of two months between each survey.

To ensure the method is repeatable a series of profile lines are surveyed every time and the extents of each site are maintained. Profile Lines are named consecutively within Coastal Cell 4a (Isle of Grain to North Foreland). There are approximately 600 profiles between Seasalter and Northern Sea Wall with GPS data dating back to 2003 (Appendix D - Profile Location Maps).

TABLE 4-1 SURVEYING SCHEDULE

SITE	**SPRING**	**SUMMER**		**AUTUMN**
	ANNUALLY	1 PER PHASE	ANNUALLY	ANNUALLY
SEASALTER	✓		✓	✓
WHITSTABLE	✓		✓	✓
TANKERTON	✓		✓	✓
SWALECLIFFE	✓		✓	✓
HERNE BAY	✓		✓	✓
RECULVER COUNTRY PARK	✓		✓	✓
NORTHERN SEA WALL	✓		✓	✓

4-5 AERIAL SURVEYS

4-5-1 AERIAL PHOTOGRAPHY

As part of the RCMP ortho-rectified aerial photography is flown every 5 years. The most recent available photography was flown in 2013 and prior to that 2008 and 2003. This is available to download from the Channel Coastal Observatory website. The next set of ortho-rectified photography should be available winter 2016/17.

Canterbury City Council, Engineering Team, has commissioned annual oblique aerial photography during 1978 and 2015; most of these sets have been scanned and stored digitally at the local council. Canterbury City Council, as a council, commission ortho-rectified photography every few years at high tide; the most recent is 2012.

4-5-2 HISTORIC AERIALS

Castle Coote spit, Seasalter, to Minnis Bay has intermittent non ortho-rectified aerial photography dating back to 1946. This is still undertaken annual on behalf of Canterbury City Council and is stored digitally at the council offices. Vertical aerial photography (and corresponding beach profile data) has been produced annually under the Environment Agency's ABMS (Annual Beach Monitoring Survey) since 1978, with ortho-rectified photos available from the Channel Coastal Observatory.

4-5-3 LIDAR

Lidar is flown annually on behalf of the Environment Agency. Sites chosen for flight are highly dependent on budget and necessity and tend to be selected on a sliding scale; areas of soft cliff or few coastal defences would be a high priority and headlands or heavily managed beaches through defences or maintenance are low on the priority.

Phase 4 of the RCMP (2017-21) will take a more consistent approach and survey all beaches along the North Kent coastline every other year.

4-6 STRUCTURES

4-6-1 GPS

The defence structures are surveyed every five years by the in-house coastal monitoring team as part of the baseline summer surveys. The most recent structure survey was undertaken in 2012, prior to that 2007 and 2003.

4-6-2 LOCAL AUTHORITIES

Local authorities have a requirement to regularly survey coastal assets. The in-house coastal monitoring team surveys the coastline two-three times per year, which provides an opportunity for any visible structural defaults to be reported.

4-7 HYDRODYNAMIC MONITORING

4-7-1 WAVE RECORD

A wave recorder is located offshore of Herne Bay. Real time data for the significant and maximum wave height are freely available via the Channel Coastal Observatory website. This data are recorded by an Etrometa Step Gauge attached to the old Herne Bay Pier Head in Herne Bay in approximately 9 meters of water.

Whilst the wave recorder is not directional, wind speed and direction are also recorded at the old Herne Bay Pier Head which provides proxy data for wave direction.

Historically, between 1979 and 1990, wave activity was recorded 600m offshore of Whitstable Harbour. The wave recorder was a pressure sensor device measuring water level fluctuations, i.e. tides and waves. The data were analysed to provide the significant wave height (Hs) and the Zero Crossing Wave Period (Tz). The highest significant wave height recorded over the 11 year period was 1.58m. On average, three events occur annually when the wave height exceeds 1m. On 50% of occasions the sea was calm. The wave periods of the larger waves rarely exceeded 6s.

4-7-2 TIDE GAUGE RECORDS

A tidal gauge is situated on the landing platform of the old Herne Bay Pier Head. Tide gauges are important for understanding the local tidal conditions. The real time data can be observed alongside the predicted data on the Channel Coastal Observatory website.

4-8 ECOLOGICAL MONITORING

4-8-1 HABITAT MAPPING

The beach vegetation within the south east of England was digitised in 2011 by the University of Southampton. The habitat mapping was based on the 2008 ortho-rectified aerial photography to provide an overview to the locations of vegetation along the coast.

4-8-2 TOPOGRAPHIC SURVEYS

As part of the GPS data each point is coded with the material underfoot. In cases of vegetation “vg” or “dv” or “gr” are used to note vegetation, dune vegetation or grass. Although no study has been undertaken to compare these boundaries, it is possible to see the evolution or regression of the beach vegetation. However this data is rather limited in that it does not describe species or population density of the vegetation.

4-8-3 ECOLOGICAL MONITORING

Wetland Bird Surveys are undertaken annually by the RSPB as part of their management of the Seasalter Local Nature Reserve. This monitors the number of wildfowl and waders along the coastline at high tide every month.

A ringing scheme is undertaken at Reculver Towers. This scheme is run in accordance with the British Trust for Ornithology. This survey monitors the health, longevity, migration patterns, survival rate and population of migrating and resident birds.

The Kent Wildlife Trust runs an intertidal monitoring programme, known as Shoresearch. Habitat, species type, distribution and diversity are recorded at Herne Bay. Additionally, if expertise is available on the day of the survey quantitative transect and quadrat surveys are undertaken alongside the usual recording. This enables a more accurate assessment of the relative richness of shores which provides a better measure of change over time. This data is freely available from the JNCC’s Marine Recorder Application. http://jncc.defra.gov.uk/page-1599

5 SEDIMENT BUDGET

5-1 METHOD

The sediment budget provides transparent and quantitative evidence of beach losses, gains and sediment pathways, in combination with both natural and artificial movements of beach grade material. This sediment budget predominately focuses on the shingle sediment movement, as this has the most relevance to beach management operations.

Data fed into the sediment budget is supplied through the Regional Monitoring Programme and uses the full dataset (2003 to 2015). To create the budget beach surfaces were combined to create continuous terrain models (gridded at 1m) across the whole frontage, Eastbourne to Rye Training Wall. With the compiled DTM's from all available survey years, it is possible create difference models from which volumetric change between two surveys can be calculated. Negative values represent erosion that has occurred between Year A and Year B, and positive values indicate accretion. Whilst these figures show an overall change in beach volume within each discrete section, it should be recognised that the data is based on the BMP survey, which is undertaken once each year and is a snapshot in time.

Some of the cells between Castle Coote and Minnis Bay are managed and mask the natural changes. The sediment budget uses Equation 1 to calculate the sediment transport rate leaving the cell and accounts for measured volume change, management activities and anticipated losses within a cell.

Equation 1 $$\boldsymbol{Qoutput} = -(\boldsymbol{\Delta V} - \boldsymbol{P} + \boldsymbol{R} - \boldsymbol{L}) + \boldsymbol{Qinput}$$

Where ΔV is the as surveyed volume change, P is the combined recycling (deposition) and replenishment, R is the Recycling (Extraction), L is the combined Losses from attrition and those associated with recycling and replenishment activities. Qinput in the volume transported from the up-drift cell and Qoutput is the volume of material transported to the downdrift cell. A worked example is outlined in Figure 5-1.

The detailed methodology for the production of the sediment budget is outlined in detail within Appendix E. The outputs are available in spread sheets and graphical plates, an example of which is shown in Figure 5-2. The results are detailed and complex in nature, so to aid understanding summaries of management activities, sediment transport rates, erosion and accretion, individual units and a regional summary are provided in Chapter 8 of this report.

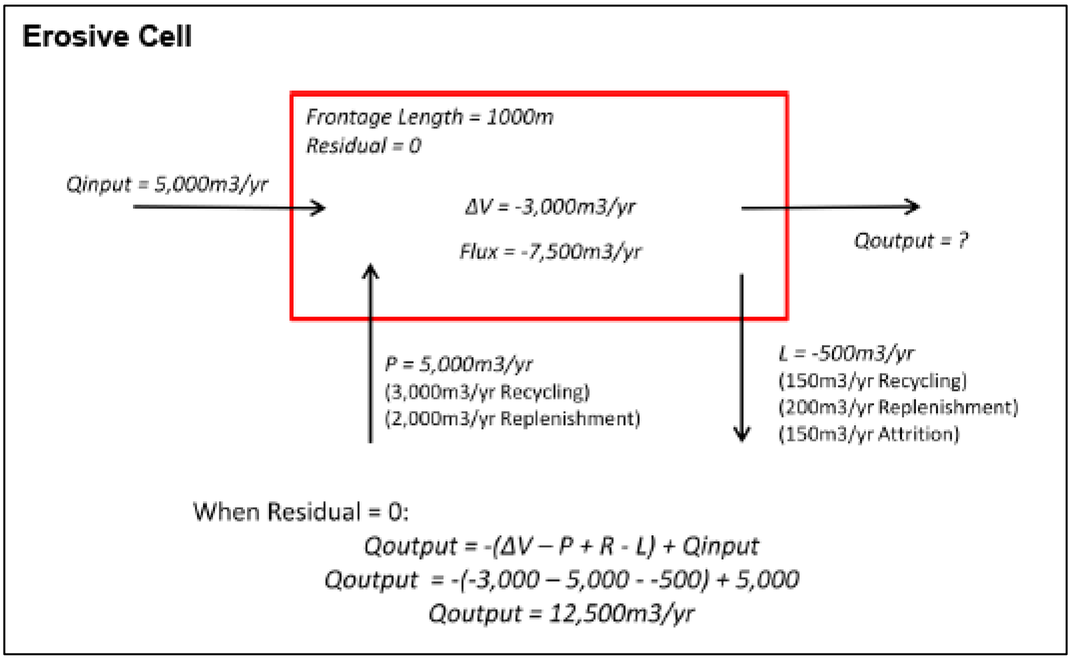


FIGURE 5-1 EXAMPLE OF AN EROSIVE CELL CALCULATED THROUGH THE SEDIMENT BUDGET

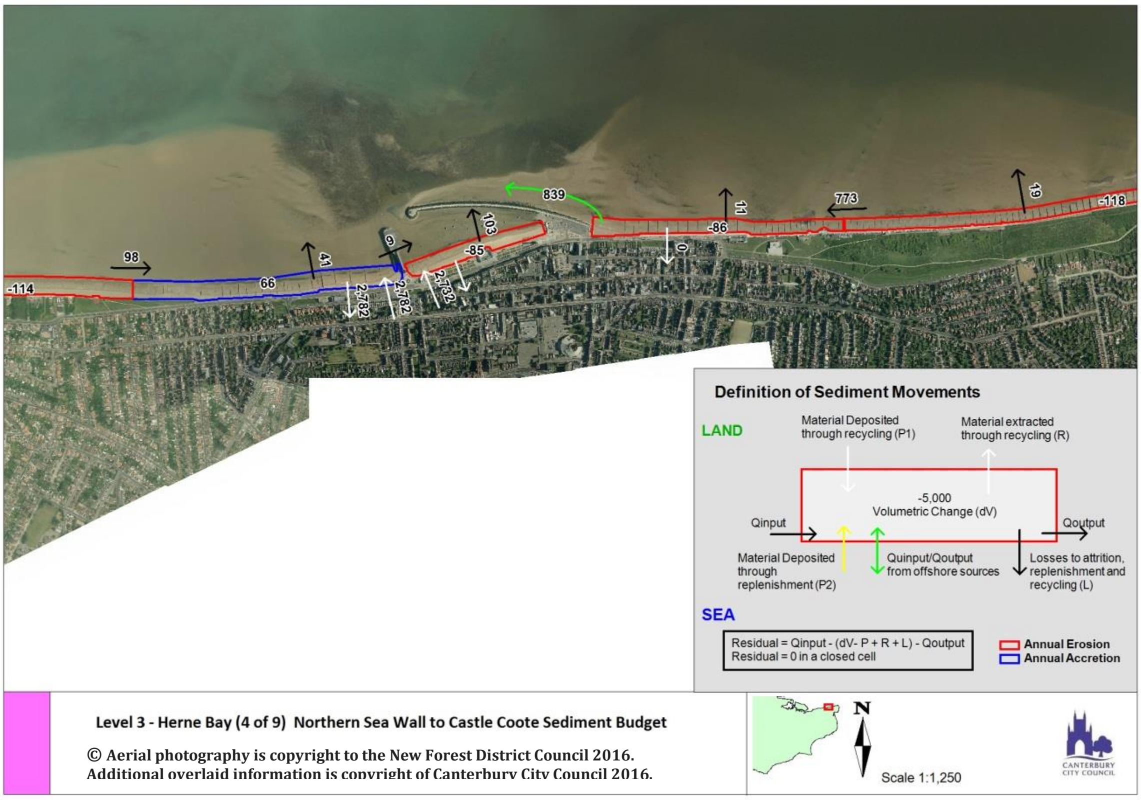


FIGURE 5-2 EXAMPLE OF DETAILED SEDIMENT BUDGET OUTPUTS (APPENDIX E)

5-2 BEACH MANAGEMENT ACTIVITIES

Current management of the beaches relies heavily on artificial transport of shingle, either through recycling along the coast or shingle replenishment (typically marine aggregate sourced offshore). A summary of the total and average annual rates are listed in Table 5-1. Full details of annual quantities and the locations of the extraction and deposition sites can be found in Appendix E.

TABLE 5-1 SUMMARY OF BEACH MANAGEMENT ACTIVITY 2003 - 2015

LOCATION	TOTAL RECYCLING VOLUME (2003-2015)	AVERAGE ANNUAL RECYCLING VOLUME	TOTAL REPLENISHMENT VOLUME (2003-2015)	AVERAGE ANNUAL REPLENISHMENT VOLUME
NORTHERN SEA WALL	41,049	3,421	0	0
RECULVER COUNTRY PARK	N/A	N/A	N/A	N/A
HERNE BAY	66,171	5,514	0	0
SWALECLIFFE	0	0	8,004	667
TANKERTON	11,020	918	45,507	3,792
WHITSTABLE	2,500	208	68,158	5,680
SEASALTER	0	0	6,076	506
NET	120,740	10,061	121,669	10,139

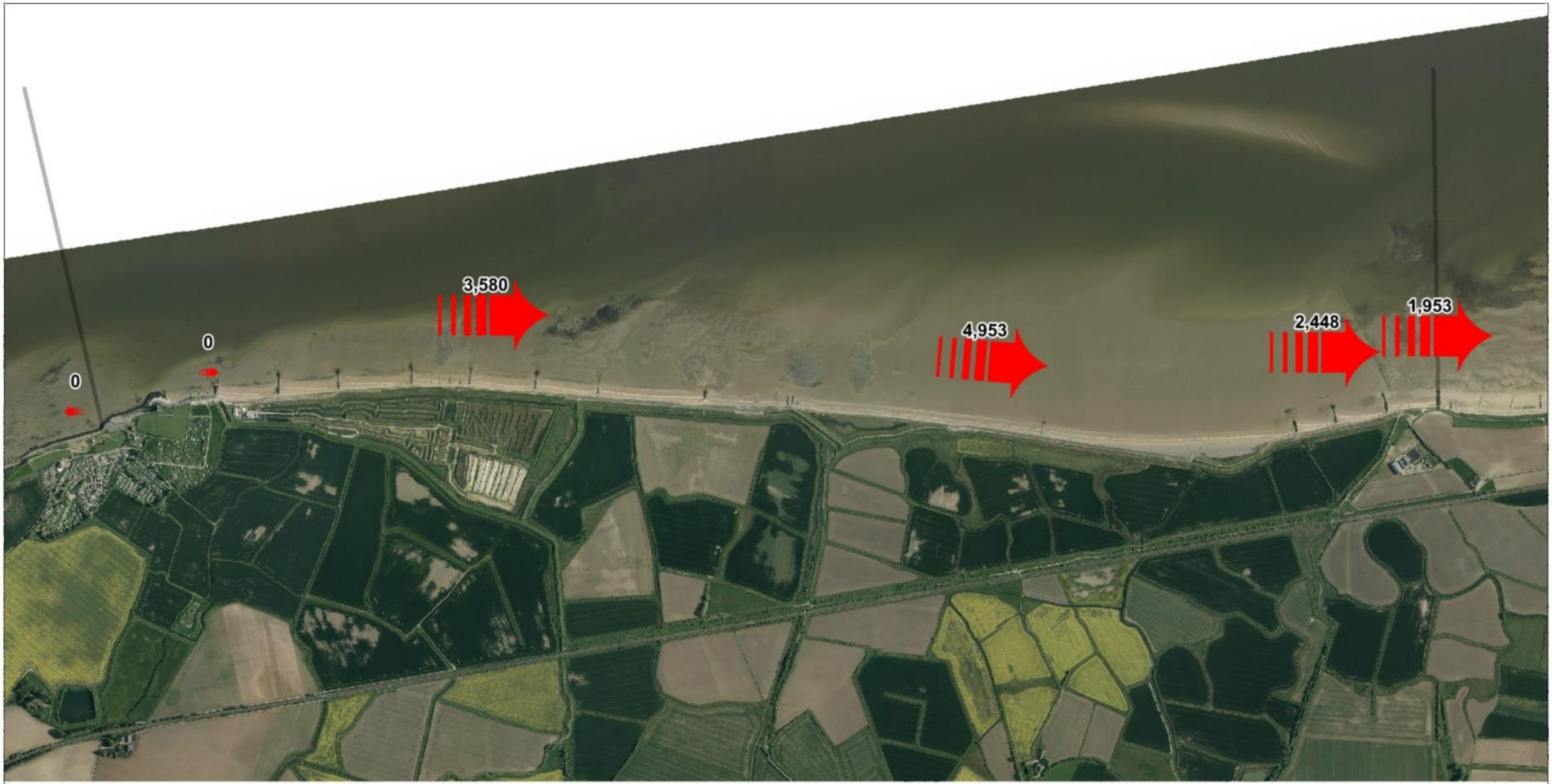
(Volumes provided by coastal management authorities)

5-3 SEDIMENT TRANSPORT RATES

From the budget it is possible to extract average annual sediment transport rates along the whole frontage based on the data collected from 2003-2015. These demonstrate a great deal of variability throughout the frontage.

Due to the dense groyne field along the majority of the frontage and the numerous terminal structures the transport rates are relatively low across the coastal cell. The transport rates across the whole frontage fluctuate between 0m^3 to 5,000m^3 with the largest transport rates at Northern Sea Wall and Seasalter where the beaches are more open and the controlling structures are wider spaced or fewer. Herne Bay, Swalecliffe and Whitstable indicate negligible transport rates due to the closely spaced groynes, and Tankerton has a varying range of transport rates due to the more open nature of the eastern side and the long, high groynes in the west.

The following figures illustrate the changes in more detail. When interpreting the results it should be emphasised that these are average annual values and the observed rates can be considerably higher (or lower) in any given year. These fluctuations are taken into consideration in Chapter 7.



Scale 1:20,000

FIGURE 5-3 SEDIMENT BUDGET – NORTHERN SEA WALL

Estimated annual sediment transport in cubic meters.

— Unit boundaries

N

0	1 - 500	500 - 1 000	1 000 - 2 000	2 000 - 3 000	3 000 - 5 000

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Scale 1:25,000

FIGURE 5-4 SEDIMENT BUDGET – HERNE BAY AND BISHOPSTONE

Estimated annual sediment transport in cubic meters.

— Unit boundaries

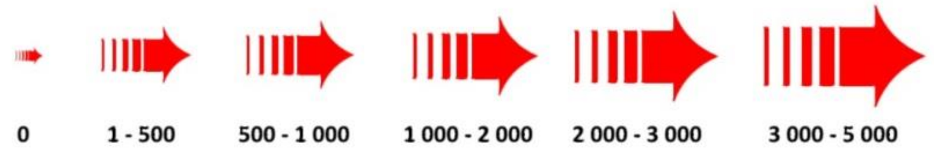

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FIGURE 5-5 SEDIMENT BUDGET – SWALECLIFFE

Estimated annual sediment transport in cubic meters.

— Unit boundaries

N

0	1 - 500	500 - 1 000	1 000 - 2 000	2 000 - 3 000	3 000 - 5 000

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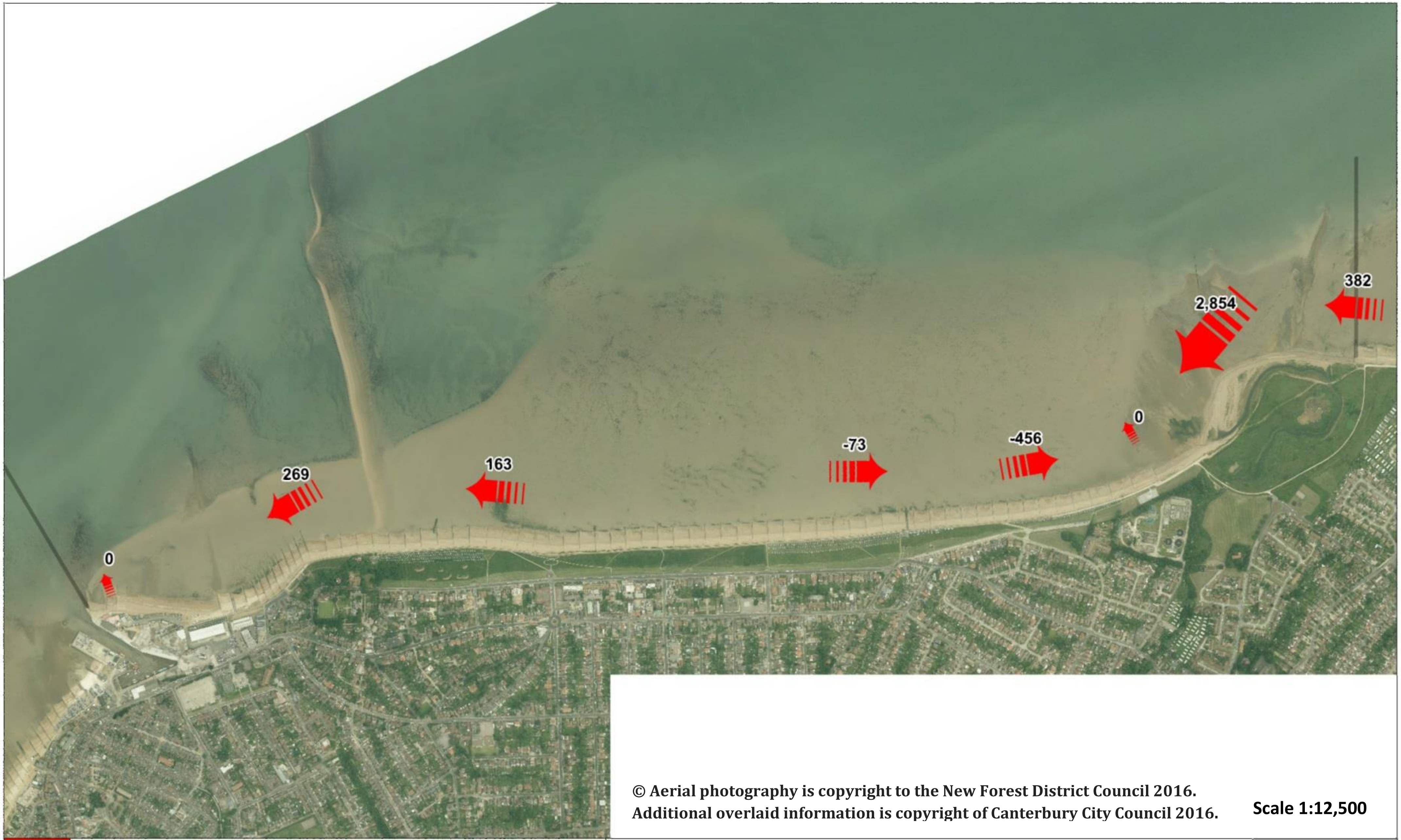

FIGURE 5-6 SEDIMENT BUDGET – TANKERTON

Estimated annual sediment transport in cubic meters.

— Unit boundaries

N

0

1 - 500

500 - 1 000

1 000 - 2 000

2 000 - 3 000

3 000 - 5 000

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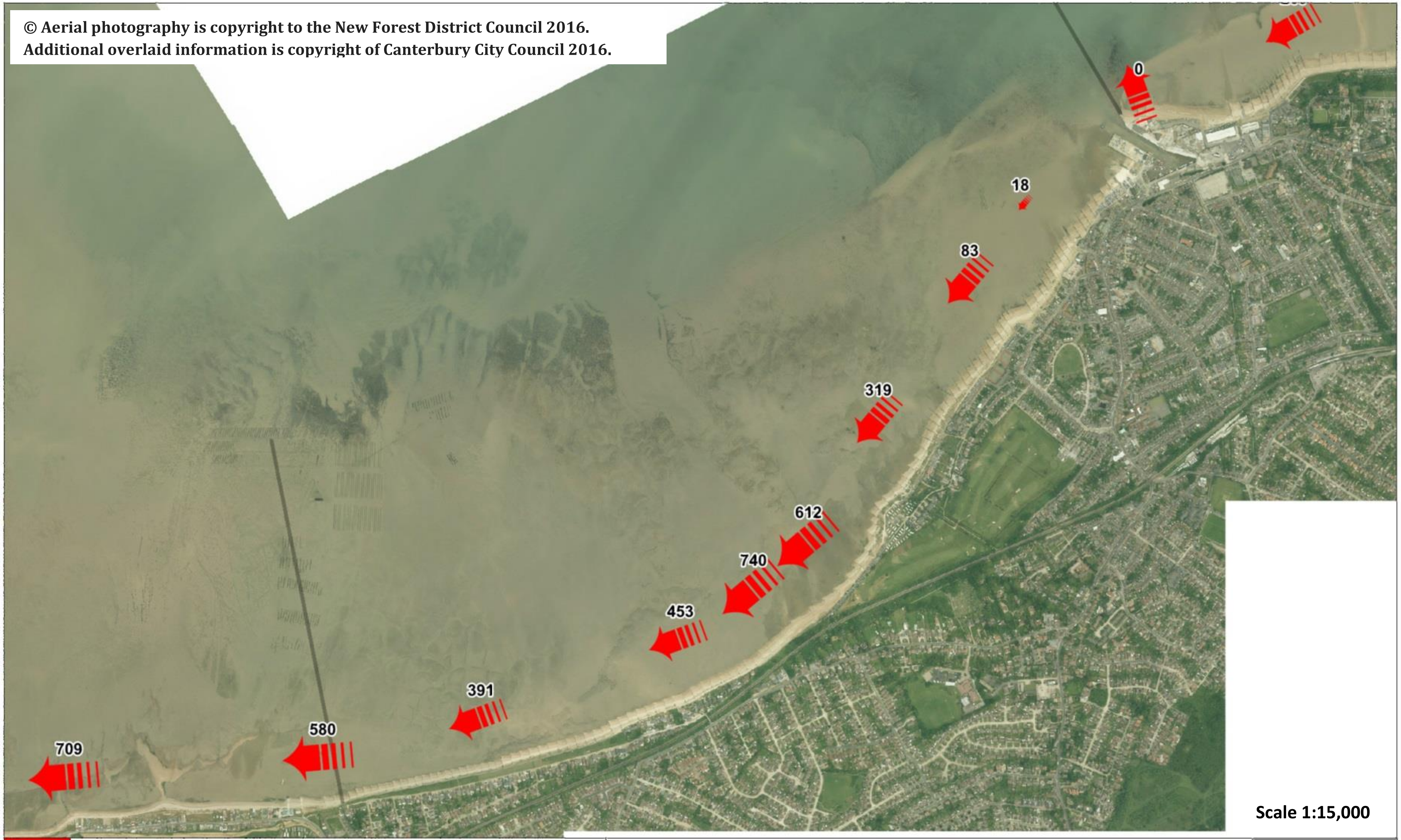

FIGURE 5-7 SEDIMENT BUDGET – WHITSTABLE

Estimated annual sediment transport in cubic meters.

Unit boundaries

N

0	1 - 500	500 - 1 000	1 000 - 2 000	2 000 - 3 000	3 000 - 5 000

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Additional overlaid information is copyright of Canterbury City Council 2016.

FIGURE 5-8 SEDIMENT BUDGET – SEASALTER

Estimated annual sediment transport in cubic meters.

— Unit boundaries

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5-4 EROSION/ACCRETION

With thirteen years of data it is possible to establish average annual erosion/accretion patterns with a reasonable degree of confidence. Standard difference models that illustrate the difference between pairs of individual surveys are misleading in this regard for the results are influenced by any beach management activities. Replenishment and shingle recycling deposition can mask erosive areas; conversely sites used as a source of recycling material can fail to highlight accretive areas.

Using the results from the sediment budget spread sheets it is possible to calculate the Net erosion/accretion rates, discounting the effects of beach management using Equation 2. Unfortunately due to the coarse nature of replenishment/recycling logs, which usually only define volumes to within the area of the works, this can only be achieved for coarse sediment cells. However, this is usually sufficient to gain an understanding of the erosive areas, the magnitude of the problem, and identify any future sources of shingle for recycling operations.

Equation 2: $$\boldsymbol{Net\ Erosion/Accretion = \Delta V - P + R}$$

The following figures illustrate the average annual erosion/accretion across the study area. Again, it should be stressed that these figures represent the average value you might expect based on 11 years of data. There can be considerable variation year on year and in some cases unusual conditions can result in a reversal e.g. an accretive area may erode due to a prolonged period of waves from a non-dominant direction.

This does however provide a basis for planning the likely necessity of beach management operations for future years based on actual recorded data.

Scale 1:20,000

FIGURE 5-9 NET ANNUAL EROSION/ACCRETION – NORTHERN SEA WALL

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

🟥 Erosive sub cell
🟦 Accretive sub cell
+/- 20 Volume change (m)
- - - Sub cell boundaries

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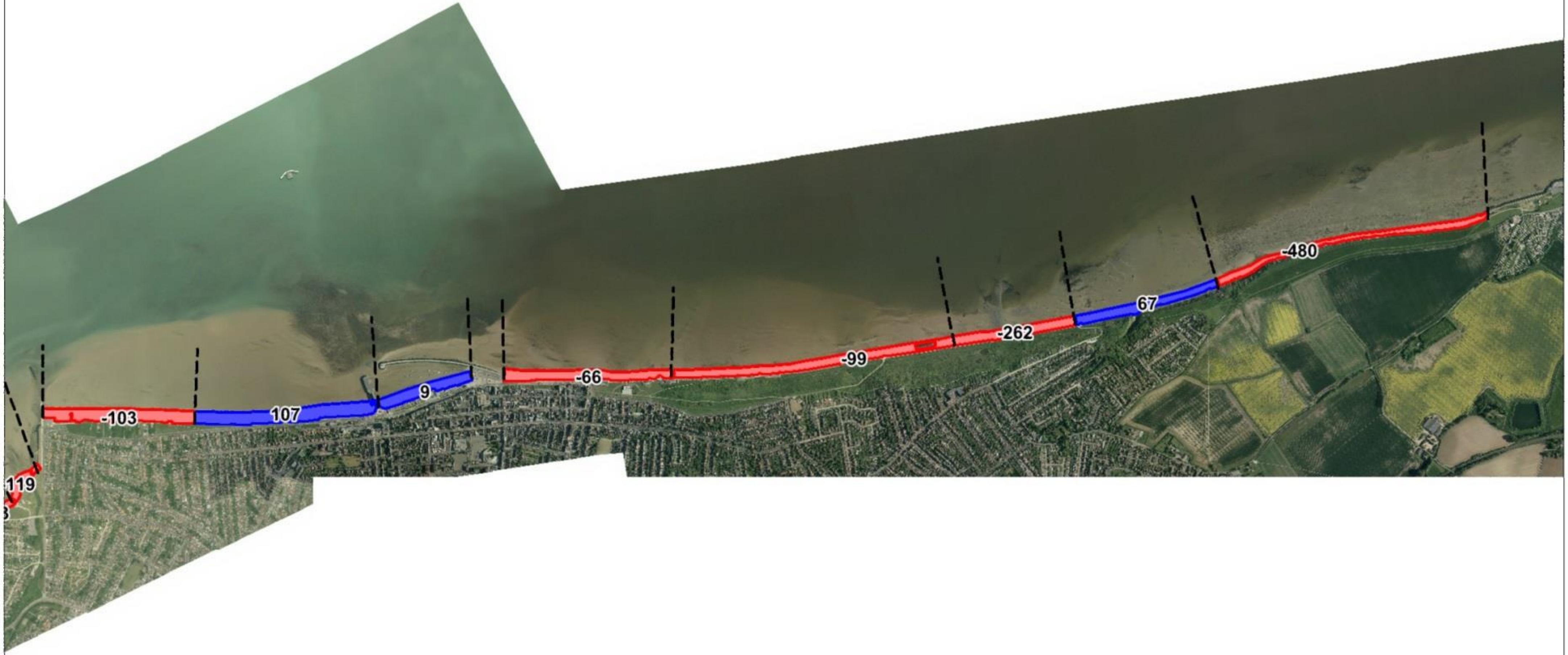

Scale 1:25,000

FIGURE 5-10 NET ANNUAL EROSION/ACCRETION – HERNE BAY AND BISHOPSTONE

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

🟥 Erosive sub cell

🟦 Accretive sub cell

+/- 20 Volume change (m)

- - - Sub cell boundaries

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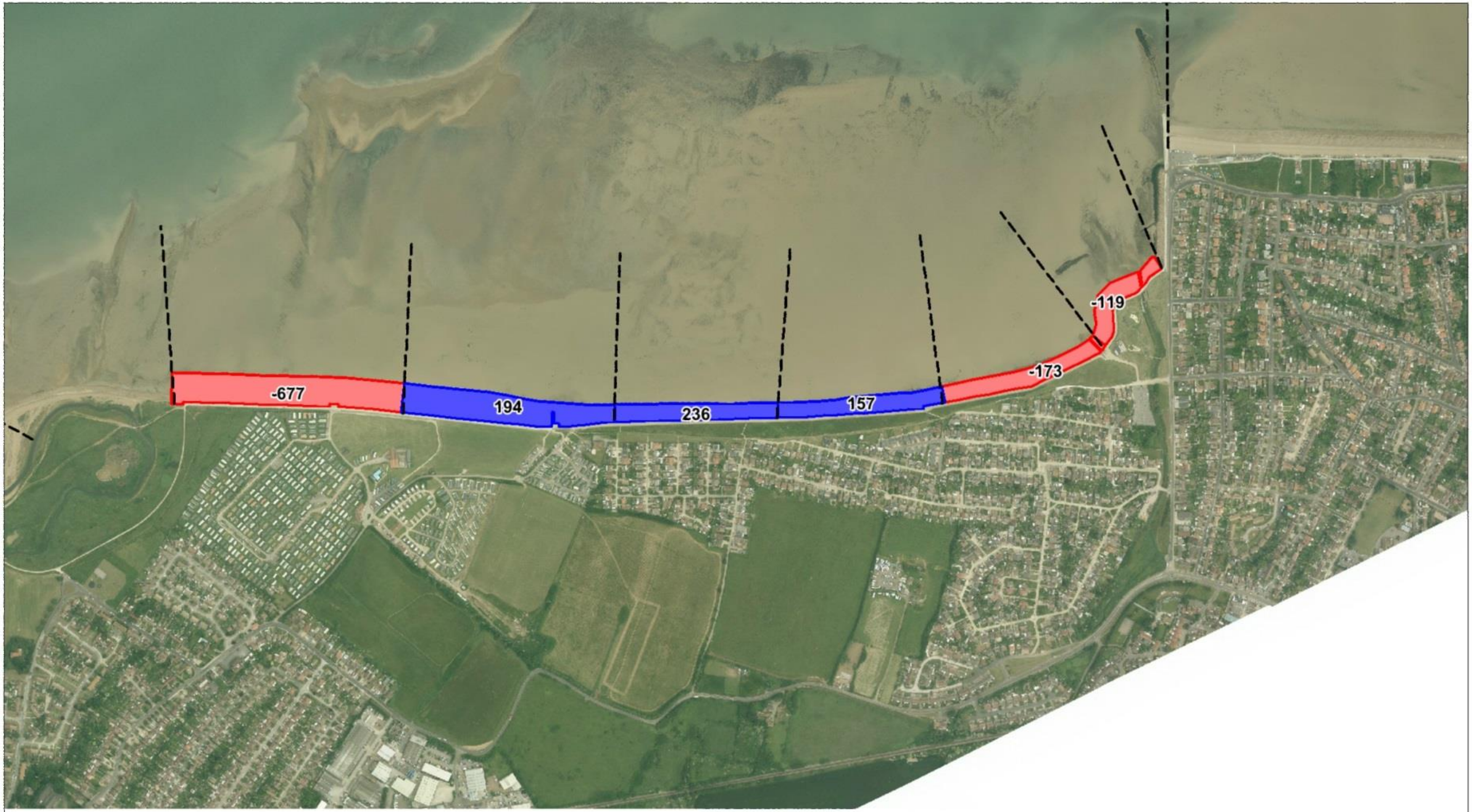

Scale 1:10,000

FIGURE 5-11 NET ANNUAL EROSION/ACCRETION – SWALECLIFFE

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

🟥 Erosive sub cell

🟦 Accretive sub cell

+/- 20 Volume change (m)

– – Sub cell boundaries

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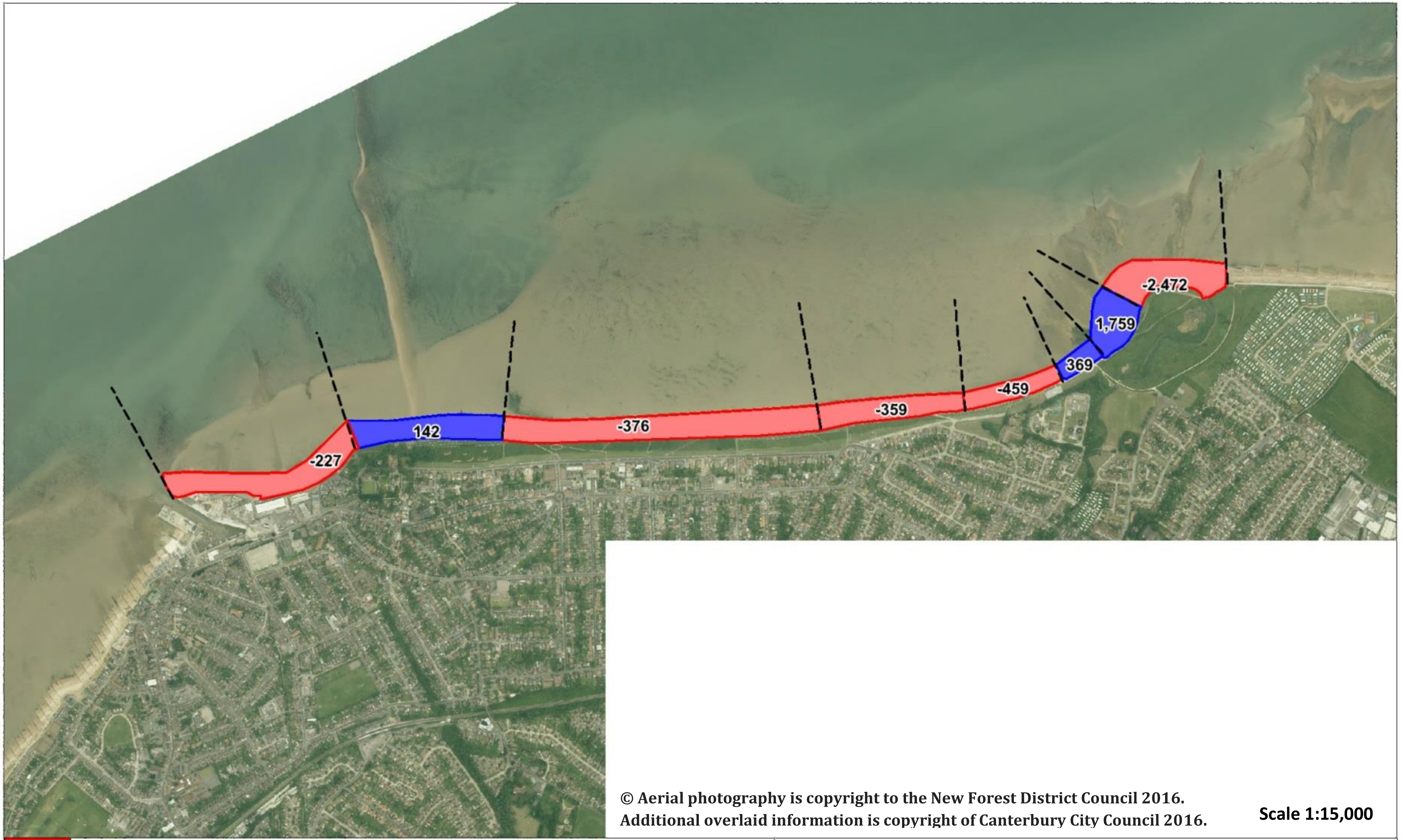

FIGURE 5-12 NET ANNUAL EROSION/ACCRETION – TANKERTON

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

- 🟥 Erosive sub cell
- 🟦 Accretive sub cell
- +/- 20 Volume change (m)
- - - - Sub cell boundaries

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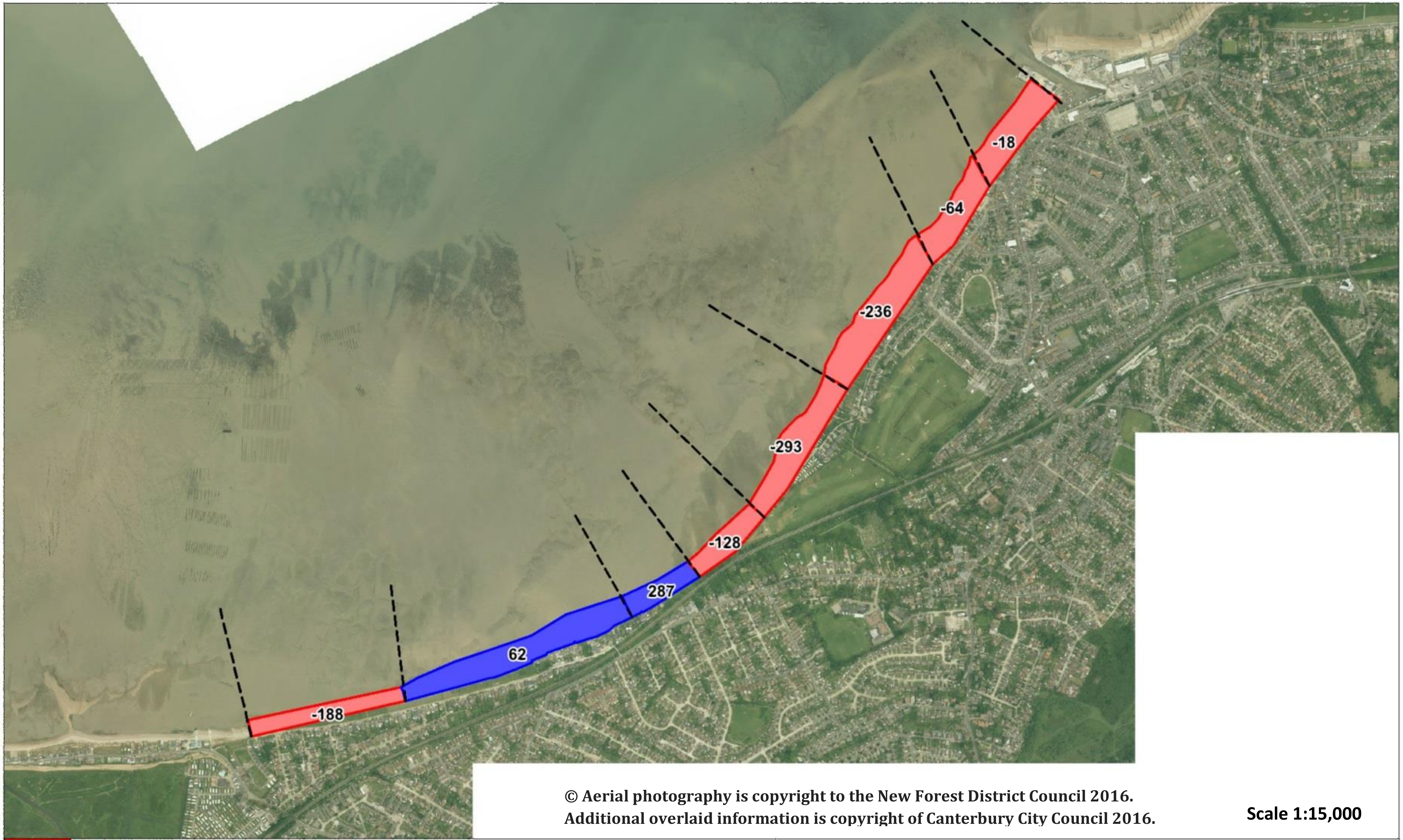

Scale 1:15,000

FIGURE 5-13 NET ANNUAL EROSION/ACCRETION – WHITSTABLE

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

🟥 Erosive sub cell

🟦 Accretive sub cell

+/- 20 Volume change (m)

- - - Sub cell boundaries

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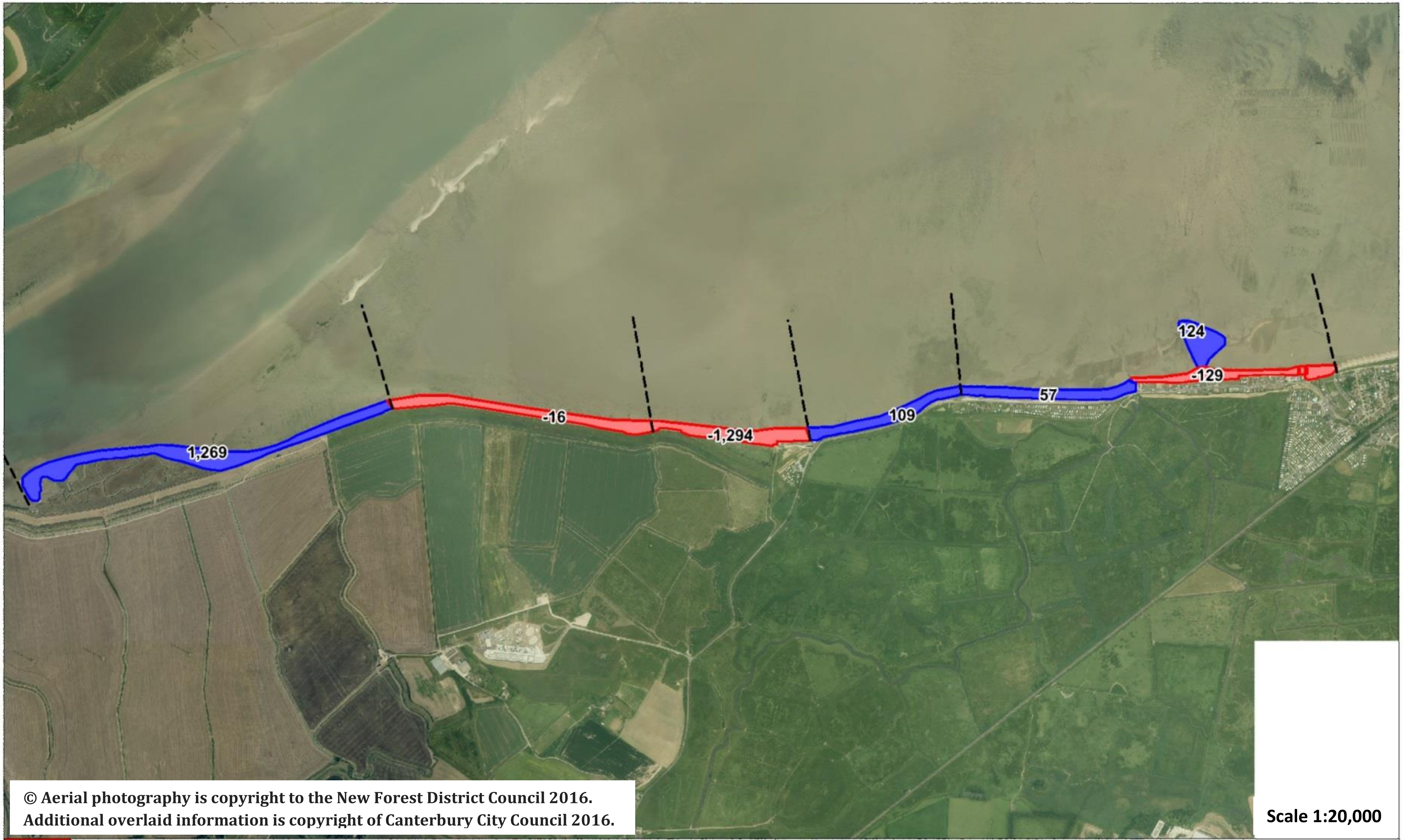

FIGURE 5-14 NET ANNUAL EROSION/ACCRETION – SEASALTER

The net accretion/erosion rate.
(Influence of beach recycling and replenishment discounted)

N

🟥 Erosive sub cell
🟦 Accretive sub cell
+/- 20 Volume change (m)
– – – Sub cell boundaries

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5-5 UNIT SUMMARY

The previous section discounted the effect of historic beach management operations, but in order to appraise those practices and consider the influence of natural processes it is important to look at the combined impact. This is considered broadly for each management unit by calculating the changes in total beach volume.

In order to make the charts more easily comparable the scale of the y-axis is consistent for each unit.

5-5-1 NORTHERN SEA WALL

The longshore drift direction along the Northern Sea Wall is primarily west to east with no sediment feed from the Reculver Towers at the west and an overspill of shingle onto neighboring sandy beach, Minnis Bay, to the west. Previously there have been small operations to return the shingle back to the Northern Sea Wall frontage.

Beach material is recycled within the frontage every 3 years to manage the longshore drift, with re-profiling taking place each year. No replenishment has occurred within this reporting period and the beach total volume is on the decline.

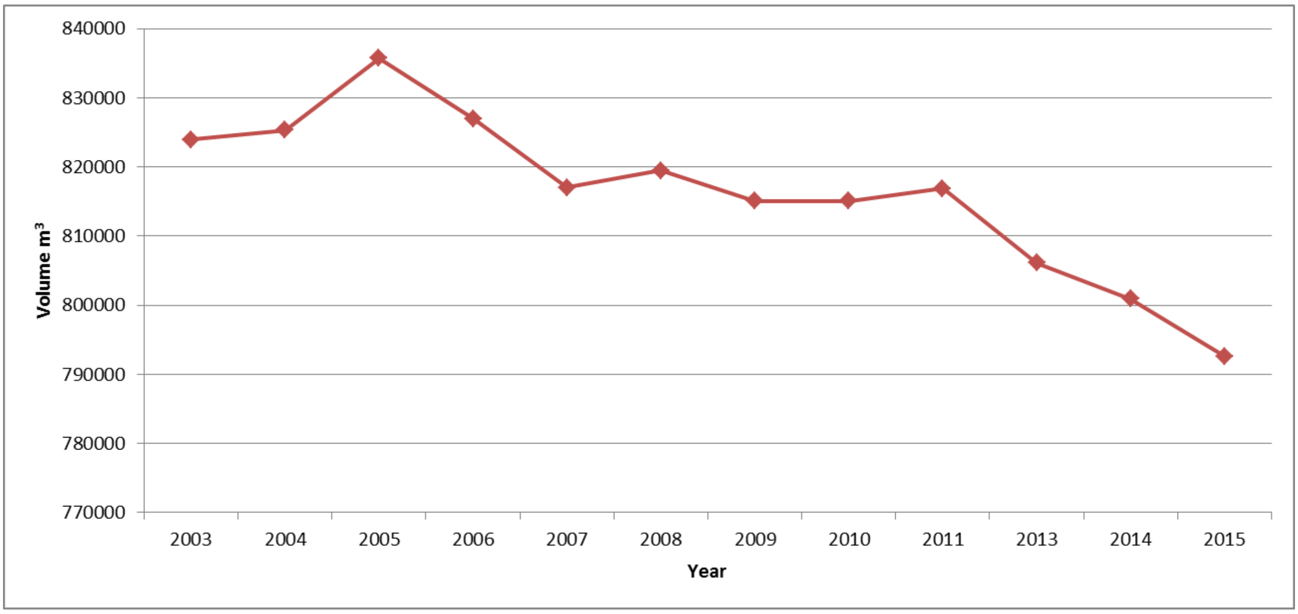

FIGURE 5-15 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN NORTHERN SEA WALL

5-5-2 RECULVER COUNTRY PARK

Reculver Country Park is a small shingle sand composite beach with the dominant drift direction from the east. This is no influx of material from the Reculver Towers in the east as the block work base protrudes into the sea so all beach material is long gone. There is little sediment feed from the sandstone cliffs however this is negligible and does not contribute to the shingle sediment system. Despite this, shingle sediment is leaving the unit and passing through to Herne Bay.

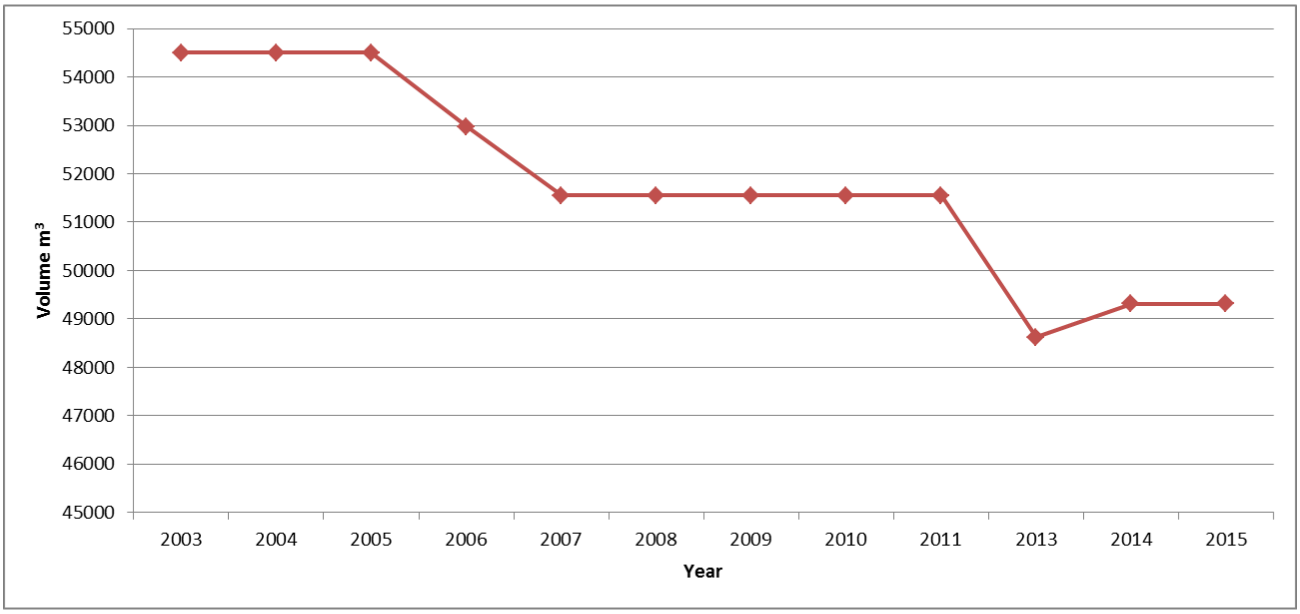

FIGURE 5-16 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN RECULVER COUNTRY PARK

5-5-3 HERNE BAY

Herne Bay receives a small volume of shingle from Reculver Country Park every year. The beach has a dense timber groyne field, installed in the 1980s and is in need of annual repairs to maintain a working defence. There have been no large schemes completed along this frontage since 1992 which saw the construction of the Neptune Arm. Little material is able to bypass the Neptune's Arm but on the whole it acts a terminal structure. Further west, Hampton Pier, a second terminal structure on the Herne Bay frontage, creates a closed sediment cell where little material travels in or out.

No material has been replenished onto this frontage since the 1990s, resulting in a gradual decline.

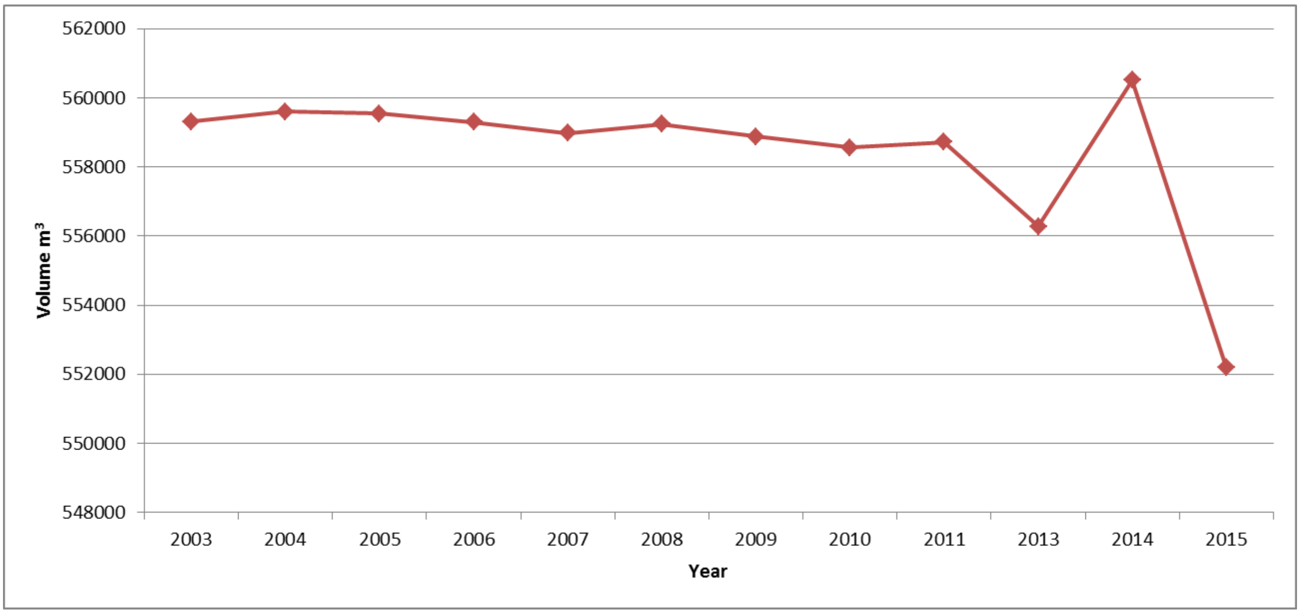

FIGURE 5-17 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN HERNE BAY

5-5-4 SWALECLIFFE

Swalecliffe is a small shingle sand composite beach, controlled by short timber groynes, constructed in the 1990s. Regular maintenance has kept the majority in good order and is able to hold the beach. No material enters Swalecliffe from the east due to the terminal structure, yet the beach remains stable.

Material was deposited onto the western end of the beach when shingle was moved from the Swale Brook mouth in Tankerton, 2010, to increase beach levels where mattress from the 1970s had become exposed.

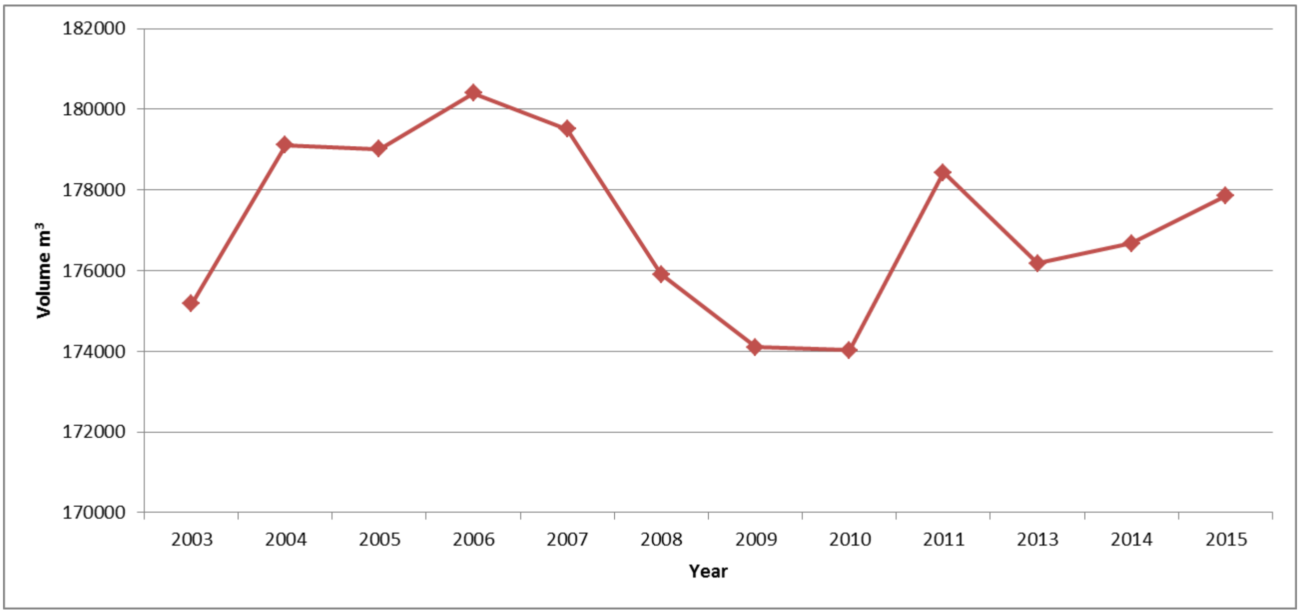

FIGURE 5-18 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN SWALECLIFFE

5-5-5 TANKERTON

Tankerton is a coarse shingle beach with a dominant transport drift of east to west. Tankerton underwent a capital scheme which started in 1999 and finished in 2006. It included three separate phases to increase standard of protection. The capital scheme saw the removal and replacement of all the timber groynes and 45,000m^3 imported in 2003/04.

Since, little has been done to improve the frontage as it has been relatively stable. However; Long Rock, an open beach to the east of the unit is fairly active and regularly requires maintenance to unblock the Swale Brook.

Whitstable Harbour, at the western end of the unit is a terminal structure which inhibits any material passing through to Whitstable beach.

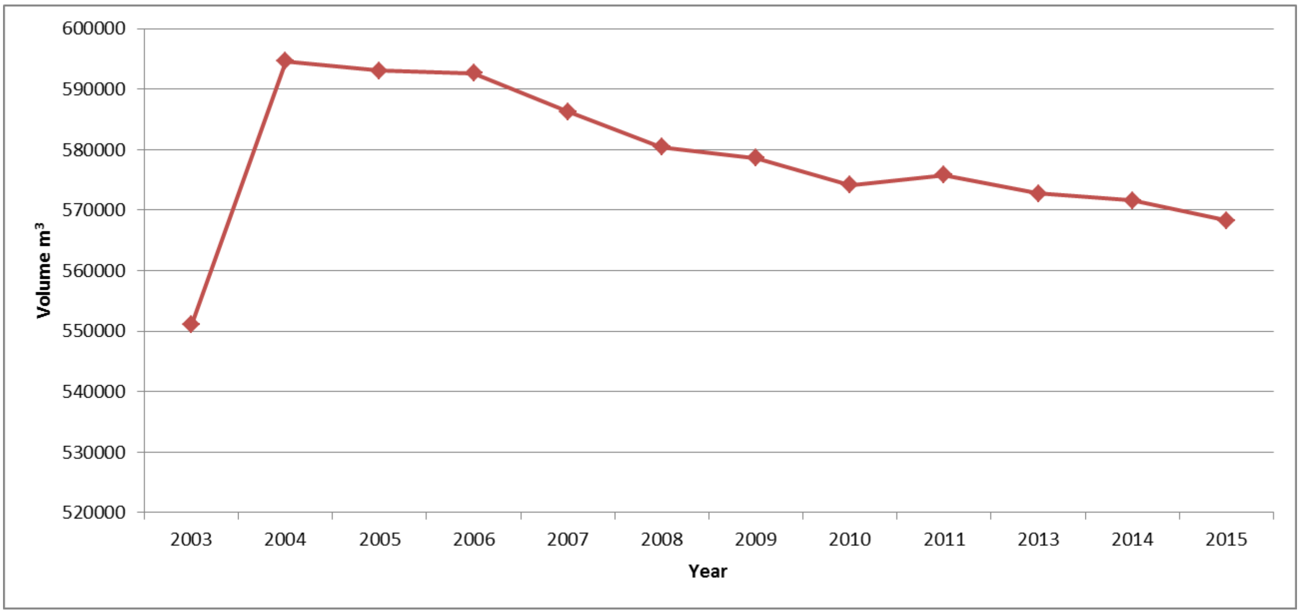

FIGURE 5-19 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN TANKERTON

5.5.6 WHITSTABLE

A large capital scheme was completed along the Whitstable frontage during 2005/06. A total of 70,000m^3 was imported and 48no. new timber groynes were installed. With no material feed from Tankerton due Whitstable Harbour, another terminal structure, and relatively new timber groynes, the beach movement along this stretch is negligible.

A small scheme, over the winter 2011/12, provided 4no. new timber groynes to close a gap in front of Golf Course Wall. Erosion had cut the beach crest within feet of the wall which was founded only on shingle.

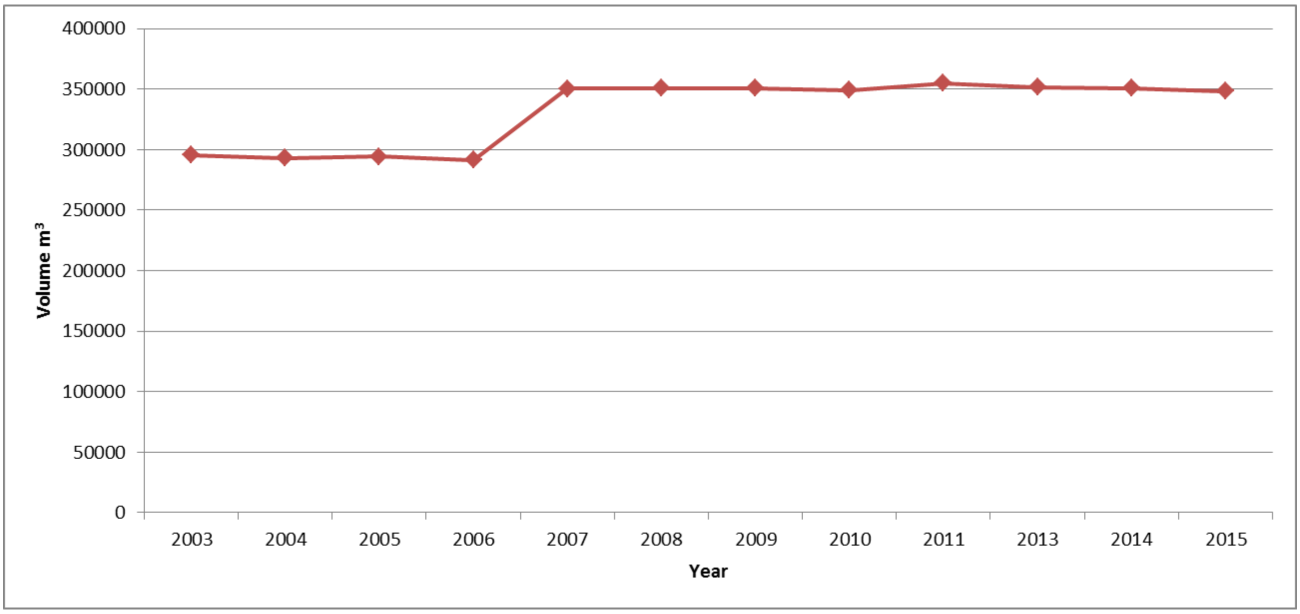

FIGURE 5-20 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN WHITSTABLE

5.5.7 SEASALTER

Seasalter receives a negligible feed of material from the east annually. The frontage changes from coarse shingle in the east to fine sand in the west, heading towards Castle Coote spit.

Since 2003 coastal work along this stretch has been limited, with 2 no. new groynes constructed in 2011, to continue from the Whitstable groyne field. This beach was previously experiencing erosion. In the same year, a small beach replenishment of 3,000m^3 was imported by the Sportsman PH.

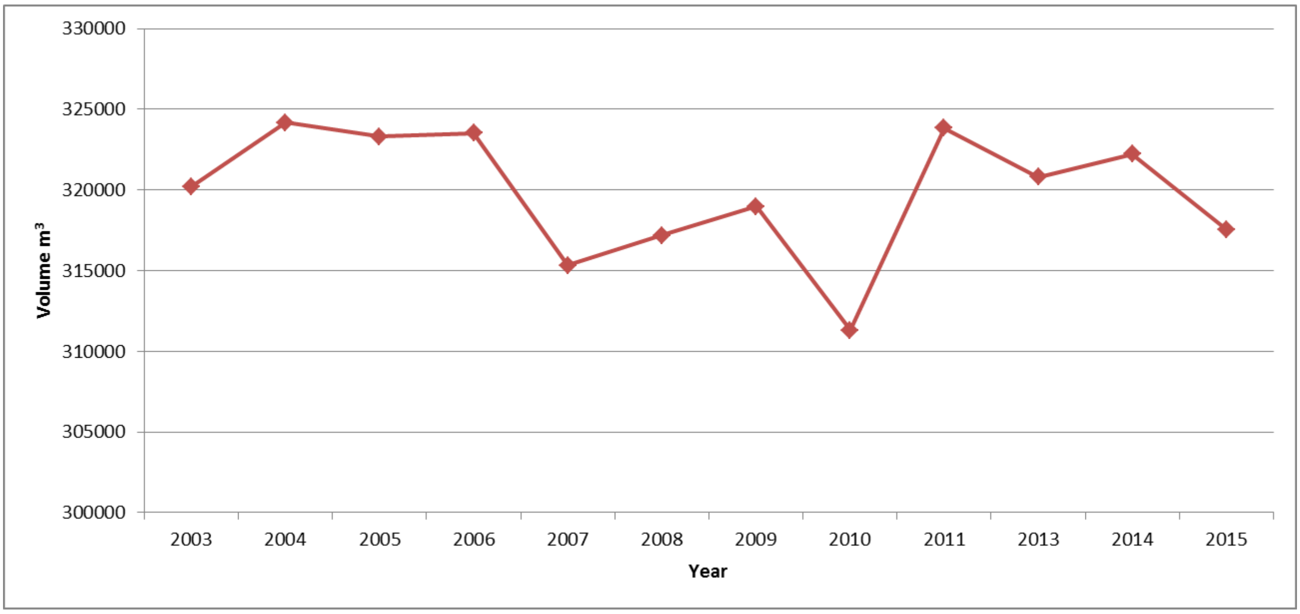

FIGURE 5-21 TOTAL BEACH VOLUME CHANGE BETWEEN THE YEARS OF 2003-2015 IN SEASALTER

5-6 REGIONAL OVERVIEW

In order to look broadly at the regional picture the sediment budget figures are presented on a management unit basis with beach management activities discounted. This gives an overview of the expected natural changes along the frontage as an annual average.

Northern Sea Wall has the largest transport rates of up to 5,000m^3 across the widely spaced rock groynes. Reculver Country Park receives little to no material from the east due to the protruding Reculver Towers however some material enters the system from the erosion and slips of the sandstone cliffs. A relatively negligible volume of sediment is transported into Herne Bay with less than 1,000m^e passing through Herne Bay. The Neptune Arm allows bypassing of a small volume of material per year. A closed cell between the Neptune Arm and Hampton Pier sees nothing pass into Swalecliffe. Due to the lack of sediment feed from the east, Swalecliffe sees negligible volumes passing through the frontage into Tankerton (sub 400m^3 per year). The most dynamic stretch of coastline sees a convergence of drift direction, moving material onto Long Rock from both directions; however the dominant transport rate is still east to west. Small volumes of shingle travel through Tankerton until it reaches the very large groynes to the west of the unit, where it is thought no material can move alongshore, east. Another terminal structure, Whitstable Harbour divides the coastal cell and ceases sediment transport east. South of the Harbour, a coastal scheme in 2006 introduced larger, and longer timber groynes and as a result, a negligible volume of shingle is transported into Seasalter. Seasalter has many fewer controlling structures and the transport rates rise accordingly, up to 1,600m^3 in places. It is thought a small volume of approximately 80m^3 per year leaves the system to Castle Coote spit.

The figures show a regional discounted loss of sediment of -5,100m^3 per year, which is the best estimate of natural change[1]. In reality, due to the input of replenished shingle, there has been an average net gain of c.3,000m^3 per year along the frontage.

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[1] In areas where management has taken place a fully 'natural' change can never be calculated. In practice beach management activities may increase or decrease net longshore or cross shore movement, so the discounted annual change may not equal what would have occurred had no management taken place.

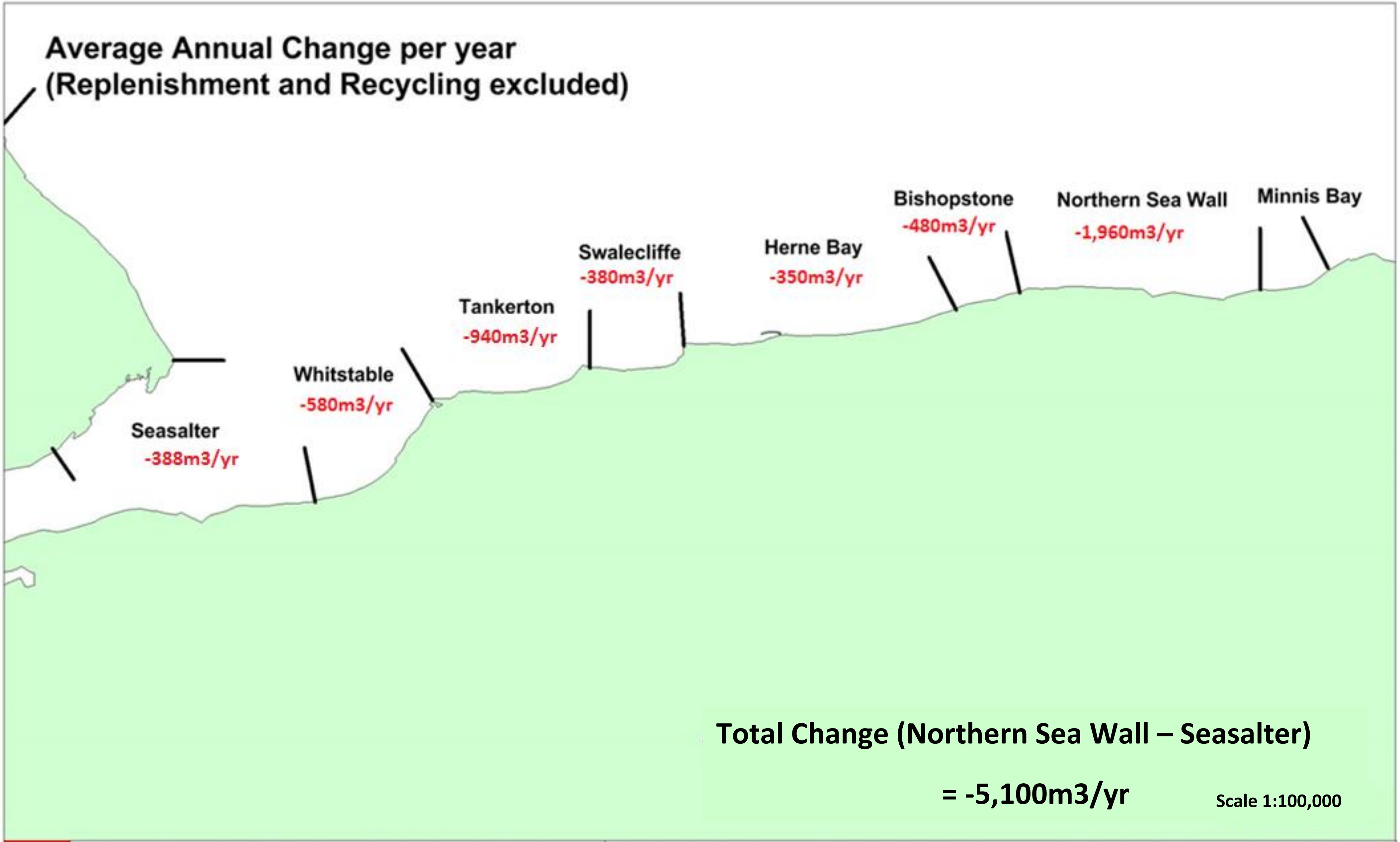


FIGURE 5-22 SEDIMENT BUDGET REGIONAL EROSION/ACCRETION SUMMARY

6 RISK ANALYSIS

6-1 DEFENCE SECTIONS

In order to perform the risk analysis the coastline was split into representative defence sections based upon sea defence, beach and foreshore characteristics (Figure 6-1-1). Details on the defence type, elevation and geometry, foreshore levels and the calculations performed for each defence section is provided in Appendix G.

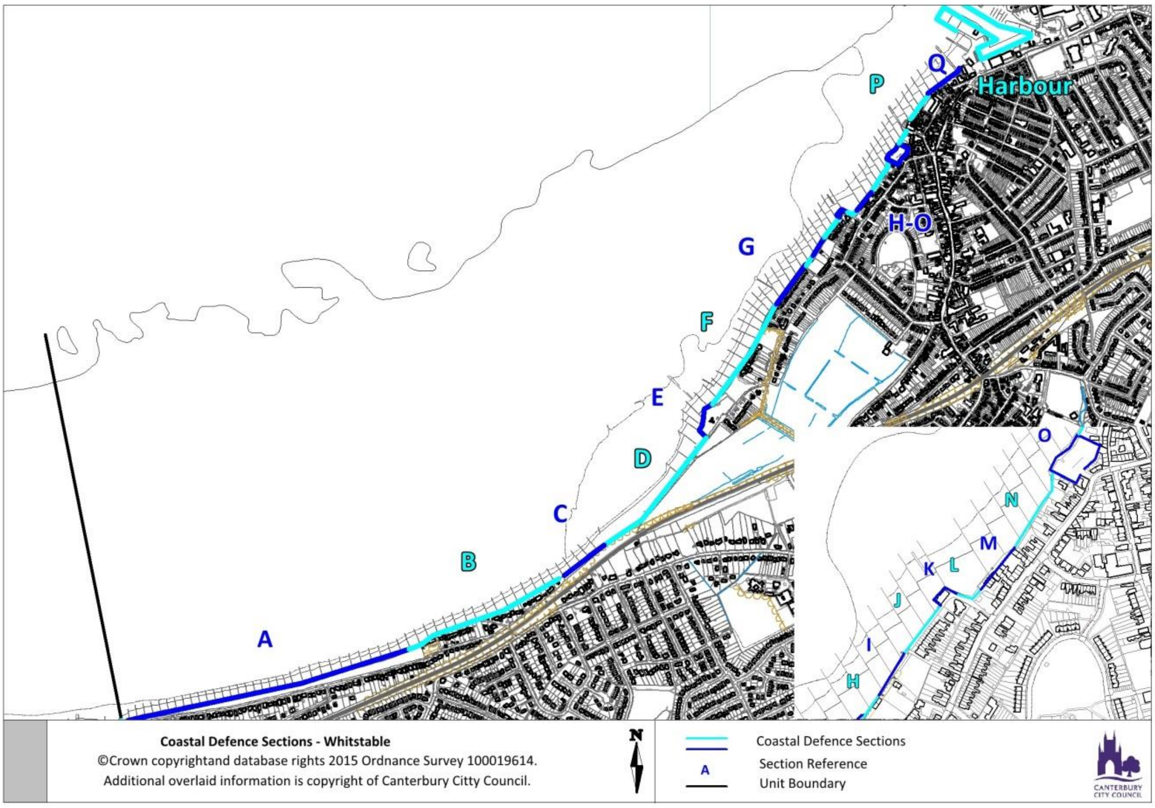


FIGURE 6-1-1 EXAMPLE OF DEFENCE SECTIONS FOR WHITSTABLE

6-2 METHODOLOGY

6-2-1 OVERTOPPING

The primary short-term threat considered in this report is excessive overtopping of the shingle beaches and structures, causing flooding and damage to property and infrastructure.

Overtopping can pose a risk to pedestrians, vehicles, trains and structures behind the defence through discharge flows and flying shingle. The EurOtop Manual (Pullen et al., 2007) defines the consequences of overtopping into four general categories;

a) *Direct hazard of injury or death to people immediately behind the defence.*

b) *Damage to property, operation and/or infrastructure in the area defended, including loss of economic, environmental or other resource, or disruption to an economic activity or process*

c) *Damage to defence structure(s), either short-term or longer-term, with the possibility of breaching and flooding.*

d) *Localised flooding from overtopping discharge*

Shingle beaches are very efficient at dissipating wave energy (Figure 6-2-1). To calculate overtopping rates under different scenarios a methodology was developed and applied consistently to the whole frontage. This is summarised in Figure 6-2-2 and described in the following text.

FIGURE 6-2-1 DISSIPATION OF WAVE ENERGY ON A SHINGLE BEACH (KINGSDOWN, 2009)

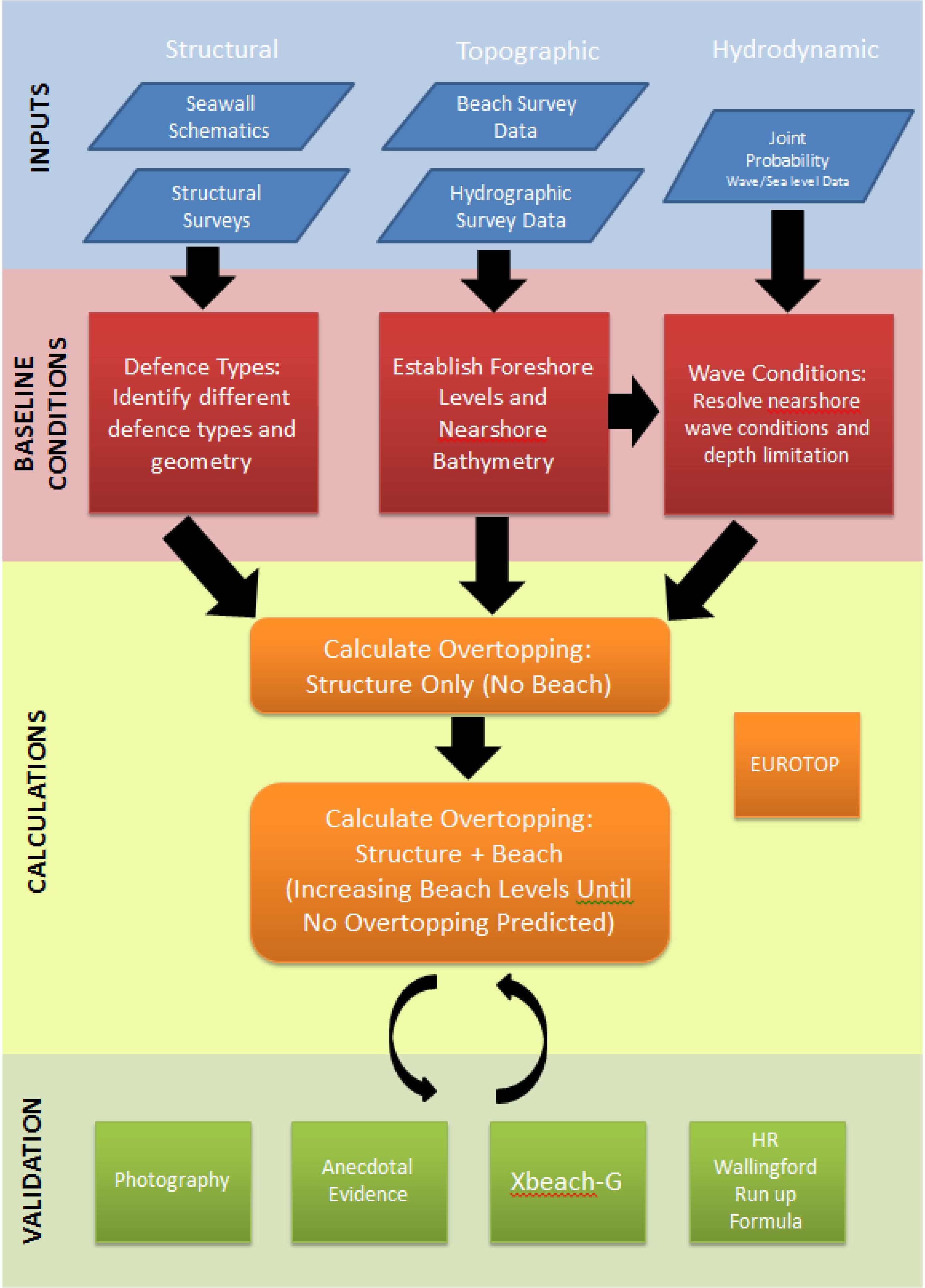


FIGURE 6-2-2 SUMMARY OF OVERTOPPING METHODOLOGY DEVELOPED FOR THIS REPORT

INPUTS

Structural geometry was obtained through sea wall schematics/as built drawings where available. These not only provide the crest height of structures but also the hidden portion of the defence and toe levels obscured by current beach levels. In areas where this information was not available the analysis relied on structure surveys of the visible defence carried out as part of the Regional Coastal Monitoring Programme. When the latter provided insufficient detail it was supplemented with LiDAR data.

Beach survey data provided current beach levels and geometry in addition to historical variations dating back to 1999. Where this provided insufficient information on beach toe levels, foreshore heights and the approach to the beach it was supplemented with bathymetric survey data.

Hydrodynamic conditions were defined by the outputs of the joint probability study (Mason, 2014) and provided nearshore conditions for return probabilities from 1 to 200 years.

BASELINE CONDITIONS

Structural geometry and foreshore levels were used to break down each management unit into defence sections. These then formed the basis for each different set of overtopping calculations. In order to calculate the worst set of conditions for each set of joint probability values it was necessary to account for the effects of depth limitation and define wave conditions at the toe of the structure/beach (Figure 6-2-3).

All management units in the study area have depth limited waves under the higher return period events. To calculate the depth limited spectral significant wave height at the structure/beach toe the results from a simple 1D energy decay model (Van der Meer, 1990) are used, in which the influence of wave breaking is included. The model converts deep water wave steepness, local water depth and the slope of the foreshore into a breaker index (Pullen et al., 2007). The latter defines the reduction in significant wave height.

Results produce a wave height limited to between 50-60% of the water depth; precise figures for each defence section are included in the results spreadsheets in Appendix G.

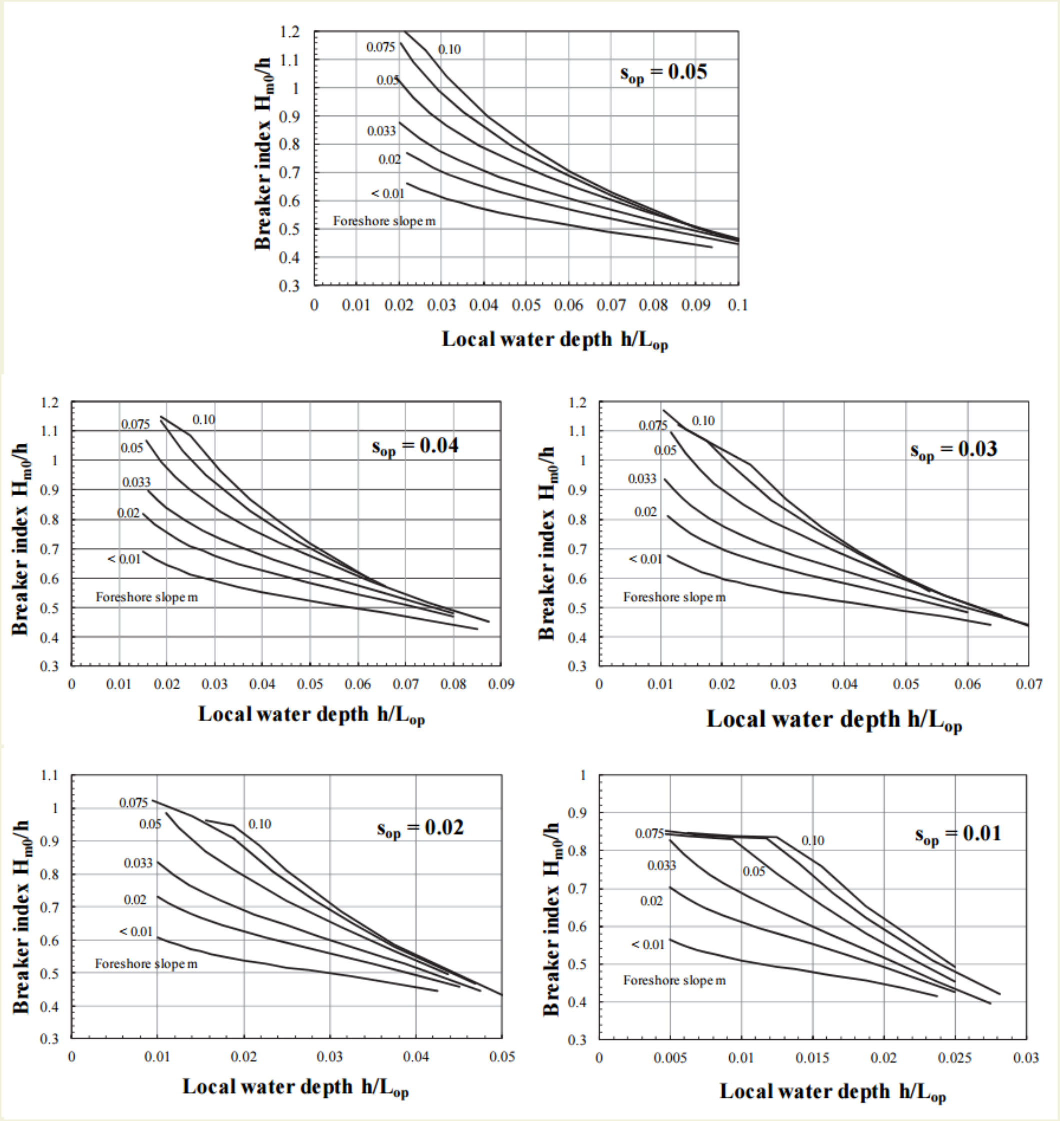


FIGURE 6-2-3 CALCULATION OF DEPTH LIMITATION USING THE BREAKER INDEX (PULLEN ET AL, 2007)

CALCULATIONS

For most calculations the EurOtop research was used (Pullen et al., 2007), based on significant previous research and physical model testing it provides a tool for calculating overtopping at a variety of sea wall and structure types.

Initial calculations were run for each defence type without a beach present (Figure 6-2-4); this provided a worst case scenario for each section. As there is more confidence in the overtopping results for standalone structures it also provided a baseline for further calculations.

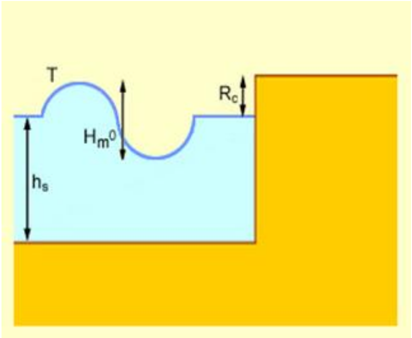


FIGURE 6-2-4 EUROTOP - CALCULATION OF OVERTOPPING AT A SIMPLE VERTICAL SEA WALL

The reason that there is more confidence in predicted results for standalone structures is that the geometry is simple and fixed. They are also well suited to Physical model testing with limited scaling effects; this also largely applies to more complex structures and rock revetments. Introducing a shingle beach to the defence geometry creates a higher level of uncertainty owing to the very limited number of laboratory or field tests.

When calculating wave run-up on shingle beaches there are a number of factors that will affect the result and are also subject to change in the short term. These include beach volume, beach shape and beach composition. The first two can be constrained by locally known variability from the coastal monitoring programme but beach composition, including grain size and grading, permeability and roughness factors can only be approximated, especially as they change both spatially (within a management unit) and temporally (over various time scales).

In order to improve on current methods of calculating beach run-up a sub-project to this report was commissioned, *Wave run-up on shingle beaches: a new method* (HRW, 2014). The report contains a comparison between a set of measured run-up data taken at Worthing beach and several established formula for predicting run-up. These include some of the methods available in EurOtop, Figure 6-2-5 illustrates the results from one of the more simplistic approaches.

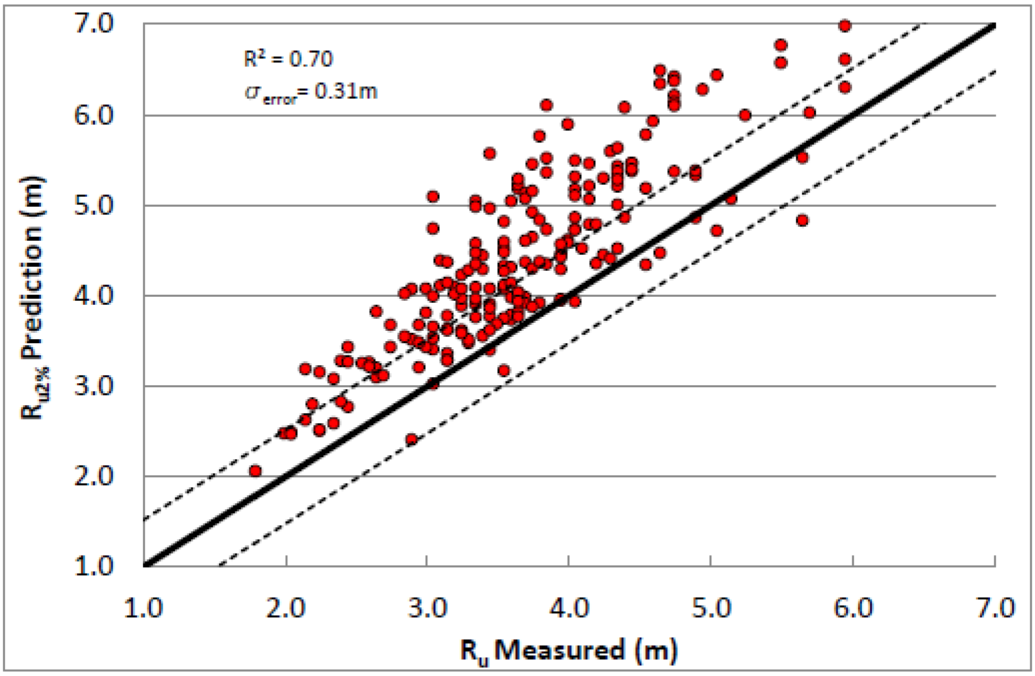


FIGURE 6-2-5 SIMPLISTIC EUROTOP METHOD VS ACTUAL MEASURED DATA AT WORTHING (HRW, 2014)

The main output of the report was an improved formula for calculating run-up on shingle beaches. The formula uses a representation of the spectral wave data, and in particular takes good account of the swell component, producing a much better fit to measured data at Worthing and smaller samples taken elsewhere on shingle beaches in the Southeast.

For this study the new formula was not used for the bulk of the calculations but was used as a validation tool to sense check the results from EurOtop, for example overtopping can only start once run-up has reached the beach crest level. There are two main reasons for this;

a) *The new formula uses spectral wave data and although recorded spectral data is available from the local wave buoys there is no way to predict the swell component of larger storms and their return periods.*

b) *There is no simple way to incorporate the new run-up formula into the EurOtop calculation tools when assessing overtopping for a combined beach and structure.*

There are plans to update EurOtop to include the formula, there is also on-going research at HR Wallingford to assess the effects of bi-modal seas and overtopping of shingle beaches and structures. When this is complete it may be possible to improve on the results of this study, but the results presented are produced using current EurOtop methodology, however the improved formula is used to help validate results.

For each defence section the structure only results were used as a starting point, a small beach was then introduced to the geometry and overtopping rates calculated (Figure 6-2-6). The size of the beach was then steadily increased until the point was reached where no overtopping was predicted. In order to make the results more comparable with surveyed beach levels and design levels each beach size was converted to a representative cross sectional area (CSA).

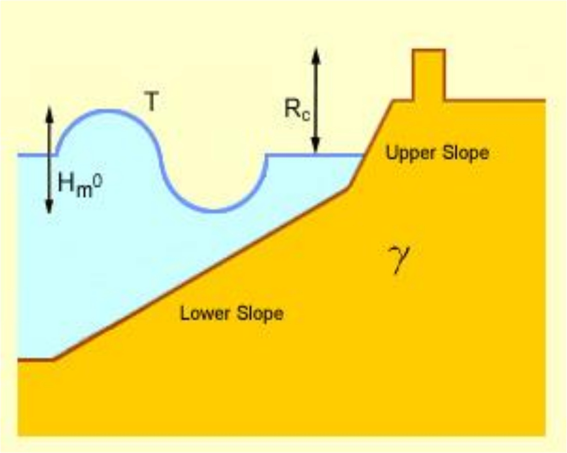


FIGURE 6-2-6 EUROTOP - CALCULATION USING MORE COMPLEX STRUCTURES

In order to calculate the influence of wave return walls with beaches it was necessary to perform an adjustment outside of EurOtop. The general principle applied within EurOtop is that a wall with a large freeboard has the biggest reduction in wave overtopping as the wave has room to be channeled by the wave return. As water levels increase the effect of the wave return declines until it reaches a point where it has no effect at all in reducing overtopping. The same principle applies to shingle beaches, where crest levels towards the top of the wall diminish the effect. This is not accounted for in EurOtop so the equations were adapted and applied as an adjustment to the overtopping figures. The full methodology is described in Appendix G.

While the authors concede that the EurOtop methodology used for this study has a propensity to over predict run-up on shingle beaches, and therefore overtopping, it effectively calculates the maximum run-up/overtopping for a given set of input conditions. The variability introduced by not fully accounting for inputs such as swell conditions means that the actual values may be lower, but rarely higher. This is important when establishing critical defence levels, and also builds in a factor of safety to the final results; hence we have carried out the validation.

VALIDATION

Given the potential uncertainty in overtopping results it was important to validate the results, this was done with four methods.

1. Photographic evidence of large overtopping events and retrospective comparison with predicted overtopping. There were several instances where this was possible, examples shown below.

FIGURE 6-2-7 OVERTOPPING AT HERNE BAY PIER, 1953

FIGURE 6-2-8 OVERTOPPING AT SWALECLIFFE, 1953

FIGURE 6-2-9 OVERTOPPING AT HERNE BAY, 1953

FIGURE 6-2-10 OVERTOPPING AT WHITSTABLE, 1978

FIGURE 6-2-11 OVERTOPPING AT HERNE BAY, 1953

FIGURE 6-2-12 OVERTOPPING AT SWALECLIFFE, 1953

2. Anecdotal evidence in the form of information that is not well documented or photographed. The prime example of this is shingle on the promenade, which is indicative of small scale overtopping (e.g. Figure 6-2-13). Where management authorities have to periodically clear this it is evident that the defence is subject to minor overtopping on a regular basis. Results can be queried to ensure these events are predicted.

FIGURE 6-2-13 EVIDENCE OF OVERTOPPING ON TO THE PROMENADE (HERNE BAY, 2016)

3. XBeach-G is a software tool developed in collaboration between Plymouth University and Deltares (Masselink et al, 2014). It simulates storm impacts on gravel beaches and computes wave-by-wave flow and surface elevations over the duration of a storm. Sample data along the study area was run in XBeach-G to check the results were comparable (Figure 6-2-14).

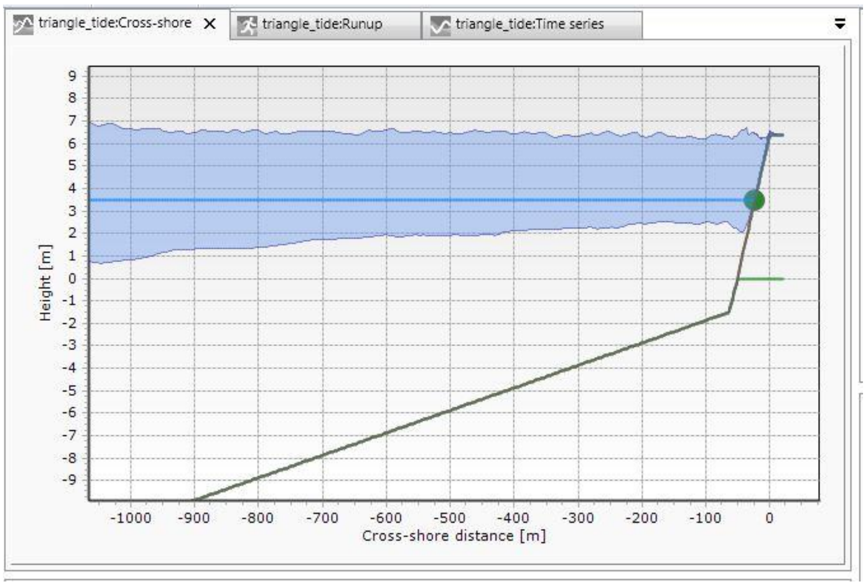
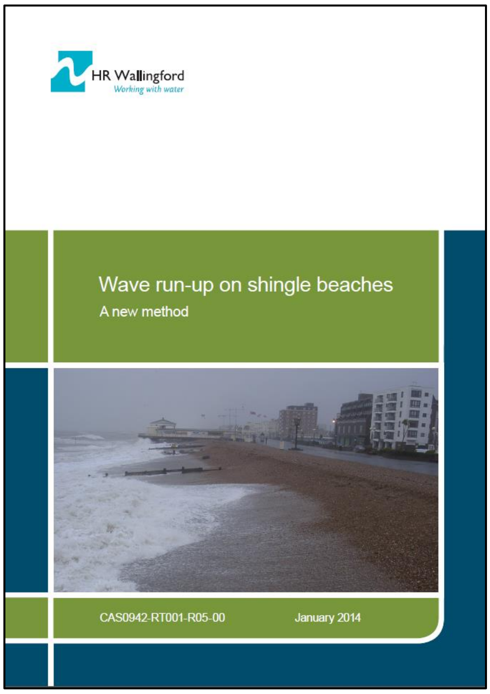


FIGURE 6-2-14 XBEACH-G SAMPLE SCREENSHOT

The improved formula presented in Wave run-up on shingle beaches: a new method (HRW, 2014, Figure 6-2-15) was used in areas that were prone to green water overtopping (No structure and run-up exceeds crest). By running calculations for a number of swell components results could be verified as reasonable and ensure that an underestimation had not been made.



HR Wallingford
Working with water

Wave run-up on shingle beaches
A new method

CAS0942-RT001-R05-00
January 2014

FIGURE 6-2-15 SUB-PROJECT RESEARCH AND DEVELOPMENT OF IMPROVED RUN-UP FORMULA.

6.1.2 SEA WALL FAILURE

Coastal defences in the Southeast are most commonly comprised of a beach and structure combination. These work in unison with the beach absorbing wave energy, breaking waves and protecting the sea wall from direct wave attack. The wall acts to further reduce the risk of overtopping from waves that run up past the crest and present a significant barrier to overtopping and erosion should the beach levels drop to lower levels. Consequently these elements should not be considered in isolation, but as two parts of the same defence with each one playing a critical role.

As beach levels lower due to steady erosion, draw down in a storm, or failure of groynes that act as controlling structures the sea wall becomes increasingly exposed to direct wave attack. In addition to a probable increase in overtopping rates, this significantly increases the risk of sea wall failure (e.g. Figure 6-2-16).

As beach levels continue to drop there is an additional threat of undermining of the sea wall foundations. This can cause the structure to collapse and/or a draining of the fill material from behind the sea wall that reduces the structural integrity (Figure 6-2-17). A beach also provides a lot of support and weighting in front of the structure, without which toppling or sliding of sea wall sections can occur (Figure 6-2-18).

FIGURE 6-2-16 DILAPIDATED GROYNES LOW BEACH AND SEA WALL FAILURE AT KINGSDOWN (2013)

Typically, before beach levels get low enough to pose a credible threat to the structure the standard of protection has already become sub-standard due to the increased likelihood and severity of overtopping. There are instances where the structure itself provides a sufficient barrier to overtopping, but often in these cases a beach is required to be maintained in order to protect the structure and prevent undermining.

FIGURE 6-2-17 EXAMPLES OF UNDERMINING AT TANKERTON (LEFT) AND RECULVER (RIGHT) (BOTH PHOTOS 1999)

Calculating failure probabilities for all stretches of structures along the study frontage is outside the scope of this report. Additionally, the conditions of sea walls are often unknown especially if covered by beach for many years. The report does however highlight areas where the loss of beach would result in the potential for undermining and/or increased exposure to wave attack that may result in a significantly increased risk of failure.

For coastal management authorities should undertake regular asset condition inspections in order to assess the need for any maintenance. Historically these may have been picked up by

NFCDD inspections. It is anticipated that this will shortly be replaced by AIMS, but in the interim each coast protection authority should conduct their own regular coastal asset inspections.

FIGURE 6-2-18 FAILURE OF A SEA WALL AT ALL HALLOWS DUE TO SLIDING/TOPPLING OF DEFENCE SECTIONS (2015)

Two types of seawall failure are considered in this method; undermining and structural failure (breach or partial breach). For seawalls in good condition undermining is assumed to be the critical failure mechanism, and for seawalls in bad condition (where there is a risk that wave attack will cause failure) structural failure is assumed to be the critical failure mechanism. These calculations are dependent upon the type, construction and condition (where known) of the sea defences (all known defence schematics are provided in Appendix F).

For undermining calculations a beach level was calculated that prevents the defence foundations from being exposed, allowing for a 1:10 slope (due to draw down during a storm event) and a 50cm depth of scour (Figure 6-2-19). The full methodology is provided in Appendix G.

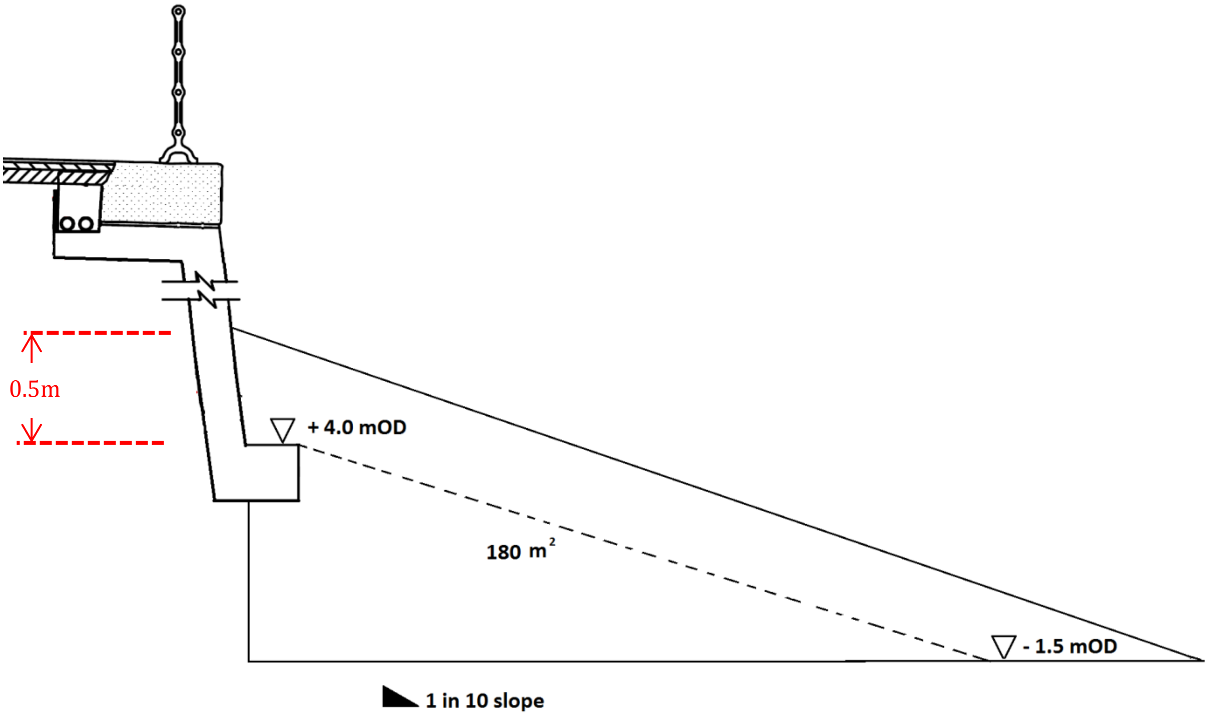


FIGURE 6-2-19 CRITICAL BEACH LEVEL TO PREVENT UNDERMINING OF THE DEFENCE FOUNDATIONS INCLUDING A 50CM ALLOWANCE FOR SCOUR

For structural failure a beach cross section is calculated that prevents critical overtopping (and wave attack) of the defence structure, using the Eurotop allowable overtopping limits (see Appendix C).

6.1.3 FLOODING & BREACHING

Flooding can occur through excessive overtopping, sea wall failure or breaching of barrier beaches. All of these scenarios can result in flooding when the hinterland is below the extreme sea level or defence height.

There are five main flood basins within the frontage, at Graveney/Seasalter, Whitstable, Swalecliffe, Herne Bay and Northern Sea Wall. In order to calculate the properties at risk from a 1:200 year event (4.3-4.5mOD) a planar still water level flood map was created using LiDAR data (most recent dataset, 2015) and combined with the Ordnance Survey's AddressBase property layer (Figure 6-2-20).

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FIGURE 62-20 EXAMPLE OF PROPERTIES (STARS) IN WHITSTABLE WITHIN THE 1:200 YEAR EXTREME WATER LEVEL PLANAR FLOODPLAIN

A database of at-risk properties was created with information including, property type (Detached, Semi-detached, Terrace, Flat etc.), council task banding, postcode and street address. This detailed information is then combined with the ZOOPLA house price database to produce cost estimates for those properties at risk of flooding (Table 6-1).

TABLE 6-1 ESTIMATED PROPERTY DAMAGE COSTS WITHIN THE 1 IN 200 YEAR CONTOUR

PLACE	PROPERTIES AT RISK	APPROX. VALUE (£K)
SEASALTER	**420**	**133,309**
WHITSTABLE	**3005**	**958,427**
SWALECLIFFE BROOK (SWALECLIFFE)	**96**	**30,731**
KITE FARM (SWALECLIFFE)	**82**	**26,250**
PLENTY BROOK (HERNE BAY)	**57**	**14,659**
HAMPTON PIER CP (HERNE BAY)	**2**	**514**
HERNE BAY	**319**	**82,041**
NORTHERN SEA WALL	**158**	**43,206**

In total this equates to a theoretical value of over £1 billion of property that is reliant on the sea defences along this frontage. There are several important caveats; firstly that the planar still water level floodplain does not account for flood pathways, and secondly that above ground properties have not been removed from the total count. In reality, the most likely flooding events would result in only a partial inundation of the flood plain; however modelling individual breach and overtopping scenarios is outside the scope of this report.

6-3 OVERTOPPING OUTPUT

In order to visualise the results for each defence section they are presented on a chart (Figure 6-3-1) which compares the predicted overtopping rate with the size of the beach cross sectional area (CSA). This shows the decrease in overtopping for each of the return period conditions (1 to 200 years) as the size of the beach increases. For sections where a rock revetment is present, a single overtopping calculation is performed for overtopping over the revetment.

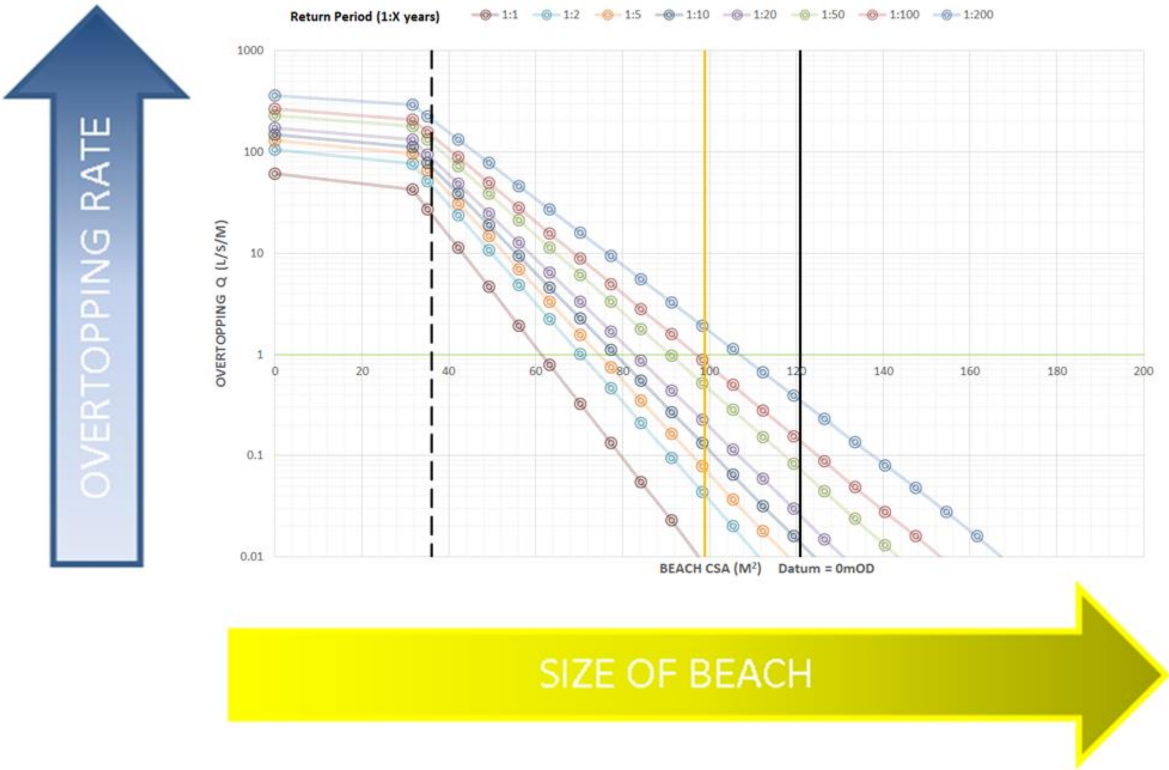


FIGURE 6-3-1 EXAMPLE OF OVERTOPPING RESULTS CHART

From the chart it is possible to read off a predicted overtopping rate for a particular beach size under different conditions. The jump from zero CSA to the next point reflects the fact that CSA is calculated above a datum (normally the beach toe level), but in reality some of that area is composed of foreshore and lower structure geometry, however to aid clarity calculations solely conducted on structures (no beach) are plotted at zero.

Three vertical lines are plotted on the chart to add context to the results:

Dashed black - the lowest CSA values recorded for the smallest beach profile (2003-2015)

Solid black – the highest CSA values recorded for the largest beach profile (2003 – 2015)

Amber line - the current lowest CSA value recorded for any profile in that defence section.

All three of these lines could represent different profiles within the section. Details for each profile can be found in Chapter 7.

The majority of these frontages have a combination of beach and sea wall and the overtopping calculations consider them both; presenting the results according to the actual structural configuration seen on site.

Where the beach is the only forward defence (i.e. no hard structure or rock armour) the calculations are based on the beach only and an additional line is plotted (red dashed), showing the minimum CSA at which the modelled crest height can be maintained at a 1:7 slope. The calculations for cross-sectional areas less than this threshold value are based upon a reduced crest height (Figure 6-23-2). This threshold CSA value is denoted by a dashed red line on the graphs.

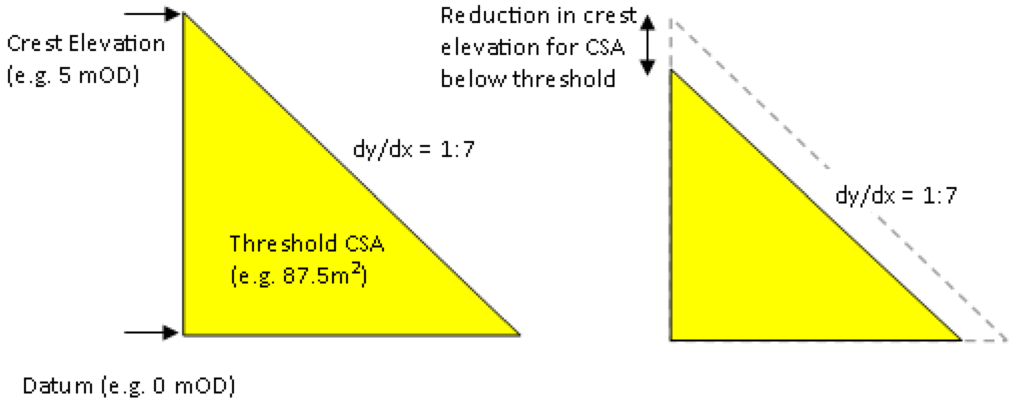


FIGURE 6-3-2 REDUCTION IN CREST HEIGHT FOR PROFILES BELOW A THRESHOLD CSA

Where defence structures have both a front wall and a rear wall results are presented for both components of the defence. The notation is a 2 after the section name for the rear wall, for example Tankerton C describes the results for the front wall, and Tankerton C2 describes the results for the rear wall. An example results graph is shown in Figure 6-3-3; full results and details of the input conditions are provided for each set of calculations within appendix G. The relationship to the defence standard of protection is shown in Chapter 7, and the implications of the results are discussed in Chapter 8.

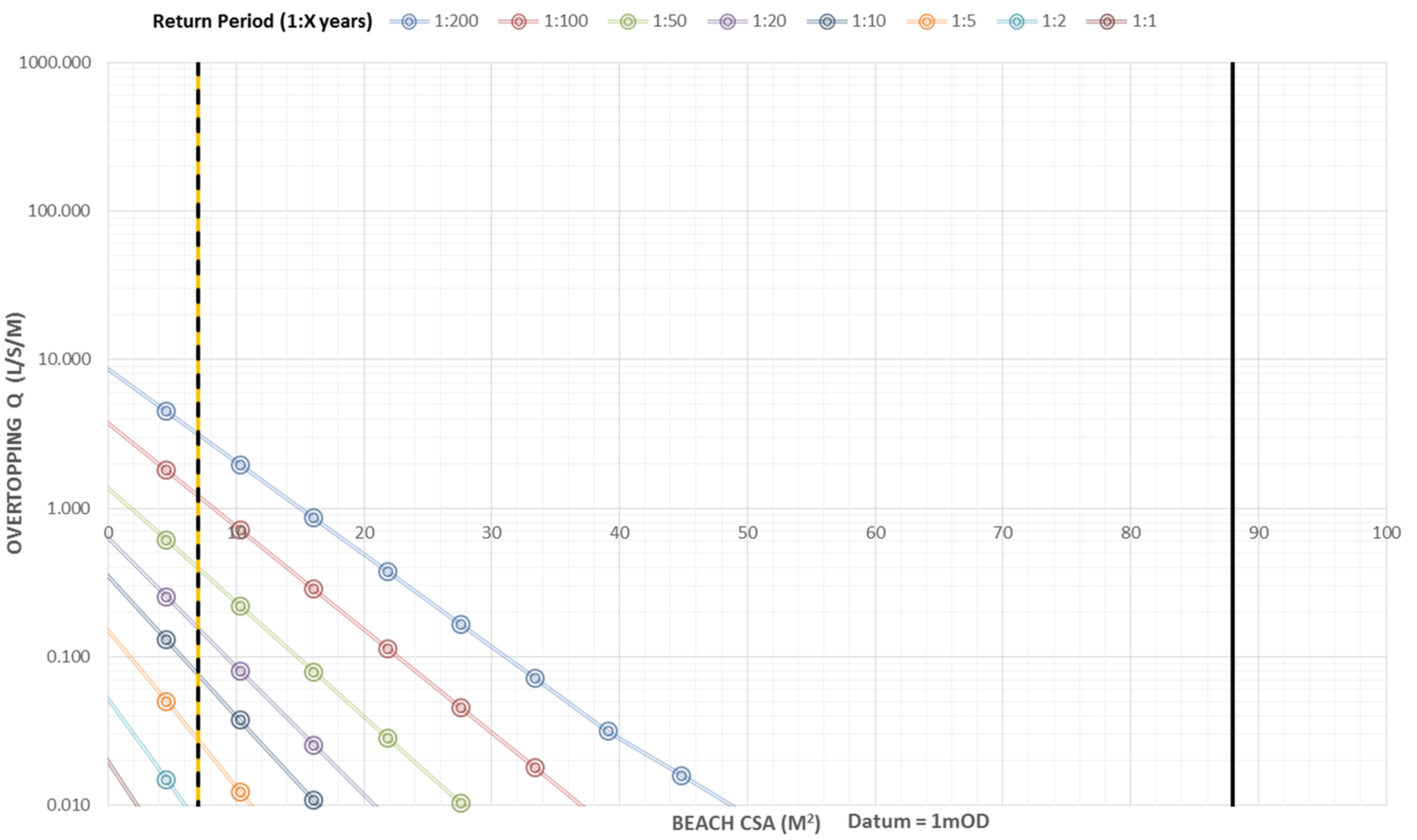


FIGURE 6-3-3 OVERTOPPING RATES OUTPUT CHART EXAMPLE

Seasalter - Section A (Seawall with Recurve)

Profile Range 4a00546 to 4a00593

━ Highest CSA of any profile in this section (2003-2015)

╍ Lowest CSA of any profile in this section (2003-2015)

━ Lowest Current CSA of any profile in this section (Summer 2015)

CANTERBURY
CITY COUNCIL

7 STANDARD OF PROTECTION

7-1 BASELINE CRITERIA

This report provides technical analysis and advice on management of shingle beaches. A shingle beach performs two coastal protection functions by breaking waves and absorbing wave energy, in addition to providing a physical barrier;

1. ***Prevention of Flooding:*** Reducing wave overtopping and preventing inundation
2. ***Protection of Coastal Structures:*** Preventing structural undermining and reducing wave impact damage, whilst providing toe weighting and structural support

These two factors are considered in unison in order to calculate the current standard of protection (SoP) and recommended beach levels. Typically the primary failure mechanism is excessive overtopping, flooding and damage to structures close to the beach. In this respect the defence can be considered to have a sub-standard level of protection, in most cases there will have to be a further reduction in beach levels before a breach or sea wall failure becomes a significant risk.

Minimum beach levels are calculated by defining a maximum allowable overtopping limit for each section based on the tolerable discharge limits and the overtopping results for a 1:200 year storm (see Appendix G). Maintaining a beach level above this threshold achieves a present day standard of protection of > 1 in 200 years. **A 1 in 200 year SoP has been used throughout this report and all sister reports, throughout the South East, in order to provide consistency in reporting.**

It is not possible to present standard of protection results for every return period, instead for SoPs other than the 1:200 year the required trigger levels can be calculated from the overtopping graphs, calculated for a range of return periods from 1:1 to 1:200 years and these are provided in Appendix G.

A full structural assessment of sea defence structures, and failure probabilities, is outside the scope of this report. It does however consider the risk of structural undermining, based on the structure toe levels of the sea defence schematics (Appendix F). The analysis takes into account beach draw down during a storm in addition to calculating the potential scour depth at the structure. This allows for the calculation of a minimum beach required to prevent undermining. In the event that this is larger than the threshold calculated for overtopping the undermining CSA is used in preference when establishing trigger levels.

It should be noted that although the overtopping limit is based on providing a 1 in 200 year standard of protection, structural damage and undermining can result from relatively minor storms once the beach level has dropped below the critical threshold.

7-2 TRIGGER LEVELS

The naming convention and definition of trigger levels varies significantly between previous beach management plans and other reports. For the purpose of this report three trigger levels are used and described below for clarity. These were designed to help aid interpretation of coastal monitoring data and to inform beach management works.

CRITICAL LEVEL – This is the minimum beach level required to prevent overtopping exceeding tolerable limits in a 1:200 year storm event and/or a significant risk of structural damage or undermining. A Sub-Critical level is also defined which is the equivalent level for a standard of protection of 1:10 (approximately equal to half the CSA of the 1:200 event).

The problem with a critical level from a beach management perspective is that any beach at or just above this level may drop below it during a single storm or in short time under exposure to average conditions. This would require regular intervention and beach works to increase the beach level throughout the year, and even then potentially leave the area with a sub-standard standard of protection during a storm. As such it is unlikely a beach would be maintained at the critical level, but it provides a good reference for when emergency works are required and the urgency.

MAINTENANCE LEVEL – This level is higher than the critical level. The difference in beach cross sectional area is defined by the largest observed annual drop in beach level (since monitoring began in 2003), or where greater the largest loss during a storm event.

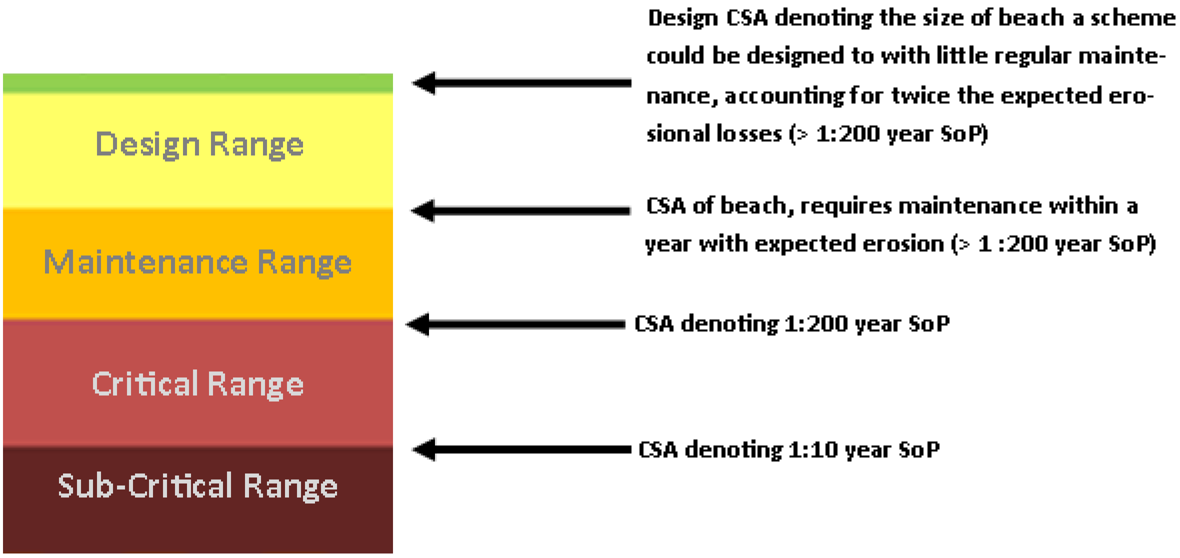
If beach levels are maintained above this level then it is highly unlikely that the beach size will reduce to below the critical level within a year or during a storm event. In reality in most years the beach level will only reduce by a fraction of this amount. Having a beach this size gives the coast protection authority time to plan works and be more efficient with little risk of levels dropping below the critical level.

DESIGN LEVEL – This is higher than the maintenance level and takes into consideration the impact of the defence failing (though undermining or significant overtopping), and builds in an appropriate factor of safety. When carrying out works, where possible, the beach size should be increased to this level.

Due to the maintenance level only referencing actual changes in beach size since 2003, there is always the possibility of a larger storm, or series of storms, that would reduce the beach size by more than the maintenance level. The design level accounts for this by adding a factor of safety, this is not a consistent figure for all locations but based on the potential impact of the defence being significantly overtopped or failing. For example a heavily urbanised area with properties below MHW would have a larger safety factor than a defence section protecting farmland. It also follows that erosive beaches have a higher design threshold than stable or accreting sections. This also allows time for remedial action and beach works following a storm event.

However, a larger beach may also be prone to higher rates of longshore transport, in particular in groyned sections of the coast.

It is important to note that CSAs within the Design Range (Yellow) and Maintenance Range (Orange) are above the 1:200 standard of protection. These areas give a factor of safety to allow time for coastal managers to intervene before the beach conditions drops below the required level of protection (Figure 7-1).



Design CSA denoting the size of beach a scheme could be designed to with little regular maintenance, accounting for twice the expected erosional losses (> 1:200 year SoP)

CSA of beach, requires maintenance within a year with expected erosion (> 1 :200 year SoP)

CSA denoting 1:200 year SoP

CSA denoting 1:10 year SoP

FIGURE 7-1 DESIGN, MAINTENANCE, CRITICAL AND SUB CRITICAL RANGES BASED ON TRIGGER LEVELS

7-3 CURRENT STANDARD OF PROTECTION

Having defined the trigger levels it is possible to ascertain not only the current standard of protection, but also to appraise how the beach has performed historically. Trigger levels are calculated as a beach cross sectional area (CSA), these can be plotted for each profile location along the frontage and compared to the surveyed beach CSA through time. Profile locations overlain on aerial photography are provided in appendix D.

In order to condense this information so that the current standard of protection, and historical performance, can be viewed as an overview of each management unit it is necessary to summarise the data for each profile as shown in Figure 7-2.

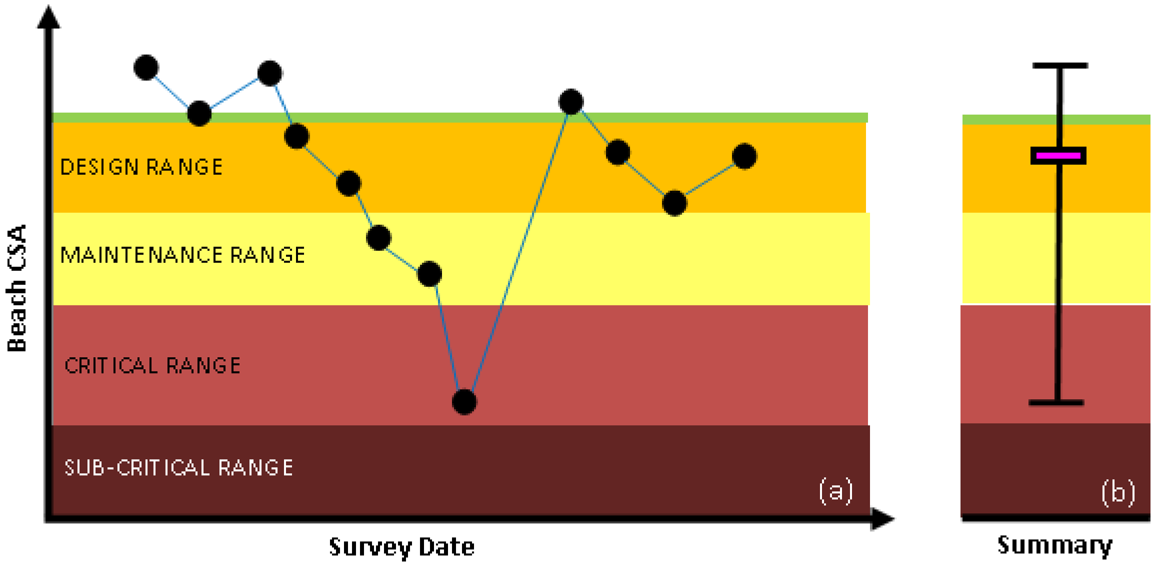


FIGURE 7-2 PRESENTATION OF STANDARD OF PROTECTION AND TRIGGER LEVELS

(A) HISTORIC VARIATION OF BEACH LEVELS (CSA)

(B) SUMMARY OF DATA, PINK BAR – CURRENT BEACH LEVEL, BLACK BARS – HISTORIC HIGH AND LOW

The following pages provide a summary of the SoP for each management unit. A table lists the key parameters for each defence section including the primary risk, likelihood and potential impact. The likelihood of the beach dropping below the critical trigger level is based on the current and historic beach levels, the presence of controlling structures, sediment transport rates and any susceptibility to erosion. Potential impacts are defined by the topography and infrastructure behind the defence.

IMPORTANT NOTE:

Standards of protection and trigger levels defined in this report are based on current information and historic data at the time of writing. This report focusses on the 1 in 200 year SoP for consistency but please note it may not be appropriate at all sites to provide this SoP as the required protection could be higher or lower. The chosen SoP should be economically viable and site-appropriate. Coastal managers should be aware that several factors can result in a change to the SoP and/or trigger levels. These include, but are not limited to the following;

- Deterioration of seawall condition leading to an increase in required beach
- Seawall raising or repair reducing beach requirements and trigger levels
- New development behind the sea defence may necessitate a higher standard of protection and larger trigger levels
- Groyne failure can result in higher trigger levels due to increased susceptibility to erosion.
- Introduction of new or larger controlling structures
- Reduction of input sediment to the system due to changes to management practices down drift
- A significant change to the grading characteristics of the beach material
- Drop in foreshore levels allowing larger waves to reach the beach
- Climate change
- A change to the management regime for example from 'little and often' to 'large and infrequent' or vice versa.

7-3-1 GRAVENEY TO SEASALTER

Graveney to Seasalter is a stable unit with typically small beaches (Appendix E, sediment budget).

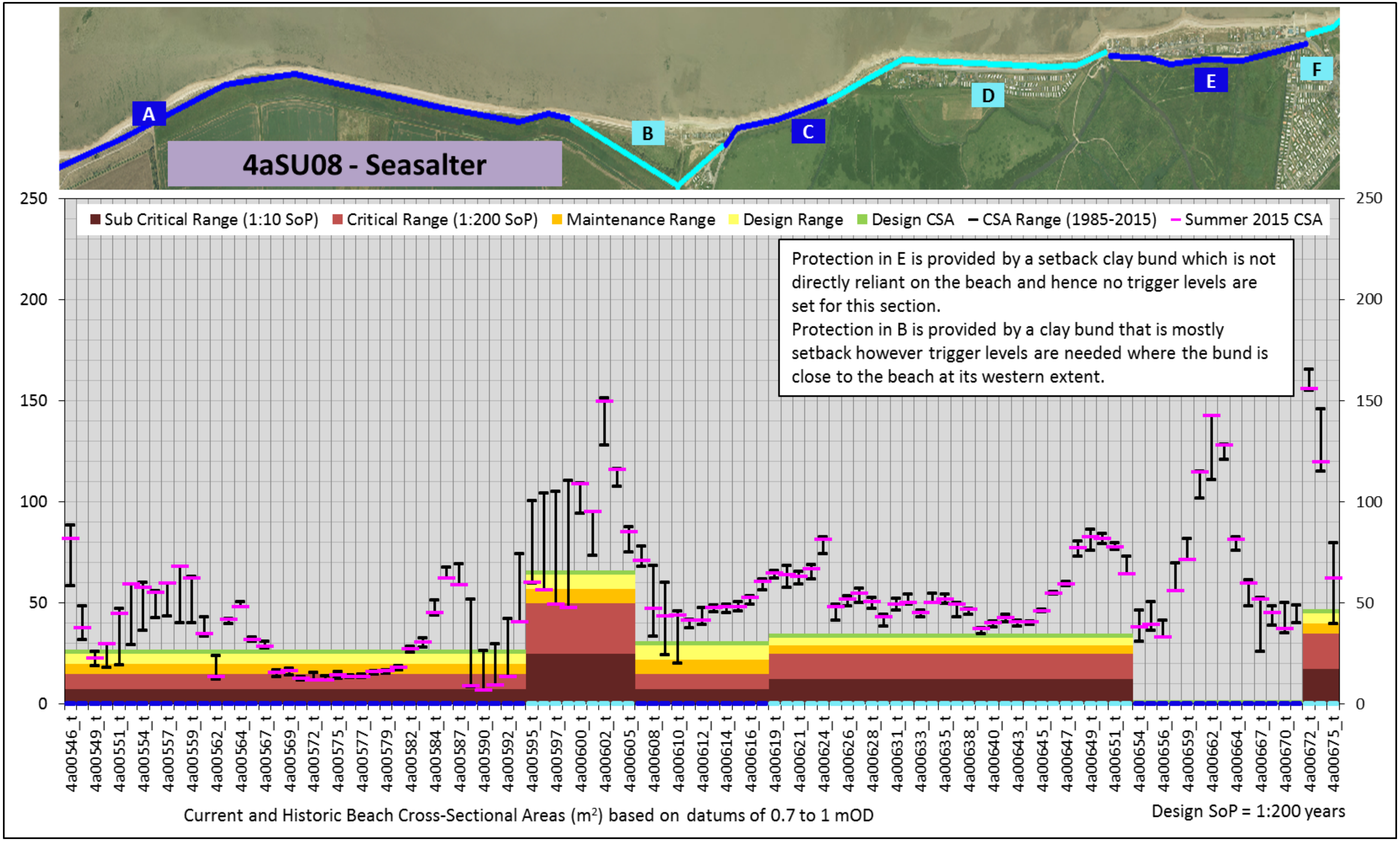
Section A, at approximately 3.6km is the longest section with the same wall type. The beach typically decreases in size towards the west. Several stretches of beach within Section A are on the threshold of the critical range (1 in 200) for undermining but have been stable for the last 30 years. Settling of the precast concrete units is evident and the joint sealant is damaged or missing.

The very large flood plain and important infrastructure links occupy the hinterland. A large power substation is located within the flood plain. The hinterland is largely pasture and arable land and therefore sparsely populated. The CSA chart shows that sections B and E are both currently above the critical however this is not taking into account the properties built seaward of these defences. These properties do not have planning permission and therefore are not afforded legal protection.

Section B is a set-back clay bund fronted by a large beach and therefore a low likelihood of failure currently. Sections C to F are all above the design level and therefore the risk of failure has a low likelihood for this area. The main flood defence in Section E is the clay bund which is set back from the properties on Faversham Road. To view the individual overtopping charts for each defence section navigate to Appendix G.

TABLE 7-1 SEASALTER INTERPRETATION TABLE: RISK MECHANISM AND CONSEQUENCES

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T. RATE (IF APPLICABLE) $LM^{-1}S^{-1}$	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A	**EA**	SAND BEACH RECURVED SEA WALL WITH BLOCKWORK APRON	-	UNDERMINING	15	-	150	ARABLE	-
B (CHALET OWNERS BEACH)		SAND, SHINGLE BEACH	CLAY BUND	UNDERMINING	15	-		ARABLE	DEFENCE LINE IS SET BACK. APPROX. 30 CHALETS LIE SEAWARD OF THIS DEFENCE
C		SAND SHINGLE BEACH, CONCRETE SEA WALL WITH RECURVE	-	UNDERMINING	15	-		ARABLE	-
D		SHINGLE BEACH, CONCRETE SEA WALL WITH RECURVE	-	OVERTOPPING	25	25		CARAVANS/ ARABLE	-
E (FAVERSHAM ROAD PROPERTIES)		SHINGLE BEACH	CLAY BUND	OVERTOPPING TO PROPERTIES (SEE NOTES)	15	-		HOUSES	FLOOD DEFENCE IS SET BACK AND NOT DIRECTLY RELIANT ON THE BEACH. APPROX. 100 PROPERTIES LIE SEAWARD OF THIS DEFENCE WITH NO PLANNING PERMISSION.
F		SHINGLE BEACH, CONCRETE SEA WALL WITH RECURVE	-	OVERTOPPING	35	25		CARAVANS	-



Protection in E is provided by a setback clay bund which is not directly reliant on the beach and hence no trigger levels are set for this section.
Protection in B is provided by a clay bund that is mostly setback however trigger levels are needed where the bund is close to the beach at its western extent.

FIGURE 7-3 SEASALTER TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M²] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

7-3-2 WHITSTABLE

Whitstable is a mildly erosive beach with large beaches (Appendix E, sediment budget).

The hinterland is densely populated and in a large flood basin, hence the potential impact is ranked at “high”. There are also several important transport links including the Margate to London railway line. The harbour is an important commercial hub for Whitstable, supporting several large fishing boats, several locally owned businesses and hosts a permanent market.

The beach levels in Section A fall between the design and maintenance trigger levels which suggest works are required, although the current level is above a 1 in 200 SoP. This is pronounced at the western extent where the coastline very slight orientates inland exposing the corner of the sea wall. The remainder of the frontage is well above the design level. To view the individual overtopping charts for each defence section navigate to Appendix G.

TABLE 7-2 WHITSTABLE INTERPRETATION TABLE: RISK MECHANISM AND CONSEQUENCES

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T RATE (IF APPLICABLE) $LM^{-1}S^{-1}$	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A	CCC	SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	55	25	3005	SOFT CLAY CLIFFS	-
B		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	60	25		SOFT CLAY CLIFFS	-
C		SHINGLE BEACH, CONCRETE SEA WALL WITH APRON	-	UNDERMINING	15	1		SOFT CLAY CLIFFS AND RAILWAY EMBANKMENT	-
D		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	UNDERMINING	15	25		GOLF COURSE	-
E		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	55	1		CARAVAN SITE AND GOLF COURSE	-
F		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	80	1		HOUSES IN LOW LYING AREA	-
G		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	110	1		HOUSES IN LOW LYING AREA	-
H		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	155	1		HOUSES IN LOW LYING AREA	-
I		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	100	1		HOUSES IN LOW LYING AREA	-

J		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	110	1		HOUSES IN LOW LYING AREA	-
K		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	-	1		HOUSES IN LOW LYING AREA	PUBLIC HOUSE ON BEACH
L		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL	OVERTOPPING	95	1		HOUSES IN LOW LYING AREA	-
M		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL	OVERTOPPING	105	1		HOUSES IN LOW LYING AREA	-
N		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	100	1		HOUSES IN LOW LYING AREA	-
O		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL	OVERTOPPING	60	25		CAR PARK	-
P		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	105	1		HOUSES IN LOW LYING AREA	-
Q		SHINGLE BEACH, CONCRETE PROMENADE	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	95	1		HOUSES IN LOW LYING AREA	-
HARBOUR		VERTICAL STEEL SHEET PILING	CONCRETE SEA WALL	OVERTOPPING	55	10		INDUSTRIAL AREA	-

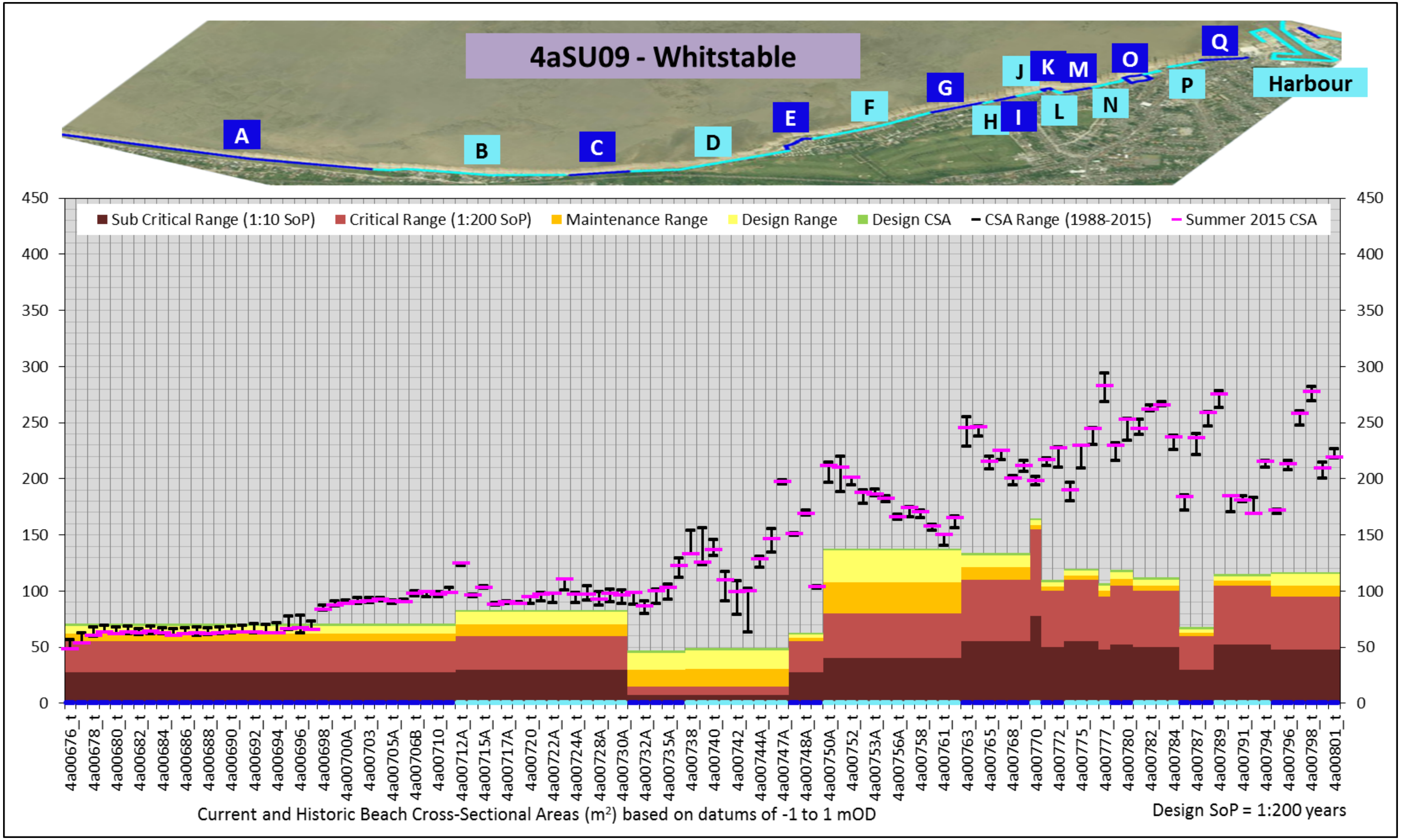


FIGURE 7-4 WHITSTABLE TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M^2] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

7-3-3 TANKERTON

Tankerton is a mildly erosive beach with large beaches (Appendix E, sediment budget).

The large beaches at Tankerton are well above the design level throughout the frontage.

Sections A and B front an industrial area and a few commercial properties which may flood in a storm event greater than 1 in 10 as the sea may overflow, through the properties and back into Whitstable Harbour, directly behind.

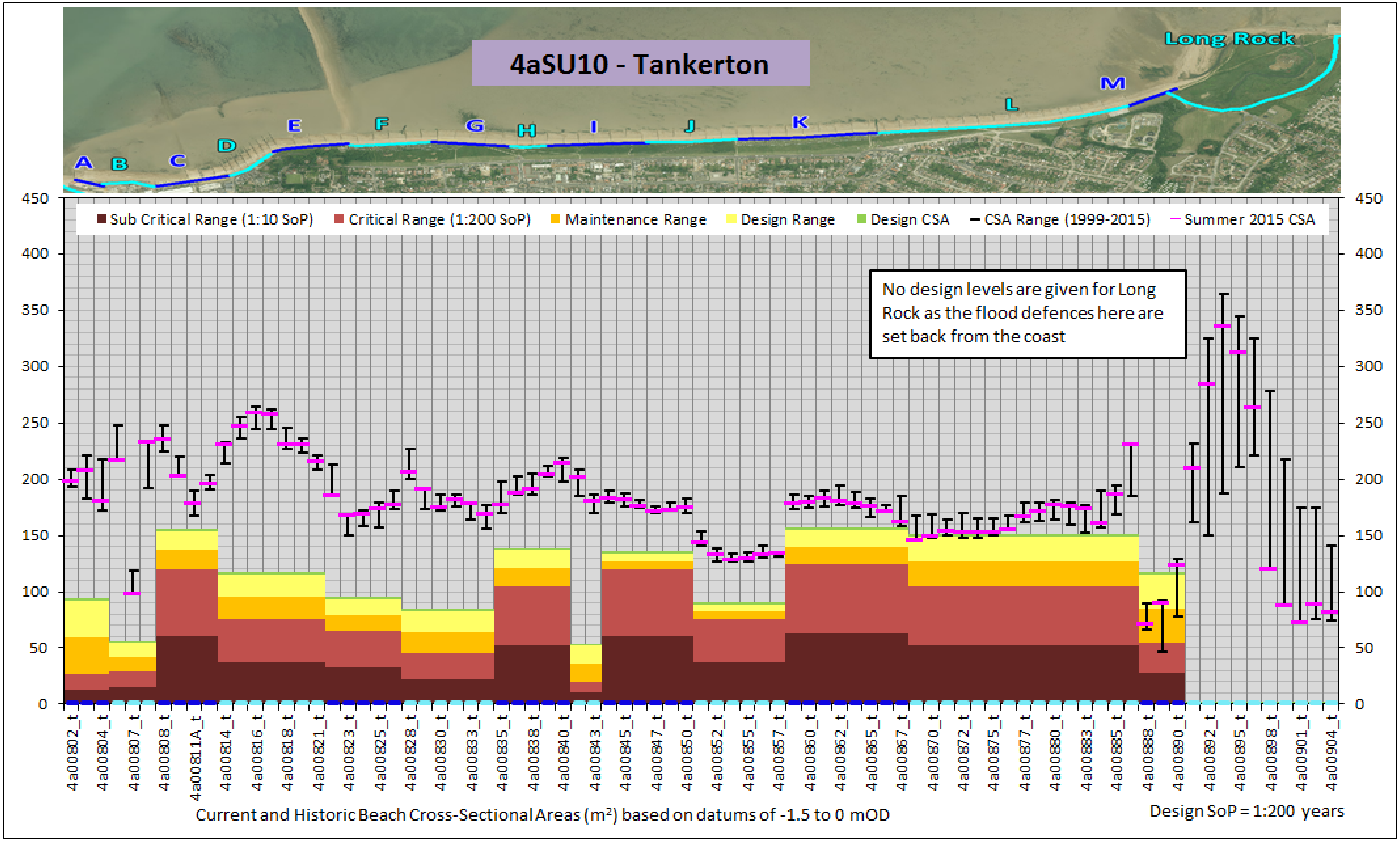
Sections C and D front residential properties and larger commercial properties. The majority of the frontage, Sections E to L, protects regraded clay slopes and therefore impacts of overtopping would be low. Section M defends the water treatment plant.

The Long Rock section is more complex than the other sections within this unit. The shingle deposits in this area are highly mobile and move with every high tide. Whilst overtopping is not a risk here, the key risk is the blocking of the Swalecliffe Brook by shingle which prevents the Swalecliffe Brook discharging into the sea; causing fluvial flooding. To view the individual overtopping charts for each defence section navigate to Appendix G.

Table 7-3 Tankerton Interpretation Table: Risk mechanism and consequences

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T RATE (IF APPLICABLE) $LM^{-1}S^{-1}$)	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A	CCC	SHINGLE BEACH, CONCRETE SEA WALL	-	UNDERMINING	26.5	-	NONE	INDUSTRIAL AREA	-
B		SHINGLE BEACH, CONCRETE SEA WALL	-	UNDERMINING	29	-		INDUSTRIAL AREA	-
C		SHINGLE BEACH, CONCRETE SEA WALL	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	120	25		INDUSTRIAL AREA AND SWIMMING POOL	-
D		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	75	25		SOFT CLAY SLOPES	-
E		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	OVERTOPPING	65	25		SOFT CLAY SLOPES	-
F		SHINGLE BEACH, CONCRETE SEA WALL	CONCRETE SEA WALL	OVERTOPPING	45	25		SOFT CLAY SLOPES	-
G		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	105	25		SOFT CLAY SLOPES	-
H		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	OVERTOPPING	20	25		SOFT CLAY SLOPES	-
I		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN AND CONCRETE -APRON	-	OVERTOPPING	120	25		SOFT CLAY SLOPES	-
J		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	75	25		SOFT CLAY SLOPES	-

		WITH RETURN							
K		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	125	25		SOFT CLAY SLOPES	-
L		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	105	25		SOFT CLAY SLOPES	-
M		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	55	25		SOFT CLAY SLOPES	-
LONG ROCK		SHINGLE BEACH	CLAY BUND	OVERTOPPING	-	25		SSSI HABITAT	HIGHLY DYNAMIC ENVIRONMENT. CLAY BUND SETBACK.



No design levels are given for Long Rock as the flood defences here are set back from the coast

FIGURE 7-5 TANKERTON TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M^2] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

7-3-4 SWALECLIFFE

Swalecliffe is a mildly erosive beach with the shingle beach getting progressively smaller towards the east (Appendix E, sediment budget).

The area of land behind Section A is occupied by a caravan site whilst the area behind section B is clay slopes, very similar to those found in Tankerton. The land behind C is a play park and EA pumping station (Westbrook). There are no highly populated areas within the coastal flood plain at Swalecliffe and so the potential impact from overtopping and flooding would be low.

The beaches at Swalecliffe are currently well above the design beach level in Section A. In Sections B and C the beaches are smaller yet still largely above the design level. One profile in Section C, Profile 4a00655, is lower than the others – this is due to being on a protruding section of sea wall with a near non-existent beach. Section D has no profiles as it is a rock revetment perpendicular to the coast with no beach. To view the individual overtopping charts for each defence section navigate to Appendix G.

Table 7-4 Swalecliffe Interpretation Table: Risk mechanism and consequences

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	.ALLOWABLE O.T RATE (IF APPLICABL) (LM^{-1}S^{-1})	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A	CCC	SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	25	25	178	GRASSLAND AND SET BACK CARAVAN SITE	-
B		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	EROSION	25	-		SOFT CLAY SLOPES	-
C		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN AND CONCRETE APRON	CONCRETE SEA WALL WITH RETURN	EROSION/ OVERTOPPING	30	25		GRASSLAND	-
D		ROCK REVETMENT	-	OVERTOPPING	-	50		HOUSES ON ELEVATED LAND	-

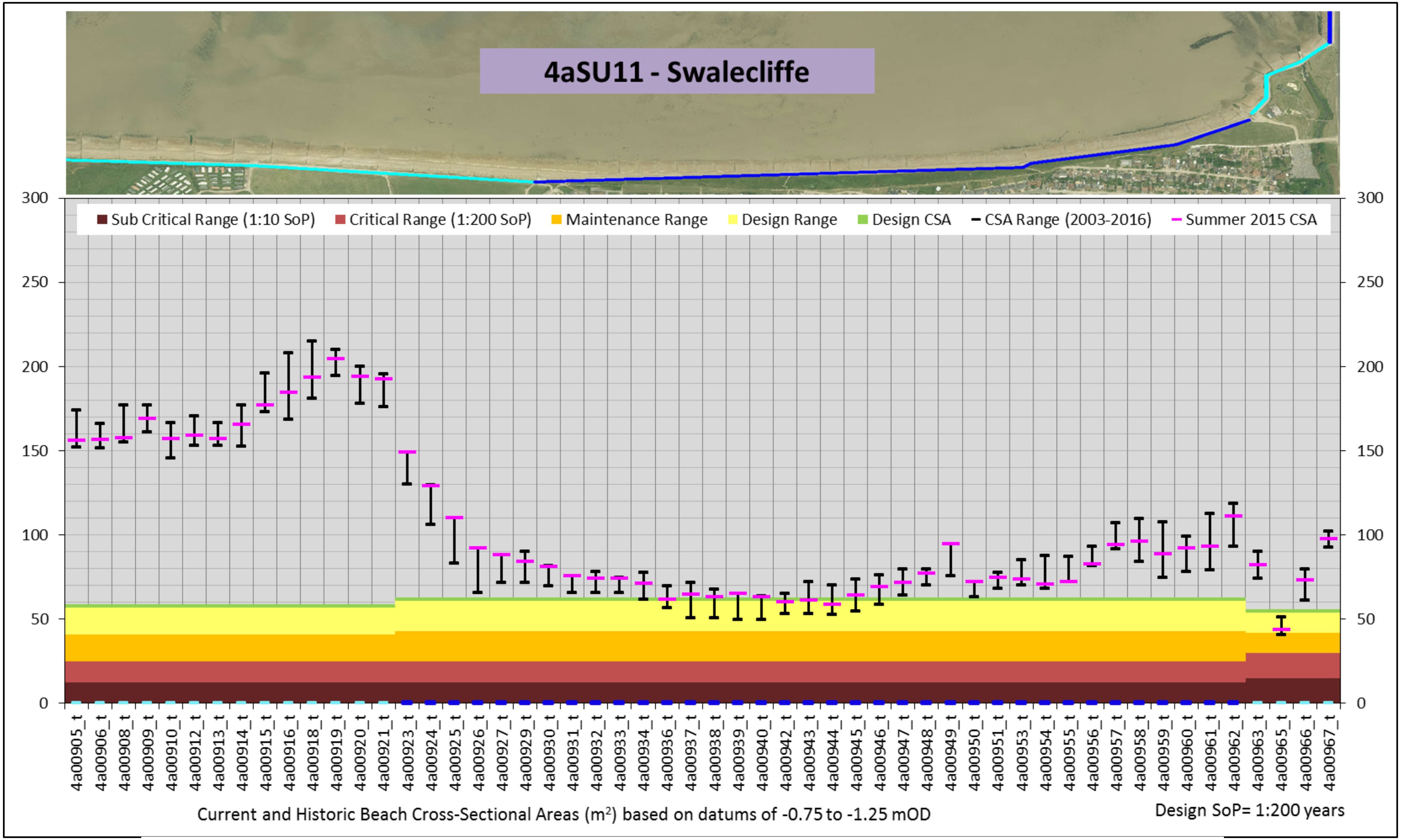


FIGURE 7-6 SWALECLIFFE TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M²] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

7-3-5 HERNE BAY

Herne Bay is a mildly erosive frontage with shingle and sand beaches throughout (Appendix E, sediment budget).

Sections A-C and Sections I to R are backed by regraded clay slopes or cliffs which have previously been highly erosive. Sections D to H are backed by residential areas and infrastructure with a flood basin directly behind F and G. The Neptune Arm breakwater reduces the risk of flooding to the centre of the town.

The beach in front of the clay slopes is above design level as the main risk here is undermining and there is a higher level of acceptable overtopping (25 l/m/s). The centre of the unit is more developed with properties directly behind the sea wall with several also in the flood plain. Section F, just east of Herne Bay Pier, is known to scour regularly and can require an annual recharge; the trigger level for this area is adapted to account for this.

The beaches in Sections G and H fall within the maintenance level and therefore may require works shortly. Profile 4a01054, the most easterly profile within Section H, would have been deemed critical in summer 2015 and it subsequently failed during the winter as the concrete blockwork apron in front of it collapsed. Section Q has a high trigger level because the defence has no rear wall and is at the base of clay slopes which are more exposed than the rest of the eastern sections. To view the individual overtopping charts for each defence section navigate to Appendix G.

Table 7-5 Herne Bay Interpretation Table: Risk mechanism and consequences

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T RATE (IF APPLICABLE) $LM^{-1}S^{-1}$	PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A	CCC	SHINGLE BEACH, CONCRETE SEA WALL	-	SEA WALL FAILURE	130	-	378	CAR PARK	-
B		SHINGLE BEACH, CONCRETE SEA WALL	CONCRETE SEA WALL	SEA WALL FAILURE	80	-		CLAY SLOPES BEHIND ROAD	-
C		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	105	25		BEACH HUT FRONTING CLAY SLOPES	-
D		SHINGLE BEACH, CONCRETE SEA WALL	-	OVERTOPPING	90	10		RESIDENTIAL INFRASTRUCTURE	-
E		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	OVERTOPPING	70	10		RESIDENTIAL INFRASTRUCTURE	-
F		SHINGLE SAND BEACH, CONCRETE SEA WALL	CONCRETE SEA WALL	OVERTOPPING	95	1		LOW LYING LAND RESIDENTIAL INFRASTRUCTURE	NEPTUNE ARM BREAKWATER FRONTS THIS SECTION
G		SHINGLE BEACH, CONCRETE SEA WALL	CONCRETE SEA WALL	OVERTOPPING	45	10		LOW LYING LAND RESIDENTIAL INFRASTRUCTURE	-
H		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	SEA WALL FAILURE	50	-		LOW LYING LAND RESIDENTIAL INFRA-	-

								STRUCTURE	
I		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	OVERTOPPING	45	25		SOFT CLAY SLOPES	-
J		SHINGLE BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	SEA WALL FAILURE	40	25		SOFT CLAY SLOPES	-
K		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	SEA WALL FAILURE	35	25		SOFT CLAY SLOPES	-
L		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL	SEA WALL FAILURE (LANDSLIP/EROSION)	55	25		SOFT CLAY SLOPES	-
M		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	SEA WALL FAILURE (LANDSLIP/EROSION)	30	25		SOFT CLAY SLOPES	-
N		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	SEA WALL FAILURE (LANDSLIP/EROSION)	80	25		SOFT CLAY SLOPES	-
O		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	SEA WALL FAILURE (LANDSLIP/EROSION)	35	25		SOFT CLAY SLOPES	-
P		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	CONCRETE SEA WALL WITH RETURN	SEA WALL FAILURE (LANDSLIP/EROSION)	35	25		SOFT CLAY SLOPES	-
Q		SHINGLE SAND BEACH, CONCRETE SEA WALL WITH RETURN	-	SEA WALL FAILURE (LANDSLIP/EROSION)	160	25		SOFT CLAY SLOPES	-
R		SHINGLE SAND BEACH, ROCK REVETMENT	-	UNDERMINING OF REVETMENT	-	-		CLIFFS WITH RESIDENTIAL INFRA-STRUCTURE ON TOP	-

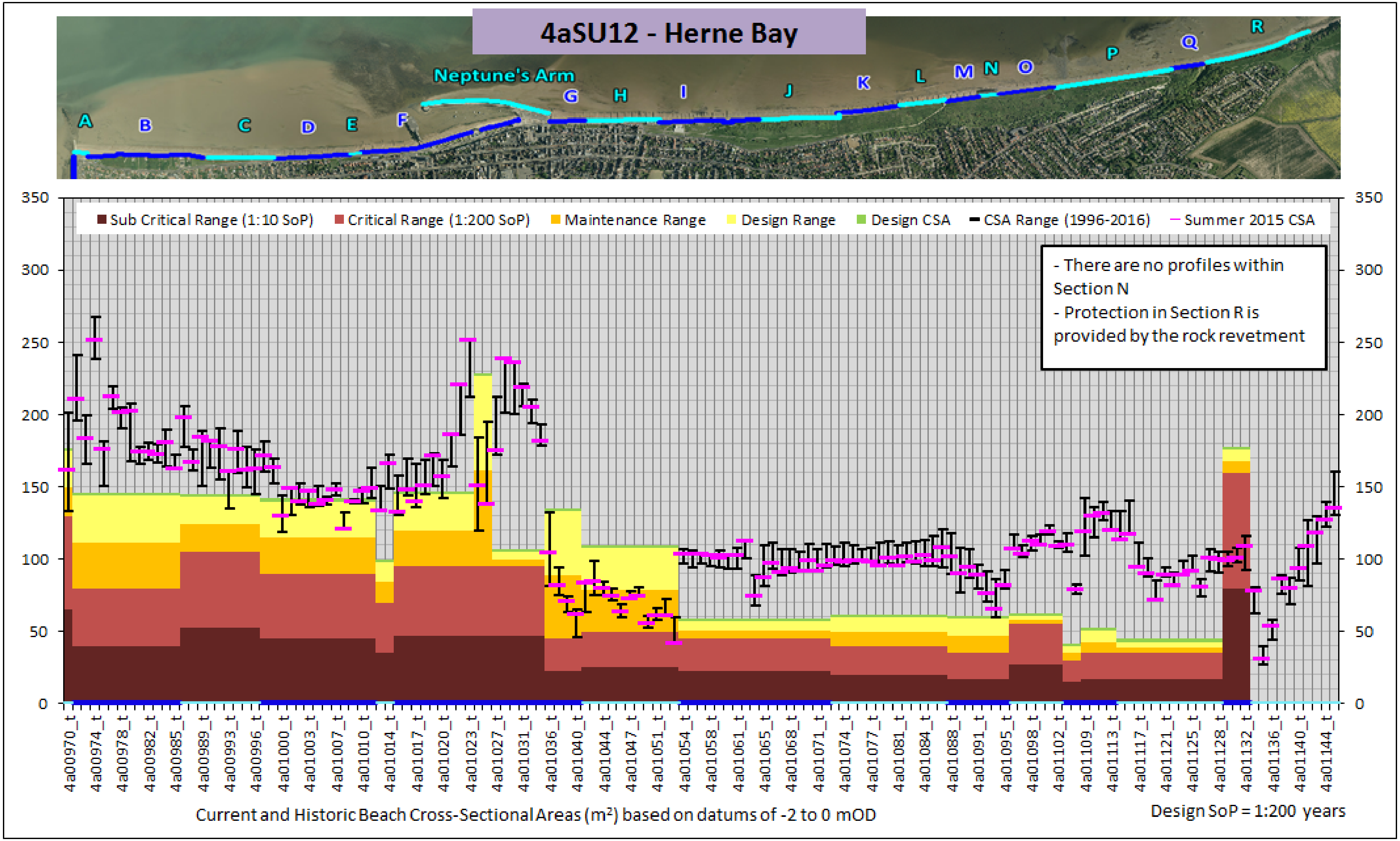


FIGURE 7-7 HERNE BAY TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M²] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

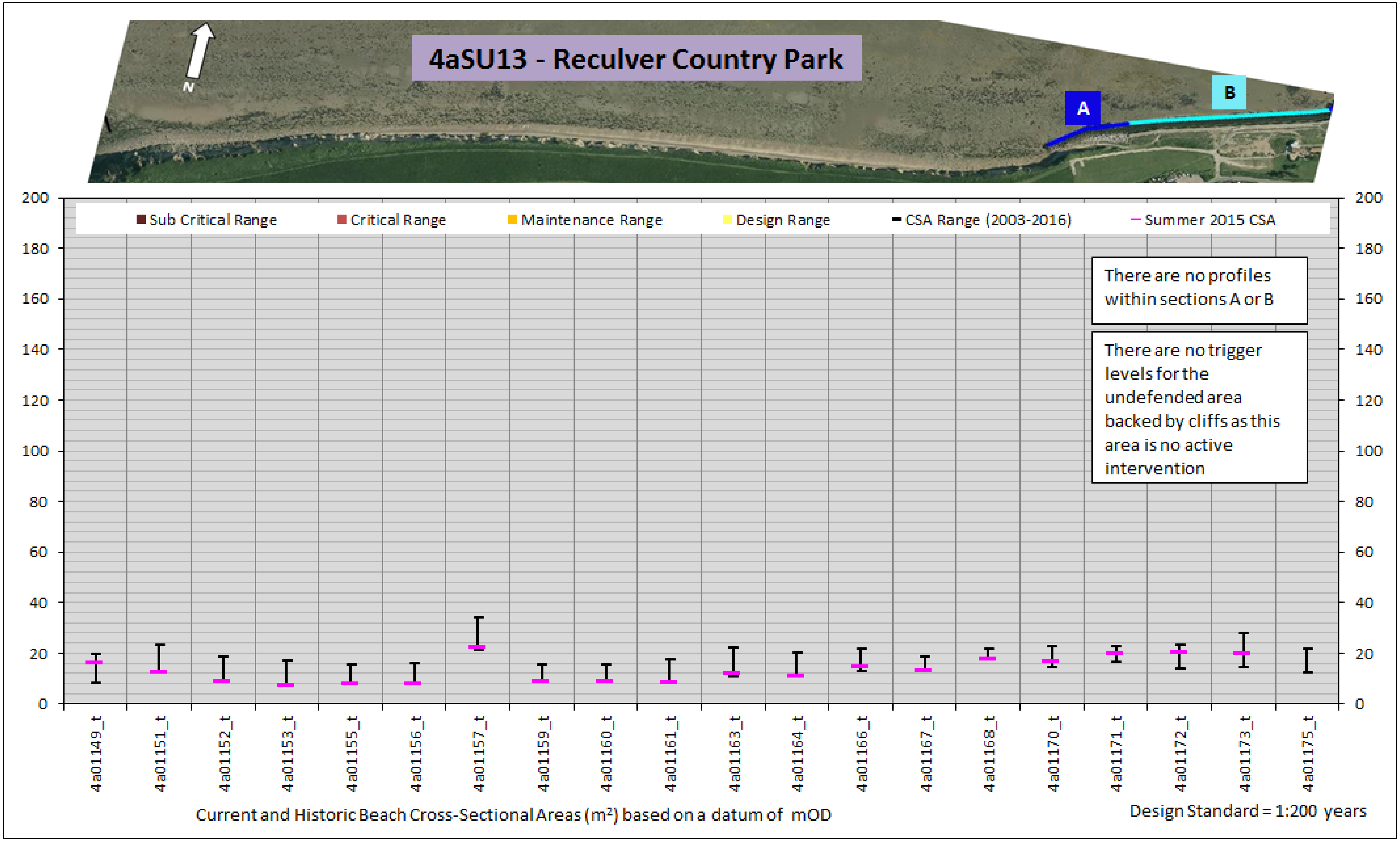
7-3-6 RECULVER COUNTRY PARK

Reculver Country Park is a largely undefended section with a small section of sea wall and rock revetment at the eastern extent, a small volume of sediment is transported into Herne Bay (Appendix E, sediment budget).

The naturally eroding cliffs are regressing very slowly, albeit with the occasional landslip. The two sections of defence do not have profile lines in front of them so no design conditions were calculated for this section as the cliffs form a highly effective natural defence line.

TABLE 7-6 RECULVER COUNTRY PARK INTERPRETATION TABLE: RISK MECHANISM AND CONSEQUENCES

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BEACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T. RATE (IF APPLICABLE) $LM^{-1}S^{-1}$	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
CLIFFS	CCC	BEACH	-	CLIFF EROSION	-	-	NONE	CLIFFS	UN-MANAGED SECTION WITH NO DESIGN LEVELS
A		ROCK REVETMENT		-	-	-		CLIFFS	
B		ROCK REVETMENT	CONCRETE SEA WALL	-	-	-		SET BACK VISITOR CENTRE	



There are no profiles within sections A or B

There are no trigger levels for the undefended area backed by cliffs as this area is no active intervention

FIGURE 7-8 RECULVER COUNTRY PARK TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M²] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: CURRENT BEACH CSA

7-3-7 NORTHERN SEA WALL

Northern Sea Wall is fronted by large shingle sand beaches (Appendix E, sediment budget). The sediment drift is west to east with shingle sediment crossing into the sandy beaches at Minnis Bay.

Two summary graphs have been included, the first indicates the 2015 summer beach levels to align with the rest of this document, the second documents the effect of the large recycling scheme in Autumn 2015 which redistributed approximately 30,000m^3 of shingle along the frontage and largely altered the current state of the beach. As designated profiles are recorded during an autumn survey not every profile shows the current level.

The rock revetment and sea wall in Section A defends the scheduled monument Reculver Towers and the remains of a Roman Fort, there is no beach present. Following the recycling scheme, the beach levels are much healthier along this coast with particular reference to Sections C and D which have been increased above the design level. The removal of sediment from Section L has reduced the CSA levels to their minimum with suggestion that there is still a large volume of sediment available. The recycling scheme mutually benefitted the extraction site as the St Augustine lagoon was reinstated. To view the individual overtopping charts for each defence section navigate to Appendix G.

TABLE 7-7 NORTHERN SEA WALL INTERPRETATION TABLE: RISK MECHANISM AND CONSEQUENCES

DEFENCE SECTION	OPERATOR	PRIMARY DEFENCE	SECONDARY DEFENCE	KEY RISK MITIGATED BY BREACH	CRITICAL CROSS SECTIONAL AREA (M^2)	ALLOWABLE O.T RATE (IF APPLICABLE) $LM^{-1}S^{-1}$	NO. OF PROPERTIES IN FLOOD PLAIN	HINTERLAND	NOTES
A (RECULVER TOWERS)	EA	CONCRETE APRON	-	STRUCTURE FAILURE	25	50	158	SCHEDULED MONUMENT	
B (EA PUMPING STATION)	EA	ROCK REVETMENT	-	OVERTOPPING	25	25		CARAVANS	PUMP STATION NEARBY
C (OYSTER HATCHERY)	EA	CONCRETE SEA WALL	-	OVERTOPPING	105	10		OYSTER HATCHERY	
D	EA	CONCRETE SEA WALL	-	OVERTOPPING	90	10		ARABLE	
E	EA	CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	110	10		ARABLE	
F	EA	CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	85	10		ARABLE	
G	EA	CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	95	10		ARABLE	
H	EA	CONCRETE SEA WALL	-	OVERTOPPING	95	10		ARABLE	
I	EA	CONCRETE SEA WALL	-	OVERTOPPING	70	10		ARABLE	

		WITH RETURN							
J	EA	CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	55	10		ARABLE	
K	EA	CONCRETE SEA WALL WITH RETURN	-	OVERTOPPING	56	10		ARABLE	
L	EA	CONCRETE SEA WALL	-	OVERTOPPING	90	10		ARABLE	
M	EA	CONCRETE SEA WALL	-	OVERTOPPING	82	10		ARABLE	

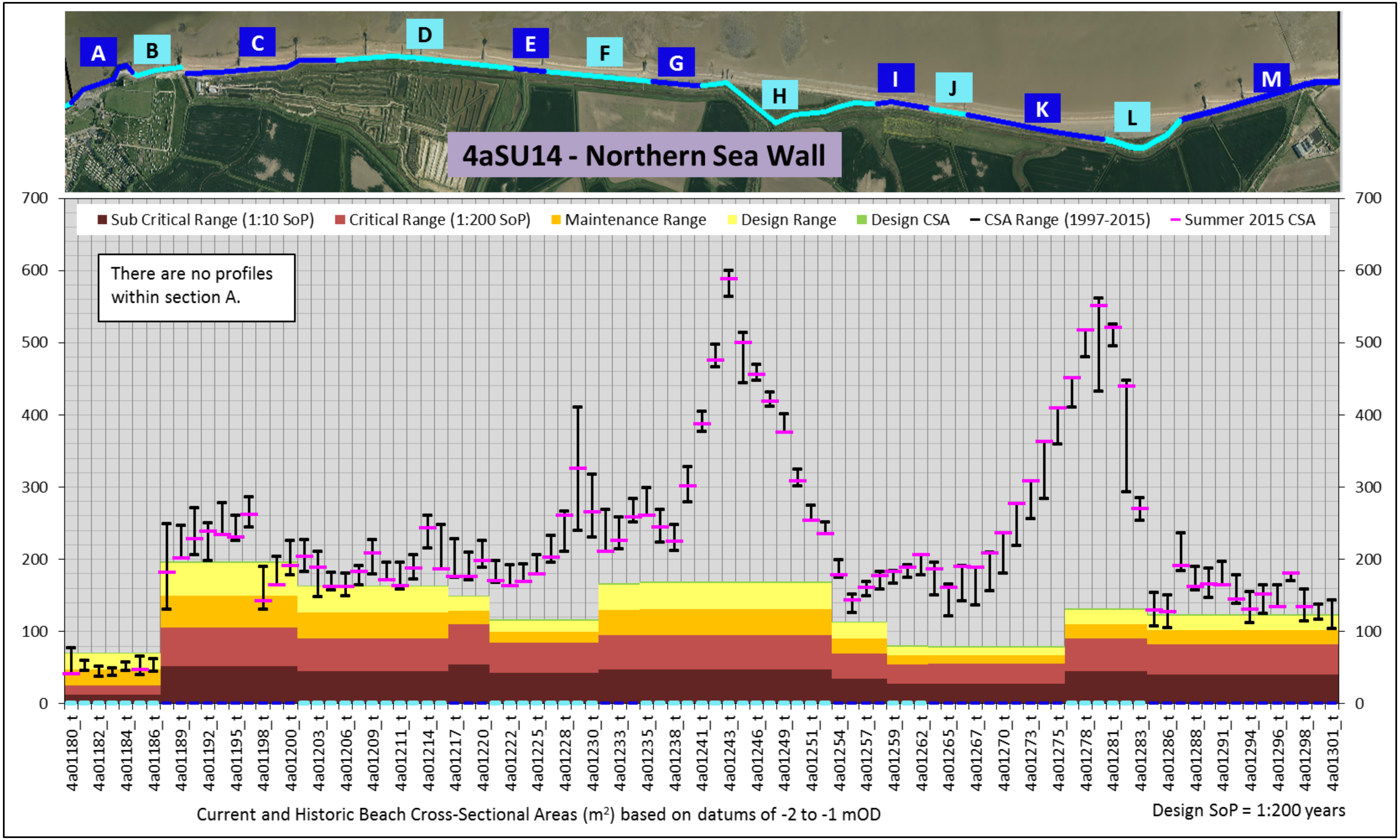


FIGURE 7-9 NORTHERN SEA WALL TRIGGER LEVELS (BEACH CROSS SECTIONAL AREA [M²] VS PROFILE LOCATION), BLACK BARS: HISTORIC CSA RANGE, PINK BAR: SUMMER 2015 BEACH CSA

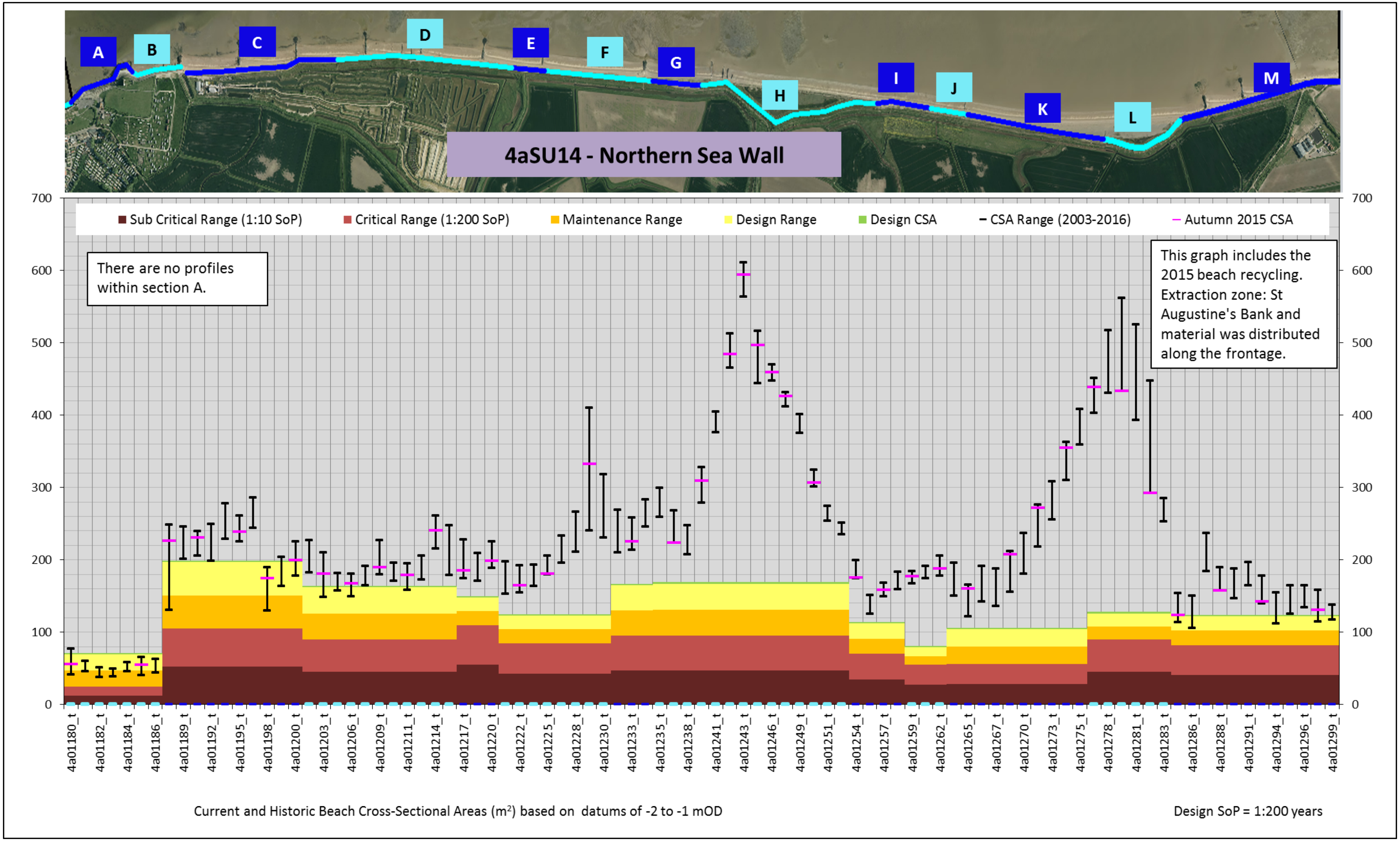


Figure 7-10 Northern Sea Wall trigger levels (beach cross sectional area [m²] vs profile location), black bars: historic CSA range, pink bar: Autumn 2015 beach CSA – (includes 2015 beach recycling)

8 BEACH MANAGEMENT PLAN

8-1 4aSU08 – GRAVENEY & SEASALTER

8-1-1 MANAGEMENT SUMMARY

TABLE 8-1 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE GRAVENEY AND SEASALTER FRONTAGE (SURVEY UNIT 4ASU08)

DEFENCE SECTION	OPERATOR	SMP SHORT-TERM POLICY	CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE	SEDIMENT BUDGET ANNUAL CHANGE IN M³)⁺	RECOMMENDED MANAGEMENT	PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS
A GRAVENEY TO THE SPORTSMAN PH	ENVIRONMENT AGENCY	HOLD THE LINE	**<1:200 (15)** SEA WALL WITH WAVE RETURN	445 (-3,563 TO 5,112)	MONITOR BEACH CSA	FARMLAND. SSSI, SPA AND RAMSAR.
B SETBACK AREA IN FRONT OF THE SPORTSMAN PH		HOLD THE LINE	>1:100 <1:200 (25) SET BACK CLAY BUND	-1,125 (-2,432 TO -291)	MONITOR BEACH CSA	GATED ACCESS. SSSI, SPA AND RAMSAR.
C THE SPORTSMAN TO APPROX. 150M EAST OF THE SAILING CLUB		HOLD THE LINE	>1:200 (25) SEA WALL	81 (-886 TO 2,944)	MONITOR BEACH CSA	GATED ACCESS. SSSI, SPA AND RAMSAR.
D APPROX. 150M EAST OF THE SAILING CLUB TO THE RED SLUICE		HOLD THE LINE	>1:200 (25) SEA WALL WITH WAVE RETURN	64 (-1,174 TO 1,686)	MONITOR BEACH CSA	GATED ACCESS. SSSI, SPA AND RAMSAR.
E RED SLUICE TO THE OYSTER PEARL PH		HOLD THE LINE	>1:200 (25) CLAY BUND	6 (-1,420 TO 1,511)	MONITOR BEACH CSA	GATED ACCESS. SSSI, SPA AND RAMSAR.
F LAND FRONTING THE OYSTER PEARL PH AND BEACH COURT CHALETS		HOLD THE LINE	>1:200 (25) SEA WALL WITH WAVE RETURN	-243 (-487 TO 2,386)	MONITOR BEACH CSA	GATED ACCESS. SSSI, SPA AND RAMSAR.

* Allowable overtopping is measured in l/m/s and determines the SoP ** The minimum CSA (m^2) before undermining occurs (bold) ⁺Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-1-2 MANAGEMENT HOTSPOTS

GRAVENEY (SECTION A)

There is concern over the level of the beach at Graveney as the toe of the sea wall is exposed and undermining of this wall could occur. There has been some movement amongst the precast concrete sections and joint sealant is missing throughout section A (Figure 8-1). The beach levels are at their lowest between profiles 4a00588 and 4a00592. Within this area there are large pieces of concrete which have previously broken away from the sea defence.

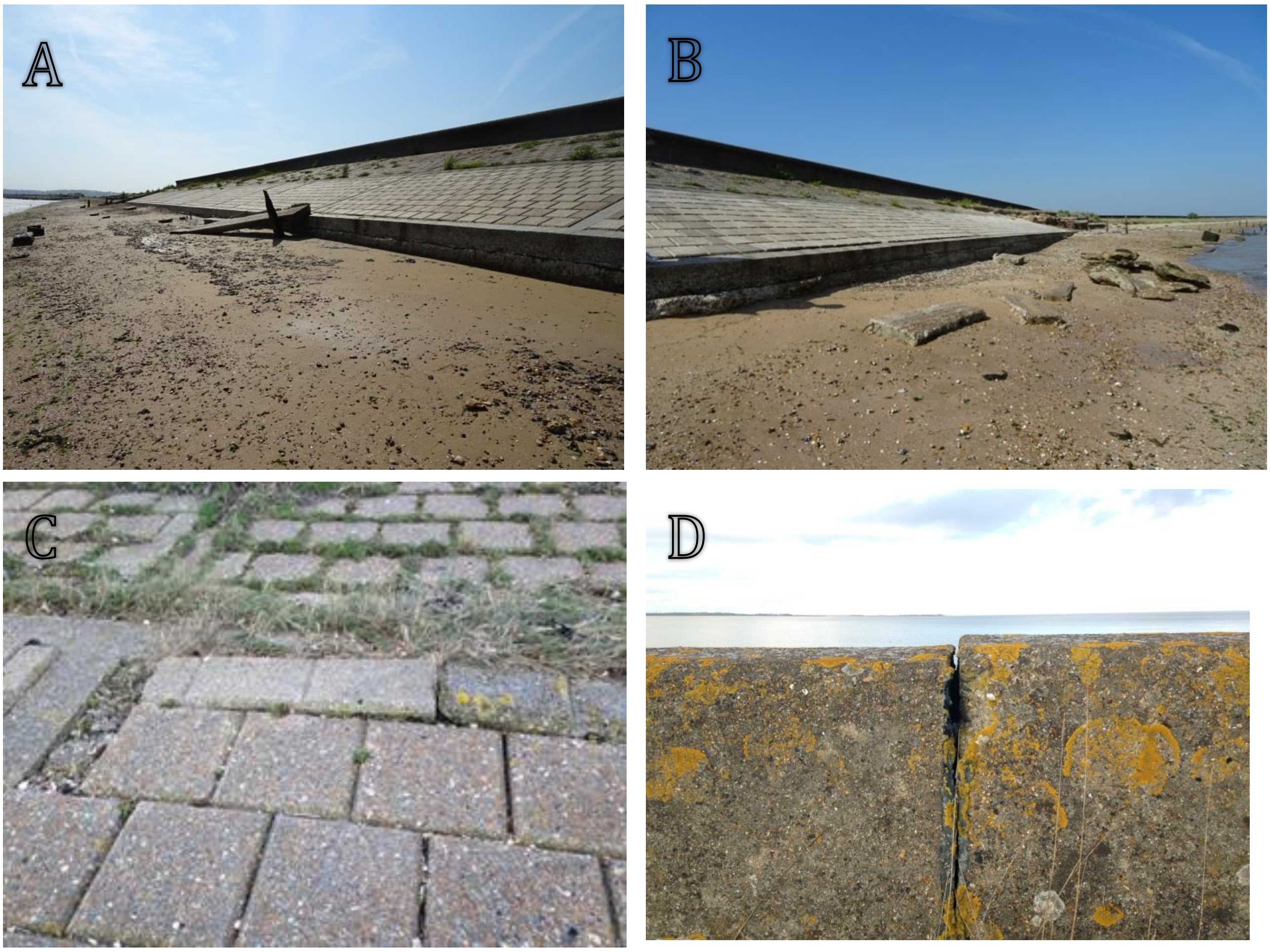


FIGURE 8-1 (A) AND (B) UNDERMINING PRESENT NEAR THE SPORTSMAN (C) BLOCKWORK APRON BREAKING AWAY DUE TO PLANT EXTRUSION AND (D) JOINT SEALANT MISSING AND SOME SETTLEMENT IN PRECAST CONCRETE SECTIONS

FAVERSHAM ROAD HOUSES (SECTION E)

There are a number of houses along Faversham Road which are built in front of the sea defence and are vulnerable to flooding and erosion (Figure 8-2); these properties flooded in 1978 during a storm surge. Whilst the beach changes are relatively low year to year there is the potential for beach material to be lost in front of these properties.

FIGURE 8-2 FAVERSHAM ROAD PROPERTIES AND THE SHINGLE BAR WHICH IS TRANSGRESSING ONSHORE © CROWN COPYRIGHT AND DATABASE RIGHTS 2016 ORDNANCE SURVEY 100019614. AERIAL PHOTOGRAPHY ©CHANNEL COASTAL OBSERVATORY.

Scour of the beach either side of tombolo is increasing as the shingle bar is moving onshore. As material is transported alongshore it is deposited along the tombolo as the waves shoal around this feature. However there is no net movement of shingle back to replenish the area that it had originated from, as waves do not propagate from the shingle bar or tombolo, so the beach either side of the tombolo is becoming depleted.

8-1-3 RECOMMENDED FUTURE WORKS

GRAVENEY (SECTION A)

Continue monitoring the sea wall at risk of undermining. Topographic data points will be collected along the structure at the beginning of every Phase (2017) as part of the Regional Coastal Monitoring Programme (RCMP), however monitoring of this structure should not be limited to the programme. Consideration may be given to beach recycling to cover the toe of the wall from undermining but with no controlling structures the material would gradually move west, again. Monitoring of the beach CSA is part of the RCMP and will be detailed in the analysis reports. The site requires further investigation and remedial works to prevent structural damage.

FAVERSHAM ROAD HOUSES (SECTION E)

Due to the low rate of change within the Graveney to Seasalter unit it is considered that beach monitoring as part of the RCMP is a sufficient response in the short term.

8-1-4 EMERGENCY WORKS

In the event of storm damage requiring urgent attention, it is recommended that bastion bags are deployed in front of the section of undermining. Other areas may require an emergency recharge. Material cannot be sourced from the shingle bank or Castle Coot Spit due to environmental restrictions, the foreshore is soft mud and covered by environmental designations (Figure 8-3). There are no sediment stores along this frontage for beach recycling and any extensive recycling works will require consultation with Natural England.

FIGURE 8-3 EXCAVATOR LOST IN THE DEEP MUD DURING THE WINDFARM CABLE INSTALLATION

8-2 4aSU09 – WHITSTABLE

8-2-1 MANAGEMENT SUMMARY

TABLE 8-2 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE WHITSTABLE FRONTAGE (SURVEY UNIT 4ASU09)

DEFENCE SECTION	OPERATOR	SMP SHORT-TERM POLICY	CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE	SEDIMENT BUDGET ANNUAL CHANGE IN M^3)$^+$	RECOMMENDED MANAGEMENT	PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS
A PRESTON PARADE	CANTERBURY CITY COUNCIL	HOLD THE LINE	1:50 (25) SEA WALL	-225 (-1,043 TO 748)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
B ADMIRALTY WALK TO RAILWAY EMBANKMENT		HOLD THE LINE	>1:200 (25) SEA WALL	-84 (-2,480 TO 1,213)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
C RAILWAY EMBANKMENT		HOLD THE LINE	>1:20 <1:50 (15) SLOPING CONCRETE	146 (-431 TO 791)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
D GOLF COURSE WALL		HOLD THE LINE	>1:200 (15) SEA WALL	-571 (-1,508 TO 292)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
E CARAVAN SITE WALL		HOLD THE LINE	>1:200 (1) SEA WALL	-91 (-671 TO 196)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
F CARAVAN SITE TO DANIEL'S COURT		HOLD THE LINE	>1:200 (1) SEA WALL	-96 (-1,214 TO 869)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
G DANIEL'S COURT TO WILKS WAY		HOLD THE LINE	>1:200 (1) SEA WALL	-26 (-274 TO 536)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
H TENNIS COURT WALL		HOLD THE LINE	>1:200 (1) SEA WALL	-11 (-97 TO168)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
I TENNIS COURT WALL		HOLD THE LINE	>1:200 (1) SEA WALL	-67 (-601 TO 143)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
J MARINE TERRACE		HOLD THE LINE	>1:200 (1) SEA WALL	-58 (-602 TO 276)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
K NEPTUNE'S ARM PH		HOLD THE LINE	(1) SEA WALL	-72 (-557 TO 85)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS
L NEPTUNE'S GAP TO THE VINES		HOLD THE LINE	>1:200 (1) SEA WALL	-60 (-698 TO 90)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.

M THE VINES & SHIPWRIGHTS LEE		HOLD THE LINE	>1:200 (1) SEA WALL	-67 (-376 TO 192)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
N SHIPWRIGHTS LEE TO KEAM'S YARD CP		HOLD THE LINE	>1:200 (1) SEA WALL	-10 (-197 TO 328)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
O KEAM'S YARD CP		HOLD THE LINE	>1:200 (25) SEA WALL	27 (-95 TO 187)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
P KEAM'S YARD CP TO THE COTTAGE		HOLD THE LINE	>1:200 (1) SEA WALL	9 (-586 TO 707)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
Q THE COTTAGE TO THE SAILING SCHOOL		HOLD THE LINE	>1:200 (1) SEA WALL	-9 (-784 TO 1,011)	MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.
HARBOUR		HOLD THE LINE	(10) HARBOUR AND RETAINING WALLS		MONITOR BEACH CSA	SSSI, SPA AND RAMSAR DESIGNATIONS.

* Allowable overtopping is measured in l/m/s and determines the SoP

** The minimum CSA (m^2) before undermining occurs (bold)

$^+$Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-2-2 MANAGEMENT HOTSPOTS

PRESTON PARADE

At the boundary between units 4aSU08 (Seasalter) and 4aSU09 (Whitstable) the sea wall curves landward which leaves one bay more exposed and consequently the beach levels are lower. There is potential that the beach level here will lower further and could eventually lead to the undermining of the sea wall, the toe height is +0.6mOD.

GOLF COURSE

Unlike the rest of the frontage of Whitstable, the sea wall fronting the Golf Course is not piled into the underlying clay. The lack of foundations leaves the sea wall at risk of undermining if the beach levels are allowed to drop too low. The consequence of the sea wall failing during a storm would be the 'back-door' flooding of Whitstable. This was previously demonstrated in 1953 where this section of sea wall had not yet been constructed and the sea flowed in behind the defences, inundating the rest of the town. Since this period, Whitstable has become more developed – an event with a similar magnitude would now have the potential to flood 20,000 properties.

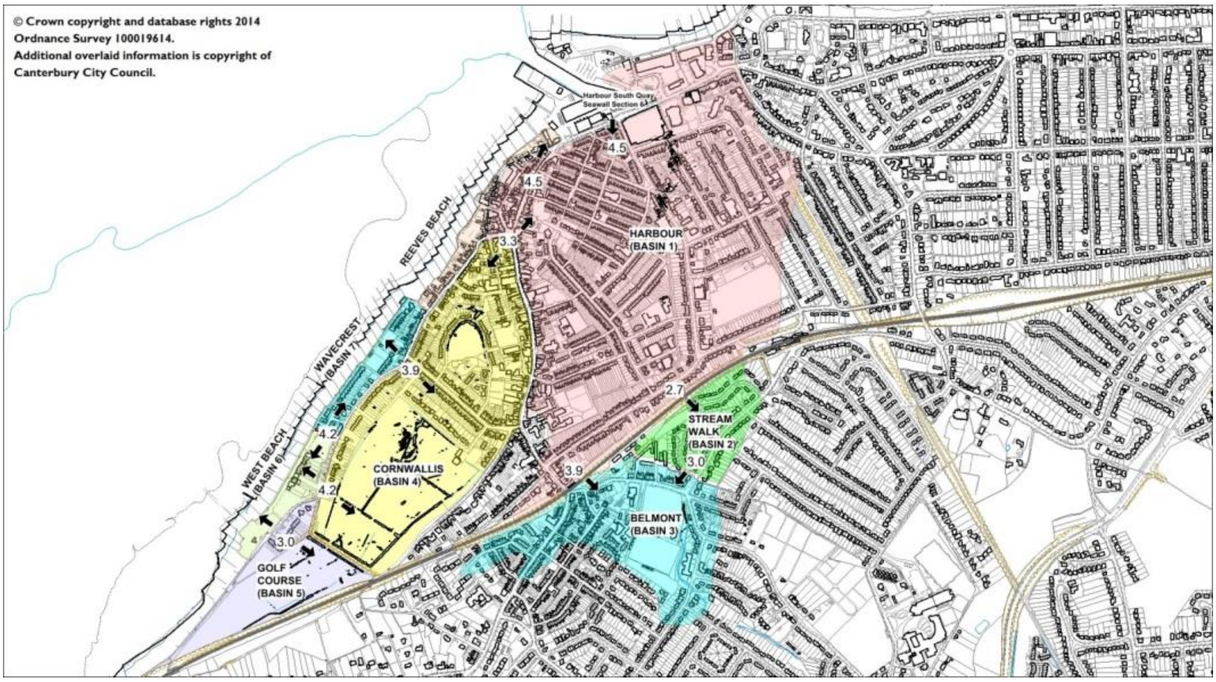


FIGURE 8-4 INTERCONNECTED FLOOD BASINS IN WHITSTABLE

8-2-3 RECOMMENDED FUTURE WORKS

Annual average volumetric change is very low. It is recommended that the beach levels are monitored against undermining CSAs regularly where data is provided as part of the Regional Coastal Monitoring Programme. Whilst the beach CSAs are above the trigger levels no maintenance work is required. The coastal scheme (2006) beach recharge and construction of new timber groynes has an expected lifetime of 50 years.

8-2-4 EMERGENCY WORKS

There is no sediment store along this frontage and previously material has been imported by barge from Ower's, Hastings and St. Katherine's Banks of the south coast.

In an emergency material could be sourced from groyne bays with a large amount of sediment in as a temporary measure.

8-3 4aSU10 – TANKERTON

8-3-1 MANAGEMENT SUMMARY

TABLE 8-3 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE TANKERTON FRONTAGE (SURVEY UNIT 4ASU10)

DEFENCE SECTION	**OPERATOR**	**SMP SHORT-TERM POLICY**	**CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE**	**SEDIMENT BUDGET ANNUAL CHANGE IN M^3)$^+$**	**RECOMMENDED MANAGEMENT**	**PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS**
A LOBSTER BAR/EAST QUAY	CANTERBURY CITY COUNCIL	HOLD THE LINE	1:50 (26.5) CONCRETE FOOTPATH	-146 (-1,376 TO 715)	MONITOR BEACH CSA	UNGATED ACCESS.
B EAST QUAY		HOLD THE LINE	>1:50 <1:100 (29) NO DEFENCE	-348 (-2,682 TO 1,633)	MONITOR BEACH CSA	UNGATED ACCESS.
C BOWLING CENTRE TO BEACH WALK		HOLD THE LINE	>1:200 (25) SEA WALL	370 (-2,273 TO 2,328)	MONITOR BEACH CSA	GATED ACCESS.
D BEACH WALK TO PUBLIC CONVENIENCE		HOLD THE LINE	>1:200 (25) SEA WALL	-135 (-2,142 TO 811)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
E PUBLIC CONVENIENCE TO THE BEACON HOUSE		HOLD THE LINE	>1:200 (25) SEA WALL	84 (-484 TO 700)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
F BEACON HOUSE TO CLIFF RD		HOLD THE LINE	>1:200 (25) SEA WALL	52 (-1,563 TO 1,221)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
G CLIFF RD TO ST. ANNE'S RD		HOLD THE LINE	>1:200 (25) SEA WALL	-1 (-558 TO 548)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
H ST. ANNE'S RD		HOLD THE LINE	>1:200 (25) SEA WALL	-22 (-1,071 TO 514)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. VEGETATED SHINGLE ON BACK BEACH. SSSI AND SAC DESIGNATIONS.
I ST. ANNE'S RD TO GRAYSTONE RD		HOLD THE LINE	>1:200 (25) SEA WALL	-74 (-429 TO 499)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. VEGETATED SHINGLE ON BACK BEACH. SSSI AND SAC DESIGNATIONS.
J GRAYSTONE RD TO PIER AVENUE		HOLD THE LINE	>1:200 (25) SEA WALL	-141 (-1,497 TO 934)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. VEGETATED SHINGLE ON BACK BEACH. SSSI AND SAC

						DESIGNATIONS.
K PIER AVENUE TO SAILING CLUB		HOLD THE LINE	>1:200 (25) SEA WALL	-181 (-1,022 TO 826)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
L SAILING CLUB TO SKATEBOARD PARK		HOLD THE LINE	>1:200 (25) SEA WALL	-1,193 (-4,532 TO 429)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
M SKATEBOARD PARK TO LONG ROCK		HOLD THE LINE	>1:200 (25) SEA WALL	365 (-447 TO 1,918)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. VEGETATED SHINGLE ON BACK BEACH.
LONG ROCK	ENVIRONMENT AGENCY/ CCC	HOLD THE LINE		-720 (-3,152 TO 3,538)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. VEGETATED SHINGLE ON BACK BEACH. SSSI, SPA, SAC AND RAMSAR DESIGNATIONS.

* The minimum CSA (m^2) before undermining occurs (bold)

** Allowable overtopping is measured in l/m/s and determines the SoP

$^+$Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-3-2 MANAGEMENT HOTSPOTS

LONG ROCK/SWALE BROOK MOUTH

The Swalecliffe Brook discharges just west of the shingle spit *Long Rock*. Due to the east to west sediment transport the mouth of the Brook often blocks with shingle deposited at high tide. It is important that this water course is kept clear to reduce the risk of fluvial flooding, especially during the winter months. Beach recycling is often required to extract the excess shingle which can be deposited just west of the Brook to increase sediment in neighbouring groyne bays or it can be trucked around to Swalecliffe (4aSU10) to fill the most western groyne bays.

The Brook has more recently (summer 2016) broken through the north face of the spit as shingle roll back has eroded the beach back to the channel. The breach location is close to the original location of the mouth and where the EA had previously cut a channel in 2013. This would be a suitable place to maintain the mouth of the Brook as the watercourse is more direct and should not block as quickly due to the large timber groyne to the east which reduces the shingle transported through longshore drift.

FIGURE 8-5 BLOCKAGE OF SWALECLIFFE BROOK MOUTH (2016)

8-3-3 RECOMMENDED FUTURE WORKS

The mouth of the Swalecliffe Brook must routinely be excavated to reduce flood risk, especially during winter months (October to March). Due to the increased frequency at which the mouth is becoming blocked consideration may be given to a longer term solution. CCC and the EA are currently investigating a partnership scheme to possibly install a culvert.

8-3-4 EMERGENCY WORKS

In the event of a storm blocking the Swalecliffe Brook mouth plant should be mobilised to clear it. The short term solution would be to send an excavator down to clear a channel but this would most likely block unless an engineering solution is installed. Once the stormy period has ended beach recycling could be considered depending on the extent of the blockage.

If maintaining the old Brook mouth, on the west side of Long Rock, operators must be aware of the disused sewage pipeline which is detailed in the summary diagram.

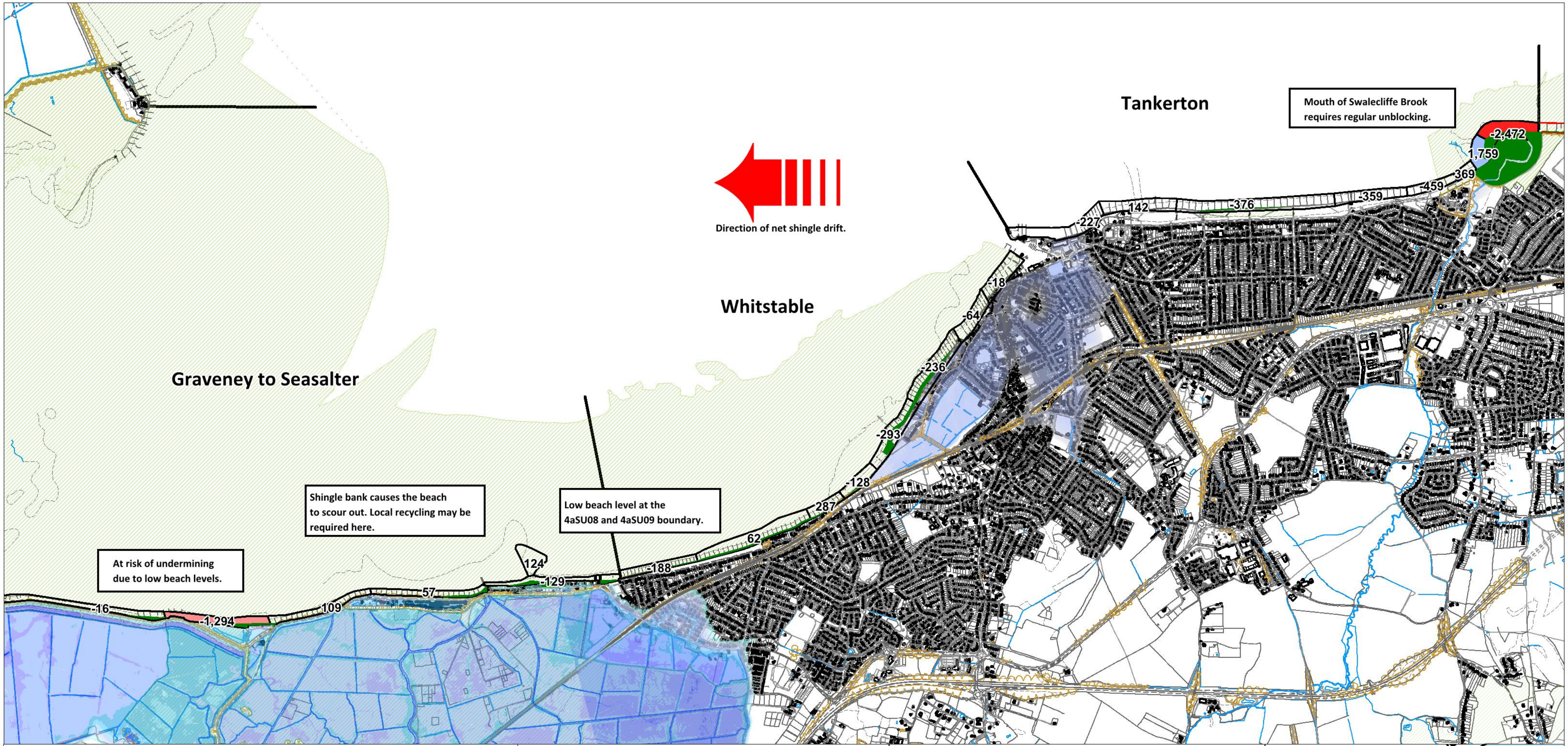


FIGURE 8-6 SUMMARY OF SEDIMENT TRANSPORT RATES, ENVIRONMENTAL RESTRICTIONS, AREAS OF CONCERN AND RECOMMENDED MANAGEMENT ALONG THE GRAVENEY TO LONG ROCK FRONTAGE

Map Legend

Polygons: Annual Average

Natural Change

- 🟥 < -3000 m3 / year
- 🟥 -2000 to -3000 m3 / year
- 🟥 -1000 to -2000 m3 / year
- ☐ -1000 to 1000 m3 / year
- 🟦 1000 - 2000 m3 / year
- 🟦 2000 - 3000 m3 / year

Environmental Constraints

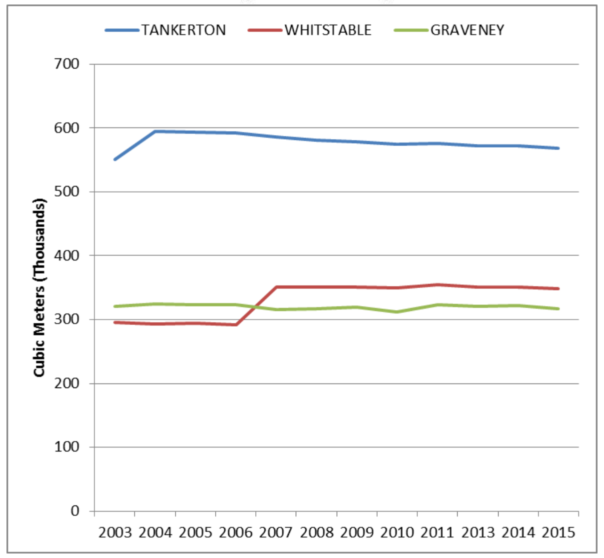
- ▨ National or International Designation
- 🟩 Vegetated Shingle - Restrictions on use of Plant

Floodplain Map

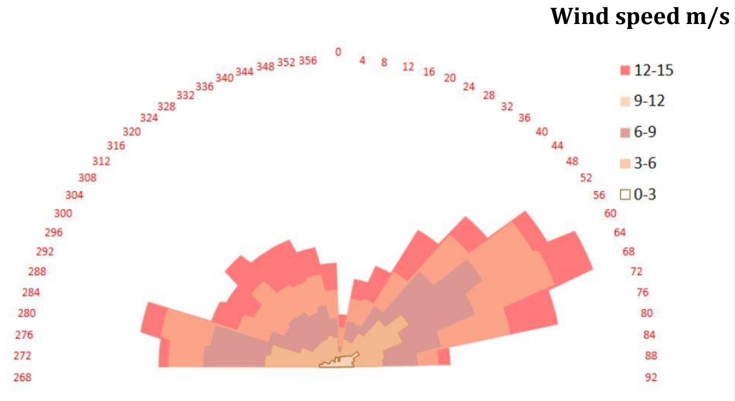
- 🟦 1:200 year extreme still water level planar flood map

Map Scale 1: 23,000

Total Volume of Beach Material in Graveney to Seasalter, Whitstable and Tankerton Units (2003-2015)



Wind Rose for Herne Bay indicative of direction, frequency & magnitude of waves, April 2014 - April 2015



8-4 4aSU11 – SWALECLIFFE

8-4-1 MANAGEMENT SUMMARY

TABLE 8-4 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE DEAL FRONTAGE (SURVEY UNIT 4ASU11)

DEFENCE SECTION	OPERATOR	SMP SHORT-TERM POLICY	CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE	SEDIMENT BUDGET ANNUAL CHANGE (M^3)$^+$	RECOMMENDED MANAGEMENT	PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS
A LONG ROCK TO COASTGUARD COTTAGE	CANTERBURY CITY COUNCIL	HOLD THE LINE	>1:200 (25) SEA WALL	-805 (-4,497 TO 1,738)	MONITOR BEACH CSA	GATED ACCESS AND ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
B COASTGUARD COTTAGE TO WEST BROOK SLUICE		HOLD THE LINE	>1:200 (25) SEA WALL	482 (-2,743 TO 3,171)	MONITOR BEACH CSA	GATED ACCESS AND ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
C WEST BROOK SLUICE TO HAMPTON PIER AVENUE		HOLD THE LINE	>1:200 (25) SEA WALL	-122 (-388 TO 423)	MONITOR BEACH CSA	GATED ACCESS AND ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
D HAMPTON PIER AVENUE		HOLD THE LINE	>1:200 (50) ROCK REVETMENT	-	MONITOR BEACH CSA	GATED ACCESS AND ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.

* Allowable overtopping is measured in l/m/s and determines the SoP

** The minimum CSA (m^2) before undermining occurs (bold)

$^+$Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-4-2 MANAGEMENT HOTSPOTS

MATTRESS EXPOSURE

Wire mattresses (300mm thick wire baskets filled with ragstone) were installed in the early 1990's and span from the most western groyne bay at Swalecliffe towards the centre of the unit for a length of approximately 450m. The mattresses maintain a minimum beach CSA to prevent the sea wall from undermining as the shingle bank to the west of the structure receded landwards. However; the erosive trend of low level losses can expose these mattresses. The mattresses are exposed from time to time but often naturally recover (Figure 8-7).

FIGURE 8-7 WIRE MATTRESS EXPOSURE AT EASTERN END OF SWALECLIFFE (2016)

GROYNE BAYS AT HAMPTON

The groyne bays surrounding the Westbrook sluice have low beach levels and the structure behind them is at risk of undermining. The scour of the beach material here is a result of the Hampton Pier terminal structure. As the terminal structure is a permanent feature it is unlikely that the beach will be able to maintain at a higher beach level here without much longer groynes.

8-4-3 RECOMMENDED MANAGEMENT

MATTRESS EXPOSURE

The large extent of the wire mattresses means that removal of the entire structure would be costly and the most practical method is to cut back the wire as it becomes exposed or to cover it with shingle. Regular visual inspections are recommended.

GROYNE BAYS AT HAMPTON

The beach levels should continue to be monitored as part of the RCMP. Structural surveys should be undertaken to monitor for cracks or early signs of undermining. The toe of the structure is +0.3mOD and the sheet piling extends down to -0.3mOD. If this is exposed to the sea the piling will corrode and compromise the integrity of the defence.

8-4-4 EMERGENCY WORKS

The frontage is well protected and is unlikely to require any emergency recycling works. Undermining of the sea wall at Westbrook sluice (eastern end of unit) may occur after extreme storm conditions. This is likely to be structural and therefore not covered within the scope of this report.

8-5 4aSU12 – HERNE BAY

8-5-1 MANAGEMENT SUMMARY

TABLE 8-5 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE DEAL FRONTAGE (SURVEY UNIT 4ASU12)

DEFENCE SECTION	OPERATOR	SMP SHORT-TERM POLICY	CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE	SEDIMENT BUDGET ANNUAL CHANGE (M^3)$^+$	RECOMMENDED MANAGEMENT	PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS
A HAMPTON PIER CP	CANTERBURY CITY COUNCIL	HOLD THE LINE	>1:2 (130) FLOATING CAR PARK	33 (-2,339 TO 5,156)	MONITOR BEACH CSA	UNGATED ACCESS, PLANT CAN TRACK ONTO BEACH FROM CP
B HAMPTON PIER CP TO ANGLING CLUB		HOLD THE LINE	>1:200 (80) CONCRETE SLABS WITH RETAINING WALL	-147 (-1,684 TO 961)	MONITOR BEACH CSA	ACCESS VIA BEACH AT HAMPTON PIER CP
C ANGLING CLUB TO SELSEA AVENUE		HOLD THE LINE	>1:2 <1:5 (25) TARMAC PROM	390 (-1,276 TO 3,665)	MONITOR BEACH CSA	ACCESS VIA BEACH AT HAMPTON PIER CP
D SELSEA AVENUE TO LANE END		HOLD THE LINE	>1:20 <1:50 (10) SEA WALL	-356 (-1,855 TO 696)	MONITOR BEACH CSA	ACCESS VIA BEACH AT HAMPTON PIER CP
E LANE END TO MINI GOLF COURSE		HOLD THE LINE	1:50 (10) SEA WALL	30 (-844 TO 913)	MONITOR BEACH CSA	ACCESS VIA BEACH AT HAMPTON PIER CP
F MINI GOLF COURSE TO NEPTUNE'S ARM		HOLD THE LINE	>1:5 <1:10 (1) SEA WALL	-92 (1,994 TO 1,276)	MONITOR BEACH CSA	ACCESS VIA NEPTUNE CP.
G NEPTUNE'S ARM TO COOPER'S HILL RD		HOLD THE LINE	>1:200 (10) SEA WALL	106 (-535 TO 1,053)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
H COOPER'S HILL RD TO EAST CLIFF PARADE		HOLD THE LINE	(50) SEA WALL	-162 (-1,109 TO 999)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
I EAST CLIFF PARADE TO LOOKOUT STATION		HOLD THE LINE	>1:200 (25) SEA WALL	-25 (-1,647 TO 3,498)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
J LOOKOUT STATION TO SEA VIEW RD		HOLD THE LINE	>1:200 (25) SEA WALL	-41 (-3,727 TO 1,205)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
K		HOLD	>1:100 <1:200	-103	MONITOR	GATED ACCESS

SEA VIEW RD TO CLIFF AVENUE		THE LINE	(25) SEA WALL	(-883 TO 769)	BEACH CSA	VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
L CLIFF AVENUE TO BURLINGTON DRIVE		HOLD THE LINE	1:100 (25) SEA WALL	-37 (-437 TO 730)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
M BURLINGTON DRIVE TO LISMORE RD		HOLD THE LINE	>1:200 (25) SEA WALL	-21 (-339 TO 231)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
N LISMORE RD TO CONYNGHAM RD		HOLD THE LINE	>1:200 (25) SEA WALL	88 (-1,461 TO 1,609)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
O CONYNGHAM RD TO RECULVER DRIVE CP		HOLD THE LINE	>1:200 (25) SEA WALL	-63 (-799 TO 1,669)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
P RECULVER DRIVE CP TO OCEAN VIEW		HOLD THE LINE	>1:200 (25) SEA WALL	-82 (-1,890 TO 1,877)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
Q OCEAN VIEW TO BISHOPSTONE GLEN		HOLD THE LINE	>1:20 < 1:50 (25) SEA WALL	59 (-471 TO 624)	MONITOR BEACH CSA	GATED ACCESS VIA PROM. SSSI, SPA AND RAMSAR DESIGNATIONS.
R EAST OF BISHOPSTONE GLEN		HOLD THE LINE	ROCK REVETMENT	-127 (861 TO 1,455)	MONITOR BEACH CSA	RESTRICTED ACCESS. SSSI, SPA AND RAMSAR DESIGNATIONS.

* Allowable overtopping is measured in l/m/s and determines the SoP

** The minimum CSA (m^2) before undermining occurs (bold)

$^+$Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-5-2 MANAGEMENT HOTSPOTS

HERNE BAY PIER

The dominant drift direction along the Herne Bay frontage is east to west; and the Neptune Arm breakwater protects the low lying flood plain. When waves approach from the west they move material into the harbour, towards the Bandstand, but no wave action can push the beach back towards the Pier. Gradually, the beach east of the Herne Bay Pier scours and exposes the wall foundations. Three timber groynes were constructed in 2013/14 to reduce the level of scour inside the harbour. Similarly, to the west of the Pier the dominant drift moves material eastwards from Lane End towards the Pier.

SECTION H (EAST CLIFF PARADE)

The CSA chart (Chapter 7) shows the most western profile in Section H (4a001053) to be within the critical range for sea wall failure. The apron did fail here in 2015 and although the apron was repaired no beach material was deposited in front of this structure. Despite emergency works, the sloping apron is still at risk of failing where the beach levels are low.

8-5-3 RECOMMENDED MANAGEMENT

HERNE BAY PIER

Small annual or biennial recharges are currently undertaken adjacent to Herne Bay Pier. Approximately 2,500 m^3 of material is to be moved from the Bandstand to the area of scour within and next to the timber groynes (Figure 8-8). Approximately 1,000-2,000m^3 is extracted from immediately west of the Pier to replenish bays towards the Lane End roundabout.

FIGURE 8-8 BEACH RECYCLING WITHIN THE HARBOUR

SECTION H (EAST CLIFF PARADE)

The low beach levels exposed the sheet piling at the side of this structure, causing a loss of fill behind this concrete block revetment which caused the sea wall to fail (Figure 8-9). Recommendations for regular structural surveys along this section and continual monitoring of the beach data from the RCMP are essential.

FIGURE 8-9 SEA WALL FAILURE IN HERNE BAY SECTION H AFTER ONE TIDE 9(LEFT) AND AFTER TWO TIDES (RIGHT)

8-5-4 EMERGENCY WORKS

Overall, beach levels are relatively healthy. In the event of emergency recycling, there is little material available within the frontage so shingle will need to be imported.

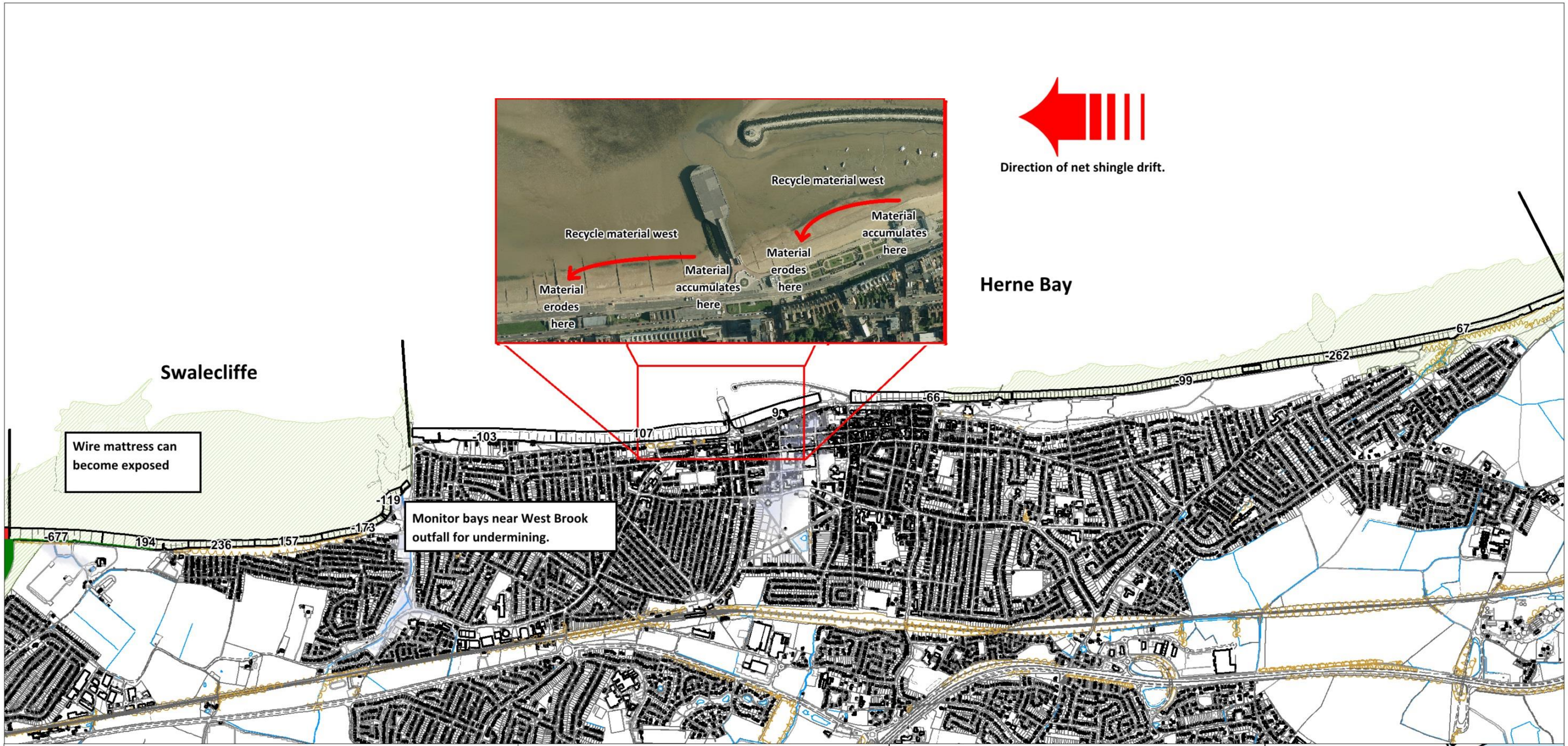


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FIGURE 8-10 SUMMARY OF SEDIMENT TRANSPORT RATES, ENVIRONMENTAL RESTRICTIONS, AREAS OF CONCERN AND RECOMMENDED MANAGEMENT ALONG THE SWALECLIFFE TO HERNE BAY FRONTAGE

Map Legend

Polygons: Annual Average

Natural Change

- ■ < -3000 m3 / year
- ■ -2000 to -3000 m3 / year
- ■ -1000 to -2000 m3 / year
- □ -1000 to 1000 m3 / year
- ■ 1000 - 2000 m3 / year
- ■ 2000 - 3000 m3 / year

Environmental Constraints

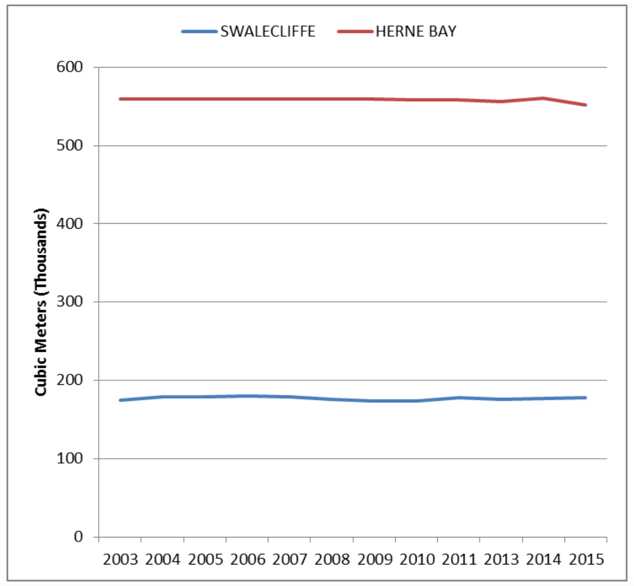
- ▨ National or International Designation
- ■ Vegetated Shingle - Restrictions on use of Plant

Floodplain Map

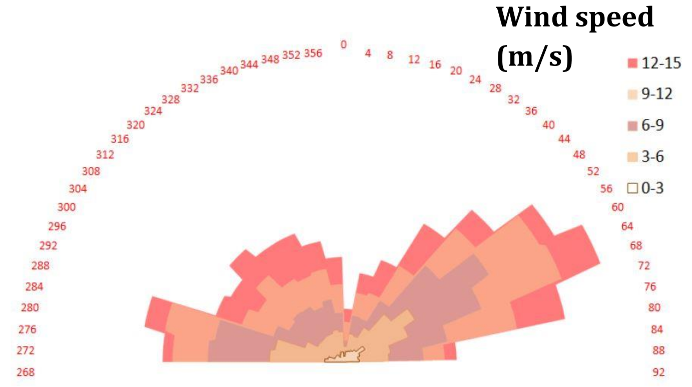
- ■ 1:200 year extreme still water level planar flood map

Map Scale 1: 18,000

Total Volume of Beach Material in Swalecliffe to Herne Bay Units (2003-2015)



Wind Rose for Herne Bay indicative of direction, frequency & magnitude of waves, April 2014 - April 2015



8-6 4aSU14 – NORTHERN SEA WALL

8-6-1 MANAGEMENT SUMMARY

TABLE 8-6 A SUMMARY OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE DEAL FRONTAGE (SURVEY UNIT 4ASU14)

DEFENCE SECTION	**OPERATOR**	**SMP SHORT-TERM POLICY**	**CURRENT SOP (ALLOWABLE OT*) OR (UNDERMINING THRESHOLD**) AND DEFENCE TYPE**	**SEDIMENT BUDGET ANNUAL CHANGE (M^3)$^+$**	**RECOMMENDED MANAGEMENT**	**PLANT ACCESS AND ENVIRONMENTAL RESTRICTIONS**
A RECULVER TOWERS	ENVIRONMENT AGENCY	HOLD THE LINE	(50) REVETMENT	-110 (-635 TO 415)	MONITOR ROCK REVETMENT	RESTRICTED ACCESS.
B RECULVER TOWERS		HOLD THE LINE	>1:200 (25) REVETMENT	12 (-635 TO 415)	MONITOR ROCK REVETMENT	RESTRICTED ACCESS.
C MOLLUSC HATCHERY		HOLD THE LINE	>1:200 (10) SEA WALL	-981 (-2,202 TO -246)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
D MOLLUSC HATCHERY		HOLD THE LINE	>1:200 (10) SEA WALL	-2,077 (-5,512 TO 1,063)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
E MOLLUSC HATCHERY		HOLD THE LINE	>1:200 (10) SEA WALL	-747 (-2,140 TO 337)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
F		HOLD THE LINE	>1:200 (10) SEA WALL	-740 (-1,718 TO 617)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
G		HOLD THE LINE	>1:200 (10) SEA WALL	-821 (-1,708 TO 541)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
H COLD HARBOUR LAGOON		HOLD THE LINE	(10) SEA WALL	968 (-4,491 TO 5,647)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
I		HOLD THE LINE	>1:200 (10) SEA WALL	-944 (-4,566 TO 4,660)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
J		HOLD THE LINE	>1:200 (10) SEA WALL	-90 (-1,850 TO 1,446)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
K		HOLD THE LINE	>1:200 (10) SEA WALL	2,457 (-1,346 TO 7,912)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
L ST. AUGUSTINE'S BANK		HOLD THE LINE	>1:200 (10) SEA WALL	-264 (-2,531 TO 1,253)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.
M ST. AUGUSTINE'S BANK TO MINNIS BAY		HOLD THE LINE	>1:200 (10) SEA WALL	694 (-3,431 TO 10,004)	MONITOR BEACH CSA	GATED ACCESS VIA PROM.

* Allowable overtopping is measured in l/m/s and determines the SoP

** The minimum CSA (m^2) before undermining occurs (bold)

+Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

8-6-2 MANAGEMENT HOTSPOTS

MOLLUSC HATCHERY

Section C and D front the Mollusc Hatchery which require protection from the sea water and essentially overtopping. The longshore transport is predominantly west to east and with little to no sediment feed from Reculver Towers causing this section to lose sediment. The shingle sand beach is prone to cliffing and often has a narrow beach crest.

COLDHARBOUR OUTFALL

The Cold Harbour outfall is frequently blocked with shingle which hinders the function of the outfall. This is due to the shortness of the outfall and exacerbated by high beach levels either side of the outfall, caused by the outfall structure itself being impermeable. CCC are currently looking at longer term solutions, such as an outfall extension.

BEACH CLIFFING

Due to the high proportion of fine sediment mixed in with the shingle at Northern Sea wall the beach is subject to cliffing. Historically, the beach has been re-profiled to maintain the design profile; however this leads to the transport of sand from the lower beach being transported up to the top of the beach, leading to a high sand content and corresponding decrease in permeability.

SALINE LAGOONS

There are two lagoons at Northern Sea Wall, the Cold Harbour Lagoon and the Plumpudding/St. Augustine’s Bank Lagoon. The former provides habitat to wintering birds however the latter has become infilled with sediment as part of a natural “roll back” process. This is a potential source of sediment for a recharge to the erosive section to the west.

MINNIS BAY

Due to the close proximity of the shingle bays and a bi directional wave climate, some shingle sediment escapes Northern Sea Wall and ends up along the sandy beach of Minnis Bay. This material has previously accumulated to a few thousand metres cubed of sediment which is a valuable source of sediment for Northern Sea Wall if works are required.

8-6-3 RECOMMENDED MANAGEMENT

MOLLUSC HATCHERY

Beach levels were below the recommended design levels until the recent beach recycling scheme redistributed shingle along this frontage. The beach loses in the region of 3,800m^3 per year and so beach recycling should aim to replace this through annual or biennial schemes. An extremely stormy year may require a greater quantity of material and the RCMP data should be used to quantity the required volumes.

COLDHARBOUR OUTFALL

The beach material here needs to be removed from the outfall regularly to maintain the flow through the channel. The EA operations team maintains the outfall using an onsite excavator and has written guidance in their Operations Manual.

BEACH CLIFFING

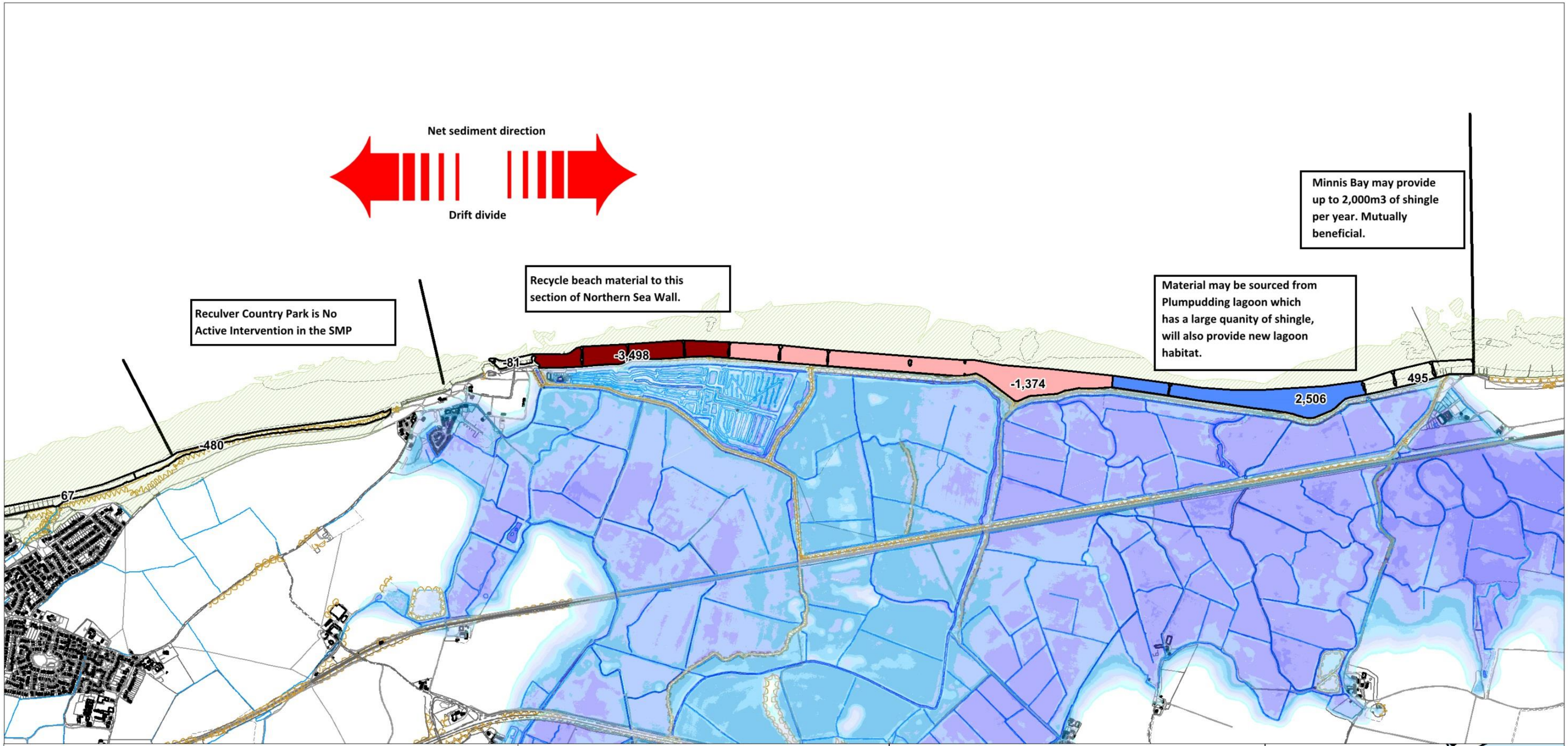
Cliffing is a natural problem for mixed sediment beaches such as Northern Sea Wall, which borders the sandy beaches of Minnis Bay, Thanet. Therefore, to a certain extent, cliffing will always be a problem. However, historically beach reprofiling dozed material from the bottom of the beach towards the top to create a wider crest, thus increasing the proportion of fine sediment along the main crest. Ceasing this practice of re-profiling should reduce the extent of cliffing however this may not be evident immediately as it will take time for all the fine sediment to wash out. In the longer term this will reduce cliffing along the frontage.

MINNIS BAY

The shingle transported onto the sandy beaches of Minnis Bay should try to be retrieved where possible. The sediment budget (Appendix E) suggests that on average c.1,950 m^3 of shingle is lost to Minnis Bay annually. It is mutually beneficial for this shingle to be retrieved as Thanet DC do not want shingle on their sand amenity beach and Northern Sea Wall need the sediment for depositing in Section C and D. Depending on the extent of the shingle in Minnis Bay, beach recovery is anticipated every other year.

8-6-4 EMERGENCY WORKS

Should emergency works be required it is recommended that the EA bring forward their normal beach recycling programme.



Reculver Country Park is No Active Intervention in the SMP

Recycle beach material to this section of Northern Sea Wall.

Material may be sourced from Plumpudding lagoon which has a large quanity of shingle, will also provide new lagoon habitat.

Minnis Bay may provide up to 2,000m3 of shingle per year. Mutually beneficial.

FIGURE 8-11 SUMMARY OF SEDIMENT TRANSPORT RATES, ENVIRONMENTAL RESTRICTIONS, AREAS OF CONCERN AND RECOMMENDED MANAGEMENT ALONG THE RECULVER COUNTRY PARK TO NORTHERN SEA WALL FRONTAGE

Map Legend

Polygons: Annual Average

Natural Change

- 🟥 < -3000 m3 / year
- 🟥 -2000 to -3000 m3 / year
- 🟥 -1000 to -2000 m3 / year
- ☐ -1000 to 1000 m3 / year
- 🟦 1000 - 2000 m3 / year
- 🟦 2000 - 3000 m3 / year

Environmental Constraints

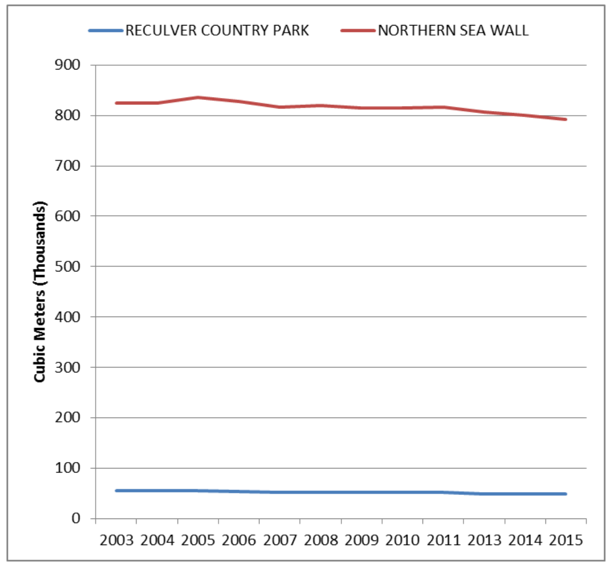
- ▨ National or International Designation
- 🟩 Vegetated Shingle - Restrictions on use of Plant

Floodplain Map

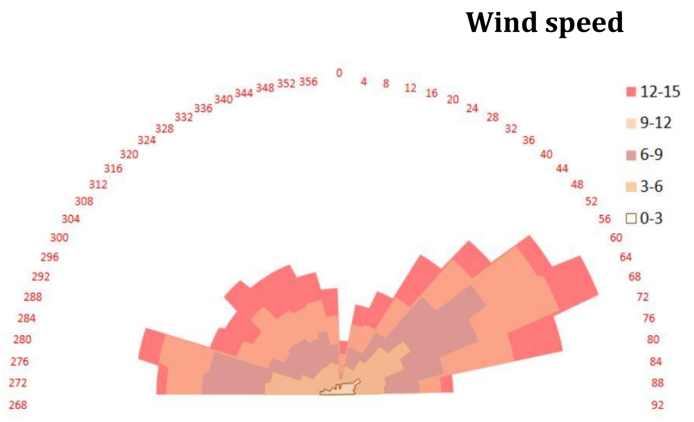
- 🟦 1:200 year extreme still water level planar flood map

Map Scale 1: 18,000

Total Volume of Beach Material in Bishopstone and Northern Sea Wall Units (2003-2015)



Wind Rose for Herne Bay indicative of direction, frequency & magnitude of waves, April 2014 - April 2015



8-7 REGIONAL OVERVIEW

TABLE 8-7 A REGIONAL OVERVIEW OF DEFENCES, STANDARD OF PROTECTION, LONGSHORE DRIFT AND RECOMMENDED MANAGEMENT ALONG THE NORTH KENT FRONTAGE (SURVEY UNITS 4ASU08 – 4ASU14).

UNIT	SMP SHORT TERM POLICY	CURRENT SOP	SEDIMENT BUDGET ANNUAL CHANGE (M^3)*	MANAGEMENT	RESTRICTIONS
GRAVENEY TO SEASALTER	HOLD THE LINE	1:100 TO >1:200	-146 (-7,266 TO 11,747)	MONITORING.	ENVIRONMENTAL DESIGNATIONS, PRIVATE LANDOWNERS, VILLAGE GREEN DESIGNATION 128
WHITSTABLE	WEST – HOLD THE LINE EAST - HOLD THE LINE	>1:20 TO >1:200	-1,264 (-2,977 TO 5,954)	MONITORING.	ENVIRONMENTAL DESIGNATIONS VILLAGE GREEN DESIGNATION 126
TANKERTON	HOLD THE LINE	1:50 TO >1:200	-2089 (-11,927 TO 4,638)	MONITORING.	ENVIRONMENTAL DESIGNATIONS
SWALECLIFFE	HOLD THE LINE	>1:200	-466 (-3,647 TO 1,401)	MONITORING.	ENVIRONMENTAL DESIGNATIONS
HERNE BAY	HOLD THE LINE	>1:2 TO >1:200	-550 (-9,685 TO 8,469)	MONITORING, BIANNUAL RECYCLING AT LANE END AND THE HARBOUR.	ENVIRONMENTAL DESIGNATIONS
RECULVER COUNTRY PARK	NO ACTIVE INTERVENTION	N/A	-546 (-1,528 TO 696)	MONITORING.	ENVIRONMENTAL DESIGNATIONS
NORTHERN SEA WALL	HOLD THE LINE	>1:200	-2,645 (-10,493 TO 10,400)	MONITORING, RECYCLING ON AN AS AND WHEN BASIS.	ENVIRONMENTAL DESIGNATIONS

* Sediment budget figures show annual average natural change, with the highest positive and negative changes in brackets.

The beaches of North Kent are generally above design although there are a few pinch points which need to be monitored closely. The frontage is heavily groyned and therefore experiences low annual changes to the beach levels.

The key areas which need close monitoring are:

Seasalter – low beach levels, may require emergency works

Long Rock – Maintain opening for river mouth (long term solution under investigation)

Swalecliffe – Mattresses at eastern end and undermining at Westbrook

Herne Bay – Biannual recycling at Lane End and inside the Harbour

Northern Sea Wall – recycle from Minnis Bay on an ad-hoc basis, recharge from St.Augustine’s Bank into sections C-E.

9 MONITORING

Future monitoring is imperative to ensuring all aspects of the coastline are maintained and recorded using a controlled method which meets the minimum requirements for individual beaches along the Graveney to Northern Sea Wall stretch. Much of this stretch is a heavily defended shingle sand beach with the same monitoring requirements along the full stretch of coastline. Long Rock, a dynamic shingle sand spit is the only anomaly.

The three main sources include the Regional Coastal Monitoring Programme (RCMP), which is a national project dedicated to collecting topographic, bathymetric, hydrological and photogrammetry data along the English coastline. For the Graveney to Northern Sea Wall stretch, the project is currently in its third Phase (2012-2017) and set to continue into its fourth Phase (2017 to 2021). All data is freely available from www.channelcoast.org. The Environment Agency run Lidar flights, formerly available via Geomatics, are now freely available through Opening Up Government (OGL) www.data.gov.uk. Lastly, asset surveys, recycling and replenishment logs, annual oblique aerial photography, photographic evidence of storms and storm damage are available through Canterbury City Council.

9-1 TOPOGRAPHIC SURVEYS

9.1.1 BEACH SURVEYS

Regular beach surveys are extremely useful for providing historic trends, assessing future behaviour and recording the effect of storms or replenishment campaigns on the beach level. Beach levels are monitored against Design, Maintenance and Critical Levels which ensure the beach remains above a level which could cause damage to infrastructure or the public. Regular monitoring of beach levels allows deterioration of the beach to be noted early so pre-emptive works can be undertaken, opposed to remedial works after a failure. Beach levels are used for planning coastal maintenance or larger schemes and monitoring recycling and replenishment volumes.

Beach levels can be acquired through beach profiles, collected using a rover on a detail pole at a known elevation and measuring beach elevations along a known transect on the beach). Beach levels can also be acquired through continuous surveys, conducted either on foot or using an ATV. The GNSS kit is mounted onto a backpack or the ATV and shore parallel lines are walked or driven to collect elevation data along each crest and trough to create a 3D model of the beach.

Profiles are to be spaced at regular intervals, to be determined by the presence of a groyne field, change in orientation and risk – classified by the hinterland (flood basin, soft cliff and dense urban areas). Profiles are referred to as intermediate and designated. Designated profiles are the key profiles which can provide a general oversight to the beach condition, spaced at 200-500m intervals. Intermediate profiles allow full coverage of the beach once per year and are much more closely spaced, between 30-100m apart.

The RCMP has surveyed the beaches along this stretch of coastline since 2003 and has set profiles according to the orientation, risk and groyne fields. From Autumn 2016 data will be collected along this frontage twice per year, Spring and Autumn. The survey requirements of the individual locations are listed in Table 9-1.

TABLE 9-1 SURVEY REQUIREMENTS

LOCATION	RISK	SEVERITY	SURVEY REQUIREMENTS
GRAVENEY TO SEASALTER	SPARSELY POPULATED BUT WITH KEY INFRASTRUCTURE AND AGRICULTURAL LAND BEHIND.	SEVERE DAMAGE TO PROPERTY, KEY INFRASTRUCTURE AND FARMLAND	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY
WHITSTABLE	DENSELY POPULATED, LARGE SETTLEMENTS AND FLOOD BASIN.	SEVERE DAMAGE TO PROPERTY, SERVICES, HUMAN LIFE AND INFRASTRUCTURE	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY
TANKERTON	CLAY SLOPES WITH LARGE SETTLEMENT AT THE TOP.	EROSION RISK TO SLOPES AND PROPERTY IF BEACH NOT MAINTAINED	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY
LONG ROCK	LOW LYING DENSELY POPULATED HINTERLAND.	SEVERE FLOODING AND DAMAGE TO PROPERTIES AND RISK HUMAN LIFE	▪ MAXIMUM SURVEY ALLOWANCE ▪ 3 BASELINE SURVEYS ▪ PROVISION FOR POST STORMS
SWALECLIFFE	LOW LYING LAND WITH LARGE SETTLEMENT. ALSO IMPORTANT RIVER OUTLET.	SEVERE DAMAGE TO PROPERTY AND SERVICES	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY
HERNE BAY	DENSELY POPULATED LARGE SETTLEMENT.	SEVERE DAMAGE TO PROPERTY, SERVICES, HUMAN LIFE AND INFRASTRUCTURE	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY
RECULVER COUNTRY PARK	CLIFFS UNDEFENDED.	LOW	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS

			▪ LIDAR SURVEY BI-ANNUALLY
NORTHERN SEA WALL	PUMPING STATION AND LARGE AREA OF AGRICULTURAL LAND BEHIND.	SEVERE DAMAGE TO AGRICULTURAL LAND AND PUMPING STATION	▪ ONE FULL BMP SURVEY (PROFILES AND 3D MODEL) IN THE SPRING, ONE ADDITIONAL PROFILE SURVEY IN THE AUTUMN ▪ PROVISION FOR POST STORMS ▪ LIDAR SURVEY BI-ANNUALLY

9.1.2 POST STORM SURVEYS

In the event of a storm, additional profiles are surveyed to provide an instant overview of any damage; allowing comparison of post storm levels to the design, maintenance and critical levels and should be used to inform any remedial works.

To instigate a post storm survey, a member of the RCMP will contact the Operating Authority (OA) within 12 hours of the storm for guidance on the post storm requirements. If beach is drawn down and it is thought to recover within a few tidal cycles then it is for the OA to decide if a survey will be beneficial. If the beach has been severely eroded and remedial works are imminent, a post storm survey is required immediately. If you have not heard from the RCMP, contact them immediately as they can mobilise for the next low tide.

A post storm survey will collect the data most useful to the OA. If damage has occurred along the whole frontage, a selection of designated profiles will provide an overview. Or, if the damage is more localised the OA should request a survey in a specific area. The RCMP will then survey a feasible number of profiles during a tidal cycle.

It is advised that a post storm survey is undertaken to recalculate the standard of protection provided by the beach using the overtopping charts.

9.1.3 BEACH MANAGEMENT SURVEYS

When beach management works are to be undertaken it might be useful to carry out a pre works (IN) and/or a post works (OUT) survey. Requests should be made to the RCMP as soon as the timing of the works are known to potentially tie at least one of these extra surveys into the regular survey schedule. This might allow a better quantification of sediment volumes added or moved. Similar to the post storm survey, it is carried out to the preference of the OA; as either a general coverage of the beach through designated profiles, a concentrated selection of profiles on a shorter frontage or a full laser scan of the beach. These surveys are likely to have to be funded from maintenance or project specific sources other than the RCMP. There is also a need to fill out a maintenance log when beach management works have been undertaken (see Section 9.8.7).

9.2 BATHYMETRIC SURVEYS

The seabed requires surveying as the cross shore transport of sediment is rarely captured in the laser scans. Ideally, one bathymetric survey per year would provide a clearer indication to the seabed movements but due to the financial implications of each bathymetric survey it is not feasible to commission them regularly. With this is mind, a full multi-beam survey was undertaken in 2013 which captured the whole coastline from Graveney to Minnis Bay in a 3D model, recording the substrate and elevation. Single-beam surveys of North Kent in 2004 and 2007.

The sea bed off the north Kent coastline is typically featureless. Deposits of fine material line the sea floor and there are no large offshore shingle deposits. A key concern in this area is the erosion of the sea floor and foreshore as the deepening of the water column would allow greater waves onto the shore in a storm event.

9.3 AERIAL SURVEYS

9.3.1 LIDAR

For sections of coastline which are difficult to access or have soft cliffs, Lidar is a suitable method of data collection for monitoring. Lidar data will be collected along this whole stretch of coastline biannually as part of the RCMP in Phase IV. .

9.3.2 ORTHO-RECTIFIED PHOTOGRAPHS

Ortho-rectified photographs provide a visual comparison of the coastline and allow GIS data to be overlaid onto the most updated photographs. As the coastline is continuously changing it would be recommended to update the photographs every five years as a minimum.

9.3.3 UAV

The Unmanned Aerial Vehicle (UAV) is a piece of quickly evolving technology which can be used to produce photogrammetry of the beach from the air; similar to Lidar. A control network would need installing to provide control points for the UAV to survey to ensure the data was accurate.

9.4 ASSET MONITORING

9.4.1 FULL INSPECTION

In accordance with the Flood and Water Management Act (2010) OAs are required to maintain a record of flood and coastal defence assets, and it is recommended that this record is updated annually with the condition of these assets.

Each asset should be recorded with the location, defects, recommended repair works and a time frame for completion. All assets should be photographed and compared against previous asset surveys to monitor any deterioration.

Sea walls should be assessed in terms of parapet or capping beam, wall section and wall toe against spalling, cracking, holes, missing or damaged sealant, slippage of precast concrete blocks, sinking, slumping of concrete revetment, vegetation growth, exposed rebar.

In addition, groynes (timber and rock) should be assessed for missing or burnt planks, eroding piles, conditions of landward connection, seaward roundhead, groyne capping beam, sheet piling; or rock groynes, slippage or holes.

9.4.2 VISUAL INSPECTION

In addition to the full asset survey it is recommended that the OA carry out a visual inspection of their coastline once per month between October and March to check for damage to the frontage caused by persistent wave attack. Waves can reduce the crest width without exceeding the storm threshold, and if the wave direction is persistently from the same direction then large volumes of sediment can be transported along the coastline leaving weak areas exposed. Any damaged sections should be photographed and dated.

Following a storm, additional visual inspections are recommended to monitor damage until remedial works can be undertaken. Again, photographs should be taken and logged with the location and date of the storm as this can verify future overtopping calculations.

A full visual inspection is recommended in the spring each year to assess any damage from the winter period and allow sufficient time to organise remedial works in preparation for the following winter. This visual inspection could be combined with the full asset survey or performed as a separate check.

9.5 ENVIRONMENTAL SURVEYS

Construction work within the coastal zone can be disruptive to the plant life. However with a good understanding on the location and distribution of vegetation works can be planned to avoid any damage. A site visit and/or use of high resolution aerial photography, such as that produced by the RCMP, should be used to identify the need for a vegetation survey. Alternatively, vegetated shingle has been mapped between Graveney and Northern Sea Wall and is available to view on magic.gov.uk, Natural England's mapping service.

If a site is identified as sustaining a significant community of shingle vegetation then monitoring should be carried out pre and post works. The East Sussex Vegetated Shingle Management Plan outlines a suitable methodology which has been used throughout the frontage as part of the beach management by East Sussex County Council (T.Scott, Appendix A, 2009). It is preferable to undertake the surveys between June and August.

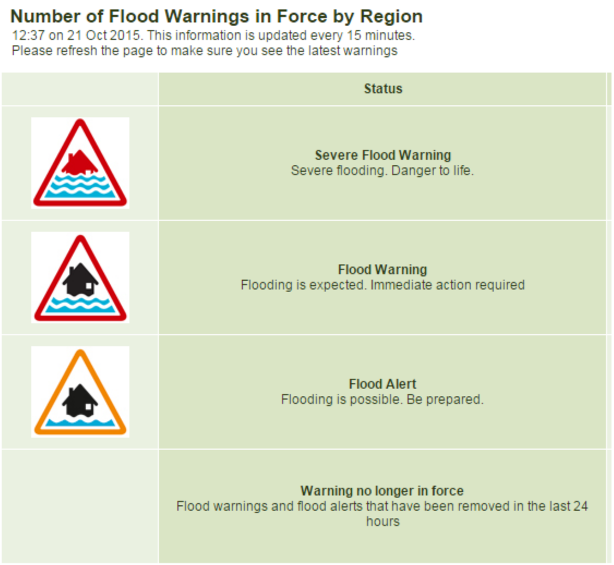
FIGURE 9-1 VEGETATED SHINGLE, SEASALTER

9.6 HYDROLOGICAL MONITORING

Wave and weather data is required along the Graveney and Northern Sea Wall coastline. The Channel Coast Observatory has an Etrometa step gauge stationed at the old Herne Bay Pier Head which covers the entire North Kent coastline. This data supports the beach monitoring but more importantly records the wave heights which informs the LLFA if the waves have exceeded the storm thresholds. The Etrometa step gauge measures both waves and tides.

9.7 WARNING PROCEDURES

It is a requirement for Lead Local Flood Authorities (LLFA) to have flood warning systems in place. It is recommended that the Environment Agency's Flood Warning System is used to inform the engineers or on-call staff of any imminent or predicted flood warnings (Figure 9-2). Email and text alerts can be set up for all involved staff. It is also recommended to monitor the wave buoys before, during and after a storm; text alerts for waves exceeding the storm threshold at individual wave buoys can also be set up at channelcoast.org/alerts.



Number of Flood Warnings in Force by Region

12:37 on 21 Oct 2015. This information is updated every 15 minutes.
Please refresh the page to make sure you see the latest warnings

	Status
⚠	**Severe Flood Warning** Severe flooding. Danger to life.
⚠	**Flood Warning** Flooding is expected. Immediate action required
⚠	**Flood Alert** Flooding is possible. Be prepared.
	Warning no longer in force Flood warnings and flood alerts that have been removed in the last 24 hours

FIGURE 9-2 ENVIRONMENT AGENCY FLOOD WARNING CATEGORIES WWW.ENVIRONMENT-AGENCY.GOV.UK

9.8 REPORTING AND INTERPRETATION

9.8.1 ANNUAL BEACH REPORT

The Operating Authority (OA) can expect an annual beach report detailing the wave conditions, recycling works and the results of the topographic survey indicating the beach response throughout the year which will be issued by the RCMP. This report will highlight areas of concern and any repeatedly eroding or accreting sections as well as suggesting areas to monitor during the next year.

The CSA of the beach will be plotted on a graph to compare the most recent survey to the design, maintenance and critical levels as described in Chapter 7. The most recent CSA will also be plotted onto a series of overtopping graphs to illustrate the risk of overtopping along the frontage (Appendix G).

9.8.2 POST STORM REPORT

Following a post storm survey a short analysis report will be sent to the OA to identify the effect of the storm compared to the pre storm condition. It will highlight any areas of coast that have become vulnerable by plotting the latest CSA against the design, maintenance and critical levels. This report will be sent out by the RCMP.

9.8.3 PRE AND POST WORK REPORT

If a survey was requested before the maintenance or scheme works this will be compared to the post works survey to determine the total volume of sediment transported. The two surveys will be analysed further in the annual report to monitor how the works have responded to the wave climate. This report will be sent out by the RCMP.

9.8.4 WAVE REPORT

A report for each wave buoy is issued once per year, by the Channel Coastal Observatory, to summarize the significant wave heights and any events what exceed the storm threshold. The only wave buoy currently in action is the Herne Bay step gauge.

9.8.5 SANDS

After each survey the topographic and Lidar data is uploaded to SANDS and sent to all OA after all surveys in their database are complete. Graveney to Reculver Country Park (Bishopstone) are within the Canterbury database and Northern Sea Wall is part of the Thanet database.

9.8.6 ASSET REPORTS

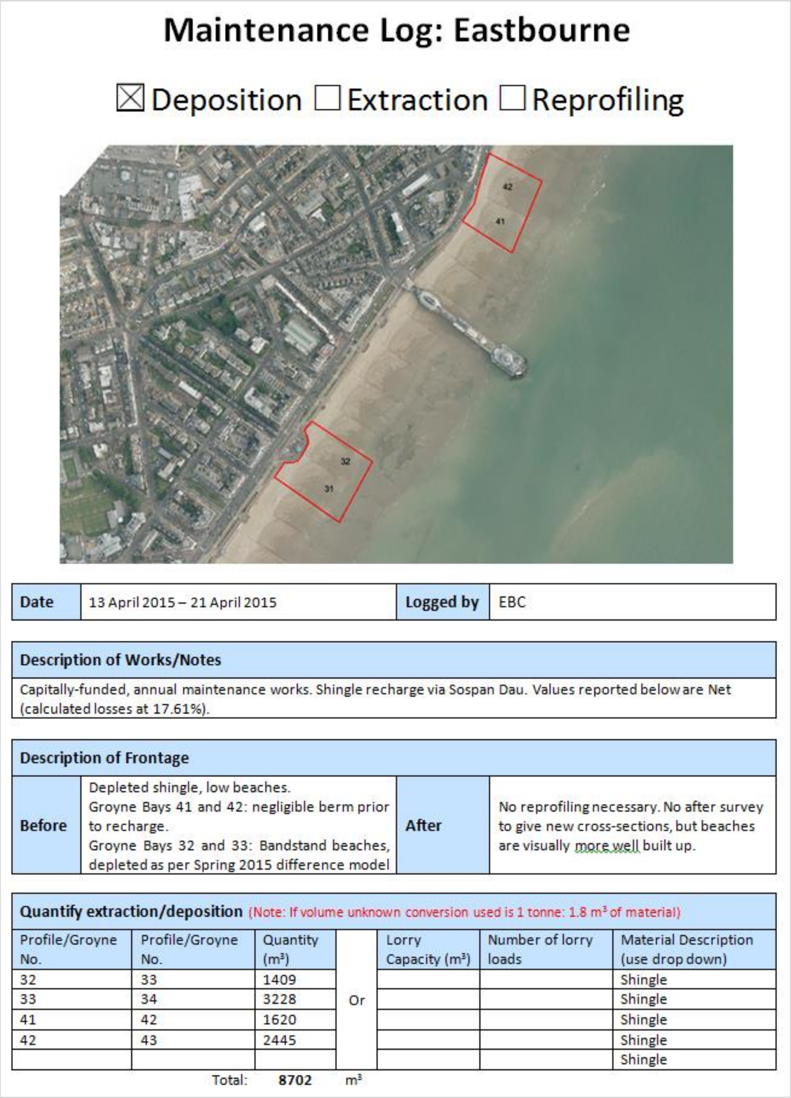
In the event of a storm, it is advised that the OA survey the assets along their stretch of coast and report any large defects such as sea wall collapse or groyne failure to Canterbury City Council with a photograph, exact location and accompanying text, to allow a recalculation of the standard of protection.

9.8.7 MAINTENANCE LOGS

It is important that all beach management works (recycling, beach recharge, reprofiling) should be logged on the appropriate form to indicate the extraction and deposition locations, the quantities moved and the start and end date of the activity (Figure 9-3).

Maintaining these records allows differentiation between artificial beach movement and natural beach transport. These volumes feed into the shingle sediment budget (Appendix E) and the annual reports released by the RCMP. Re-profiled beaches require a log to indicate the location; no further information is required.

It is the responsibility of the OA to issue the maintenance log within one month of completion of the works and sent to the RCMP based at Canterbury City Council. A blank maintenance form is attached on the following page, to be completed following each artificial movement of shingle or sand.



Maintenance Log: Eastbourne

☒ Deposition ☐ Extraction ☐ Reprofiling

Date	13 April 2015 – 21 April 2015	**Logged by**	EBC

Description of Works/Notes
Capitally-funded, annual maintenance works. Shingle recharge via Sospan Dau. Values reported below are Net (calculated losses at 17.61%).

Description of Frontage			
Before	Depleted shingle, low beaches. Groyne Bays 41 and 42: negligible berm prior to recharge. Groyne Bays 32 and 33: Bandstand beaches, depleted as per Spring 2015 difference model	**After**	No reprofiling necessary. No after survey to give new cross-sections, but beaches are visually more well built up.

Quantify extraction/deposition (Note: If volume unknown conversion used is 1 tonne: 1.8 m³ of material)

Profile/Groyne No.	Profile/Groyne No.	Quantity (m³)		Lorry Capacity (m³)	Number of lorry loads	Material Description (use drop down)
32	33	1409				Shingle
33	34	3228	Or			Shingle
41	42	1620				Shingle
42	43	2445				Shingle
						Shingle
	Total:	**8702**	m³			

FIGURE 9-3 EXAMPLE OF COMPLETED RECYCLING LOG FOR DEAL (2015)

Maintenance Log: [place name here]

☐Deposition ☐Extraction ☐Reprofiling

Date		**Logged by**	

Description of Works/Notes

Description of Frontage			
Before		**After**	

Quantify extraction/deposition (Note: If volume unknown conversion used is 1 tonne: 1.8 m^3 of material)						
Profile/Groyne No. Start	Profile/Groyne No. End	Quantity (m^3)		Lorry Capacity (m^3)	Number of lorry loads	Material Description (click in cell for drop down)
			Or			

Total: m^3

GLOSSARY

Accretion	The addition of sediment vertically or horizontally due to the natural action of waves, currents and wind.
Accumulation	Any addition of sediment, either natural (accretion) or man-made.
Alluvium	A deposit resulting from the action and products of rivers or streams.
Apron	A layer of stone, concrete or other material to protect the toe of the sea wall against scour.
Armour	Resistant rocks or specially shaped concrete blocks of a specific size, geometry and weight which are placed as primary protection against wave action on the seaward side of other structures (see revetment).
Asset	This refers to something of value and may be environmental, economic, social, recreational and so on.
Backshore	A morphological term for the area of beach that lies between high water and the landward limit of marine (storm wave) activity.
Backwash	The seaward return of the water following the up-rush (swash) of the waves. For any given tide stage the point of farthest return seaward of the backwash is known as the Limit of backwash. Depending on the permeability of the beach the water volume in the backwash is smaller than in the swash.
Bar	An elongated deposit of sand, shingle or silt, occurring slightly offshore from the beach and submerged at high tide. The bar may be parallel to the beach or connected and at an angle.
Barrier Beach	A sand or shingle bar above high tide with low lying land or a lagoon on the landward side.
Bathymetry	Topography of the sea floor usually below low water.
Beach	The zone of non-cohesive material (e.g. sand, gravel) that lies between the mean low water line and the place where there is a marked change in material or physiographic form, or to the line of permanent vegetation (the effective limit of storm waves and storm surge). The beach or shore can be divided into the foreshore and the backshore.
Beach crest width	The horizontal distance of the crest measured from the seaward edge of the promenade (or other determined point, see beach) to the point where the beach slope angle drops down towards the sea. This usually assumes a uniform crest level but can also include a gentle slope. A better term is 'beach width at xmOD'.
Beach face	Upper surface of the beach.
Beach Profile	Cross-section (side view) of the beach perpendicular to the shoreline. The profile extends from a point landwards of the backshore to low water or beyond.
Beach recharge	This is the management practice of adding new beach sediment (such as sand or gravel) to a beach using material from outside the sediment cell (for example offshore dredging sites or inland quarries). This is also known as beach replenishment or beach (re)nourishment.

Beach recycling	The movement of sediment along a beach, typically from areas of accretion to areas of erosion.
Beach re-profiling	The shaping of the beach profile to achieve a desired crest height, width or slope, typically using bulldozers or other plant.
Berm	A constructive ridge located along the higher part of a beach, above high water as a result of cross shore transport moving sediment towards the swash limit. It is marked by a break of slope at the seaward edge. There are usually a sequence of berms present with storm berms located in the back beach area.
BMP	Beach Management Plan. It provides a basis for the management of a beach for coastal defence purposes, taking into account coastal processes and the other uses of the beach.
Brackish water	Freshwater mixed with seawater.
Breach	Failure of a barrier beach or coastal protection structure allowing flooding through tidal water exchange for at least half of the tidal cycle, i.e. the level of the breach is at or below 0mOD.
Breaching	Process of removing or lowering a beach or structure to form a breach.
Breaker zone	Area in the sea where the waves break.
Breakwater	A protective structure of stone or concrete used to break the force of waves, reducing wave energy and hence enhancing protection to the shore.
CCO	Channel Coastal Observatory. Based at the National Oceanography Centre in Southampton, responsible for the distribution of data collected under the six Regional Coastal Monitoring Programmes.
CD	Chart Datum – an arbitrary local datum or plane to which depths or heights are referred. (Also see OD).
Cliffing	Cliffing on beaches refers to the development of seaward slopes in beach material that are at the angle of repose (Depending on the beach material properties [grain size composition, moisture, compaction, cementation] the angle of repose can vary between ~35 and 90 degrees.), usually with a sharp break of slope to the beach below developing near the wave run-up limit.
Climate Change	Long term changes in climate. The impact of climate change along the coast is usually associated with changes in sea level and wave climate.
Coastal defence	General term used to encompass both coast protection against erosion and sea defence against flooding.
Coastal processes	Collective term covering the action of natural forces on the shoreline and nearshore seabed.
Coastline	The generalised shape, outline, or boundary of a coast, which marks the area between the seaward limit of terrestrial influence and the landward limit of marine influence.
Consequence	An outcome or impact such as economic, social or environmental impact. It may be expressed quantitatively (e.g. monetary value), categorically (e.g. high, medium, low) or descriptively.

Crest	Highest part in cross section of a beach or structure (e.g. breakwater or sea wall)
Crest level	The height of the crest (usually the highest point), generally in mOD.
Deep water	Area where surface waves are not influenced by the sea-bed, i.e. where water depth exceeds half the wavelength.
Defence	Manmade structure (e.g. sea wall, embankment, recharged beach) or natural feature (e.g. beach, dune) that prevents seawater from reaching the hinterland under varying conditions.
DEFRA	Department for Environment, Food and Rural Affairs, formerly the Ministry of Agriculture, Fisheries and Food (MAFF).
Delta	Sediment body, which is formed where a sediment-laden current enters an open body of water, and deposits its sediment load as a result of a reduction in velocity of the current.
Depth limited (waves)	Situation in which wave propagation is limited by water depth.
Downdrift	Direction of longshore movement of beach materials.
Dredging	Excavation, digging, scraping, drag lining, suction dredging to remove sand, silt, rock or other underwater sea-bed material.
Drift reversal	A switch of an indigenous direction of littoral transport.
Drift-aligned	A coastline that is orientated obliquely to prevailing incident wave fronts. The coast is characterised by strong longshore transport.
Dune	A landform produced by the action of wind on unconsolidated material, normally sand, to produce ridges or mounds of loose sediment.
Dynamic equilibrium	A state of balance between environmental conditions acting on a landscape and the resisting earth material which themselves fluctuate around an average that is itself gradually changing.
Embankment	A linear mound of earth that stretches some distance along the coast that protects the hinterland behind from flooding.
Environment Agency (EA)	UK non-departmental government body responsible for delivering integrated environmental management including flood defence, water resources, water quality and pollution control. It has the strategic overview of all flood and coastal erosion risk management.
Environmental Impact Assessment (EIA)	Environmental Impact Assessment. Detailed studies that predict the effects of a development project on the environment. They also provide plans for mitigation of any significant adverse impacts.
Erosion	The removal of any material (clay, rock, soil, sand, gravel) by such agents as running water, waves, wind, moving ice and gravitational creep or falls from its original location. The landward retreat of a shoreline due to these processes.
Estuary	Mouth of a river, where fresh river water mixes with the seawater.

Flint	Micro-crystalline nodules or bands of silica found in the chalk. It is dark grey or black when recently released from the chalk or brownish in colour when it has been removed from the chalk for tens of thousands of years.
Flooding	Refers to inundation by water of land whether this is caused by breaches, overtopping of banks or defences, or by inadequate or slow drainage of rainfall or underlying ground water levels due to tide locking of the coastal outfall structures.
Foreshore	A morphological term for the lower shore zone/area on the beach that lies between mean low and high water.
Geographic Information System (GIS)	Software which allows the spatial display and interrogation of geographic information such as ordnance survey mapping and aerial photography.
Groundwater	The zone in a soil or rock that is saturated with water, mostly derived from surface sources.
Groyne	A structure, which is generally built approximately perpendicular to the shoreline in order to control the movement of beach material and reduce longshore currents and/or to trap and retain beach material. Most groynes are made of timber, rock or concrete and extend from a sea wall or the backshore wall onto the foreshore and rarely even further offshore. They can also take the form of T-shaped groynes, fish-tail and terminal groynes. Other structures perpendicular to the coastline (e.g. outfalls, ramps) can function as a groyne.
Groyne bay	The bay between two groynes.
Groyne field	Series of groynes acting together to protect a section of beach.
Hazard	A situation with the potential to result in harm. A hazard does not necessarily lead to harm.
Hinterland	The land directly adjacent to and inland from a coast, extending landward from the upper limit of extreme wave and tidal energy.
Hold the Line (HTL)	Shoreline Management Plan policy to hold the existing defence line by maintaining or changing the standard of protection. This policy should cover those situations where work or operations are carried out in front of the existing defences (such as beach recharge (see the glossary), rebuilding the toe of a structure, building offshore breakwaters and so on) to improve or maintain the standard of protection provided by the existing defence line.
H_s	See significant wave height.
Hydrodynamic	The process and science associated with the flow and motion in water.
Intertidal areas	The area between mean high water level and mean low water level in a coastal region.
Inundation	An overflow of water or an expanse of water submerging land.
Joint Probability	The probability of two (or more) variables occurring together.
Joint Return Period	Average period of time between occurrences of a given joint probability event.

Land Reclamation	Process of creating new, dry land on the seabed.
Landslides	The large-scale mass movement of sub-aerial material down-slope, or its vertical movement down a cliff face.
Longshore drift/ transport	Transport of sediment along the shore by the combined effect of swash and backwash set up by wave driven currents. Currents produced in the surf zone are caused by waves breaking at an angle and the current running roughly parallel with the shore. (Also see drift-aligned, drift convergence, drift divergence, drift reversal).
Long term	Refers to a time period of decades to centuries.
Managed Realignment (MR)	Shoreline Management Plan policy to realign the shoreline by allowing the shoreline to move backwards or forwards, with management to control or limit movement (such as reducing erosion or building new defences on the landward side of the original defences).
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water Spring (MLWN)	The lowest level to which neap tides retreat on average over a period of time (often 19 years).
Mean Low Water Spring (MLWS)	The lowest level to which spring tides retreat on average over a period of time (often 19 years).
Mean Sea Level (MSL)	Average height of the sea surface.
Medium term	Refers to a time period of decades.
Met Office	UK Meteorological Office.
Metres Ordnance Datum (±mOD)	Elevation in metres above or below Ordnance Datum.
Natural Processes	Those processes over which people have no significant control (such as wind and waves).
Nearshore	The zone, which extends from the swash zone to the position marking the start of the offshore zone, typically at water depths of the order of 20m.
No Active Intervention (NAI)	Shoreline Management Plan policy where there is no investment in coastal defences or operations. This assumes that existing defences are no longer maintained and will fail over time or undefended frontages will be allowed to evolve naturally.
Offshore	The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the seabed on wave action is small in comparison with the effect of wind.

Offshore Bank	A large scale unconsolidated body of soft sediment, such as sand, gravel and mud which can form topographic highs on the seabed. They are located in the offshore zone and are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum.
Operating Authority	A body with statutory powers to undertake flood defence or coast protection activities, usually the Environment Agency or maritime District Council.
Ordnance Datum (Newlyn)	A universal zero point/datum used in the UK, equal to the mean sea level at Newlyn in Cornwall.
Overtopping	Water carried over the top of a coastal defence due to wave run-up or still water level exceeding the crest height. See 'green water', 'white water' and 'overwashing'.
Overwashing	Overtopping that leads to water and sediment transported landward which does not return back to the sea following the event.
Percolation	The process by which water flows through the interstices of sediment. Specifically, the infiltration of water during swash into the unsaturated beach material which reduces wave run-up on the beach but which can also lead to water seepage at the landward side, potentially causing instability of the landward slope or a barrier.
Pile	Long heavy section of timber, concrete or metal, driven into the ground or seabed as support for another structure. Especially around/or at the toe of a shore protection structure.
Recession	Movement of the shoreline to landward.
Reef	A ridge of rock or other material lying just beneath the surface of the sea.
Regression	A fall in sea-level resulting in withdraw of the sea from the land.
Relict	Geomorphological feature formed or sediment deposited under past processes and climatic regimes.
Return Period	A statistical measure denoting the average probability of occurrence of a given event over time.
Revetment	A sloping surface of armour used to protect an embankment, sea wall or natural shoreline against erosion.
Rock platform	Gently seaward sloping, intertidal bench cut into the land mass by the action of waves and also known as a wave-cut platform.
Roll back	The gradual net landward migration of the coastline, includes rollover of a subaerial sediment barrier, mainly shingle and gravel.
Saltmarsh	An area of soft, wet land periodically flooded by saline water. Usually characterised by grasses and other low vegetation. Also known as a salting.
Scour	Permanent or temporary erosion of underwater material by waves or currents, especially at the interface between sediment and a structure.

Sea wall	A shoreline structure primarily designed to prevent flooding, erosion and other damage due to wave action. Structure types include solid, near vertical steel of concrete structures of different profiles. A stronger deviation from the vertical indicates a 'revetment'.
Sediment	Particles of rock covering a size range from clay to boulders.
Sediment cell	A length of coastline and its associated near shore area within which the movement of coarse sediment (sand and shingle) is largely self-contained. Interruptions to the movement of sand and shingle within one cell should not affect beaches in an adjacent sediment cell.
Sediment sub-cell	A smaller part of a sediment cell within which the movement of coarse sediment (sand and shingle) is relatively self-contained.
Sediment supply	The source of sediment.
Sediment transport	The movement of a mass of sedimentary material by the forces of currents, waves or wind.
Setback	Prescribed distance landward of a coastal feature (e.g. the line of existing defences).
Shingle	Gravel-sized beach material, normally well rounded as a result of abrasion.
Shoreline	A boundary line between land and water.
Shoreline Management Plan (SMP)	A non-statutory plan, which provides a large-scale assessment of the risks associated with coastal processes and presents a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner. The first SMP (SMP1) was completed for the Isle of Wight in 1997. The SMP is periodically reviewed. The second SMP (SMP2) is being competed in 2010.
Short term	Refers to a time period of months to years.
Significant wave Height (Hs)	The average height of the highest of one third of the waves in a given sea state.
Sink	Area at which beach material is irretrievably lost from a coastal cell, such as an estuary, a deep channel in the seabed or dunes inland.
Spit	An elongated accumulation of sand or gravel, which projects into the sea or across a tidal inlet. Longshore drift of material is usually responsible for the development of a spit.
Standard of Protection (SoP)	The level of return period event which the defence is expected to withstand without experiencing significant failure.
Still Water Level (SWL)	Average water surface elevation at any instant, excluding local variation due to waves and wave set-up, but including the effects of tides and surges.
Storm Surge	A rise in water level in the open coast due to the action of wind stress as well as a change in atmospheric pressure on the sea surface. A surge typically has a duration of a few hours. See 'surge'

Subtidal	Part of the coast that is permanently below water.
Surge	Changes in water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and that predicted using harmonic analysis, may be positive or negative.
Suspended Sediment	A mode of sediment transport in which the particles are supported, and carried along by the fluid. See 'bedload transport'.
Swell Waves	Remotely generated wind-waves (i.e. Waves that are generated away from the site). Swell characteristically exhibits a more regular and longer period and has longer crests than locally generated waves.
Tidal range	Difference in height between high and low water levels at a point.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of primarily the moon and sun acting on the rotating earth.
Toe level	The level of the lowest part of a structure, generally forming the transition to the underlying ground.
Tombolo	An accumulation of sediment from the shore to an offshore island, formed by the deposition of material when waves are refracted and diffracted around the island. In a tidal environment a tombolo may exists at all states of the tide or only during lower states leaving a 'salient' at high tide.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Trigger Levels	A set of criteria that trigger an intervention. The intervention can range from increased monitoring to preparation of interventions to an intervention. There is a sequence of Trigger Levels with an increasing level of action and associated costs.
Undermining	Erosion at the base, e.g. of a sea wall, so that the feature above becomes unstable and is vulnerable to collapse. Usually the consequence of 'scour'.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave Climate	The seasonable or annual distribution of wave height, period and direction measured over a longer period of time.
Wave Direction	Direction from which a wave approaches.
Wave Height	The vertical distance between the crest and the trough.
Wave Hindcast	The retrospective forecasting of waves using measured wind information.
Wave Period	The time it takes for two successive crests (or troughs) to pass a given point.
Wave Return Wall	A sea wall whose seaward face is designed to reflect wave energy.

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