REPORT (FINAL)

Cornwall Beach & Dune Management Plans – Par Sands

Prepared for

Cornwall Council

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Contents

Document history

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Executive Summary

This Beach & Dune Management Plan (BDMP) for Par Sands has been produced as part of the Cornwall Beach & Sand Dune Management Project commissioned by Cornwall Council in 2015. The BDMP has two purposes:

1. Identify the best management approach; in terms of monitoring and intervention (when trigger levels are reached) requirements for the beach and dune system at Par Sands; based upon the best practice framework developed as part of the Cornwall Sand Dune and Beach Management Strategy produced by Halcrow in 2009, and updated as part of developing the new BDMPs by CH2M in 2015 (see Appendix A).
2. Provide a long-term (50 year) approach to beach and dune management at Par Sands that is based upon an up-to-date understanding of the beach-dune system and coastal processes at the site, as well as predictions of future coastal evolution. For background information, Appendix B provides an overview of how beach-dune systems work.

This BDMP report provides:

- An introduction to the project and BDMP (Section 1);
- A summary of the characteristics (Section 2) and coastal process drivers at Par Sands (Section 3); and
- Discussion and definition of suitable management techniques to apply at Par Sands, including a plan of action and the recommended monitoring and response programme (Section 4).

The key issues to be addressed by beach and dune management activities include:

- Potential for dune erosion in the future and exposure of a historic landfill site.
- Planning for adaptation of backshore assets in the future.
- Lack of information / data relating to dune erosion and beach levels to inform management.
- Uncontrolled public access within the dunes resulting in dune erosion and trampling, littering and dog fouling.
- Ensure sediment removal from the Polmear Stream remains in the beach-dune system.
- Consideration of environmental impacts on designated features.
- Control of non-native invasive species within dune vegetation.
- Limited funding to undertake management activities.

The key recommendations at Par Sands are focussed on ensuring that the dunes continue to provide a flood defence function to the low-lying land behind. The dunes appear to be stable and in places accreting, so intervention requirements in the form of dune stabilisation at present is probably limited. However, as sea levels rise the need for dune stabilisation measures will become increasingly necessary to ensure the dunes continue to fulfil an important flood defence role.

Introduction

1.1 Project Background

Many of the sand dunes and beaches around Cornwall's coast are currently experiencing erosion and sediment loss. This is a pressing concern as these sand dunes and their associated sandy beaches are one of the most important resources in Cornwall due to:

1. Their role in providing protection against the risk of coastal flooding due to the dynamic nature of beach-dune interactions and their sheer size preventing the sea from impacting upon the hinterland behind the dune systems.
2. Their role in providing important biologically diverse habitats that cannot be easily recreated elsewhere if it were to be lost to coastal erosion or inappropriate development.
3. Their role in providing access to the sea for residents and visitors alike, which is vital to the holiday industry upon which a significant proportion of Cornwall's economy depends.

It is vital therefore that the sand dunes and beaches around Cornwall's coast, that represent some 15% of the total sand dune habitat in Britain, are managed in a holistic, sustainable way over the long-term that balances the needs of each of the three distinct functions of sand dunes and beaches that combined make up the beach-dune system.

To ensure that these vital resources are managed in such a way, in 2009 the Cornwall Sand Dune and Beach Management Strategy was developed by Halcrow (now CH2M) for the Cornwall & Isles of Scilly Coastal Group. The main focus of the strategy is the management of flood and coastal erosion, although the habitat and tourism value of the dunes will also be considered. This project delivered an Inventory of Beaches and Dunes; a Best Practice Management Guide and two pilot Beach and Dune Management Plans (BDMPs) for Fistral Beach and Harvey's Towans (Hayle).

To build on this previous work, Cornwall Council commissioned CH2M to work with them and local communities to (a) produce seven new BDMPs for locations at Constantine Bay, Porthcothan, Porthtowan, Par Sands, Praa Sands, Summerleaze and Widemouth Bay; and (b) review and update the two pilot BDMPs for Harvey's Towans and Fistral Beach produced in 2009. Figure 1.1 shows each of these locations.

This document is the BDMP for Par Sands and sets out sustainable management practices for the sand dunes and beach in this area. It should be reviewed every 5-10 years unless significant, rapid changes occur that warrant an earlier review.

Figure 1.1 BDMP locations around Cornwall

1.2 Project Aims

Beaches and Sand Dunes have many uses and functions. These include amenity, recreation, commercial and community uses, and coast defence, habitat and earth science functions; all of which have social, environmental and economic value. In this case, the main focus of the BDMP is the management of the dunes and beach to ensure they fulfil their flood and coastal defence function to help protect communities around the coast of Cornwall from coastal flooding and erosion by the sea; whilst also considering the needs for management of habitat and amenity use in the area.

BDMPs are a non-statutory method of providing a coastal defence plan for managing a beach and dune system at a local level that takes into account and, where possible, promotes or enhances the other uses and functions of a beach. BDMPs provide a framework for more cohesive management of a beach and dune system that may be regulated and used by different parties, all with their own agendas. They establish a means to control the physical form of beaches and sand dunes and the general beach and dune environment, and to promote good practice within the environment.

BDMP production is often led by Local Authorities with support from the Environment Agency and is usually done in collaboration with relevant stakeholders, as will be the case here. Assistance is available to the authorities to undertake appropriate management and to maintain the coastal defence function provided by the beach and dune system and any associated hard defence structures, as well as other requirements both now and in the future.

Given this, **the aim of this BDMP is to provide a new long-term strategic BDMP for Par Sands**. This will be achieved by delivering the following objectives:

1. Identify the best management approach; in terms of monitoring and intervention (when trigger levels are reached) requirements for the beach and dune system at Par Sands; based upon the best practice framework developed as part of the Cornwall Sand Dune and Beach Management Strategy produced by Halcrow in 2009, and updated as part of developing the new BDMPs by CH2M in 2015 (see Appendix A).
2. Provide a long-term (50 year) approach to beach and dune management at Par Sands that is based upon an up-to-date understanding of the beach-dune system and coastal processes at the site, as well as predictions of future coastal evolution. For background information, Appendix B provides an overview of how beach-dune systems work.

1.3 Dune Management Plan

To achieve the aim and objectives defined in Section 1.2, the BDMP for Par Sands is structured as follows:

- Section 1 – Introduction (this section).
- Section 2 – Site Description.
- Section 3 – Factors Affecting the Beach Dune System.
- Section 4 – Beach & Dune Management Plan.

1.4 Key Contacts

The BDMP and its implementation is led by Cornwall Council. The key contact for this work is:

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Site Description

2.1 Location

Par Sands is located on the south coast of Cornwall, approximately 4km to the east of St Austell. The beach is set-back within St Austell Bay, enclosed by the docks and china clay works in the west and the steep cliffs of Kilmarth in the east (refer to Figure 2.1).

Figure 2.1 *Map showing the Par Sands BDMP location and extent (red outline).*

2.2 Setting

Par Sands is a wide sandy beach backed by healthy sand dunes, which provide an important flood defence function for the low lying land to the north. The beach and dunes, which have been accreting over the past 50 years, form part of a designated Local Nature Reserve (LNR) and Cornwall Nature Conservation Site, and are bordered to the west by the Par River and to the east by Polmear Stream. Both these watercourses have basic rock training works to control their migration across the beach. The caravan park, located behind the dunes, is a popular recreation attraction for both tourists and locals. An area of historic landfill is situated in the dunes to the west, and there are a number of beach huts located within the dunes, however, the number is steadily decreasing. The hinterland is in multiple ownership. Par Sands is managed by Cornwall Council, however, the wetland in the vicinity of the stream is managed by the Local Nature Reserve together with the group, Friends of Par Beach.

2.3 Key Characteristics

2.3.1 Present Site

The principal characteristics of the present beach system are as follows:

- The beach is set-back within St Austell Bay, enclosed by the docks and china clay works in the west and the steep cliffs of Kilmarth in the east.
- Par Sands was originally formed at the mouth of an in-filled river valley (Halcrow, 2009b). The wide sandy beach is formed from the erosion of valley infill material and small inputs of material from erosion of the flanking cliffs (Halcrow 2009b), although much of the modern beach sand consists of quartzose sand waste washed down from China Clay workings to the north of St Austell (Pye, 2007).
- The beach is backed by dunes.
- The land is low-lying and is designated as a Local Nature Reserve.

The principal characteristics of the dune system are:

- The dunes were estimated in 2009 to be around 10ha (Halcrow 2009a), which have become well established and form a successive dune habitat.
- Embryo dunes have formed at the interface of the dune toe and beach.
- The Par River discharges to the sea to the west of Par Sands.
- Aerial photos analysed for the Par Beach Management Plan show that the dune area advanced 100-150m seaward between 1946 and 1997. This represents an advance of over 2m per year (Environmental Consultants (CTNC) Ltd, 1997).
- The dunes today are generally healthy and show signs of accretion along the dune toe with clear evidence of dune growth with the formation of embryo dunes and young dune grass.
- Marram Grass is growing well and effectively stabilising the dunes. This is likely to be a response to a dune planting programme in the 1980's when the dunes were fenced off and Marram Grass was planted.
- Aerial photographs from 2007, 2009 and 2012, show how the dunes have remained stable.

2.4 Natural and Historic Environment

The Study Area contains the following nature conservation designations. These are central in the consideration of options for the beach and dune management plan:

- Par Beach and St Andrews Road Local Nature reserve (LNR).

- Cornwall Area of Outstanding Natural Beauty.

These features are shown on Figure 2.2 and discussed in further detail below.

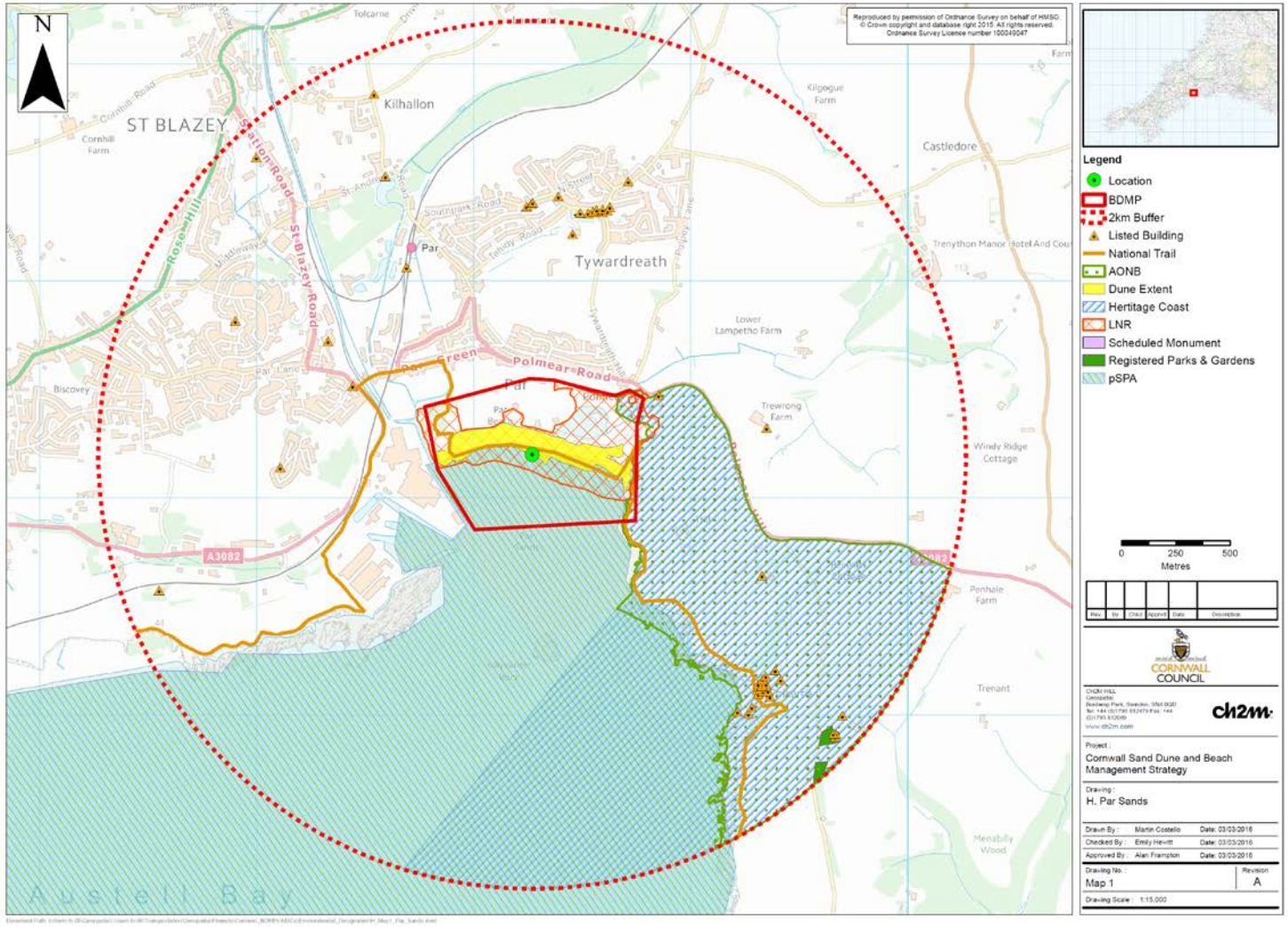


Figure 2.2 Environmental designation features in the vicinity of the Par Sands BDMP area.

2.4.1 Ecology

2.4.1.1 Designated Nature Conservation Sites

The following nature conservation designations and their qualifying interest features are all within or lie in close proximity to the Study Area and will require consideration during the development of the BMP:

- Par Beach encompasses The Par Beach and St Andrews Road Local Nature reserve (LNR). The LNR supports a dune system, open water lagoon and reedbeds behind the dunes which is frequented by overwintering birds and birds in passage. At the western end of the site (a reclaimed refuse area), marshy grassland supports a variety of plant species and wildflowers. The site contains a number of non-native plant species, with the dunes dominated by introduced shrub species Sea Buckthorn *Hippophae rhamnoides* and Japanese Rose *Rosa rugose*. The active volunteer group 'Friends of Par Beach' work to help to assist manage the LNR along with Cornwall County Council.

Designated sites identified and considered or discounted for bird-habitat connectivity between the protected area and the site, are described below. Sites identified as having possible connectivity will require consideration during the development of the BDMP (see also Figure 2.3):

- Par Sands falls within the northeast section of a possible Special Protected Area (pSPA), Falmouth Bay to St Austell Bay pSPA. The pSPA supports rare wintering birds and diving birds that are proposed for designation under the Birds Directive (2009/147/EC). The pSPA is a large area, and encompasses the Fal and Helford SAC within the pSPAs north western section. This site is designated under article 4 (4) of the Habitats Directive (92/43/EEC) for the following Annex 1 habitats: Sandbanks which are slightly covered by sea water all the time; Mudflats and sandflats not covered by seawater at low tide; Large shallow inlets and bays that include low tidal sandbanks and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*). Other Annex I habitats that are present as a qualifying feature of the SAC but not the primary reason for selection include Estuaries and Reefs and includes the Annex II plant species Shore dock *Rumex rupestris*. **Consideration is required**.

- Loe Pool geological and biological SSSI is approximately 6km southeast of Par Sands, and is the largest freshwater lagoon in Cornwall protected from seaward influx by a shingle sand bar. The site has geologically interesting features and supports a scarce habitat found nowhere else in Cornwall with important wintering birds, wild-fowl and rare plant species. **Connectivity with Par sands is unlikely** due to the stark differences in saline and freshwater habitats.

- Tamar Estuaries Complex SPA is approximately 26km from Par Sands. The estuary system is a large marine inlet on the English Channel coast comprising the estuaries of the rivers Tamar, Lynher and Tavy. Habitats include extensive tidal mud-flats bordered by saltmarsh communities. The mud-flats contain extensive and varied infaunal communities rich in bivalves and other invertebrates, and feeding grounds for waterbirds in numbers of European importance. Saltmarshes provide important feeding and roosting areas for large numbers of wintering and passage waterbirds. This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Little Egret *Egretta garzetta* (on passage, and a population over winter) and Avocet *Recurvirostra avosetta* (over winter). **Unlikely to be any connectivity** with Par Sands due to the lack of estuarine influence.

- Marizion Marsh SPA/SSSI is approximately 60km southwest from Par Sands from its nearest point. The marsh is at the mouth of a wide coastal valley, separated from the sea by a shingle bar with fringing sand dunes. The marsh is important for passage and wintering birds associated in particular with the extensive reedbed. The site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Annex I species Aquatic Warbler *Acrocephalus paludicola* (in passage) and Bittern *Botaurus stellaris* (over winter). **Connectivity with Par Sands is possible** due to the site providing a small amount of similar habitat.

- The Exe Estuary SPA is approximately 95km northeast from Par Sands, is a complex of coastal habitats waters, foreshore, low-lying land, three saltmarshes and an unusual double spit across the mouth of the estuary, and the sand dunes of Dawlish Warren. The mud and sandflats support Eelgrass Zostera spp. and Enteromorpha beds, and contain an abundance of invertebrates including extensive Mussel Mytilus edulis beds, which together provide rich feeding habitats for wintering waders and wildfowl. site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Annex I species Avocet Recurvirostra avosetta and Slavonian Grebe Podiceps auritus (over winter) and qualifies under Article 4.2 of the Directive (79/409/EEC) as a wetland of international importance for regularly supporting at least 20,000 waterfowl. **Unlikely to be any connectivity** with Par Sands due to the lack of estuarine influence.
- Isles of Scilly SPA is approximately 120km from Par Sands at its closest point. The SPA qualifies for its seabird assemblage of international importance and breeding seabird assemblage of European importance. The isolated nature of the islands and rocks, together with their low levels of disturbance and predation, makes them particularly suitable for nesting seabirds. This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following Annex I species Storm Petrel *Hydrobates pelagicus* and Lesser Black-backed Gull *Larus fuscus*. The site also qualifies under Article 4.2 of the Directive (79/409/EEC) for regularly supporting a seabird assemblage of international importance of at least 20,000 seabirds. The SPA boundary only encompasses those areas used for nesting. The vast majority of the feeding areas used by the seabirds are marine waters outside the SPA. **Connectivity with feeding areas seaward around Par Sands is a possibility**.
- The Severn Estuary SPA/SSSI (approximately 147km from Par at its nearest point) is located northwest between Wales and England. It is a large estuary with extensive intertidal mud-flats and sand-flats, rocky platforms and islands. Saltmarsh fringes the coast backed by grazing marsh with freshwater ditches and occasional brackish ditches. The seabed is rock and gravel with sub-tidal sandbanks. High densities of ragworms, lugworms and other invertebrates form an important food source for passage and wintering waders and large numbers of wintering waterbirds, especially swans and ducks. The site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive: Bewick's Swan (over winter). This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: Ringed Plover (on passage), Curlew, Dunlin, Pintail, Redshank and Shelduck. The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. **May be some connectivity** with the small amount of similar grazing marsh habitat within the LNR, although numbers are not likely to be significant.

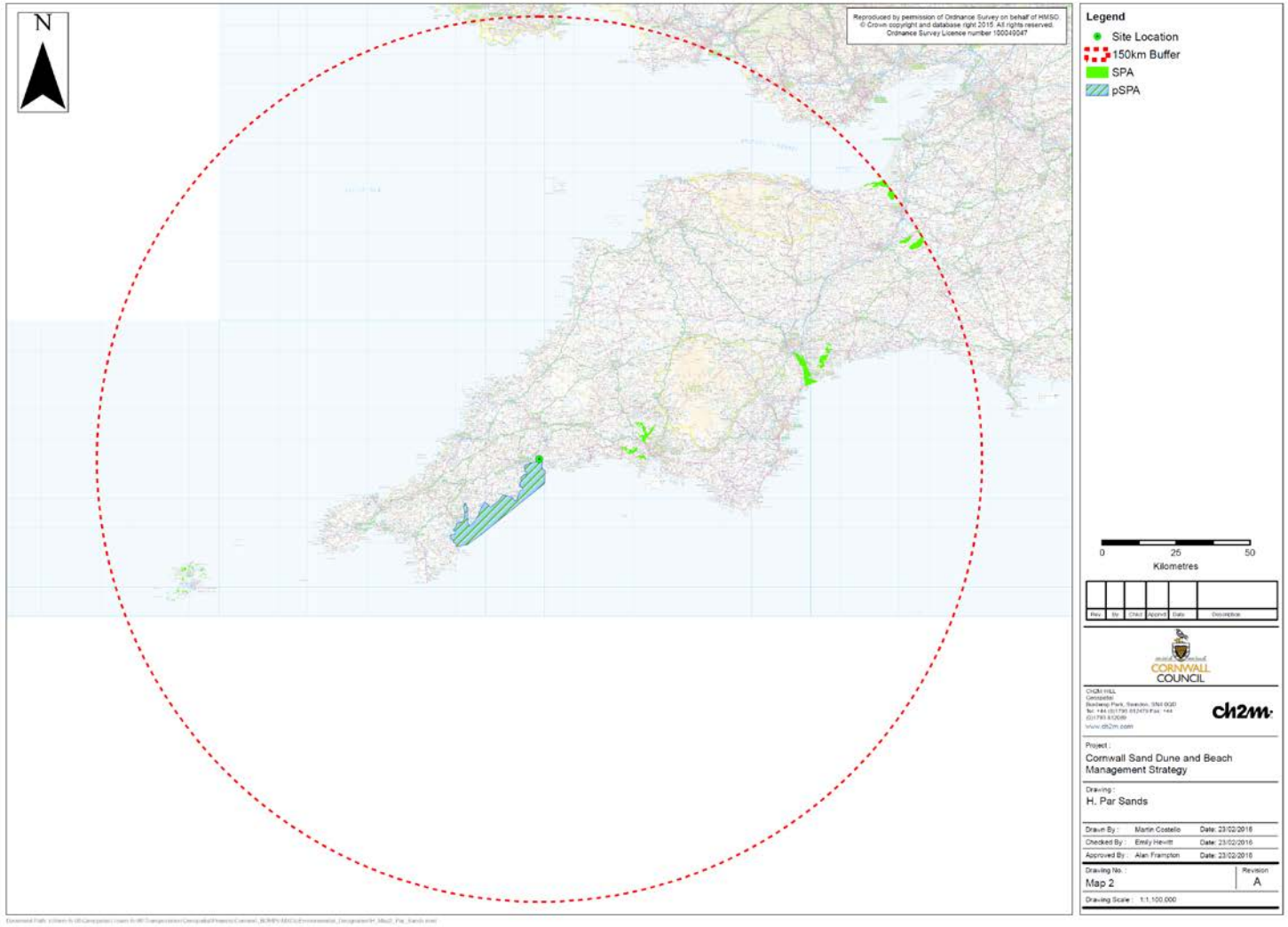


Figure 2.3 *Potential bird-habitat connectivity between the protected area and the BDMP site.*

2.4.1.2 Biodiversity Action Plan (BAP) Habitats

The following are listed as UK priority BAP habitats and are either represented in the Study Area or are within 1km as identified in the Cornwall County Council report: Ecological Assessment of Coastal Zone Management Issues at Par sands (Spalding Associates Ltd, 2005). Only habitats that are considered relevant to the Study Area, i.e. they are likely to be impacted upon or are likely to have an influence on the proposed scheme, have been described. The associated targets are quoted under them:

- Coastal Sand Dunes:
    - Strandline and mobile dunes (open dune) (Quality assessment: Unfavourable due to presence of non-natives):
        - Retain extent of existing open dune.
        - Re-instate strandline habitat where possible.
        - Monitor trampling erosion of foredune and yellow dune.
        - Eliminate invasive non-natives, reduce other non-natives.
        - Control ruderal species.
    - Dune grassland (Quality assessment: Unfavourable due to restricted zonation, lack of short turf, presence of non-natives and frequent scrub):
        - Retain existing dune extent.
        - Re-instate grey dune and dune grassland wherever possible by removal of scrub particularly non-natives.
        - Maintain areas of bare sand on grey dune habitat.
        - Eliminate invasive non-natives, reduce other non-natives.
- Reed beds (swamp) (Quality assessment: Unfavourable due to indicators of negative change – scrub invasion of reed bed):
    - Maintain reed bed cover.
    - Reduce scrub on reed bed.
    - Target management to retain reed beds for reed fauna.
    - Littoral and infralittoral sediment.
- Mudflats and sandflats not covered by seawater at low tide (Quality assessment: Probably unfavourable although no baseline data exists):
    - Re-instate strandline habitat (it was noted on the site visit, March 2015 that strand line sea weed is no longer being managed and removed).

2.4.2 Designated Geological Conservation Sites

There are no designated geological sites in the BDMP area.

2.4.3 Landscape Setting

The following landscape designations run from the eastern edge of Par Beach (see Figure 2.2 above):

- Cornwall Area of Outstanding Natural Beauty (South Coast eastern) runs from Par Sands to Looe. The Fowey ria characterised by a drowned Fowey river valley forming a network of creeks that lead toward a coastline of low cliffs and small beaches, with rounded land masses dominated by oak woodland, much of which is ancient and panoramic views from Gribben Head along the coast and across the Fowey estuary.
- The AONB also encompasses the Gribben Head - Polperro Heritage Coast which stretches seaward and along the coast and around the River Fowey to West Looe.

2.4.4 Archaeology and Cultural Heritage

A number of historic sites are located within the area and include a registered Historic Park and Garden (Menabilly), a Scheduled Monument (Wayside Cross) and listed buildings (see Figure 2.2 above).

2.5 Land Use

Par Harbour began as a port to export copper and tin, and was converted from an open bay into a safe port in the early 1800s, then in the 1930's it became increasingly important for the shipping of china clay. The Port of Par was closed to shipping at the end of 2007.

Historically china clay was dumped on the beach at Par, but this practice has since ceased (Royal Haskoning, 2011b) as a result of an environmental clean-up of the industry (Halcrow, 1999b). There is evidence of the china clay waste on the east bank of the River Par, opposite the china clay works, where recent erosion of the overlying sand has exposed the clay layer beneath.

Old photographs (Francis Firth, online) show the beach huts were originally on the beach, with no presence of dunes. Today, the same beach huts are fronted by sand dunes that have developed and accreted since then, which suggests that the dunes are a fairly recent feature and possibly formed a result of the china clay waste being dumped on the beach.

2.6 Value of the Dunes

The management of the dunes needs to acknowledge the benefit of the sand dunes for their aesthetic value, and thus attractiveness to local residents and visitors, as well as acknowledging the coastal defence function of the dunes. The specific values of the dunes at Par Sands include:

- Coastal erosion and flood defence buffer for properties and tourism assets behind the sand dunes.
- Local recreational and educational value.
- Providing a store of sand that can naturally feed the beach to compensate for seasonal erosion.
- To form an aesthetically attractive backdrop to the beach, providing sheltered areas and viewing points for beach users.
- Significant environmental habitat value.

2.7 Key Problems Experienced

The key issue at Par Sands is that the dunes provide a flood defence function to the low-lying land behind. The dunes appear to be stable and in places accreting. There is an interest at looking at the effect of removing invasive species from within the dunes.

In addition, the following observations were made by Spalding Associates Ltd (2005) and are still relevant following the site visit in March 2015 (refer to Appendix C):

- Recreational pressure.
- Localised trampling erosion and loss of sand cover on the dune.
- Restriction of the dune system.
- Presence of invasive non-native plant species.
- Localised pollution.
- Removal of strandline habitat.
- Trampling of the rocky shore.

2.8 Other Studies

2.8.1 Shoreline Management Plan (SMP) Policy

Par Sands lies within Policy Unit 6.3 (Par Sands) of the Cornwall & Isles of Scilly Shoreline Management Plan Review (SMP2), adopted in 2011 (Royal Haskoning, 2011b).

The policy for flood and coastal erosion risk management defined in the SMP2 for this area over the next 100 years is:

- Short term (to 2025) = No Active Intervention.
- Medium term (to 2055) = Managed Realignment.
- Long term (to 2105) = Managed Realignment.

The intent of this policy is to *"investigate landfill risks and identify possible strategy for MR & dune roll back into hinterland. Identification of this area as a 'Coastal Change Management Area' within the land use planning system may be necessary."*

Factors Affecting the Beach Dune System

3.1 Wind, Wave Climate and Tides

3.1.1 Wave Climate

The coastline at Par Sands is orientated east-west, with the beach and dunes facing approximately 180 to 195 degrees (south). The predominant wave direction along the south coast of Cornwall is reported to be from the south and south-west (approaching from 180° – 270°) and the coastline is exposed to open Atlantic swell waves (Royal Haskoning, 2011b).

The Looe Bay Directional Waverider Buoy, operated as part of the South West Regional Coastal Monitoring Programme (SWRCMP), is the nearest wave buoy to Par Sands, and has been reviewed for this study. The wave buoy is located approximately 15 miles east from Par Sands, and provides a record of wave height for a seven year period between 18th December 2006 and 30th June 2014. A plot of wave height in Figure 3.1 shows that the predominant wave direction in this area is from the west. The data set also indicates significant wave heights frequently exceed 5m during the winter months and that wave periods of 15 seconds and higher (i.e. powerful well waves generated by storms offshore) are not uncommon (Royal Haskoning, 2011b).

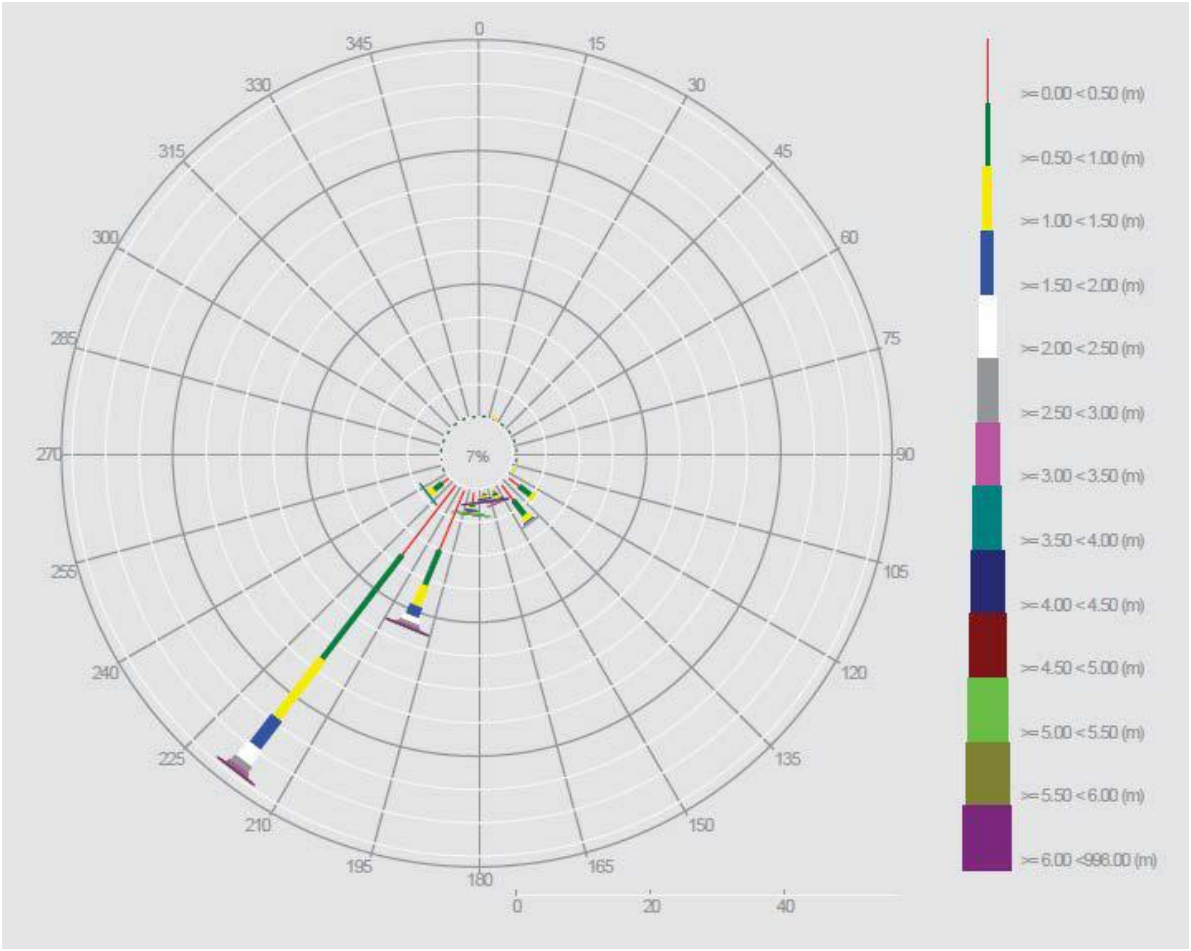


Figure 3.1 Offshore wave height recorded by the Looe Bay Directional Waverider Buoy between 22nd June 2009 and 30th June 2014 (PCO, 2014a).

3.1.2 Storm Waves

Storm analysis undertaken by PCO (2014b) provides an overview of the storm conditions recorded by the Looe Directional Waverider Buoy since 2007.

For each wave buoy in the SWRCMP, an individual storm threshold is set. A storm event is defined when significant wave heights equivalent to the 0.25 year return period (i.e. the threshold wave height (Hs) for 2 to 4 storms in an average year) occurs for set period of time (i.e. 16 hours). The significant wave height is calculated when a 5 year time series of data becomes available for the wave buoy and is then reset each year. Prior to that, the height is based on an educated conservative guess from looking at the wave data available. The reason that the 0.25 year return period is used is because the SWRCMP have found that in general there are 3 to 4 storms in any one year that result in the movement significant amounts of sediment.

For their reporting, PCO produce a storm calendar. The calendar includes a graph, where each dot represents a storm (i.e. where the Hs exceeds the storm threshold) and shows the Hs for that particular storm. PCO plot the significant wave height for the 1 year return period for that particular buoy on the graph (calculated in the same way as significant wave height for the 0.25 year return period) as a red line. Where storms plot above the red line they are considered to be more severe/extreme and are listed in a separate table. The storm calendar and table for the Looe Directional Waverider Buoy are presented in Figure 3.2 and Table 3.1 respectively.

The storm calendar shows that nine severe/extreme storms have exceeded the 1 year Return Period since 2009; six of those storms (67 %) occurred between October 2013 and February 2014. The impact of these storms on beach change is described in Section 3.3.

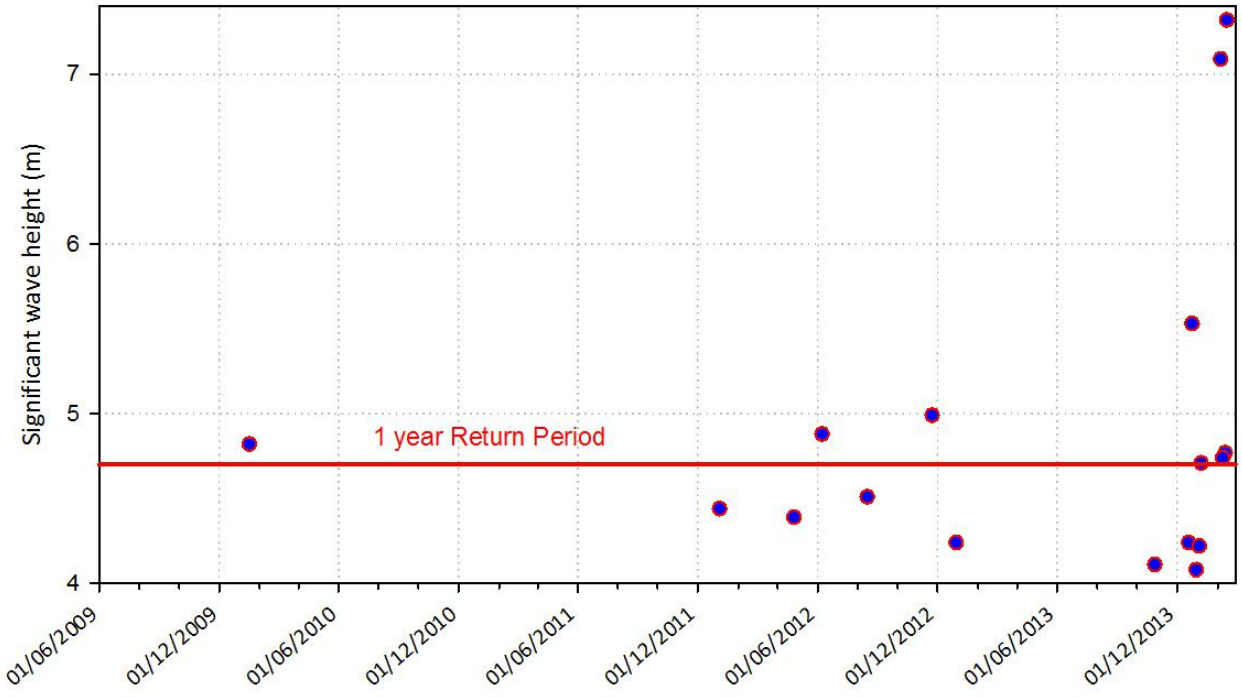


Figure 3.2 Storm calendar for Looe (source: PCO, 2014b).

Table 3.1 Storms exceeding 1 year Return Period at Looe since deployment in 2009. Those occurring during the storm season October 2013 to February 2014 are shaded pink (source: PC0, 2014b).

Date	Wave Height (m)	Return Period
14/02/2014	7.32	> 1 in 30 years
05/02/2014	7.09	> 1 in 30 years
23/12/2013	5.53	> 1 in 5 years
22/11/2012	4.99	1 in 2 years
07/06/2012	4.88	> 1 in 1 year
16/01/2010	4.82	> 1 in 1 year
12/02/2014	4.77	> 1 in 1 year
08/02/2014	4.74	> 1 in 1 year
06/01/2014	4.71	> 1 in 1 year

3.1.3 Tides

Tidal levels have been extracted from the current Admiralty Tide Tables (UKHO, 2013) for the closest location with the best available data, in this case Par, and converted to Ordnance Datum (mOD). The tide levels for Par are presented in Table 3.2 and illustrated in relation to a typical beach-dune profile at Par Sands in Figure 3.3.

Table 3.2 Tide levels (in mOD) for Par, adjusted from standard port Plymouth (Devonport).

Tidal Condition	Tide Level (mOD)
Highest Astronomical Tide (HAT)	2.45
Mean High Water Spring (MHWS)	1.55
Mean High Water Neap (MHWN)	0.45
Mean Sea Level (MSL)	0.08
Mean Low Water Neap (MLWN)	-1.25
Mean Low Water Spring (MLWS)	-2.35
Lowest Astronomical Tide (HAT)	Data not available

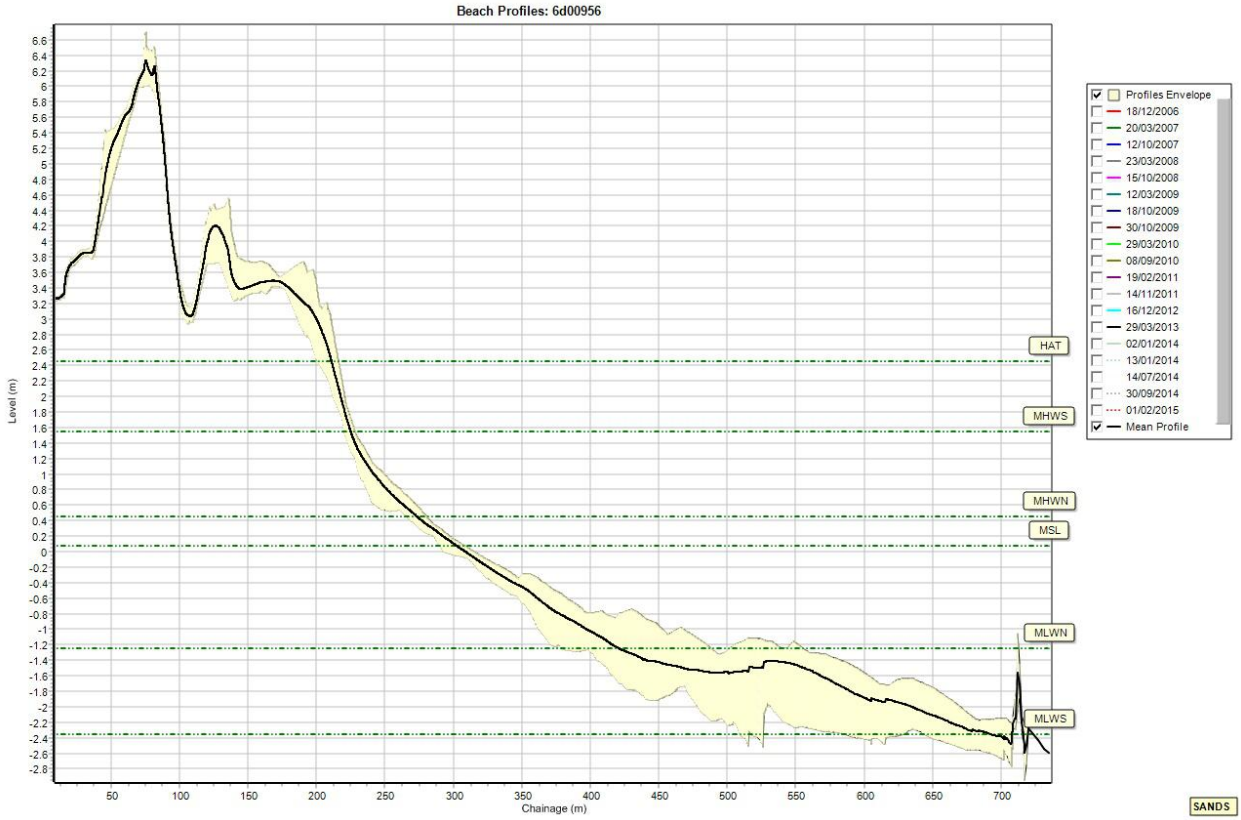


Figure 3.3 Tide levels in relation to typical beach-dune profile at Par Sands (based on SWRCMP monitoring data).

3.1.4 Climate Change and Sea Level Rise

Information on the impacts of climate change is available from 'Advice for Flood and Coastal Erosion Risk Management Authorities' (Environment Agency, 2011). This guidance highlights that the main risk of climate change in relation to beach management is from sea level rise.

The guidance (Environment Agency, 2011) suggests that predictions of the future rate of sea level rise for the UK coastline should be taken from UKCP09. Data downloaded from UKCP09 provides sea level rise from 1990. Anticipated rates of relative sea level rise and surge estimates over three time periods are presented in Table 3.3. The following estimates are presented in the table:

- Lower End Estimate: this is the low emissions scenario, 50% frequency, taken from the UKCP09 User Interface.
- Change Factor: this is the medium emissions scenario, 95% frequency, taken from the UKCP09 User Interface.
- Upper End Estimate: these are generic values of sea level rise provided in the climate change guidance; they are 4mm (up to 2025), 7mm (2026 to 2050), 11mm (2051 to 2080), and 15mm (2081 to 2115).
- H++ Scenario: these are generic values of sea level rise provided in the climate change guidance; they are 6mm (up to 2025), 12.5mm (2026 to 2050), 24mm (2051 to 2080), and 33mm (2081 to 2115).
- Upper End Estimate + Surge Estimate: This is the upper end estimate plus the upper end surge estimate. The surge estimate are generic values provided in the climate change guidance; they are 20cm (up to the year 2020's), 35cm (up to the year 2050's), and 70cm (up to the year 2080's). With regard to the surge increase, the uncertainty with surge increase is even greater than for sea level rise.

The climate change guidance (Environment Agency, 2011) recommends that in planning future coastal management options, the Change Factor (medium 95% frequency scenario) be used as the preferred scenario. All other scenarios are included to demonstrate the sensitivity of decision making through time, and can be used to refine the options to prepare for a wider range of future change.

Table 3.3 Relative sea level rise estimates for Par Sands (see text above for explanation of terms used in this table).

Time period	Various estimates of relative sea level rise and surge (mm/year)				
	Lower End Estimate	Change Factor	Upper End Estimate	H++ Scenario	Upper End Estimate + Surge Estimate
2015 to 2025	0.03	**0.06**	0.04	0.24	0.06
2015 to 2055	0.15	**0.26**	0.27	0.62	0.49
2015 to 2115	0.44	**0.78**	0.92	1.62	1.92

3.2 Sediment Budget and Linkages

At Par Sands, sediment movement is dominated by alongshore and cross-shore transport process. It has been previously reported (Halcrow, 2009b) that there is no alongshore movement outside of the Par Sands bay as a result of the bounding rock headlands, however, the beach at Carlyon Bay was recharged with material comprised of gritty sand and geotextile material and local residents report that some of this sediment was later found on the beach at Par Sands (refer to Appendix C), which suggests that there is potential for sediment to be moved alongshore between the headlands.

Following cessation of the dumping of mining waste, the main sources of sediment to the beach at Par now include erosion of cliffs, discharge from the Par River and Polmear Stream and beach nourishment, as described below:

- Material supplied from erosion of the cliffed headlands is a possible sediment source to the beach, but the composition of beach material indicates that this has not been a significant supply of material over the last few hundred years (Halcrow, 1999a).
- The Par River and Polmear Stream are reported to potentially supply the beach with an input of sediment, although the quantity and type of sediment are not specified (Royal Haskoning, 2011b).
- It is reported (Halcrow, 2009b) that beach nourishment has been implemented for the caravan park behind.

There are no significant offshore sand deposits in the area and input from further along the coastline is limited.

3.3 Historical Changes

3.3.1 General Description

Par Sands is located on the south coast of Cornwall, approximately 4km to the east of St Austell. The beach is set-back within St Austell Bay, enclosed by the docks and china clay works in the west and the steep cliffs of Kilmarth in the east. Par Sands was originally formed at the mouth of an in-filled river valley (Halcrow, 2009b). The wide sandy beach is formed from the erosion of valley infill material and small inputs of material from erosion of the flanking cliffs (Halcrow 2009b), although much of the modern beach sand consists of quartzose sand waste washed down from China Clay

workings to the north of St Austell (Pye, 2007). The beach is backed by dunes (estimated in 2009 to be around 10ha, Halcrow 2009a), which have become well established and form a successive dune habitat. Here, the land is low-lying and is designated as a Local Nature Reserve. Embryo dunes have formed at the interface of the dune toe and beach. The Par River discharges to the sea to the west of Par Sands. The river used to exit to the sea along the breakwater but changed its course in 2007/2008 and now flows out to sea further to the west in a straight line, and against the footings/defences of the china clay factory. The Polmear stream also discharges across the beach at the eastern end of Par Sands.

The evolution of this section of coastline has fundamentally been changed through man's interventions. Par Harbour began as a port to export copper and tin, and was converted from an open bay into a safe port in the early 1800s. From the 1830s onwards it became increasingly important for the shipping of china clay. Historically china clay was dumped on the beach at Par, but this practice has since ceased (Royal Haskoning, 2011b) as a result of an environmental clean-up of the industry (Halcrow, 1999b). There is evidence of the china clay waste on the east bank of the River Par, opposite the china clay works, where recent erosion of the overlying sand has exposed the clay layer beneath. The Port of Par was closed to shipping at the end of 2007.

Old photographs (Francis Firth, online) show the beach huts were originally on the beach, with no presence of dunes. Today, the same huts are fronted by sand dunes that have developed and accreted since then; this suggests that the dunes are a fairly recent feature and possibly formed a result of the china clay waste being dumped on the beach. At the western end of the beach there is a small section of fill, which is comprised of seaweed and litter picked up from the strandline. Some of this fill was washed away during the 2014 storms. The process of beach clearing is no longer undertaken, and seaweed is left top build-up along the strandline in the summer for environmental reasons. Aerial photos analysed for the Par Beach Management Plan show that the dune area advanced 100-150m seaward between 1946 and 1997. This represents an advance of over 2m per year (Environmental Consultants (CTNC) Ltd, 1997).

The dunes today are generally healthy and show signs of accretion along the dune toe, where during the site visit, there was clear evidence of dune growth with the formation of embryo dunes and young dune grass. Marram Grass is growing well and effectively stabilising the dunes. This is likely to be a response to a dune planting programme in the 1980's when the dunes were fenced off and Marram Grass was planted. Within the dunes, Gorse, Sea Buckthorn and Rosa Regosa are growing, but are all invasive species and fighting for space. They can be removed by spraying them with chemicals, however, if they are having a stabilising effect on the dunes then this may prove detrimental to the dune state and therefore the flood defence function they perform (see description of flood risk below). There are some isolated areas of dune erosion, generally limited to the east bank of the River Par.

There is a risk of flooding at Par Sands as there is low-lying land behind the dunes and should they breach this will result in significant flooding of the land behind. Following the 2013/2014 storms Royal HaskoningDHV, (2015) report that the dunes were breached and there was flooding between the first and second dune ridge and there was evidence of overtopping into the dune slack between the fore dune and the back dune. However, they do suggest that it is unlikely that the storm damage resulted in any increased risk of overtopping of the main dune ridge, but it is possible that there is an increased flood risk to the car park at the western end of the beach, which is situated on the lower part of the dune. Waves in this location are expected to be reduced due to its sheltered location. Presently, there is a flood warning system on the ground, which the Environment Agency respond to. A tidal gate on the River Par helps to reduce tidal flooding up river (Royal Haskoning, 2011b) but high tides do reach the toe of the dunes.

Current management intervention at Par Sands is limited to the western and eastern extents of Par Sands. At the western end, hard defences constructed on the west bank of the Par River protect the clay mining works and harbour. The Par River channel is also dredged on an annual basis, with 45,000 tonnes removed to improve navigation through the channel (Royal Haskoning, 2011b). To the eastern end of Par Sand, boulders were placed in the stream in the late 1970's to help stabilise the

bank of the river at a pinch point; prior to this work this area used to flood during high tides. It is reported (Halcrow, 2009b) that beach nourishment has been implemented at the eastern end of Par Sands for the caravan park behind.

Further details are provided in Appendix C.

3.3.2 Long Term Evolution

3.3.2.1 Comparison Ordnance Survey Mapping

A comparison of 1888/1889 and 2000 editions of Ordnance Survey Mapping shows:

- Mean High Water is observed to have advanced more at the eastern end (200m) than the western end (150m).
- The eastern side near to the river has built out to the west of the rock. The western side has remained constant. The beach plan orientation has not changed at the low water mark.

3.3.2.2 Analysis of Aerial Photographs

Using aerial photographs, the dune toe was digitised and compared (refer to Figure 3.4). The analysis shows that the between 2001 and 2007:

- Significant accretion along the majority of the frontage of the dunes at Par Sands. In general, the seaward face of the fully mature dune system has accreted seaward between 5 and 13m over the 5 year period. This represents an average rate of accretion of between 1 and 2.5m per year.
- The exception to this is at the western extremity of the beach (nearest the river), where a stretch of dunes roughly 60m wide eroded landwards approximately 5m, and where a section of foredune roughly 100m wide by 10m deep was completely lost.
- Over this period, there was notable build-up of the foredunes in the middle of the beach over the past 5 years, with the original embryo dunes increasing in width and growing slightly seaward. The density of vegetation cover appeared to have increased over time as well.

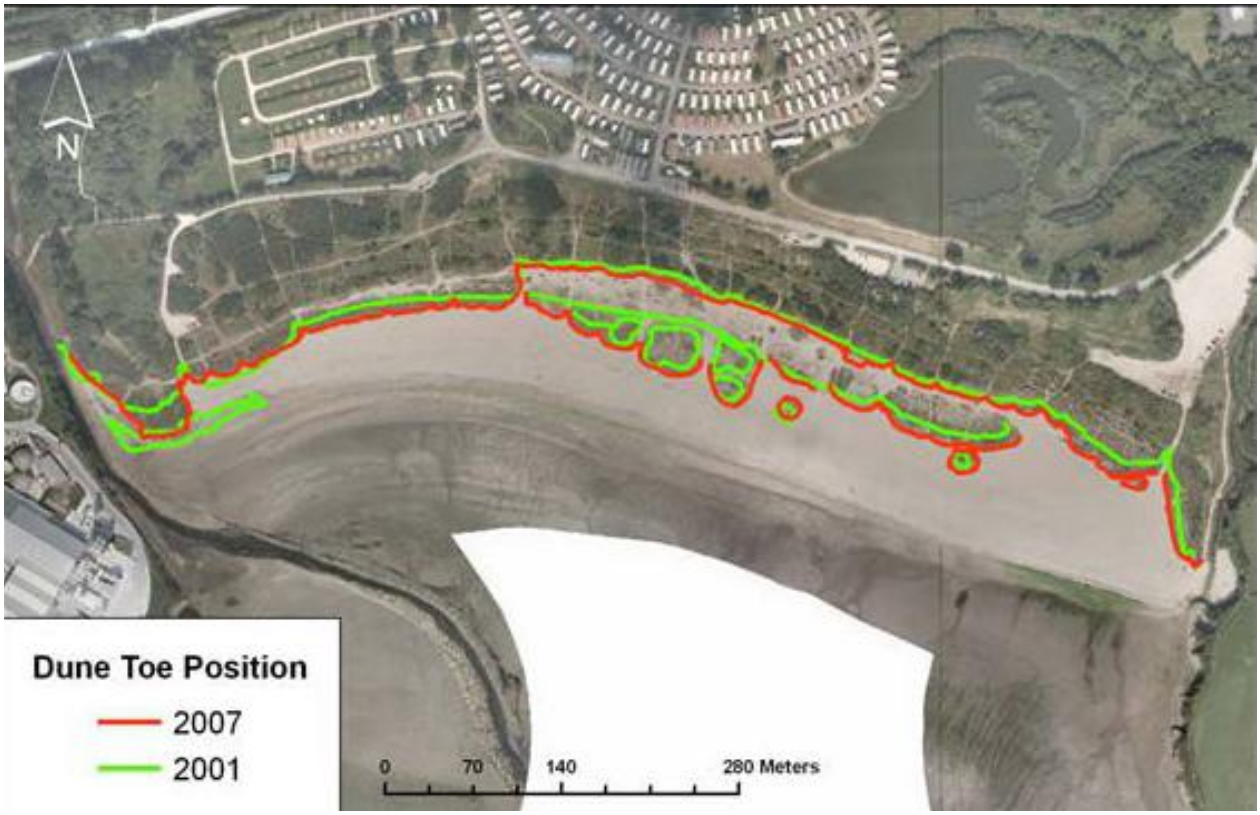


Figure 3.4 Dune toe positon at Par Sands in 2001 and 2007 (source: Halcrow, 2009c).

3.3.2.3 Beach Profile Analysis

Analysis of the beach profile data collected by the SWRCMP was undertaken to identify changes in the dunes and beach, including cross-sectional area (CSA), between December 2006 and March 2008 for four locations: 6d00965, 6d00960, 6d00956 and 6d00952 (refer to Figure 3.5). The study concluded the following:

- Dunes: The four profiles at Par Sands generally show no discernible trends for the dune area. All changes over this period equate to less than 1% of the material present above the master profile. The maximum variability on any profile was 10m^2, but this equates to a small volume over the 100m of dunes surveyed. The exception to this along the two profiles (6d00956 and 6d00960) in the centre of the site, which show a slight increase in the sand levels on top of a foredune in front of the main dune system. The increase in crest height of the foredune feature was in the order of 15 to50 cm between 2008 and 2006, indicating that this may be a growing feature.
- Beach: Only one of the four profiles showed a loss of beach material over the analysis period. The western-most profile lost 1% of its CSA over that time. A possible explanation for this is the loss of the foredune in this area. The other three profiles remained stable or accreted slightly.

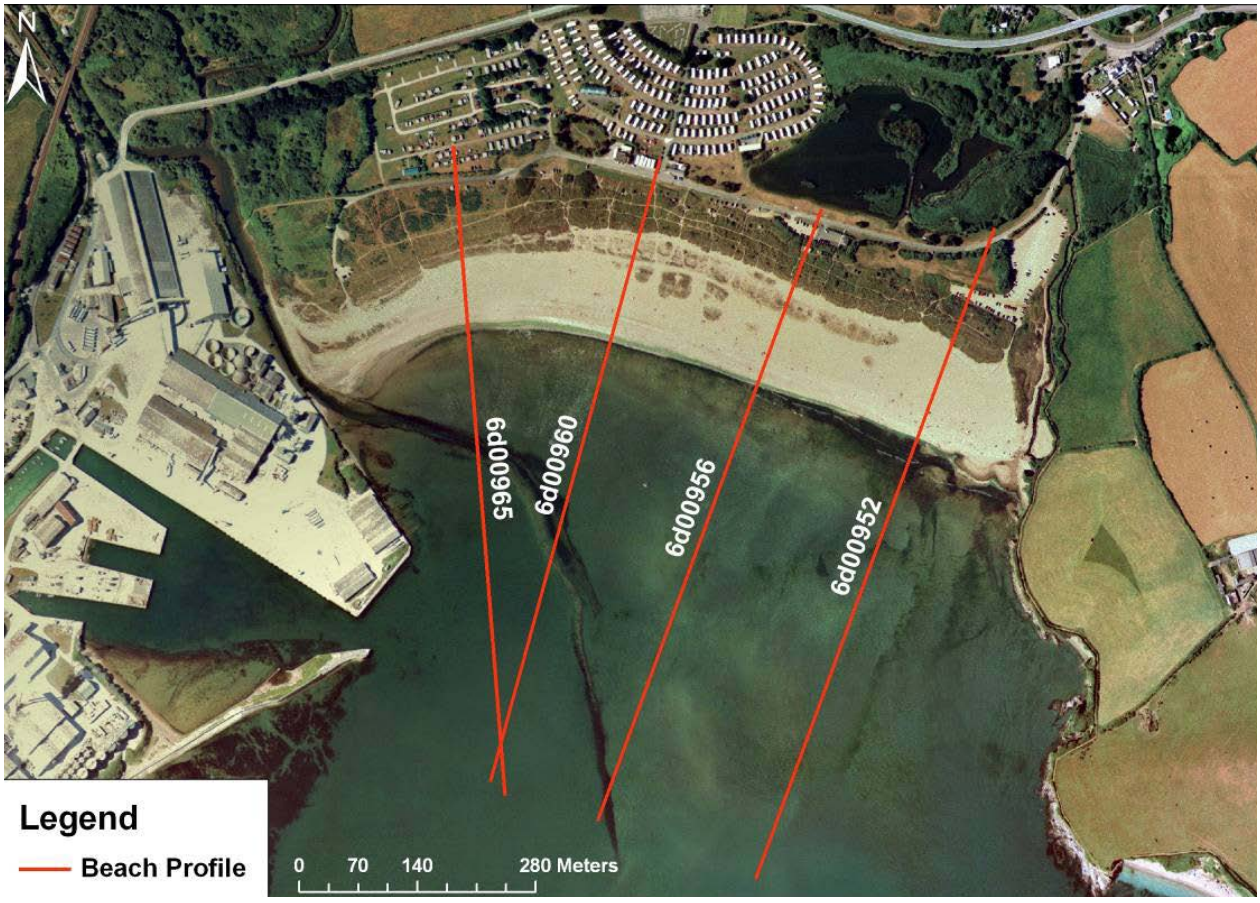


Figure 3.5 Diagram showing position of SWRCMP beach profiles at Par Sands.

Beach profile monitoring undertaken by PCO for the SWRCMP, provides recent data and analysis for the beach at Par Sands. A summary of the findings from the latest annual survey report (PCO, 2014c) are presented in this section and provide an overview of beach profile change in the past year, between Spring 2013 and Spring 2014, and over the longer-term from the baseline survey in 2007 to the most recent survey in Spring 2014. The calculations of CSA include the beach and part of the dunes.

- In the past year, between Spring 2013 and Spring 2014 (refer to Figure 3.6), profile 6d00965 remained stable, whilst profiles 6d00952, 6d00956 and 6d00960 all lost material.

- Over the longer term, between 2007 and Spring 2014 (refer to Figure 3.7), the two profiles to the west, 6d00960 and 6d00965, gained material (possibly linked to change in course of the river), but at the east of the beach, profiles 6d00956 and 6d00952 lost material.
- Mapping of the Mean High Water (MHW) contour (refer to Figure 3.8) shows variation on the position of the MHW contour, with no clear trend.

As part of the SWRCMP, PCO have also prepared two reports (PCO, 2014d and 2014e), which examine the change to a selection of the beaches along the south-west coast, with a view to identify how beach change occurring as a result of the 2013/2014 winter storms compares to the longer-term behaviour of the beach. For the first report (PCO, 2014d) have undertaken analysis of beach profile data to assess beach volume change over the longer term (typically between 2003 and 2013), the 2013/2014 winter storm period (typically between October/September 2013 and February 2014), and over a post-storm period between winter 2013/2014 and summer 2014. The second report (PCO, 2014e) provides the results of topographic difference modelling undertaken by the Environment Agency. The modelling compares the last available LiDAR flown sometime before the 2013/2014 winter storms and LiDAR flown after the 2013/2014 storms. Where this analysis has been completed for the BMP sites, a summary of the changes are described below.

- The long-term volume change between the baseline survey in 2007 and Summer 2013 was 16,400m^3. The net change over the 2013/2014 winter period (from March 2013 to January 2014) was -27,400m^3, but the net change from Winter 2013/14 to Summer 2014 was 20,522m^3. The percentage of beach volume recovered by Summer 2014 was therefore +75% (refer to Figure 3.9).
- The topographic difference model plot for Par Sands (refer to Figure 3.10) shows the beach elevation change between the 21st March 2012 and 1st April 2014.The plots shows that the dunes have accreted vertically over this time and a reduction in beach level along the MHW line (particularly at the western end around the site of fill, corresponding to loss following the 2013/2014 storms, and the eastern end of the beach).

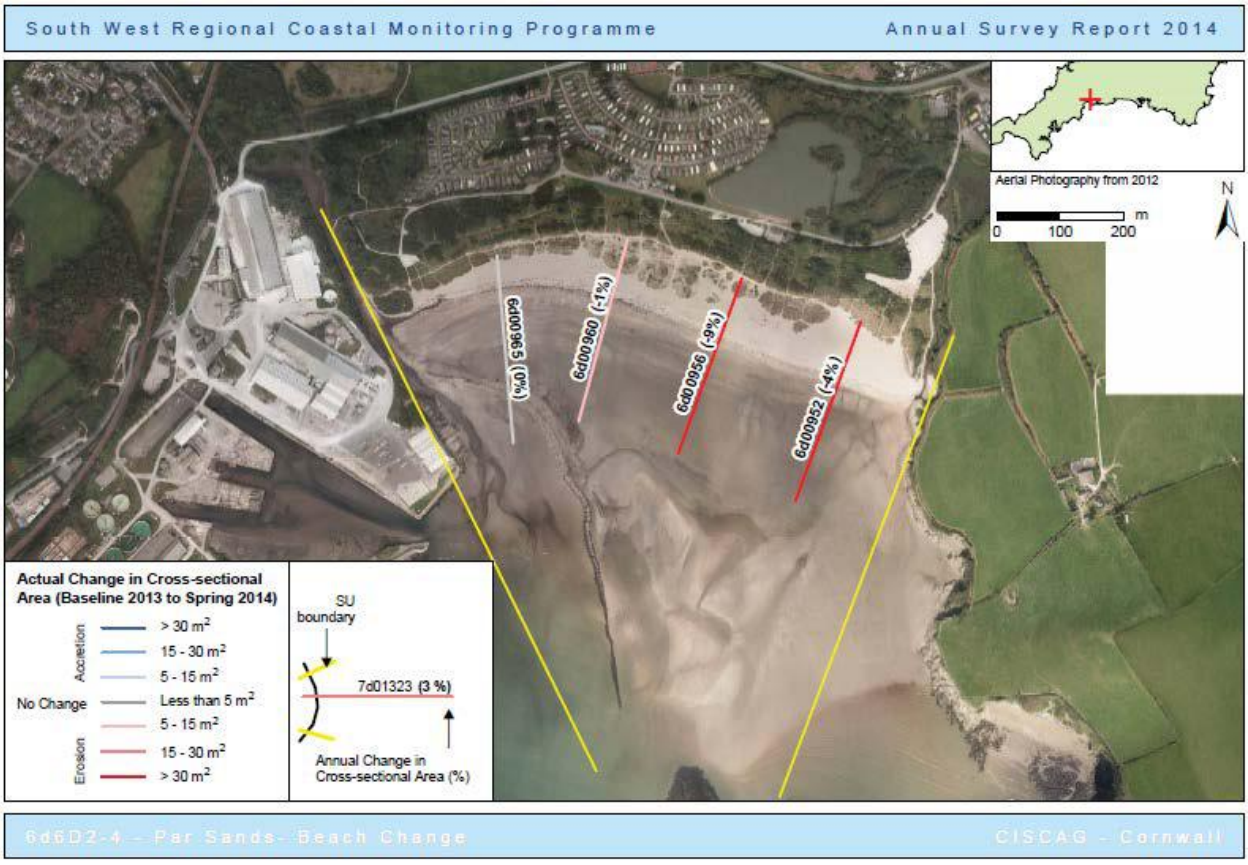


Figure 3.6 Beach profile change at Par Sands Spring 2013 to Spring 2014 (source: PCO, 2014a).

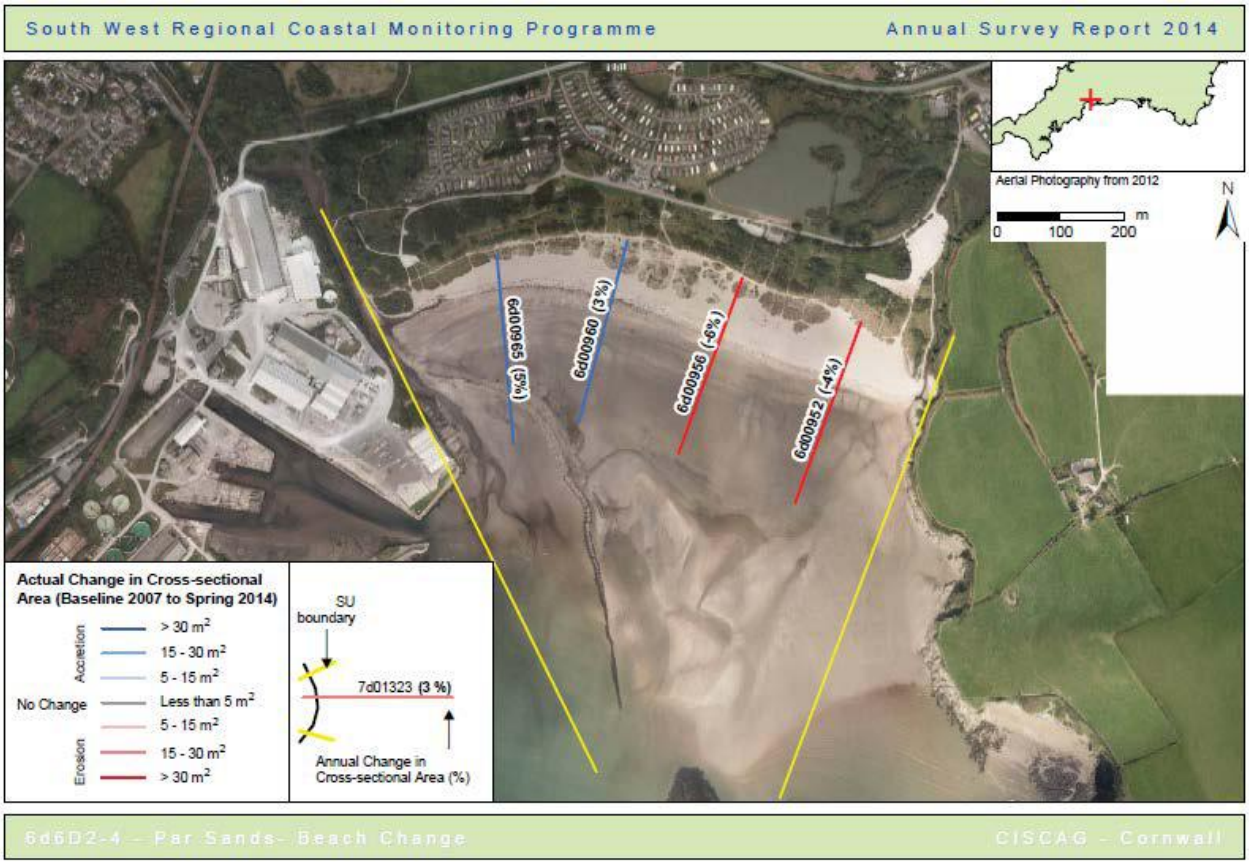


Figure 3.7 *Beach profile change at Par Sands baseline 2007 to Spring 2014 (source: PCO, 2014a).*

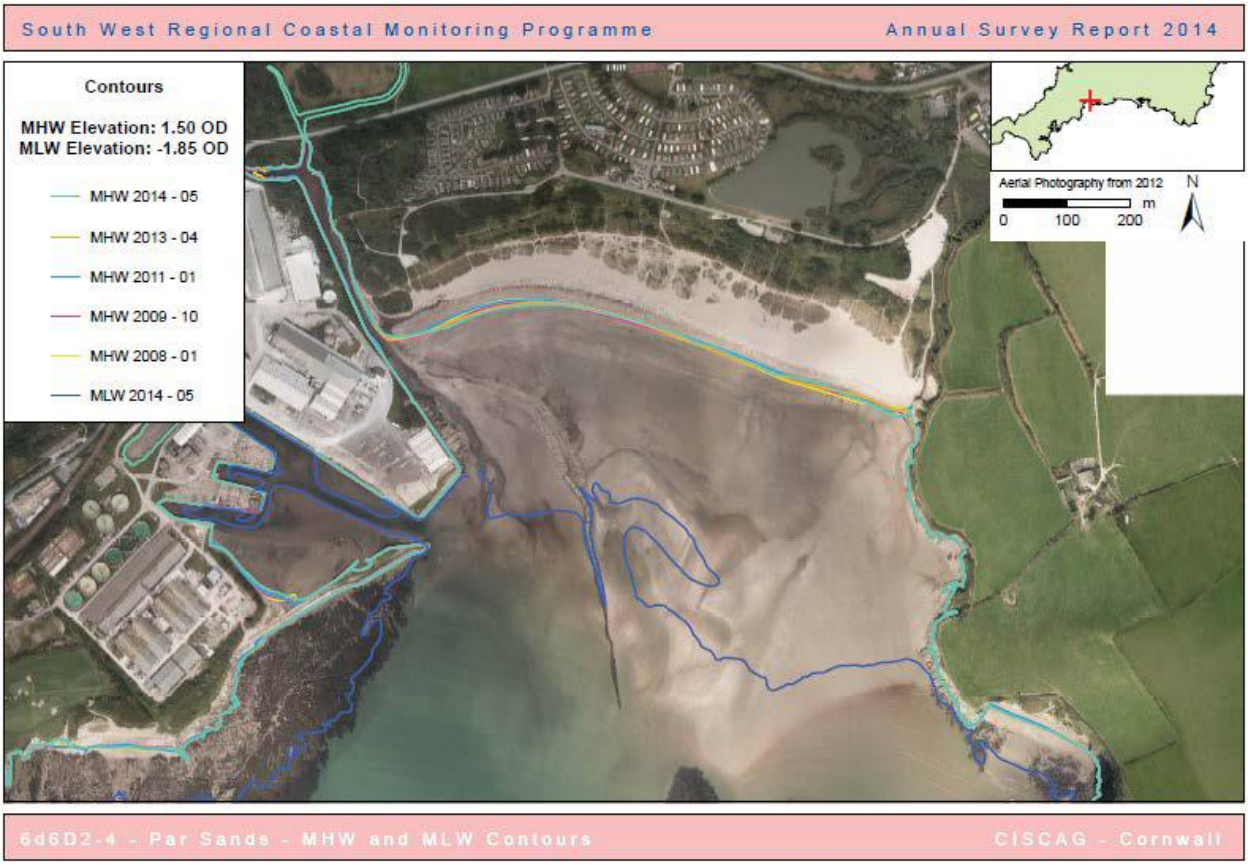


Figure 3.8 *MHW contour change at Par Sands (source: PCO, 2014a).*

Figure 3.9 *Volume change at Par Sands (PCO, 2014b).*

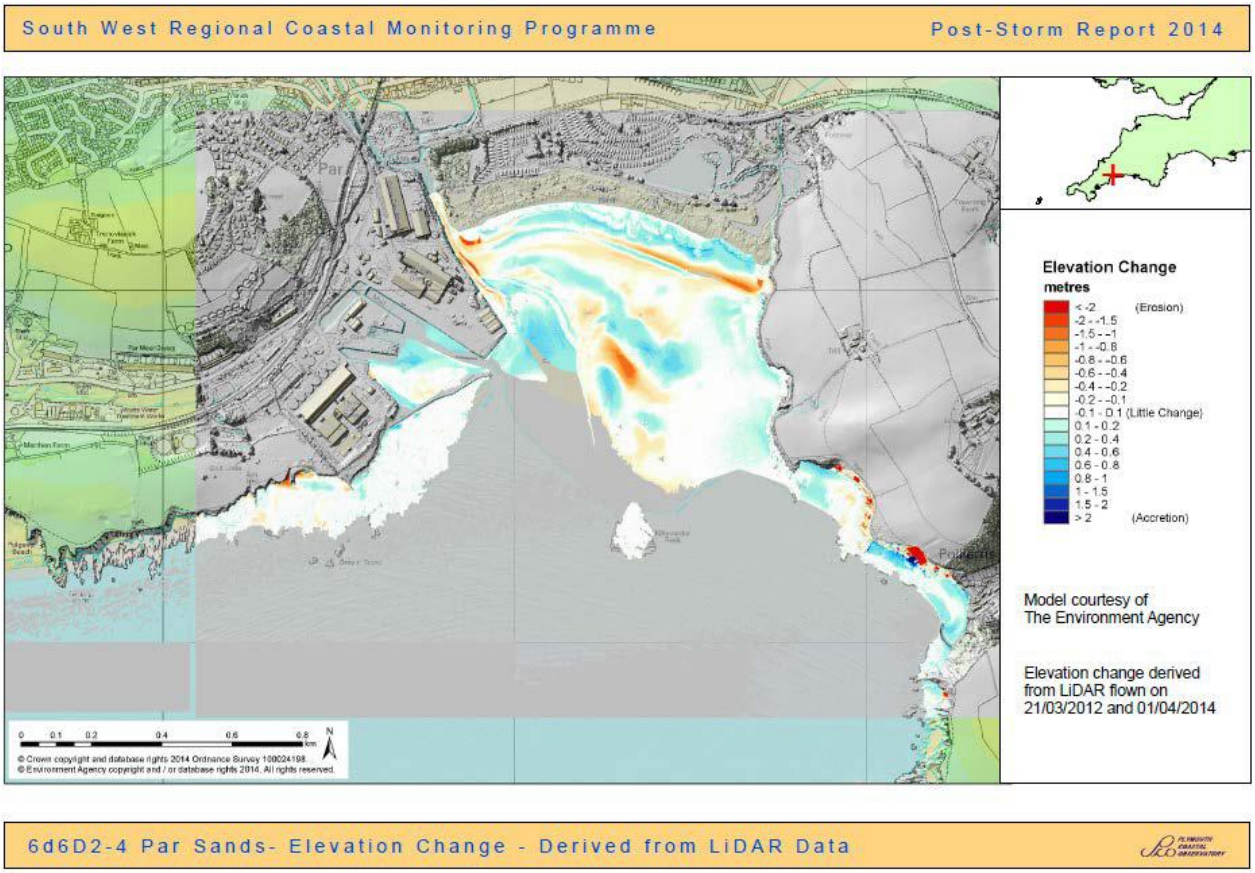


Figure 3.10 *Post storm elevation change at Par Sands (source: PCO, 2014c).*

3.4 Summary of Site Influences

Par Sands is south-facing and open to the south-westerly Atlantic swell waves. It is set back within St Austell Bay and therefore sediment transport to the beach by alongshore processes is limited, although there is evidence of nourishment material from Carlyon Bay ending up on Par beach which suggests a west to east import of material alongshore. The beach has been highly influenced by mining in the past, when waste material was dumped on the beach. Although this practice has now ceased, the dunes, and in places the beach, continue to accrete vertically.

The dunes have a flood defence function to the low-lying behind and it therefore very important that they are maintained in their current if not a more robust state. The dunes to appear to be accreting at the dune toe along the length of the frontage, however, beach profile analysis shows that the beach at the western end of Par Sands is accreting whilst the east is eroding. This may be linked to the change in course of the river, or another explanation could be that the beach nourishment material placed at the eastern end of the beach for the caravan park (as reported on by Halcrow, 2009b) could have moved from east to west, which is contrary to the net drift direction for this section of coastline. The overall net volume change between 2007 and Summer 2014 was accretion (PCO, 2014e), despite the storms of 2013/14, and given that the profiles include sections of the dunes is likely to be representing their vertical accretion.

3.5 Future Changes

The key issue at Par Sands is that the dunes provide a flood defence function to the low-lying land behind. The dunes appear to be stable and in places accreting, so intervention required at present is probably limited. However, as sea levels rise and without new influx of sediment, this accreting trend will like stop and reverse to become one of erosion. This will in turn lead to erosion and narrowing of the dunes, particularly if the dune system is constrained from migrating landwards due natural or human factors. The size of the dunes in this area will therefore reduce, making the system more vulnerable to storm impacts and increased risk of erosion leading to breaching and so flooding. The extent of potential flooding and erosion is shown in Figure 3.11.

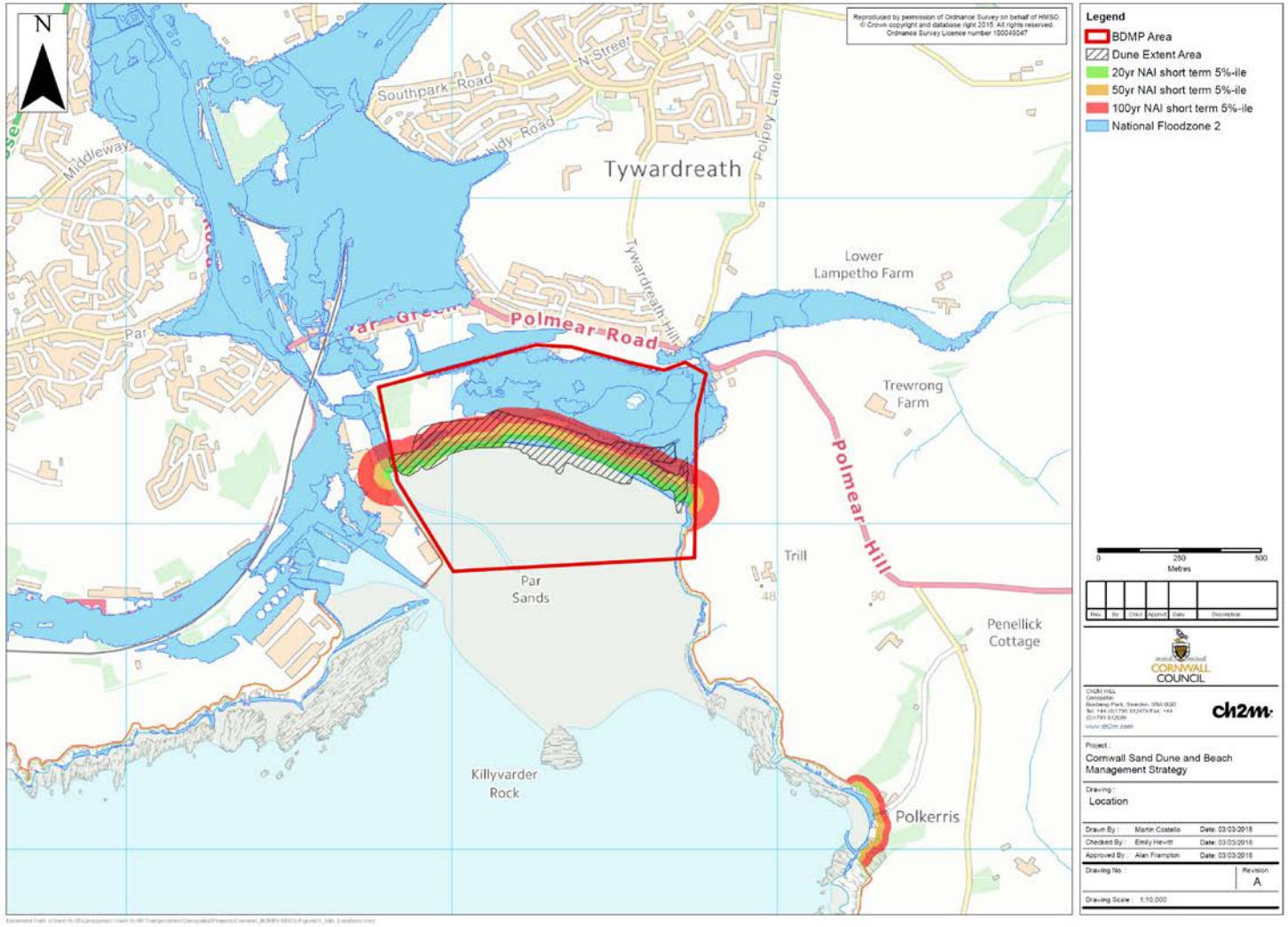


Figure 3.11 Flood and erosion risk projections for Par Sands.

Beach & Dune Management Plan

This section covers the development of the Beach & Dune Management Plan and is divided into three sections:

1. Key Issues.
2. Management techniques to apply at Par Sands.
3. Plan of Action.

4.1 Key Issues

The key issues to be addressed by beach and dune management activities include:

- Potential for dune erosion in the future and exposure of a historic landfill site.
- Planning for adaptation of backshore assets in the future.
- Lack of information / data relating to dune erosion and beach levels to inform management.
- Uncontrolled public access within the dunes resulting in dune erosion and trampling, littering and dog fouling.
- Ensure sediment removal from the Polmear Stream remains in the beach-dune system.
- Consideration of environmental impacts on designated features.
- Control of non-native invasive species within dune vegetation.
- Limited funding to undertake management activities.

4.2 Appropriate Management Techniques at Par Sands

This section discusses the management techniques to be applied at Par Sands to manage the beach and sand dune system in a sustainable way for the next 50 years. These techniques have been identified from the *Sand Dune Management Techniques Preliminary Decision Support Tool* (see Appendix A) and determined to be appropriate for this location following detailed appraisal (see Appendix D).

The key recommendations at Par Sands are focussed on ensuring that the dunes continue to provide a flood defence function to the low-lying land behind. The dunes appear to be stable and in places accreting, so intervention requirements in the form of dune stabilisation at present is probably limited. However, as sea levels rise the need for dune stabilisation measures will become increasingly necessary to ensure the dunes continue to fulfil an important flood defence role.

The hinterland is in multiple ownership. Par Sands is managed by Cornwall Council, however, the wetland in the vicinity of the stream is managed by Cornwall Council as a Local Nature Reserve together with the group, Friends of Par Beach. Given this ownership situation, Cornwall Council's role is to lead on implementing the management activities defined in this BDMP and plan for adaptation, but with the support of the LNR and Friends of Par Beach.

4.2.1 Dune Stabilisation

The dunes have a flood defence function to the low-lying behind and it therefore very important they are maintained in their current, if not a more robust, state. The dunes at the present time appear to be accreting at the dune toe along the length of the frontage, however, beach profile analysis shows that the beach at the western end of Par Sands is accreting whilst the east is eroding.

In the past, dune restoration has been undertaken using wooden fences to trap sand and build up the dunes in areas of breach, however the buried fencing later became a hazard to walkers.

Even in the short term under a No Active Intervention policy, some form of dune stabilisation for 'access or safety management' may be acceptable to, for example, ensure historic landfill within the dunes is not exposed and to address erosion of the River Par dune bank. Natural forms of stabilisation, such as planting, thatching, mulching, matting or sand binders, combined with fencing and signage, would allow natural processes to continue, help retain sand on the dune system, and assuming native plants are used, could have long term positive effects on BAP habitats. Over stabilisation of the dunes would however, not be desirable for habitats and risk of the dunes becoming un-dynamic and unable to react to pressures.

If stabilisation measures are required, access management and signage will be needed to prevent beach visitors trampling any establishing vegetation and hindering stabilisation of the dunes. Although these are relatively low cost measures, they would require ongoing commitment to management and maintenance, with the expectation being that storms will periodically erode stabilised areas and thus re-stabilisation will be needed to encourage post-storm recovery.

Any planned stabilisation measures should be discussed with Natural England prior to implementation, unless it is an emergency situation.

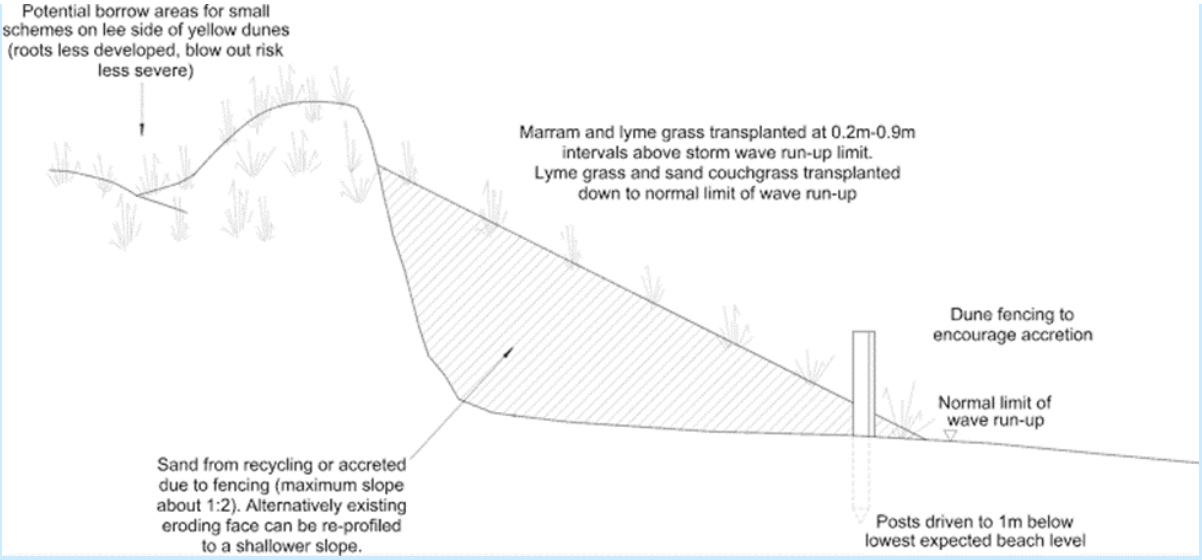
BOX 1 and BOX 2 provide specific guidance on dune planting and dune thatching respectively.

BOX 1: Dune planting guidance

- Planting should only include those species that are indigenous to the site to maintain the natural ecosystem.
- Plant marram grass (Ammophila arenaria) on the face of eroding dunes above the limit of direct wave attack.
- Plant sand couchgrass (Elymus farctus) or lyme grass (Leymus arenarius) along the toe of existing dunes to encourage the growth of new foredunes, as these species are tolerant to occasional inundation by seawater.

Example of dune planting

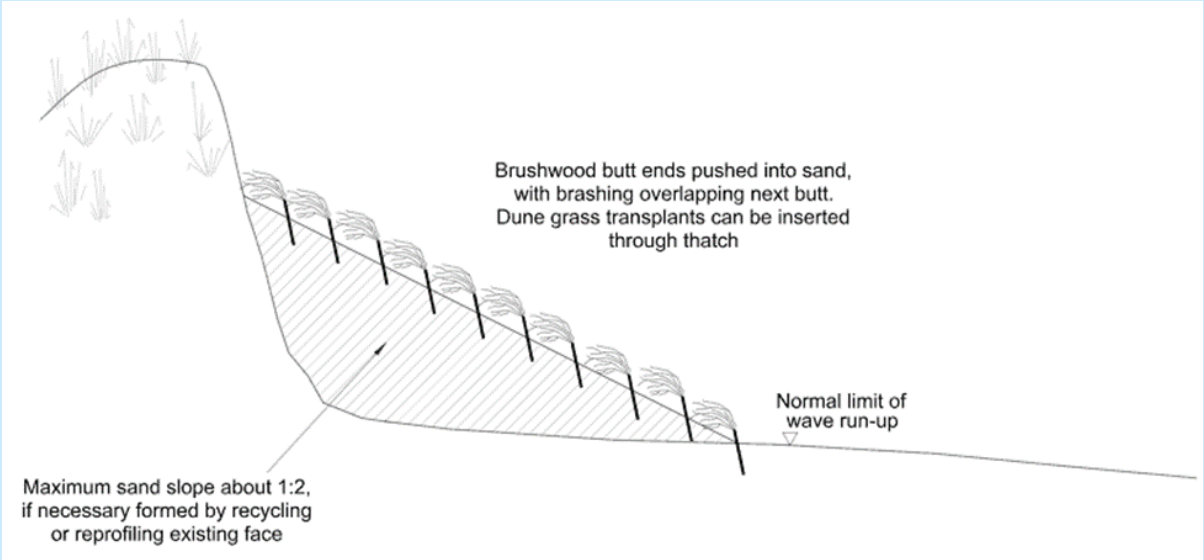
- Planting grasses from seed is not recommended in the very active foredune environment.
- Planting should be undertaken in the spring to maximise potential growth and minimise the risk of storm erosion.
- Dune planting schemes must be continuously managed to establish a vigorous growth and to repair natural or human damage.
- Re-profiling, thatching or fencing are normally required in association with planting to enhance dune recovery and to restrict public access or damage.
- Educational signage at backshore car parking areas or along footpaths should be used to explain management schemes and encourage public interest and support for the management objectives.



For further information, refer to [Link no longer available]

BOX 2: Dune thatching guidance

- Materials can include timber or brushwood cuttings, must be degradable and should not introduce foreign seeds, live cuttings or pollutants that may damage the dune ecology.
- Conifer brashings (lower branches) from spruce or fir are preferred for their flat, fan shapes.
- Thatch should be laid to cover 20% - 30% of the exposed sand surface.
- Dune grasses should be transplanted through the thatch to promote sand retention and restoration of natural habitats.
- Thatching should not be undertaken on steep, freshly eroded slopes. The dune face should be regraded or built out with recycled sand prior to further works. A maximum slope of 1:2 is recommended.
- Thatching should not extend seaward of the line of normal wave run-up.
- Thatch must be regularly maintained to maximise effectiveness and to minimise impact on public use and visual amenity.



For further information, refer to [Link no longer available]

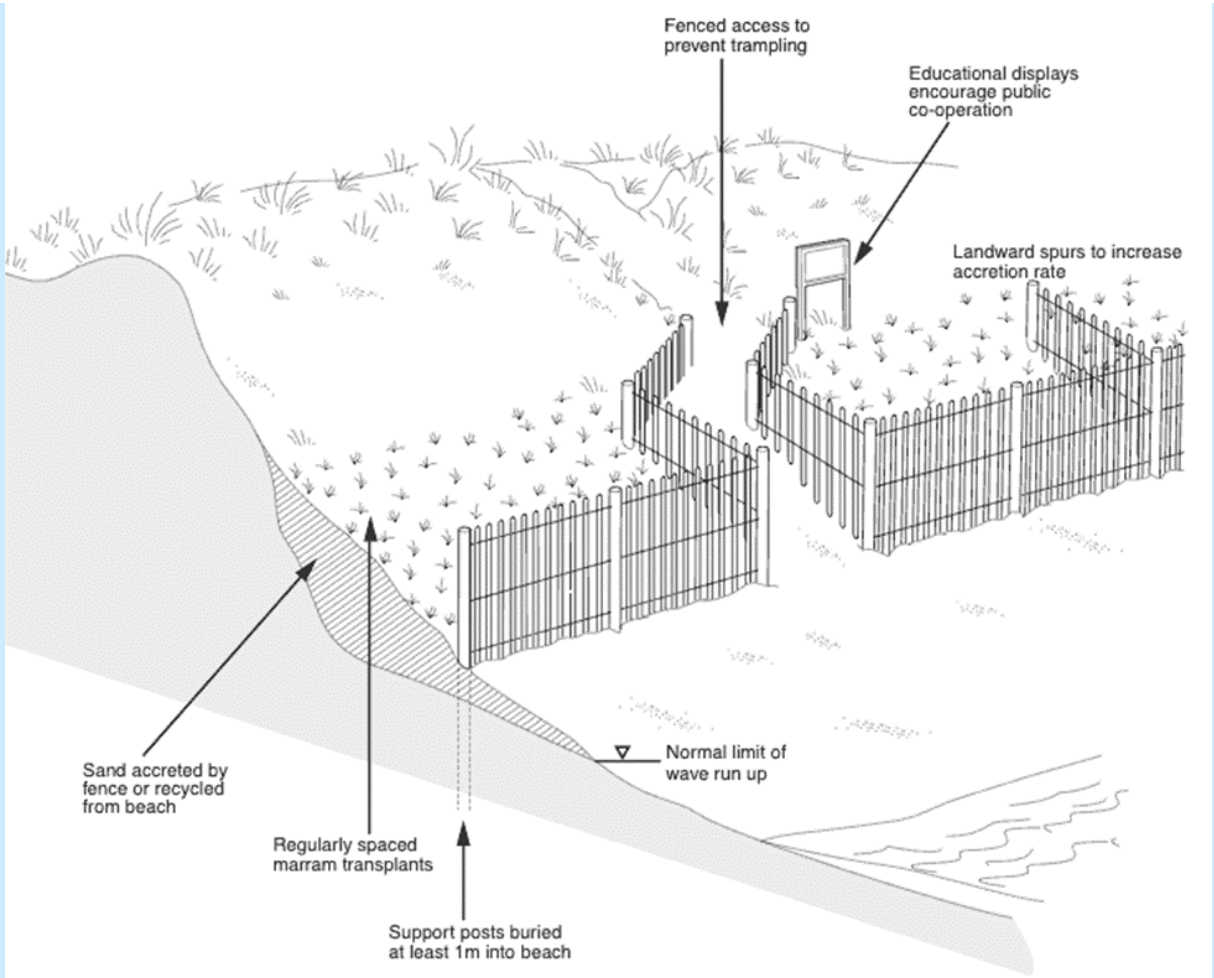
4.2.2 Morphological Modification

The accreting nature of this shoreline at the present time shows that embryo dune formation is possible at this site. At the dune toe, embryo dune formation may not succeed as high trampling pressure means that vegetation and sand build up do not survive long enough to fully establish into dunes. To encourage embryo dune formation fencing could be constructed to prevent access to the dune toe where embryo dunes could form. If the dune front is subject to regular wave action the embryo dunes will not be able to fully establish. Further investigation and monitoring is recommended before implementing these measures to ensure conditions are suitable for embryo dune formation at the proposed location on the dune site.

BOX 3 provides specific guidance on dune fencing.

BOX 3: Dune fencing guidance

- Fencing materials can include chestnut palings, brushwood, wooden slats or synthetic fabrics, dependent on required life, length of frontage, commitment to maintenance and vandalism potential.
- Brushwood is normally the cheapest material but has a life expectancy of less than one year.
- Synthetics can be low cost (strawberry netting), or expensive (polyproplylene, nylon or composite wire/synthetic webs) and life expectancies vary from one year to decades. Maintenance is minimal, however synthetics should be avoided in areas likely to be heavily affected by storms to reduce hazards to swimmers, navigation and sea life if it becomes damaged.
- Chestnut paling fencing is commonly used and is widely available, easy to erect and has a life expectancy of 2-5 years.
- Fencing can be installed forward of the toe of the dunes where it will be subject to occasional wave attack during storms.
- Fencing posts should be buried to about 1m below the lowest expected beach level. Substantial timbers may be required at locations exposed to regular wave attack.
- Fencing should be constructed parallel to the dune face. Short spurs running landward up the dune face can also be beneficial to recovery in areas subject to dominant winds blowing at an acute angle to the shoreline.
- The void to solid ratio for any fence material should be between 30% and 50% to achieve effective sand accumulation.
- Fencing can be undertaken at any time of year and should be complemented with dune grass planting after the fencing is in place.
- Access routes through the dunes should be defined by the fencing at regular intervals along the dune face.



For further information, refer to [Link no longer available]

4.2.3 Sediment Modification

Clearance of sand at the mouth of the Polmer Stream may also be acceptable to reduce flood risk upstream. Removed sand should be placed back to the beach, to areas away from BAP habitat, but ensuring that the sediment remains in the system.

4.2.4 Ecological Modification

Currently, BAP habitat is in unfavourable condition and within the dunes, Gorse, Sea Buckthorn and Rosa Regosa are all invasive non-native species fighting for space. There is also growth of Rosa Regosa within the new dunes.

Removal of non-native invasive species will improve the condition of designated features. However, best practice methods should be used to minimise both impacts to protected species and risk of destabilising dunes. Removal of these non-native species by pulling up by hand or mechanically and treating with a biodegradable herbicide is required to have a positive long term impact on the improvement of designated features and BAP habitat.

In addition, it is suggested that these efforts to control invasive species should form part of a new dune habitat management plan for Par Sands that sets out wider habitat management to maximise ecological gains in the area. Such a habitat management plan should be developed in partnership with Natural England.

4.2.5 Adapt Backshore

The SMP policy for Par Sands is No Active Intervention (NAI) in the short term, transitioning to Managed Realignment (MR) in the medium to long term. The policy intent is to investigate landfill risks and identify a possible strategy for MR and dune roll back into the hinterland.

The holiday park located on the low-lying land behind the dunes will hinder the ability for natural dune rollback to occur in the future. To maintain the flood defence function of the beach and dune system, and reduce risk of flooding to low-lying land, the dune and beach system needs to be able to roll-back naturally. Under a MR policy in the medium and long term, coastal adaptation measures involving the relocation of existing development and car parks will be required to allow natural processes to occur and lead to positive benefits to designated features and BAP habitat, while avoiding any impact on features elsewhere. Coastal adaptation will require longer term land use planning with relevant land owners and authorities. To guide coastal adaptation efforts, Cornwall Council, as the local planning authority, should develop a Coastal Change Management Area (CCMA) at Par Sands in line with National Planning Policy Framework (DCLG, 2012) and drawing upon the predictions for future coastal change described in Section 3.5 of this BDMP. To aid Cornwall Council in leading on this activity, use should be made of the *Coastal Change Adaptation Planning Guidance for England* (CCAPG) published in 2015 (Halcrow, 2015), which highlights a number of coastal adaptation options for beach and dune systems including:

- Rollback or relocate property, community facilities and infrastructure.
- Ensure new development does not cause adverse effects/ transfer coastal change risks to other areas.
- Use area action plans/neighbourhood plans to manage future development in coastal communities.
- Implement managed realignment to manage coastal change, working with natural processes and restoring habitat.
- Remove defences to restore natural processes, making use of the natural environment.
- Explore other ways to conserve historical assets in situ but also record assets to secure the evidence.

In addition, at Par Sands an additional option to consider will be the removal of historic landfill to a new (safe) disposal site before it is eroded into the marine environment.

The ultimate trigger for implementation of rollback (or other adaptation measures) will be when assets are assessed as being at imminent risk of loss to erosion (Halcrow, 2015), guided by ongoing monitoring (see BOX 4). However, at Par Sands, rollback will need to be planned for at the earliest opportunity and the work on implementation will be over a longer period of time to reduce flood risks. This more pro-active approach to implementation would see assets relocated before they become exposed to such a level of risk.

BOX 4: "Imminent Risk"

Imminent Risk is defined in the *Coastal Change Adaptation Planning Guidance for England* (Halcrow, 2015) as being when an asset is within the maximum extent of erosion that has historically occurred at a specific location. This needs to be determined on a site by site basis and informed by analysis of longer term data records, for which ongoing coastal monitoring delivered by the South West Regional Coastal Monitoring Programme (refer to Section 4.4.1) is essential.

4.2.6 Access Management

Trampling of the dunes has previously been a problem which has been overcome through access management, including fencing of older dunes to prevent access and the construction of ramps to provide disabled access.

The implementation of specific route ways can lead to a concentration of foot traffic in these areas, and focus trampling. The construction of boardwalks in key areas may be required to reduce the impact of this high level of trampling on the dune surface. There are a number of different designs of boardwalk and sloping stepped structures which may be applied (BCTV, 2005). Careful design would be required to construct these structures at appropriate locations and appropriate designs should be chosen to minimise problems such as burial or undermining of the boardwalks as dune systems are very dynamic. There should be a preference against introducing any new materials to a site if at all possible, however materials that can easily be removed, such as wood, would not permanently impact on landscape and can be removed when no longer needed. The design should also minimise the impact on natural dune processes. The increased focus of visitors around the entrances to board walks would require detailed design and monitoring to ensure this did not result in increased erosion.

BOX 5 provides further specific guidance on boardwalks and walkway guidelines.

BOX 5: Boardwalk / walkway guidelines

- Access routes should be clearly visible and defined.
- In general, construction of excessively wide access routes on coastal dunes limits the amount of vegetation that can grow. In general, they should be no wider than 4 feet (and preferably narrower) and extend no longer than necessary to provide access to the beach.
- Access through the dunes should be perpendicular to the beach and follow the natural contours of the dunes rather than cutting straight lines susceptible to wind erosion
- In some circumstances, rollout structures used on a seasonal basis are a good option. These temporary structures can be removed during the off-season to reduce the potential for storm debris and to allow the dune to function unimpeded when wind-driven sediment transport is generally higher and the demand for beach access is reduced.
- Construction activities should be timed to minimise or avoid impacts if they are in or adjacent to endangered or threatened species habitat.
- Construction that will remove plant cover and expose areas to erosion during the storm season (winter) is not recommended.
- For permanent walkways consider materials that will resist rot and other deterioration, such as wood and wood composites.
- For removable options non-wood materials such as bark chips or matting are low cost and have low impact on the environment.
- Elevated structures should be at least 2 feet above the surrounding dune to allow movement of sand or sediments, dune growth, and enough sunlight to penetrate under the structure for plant growth.

For further information, refer to http://www.mass.gov/eea/agencies/czm/program-areas/communications/cz-tips/cz-tip-boardwalks.html (link correct when accessed on 29th July 2016).

Example of a removable access structure (Source: http://lizardandpenrose.blogspot.co.uk/2012/03/under-boardwalk.html; link correct when accessed on 29th July 2016).

4.2.7 Manual Maintenance

Current management practices include the manual removal of litter and this should continue.

Increased provision of bins for litter and dog waste during the summer months (beyond those in place all year round), strategically placed on the beach, along dune access routes, around the car parks and local facilities, should be considered to address seasonal litter and dog fouling issues. The provision of additional bins should match demand, and so the number could be reduced during the low season to current levels.

Accompanying signage is also important as education has a big role to play with beach visitors encouraged not to litter but to take their waste home or put it in a bin. Consideration should be given to the need for a local community / voluntary ranger service to reinforce these messages. Beach recycling facilities should be made available alongside general refuse bins.

4.2.8 Public Awareness

Education of beach users in the importance of dune management could encourage people to respect the management techniques put in place. Information signs should be developed and situated at key locations, such as at beach/dune access points, and next to the car park pay and display machine, to explain the importance of the dunes and the management techniques being employed. Signage needs to be eye catching and should include information such as:

- The importance of the dunes at Par Sands.
- The pressures on the dunes, including high visitor numbers and wave erosion.
- The impact of the actions of beach users on the dune system.
- Dune Management techniques in place and how they can help the dune system.
- How the beach users can contribute in protecting and enhancing the dune system.

Smaller repeater signs should be placed at strategic locations within the dunes. Educational leaflets could also be produced and placed at strategic locations within the leisure park facilities. Signs indicating access routes should be clear and easily visible to make following the designated routes the 'easy option' for visitors.

Liaison with regular beach users could also be carried out through the already established Friends of Par Beach group, bringing together local residents, businesses, landowners and beach users. Cornwall Council could liaise with the user group, providing information on the site and management activities carried out and consulting local users on proposed techniques. Public awareness campaigns may also help to promote conservation of the dunes and promote dune recovery. All signage and associated management measures will require regular maintenance to be effective. This can be carried out by a dune warden.

Alongside educational information, a beach/dune ranger could reinforce messages while also provide an authoritative figure to ensure management measures implemented are not damaged by the public. A ranger could patrol the site conversing with the public and providing a contact between the beach/dune users and the beach/dune managers as an effective way of providing information to visitors during the summer months.

Figures 4.1 to 4.4 provide examples of different types of signage.

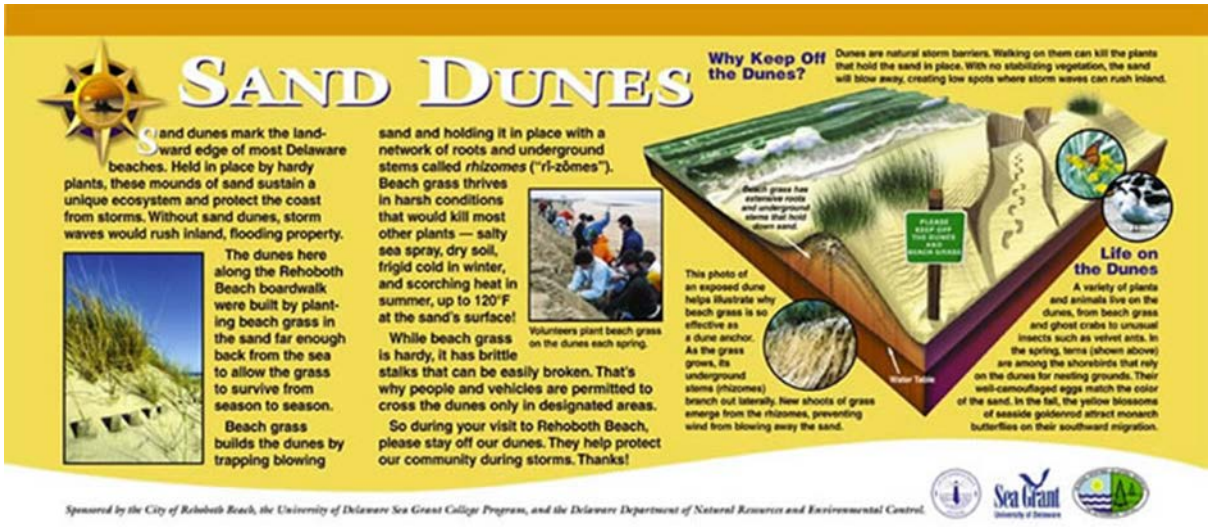


Figure 4.1 Sand dune educational signage example (from https://www.deseagrant.org link correct when accessed on 29th July 2016).

Figure 4.2 Beach signage examples (from http://www.screenmakers.com.au/services/parks-and-places/bondi-to-bronte-coastal-walk; link correct when accessed on 29th July 2016).

Figure 4.3 Post and panel beach signage example, Exmouth (from http://www.signsexpress.co.uk link correct when accessed on

29th July 2016).

Figure 4.4 Dune signage example, Studland Bay (from http://www.earthstudies.co.uk link correct when accessed on 29th July 2016).

4.2.9 Monitoring

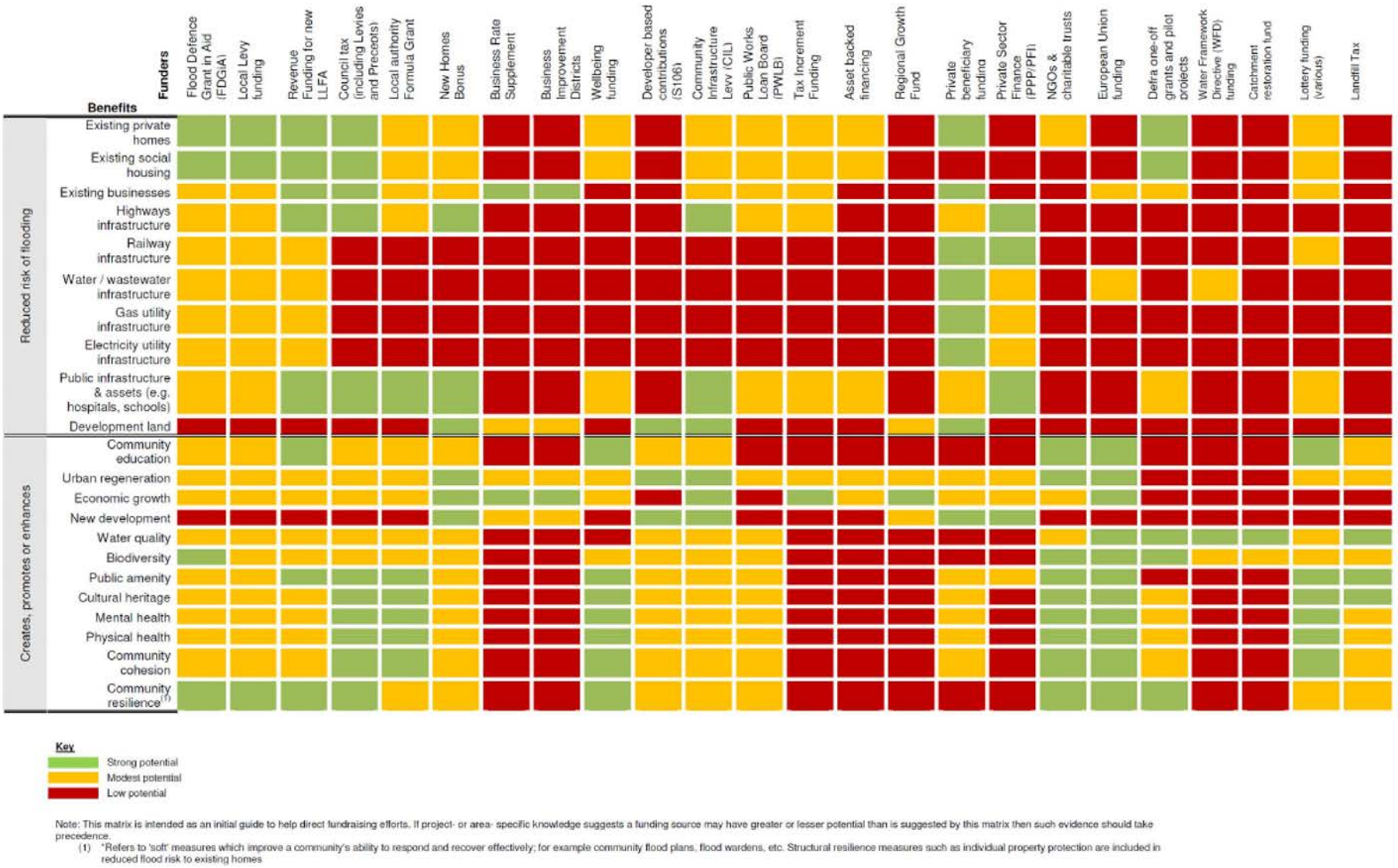
Beach surveys are currently undertaken by the South West Regional Coastal Monitoring Programme on a twice yearly basis, with additional post storm surveys following major storm events, if called out by Cornwall Council. The frequency of ongoing monitoring by the regional coastal monitoring programme could be increased or supplemented by local inspection to include post-storm events/post-winter surveys and provide greater coverage (beach and dunes). This will provide information for later management decisions to inform of any patterns in beach and dune erosion. Further detail is provided in Section 4.4.1.1.

Monitoring of dune vegetation by visual inspection should be undertaken regularly to assess the abundance and extent of vegetation, to inform revised assessment of the BAP habitat condition and determine if it is necessary to take action to further remove non-native, invasive species; giving consideration to whether or not doing so will adversely impact the stability of the dunes in the areas where vegetation clearance is proposed. Refer also to Section 4.4.1.2.

4.2.10 Funding

In the short term, under a NAI policy there would likely be no public funding for flood or erosion risk management unless a case can be made to transition to the MR policy. This will need to be informed by ongoing monitoring. Under a MR policy in the medium to long term, some funding for beach or dune management activities related to managing coastal flood/erosion risk is likely to be available from FCERM Grant in Aid (GiA) sources. However, funding for activities beyond FCERM will need to be derived from other non-FCERM-GiA sources (i.e. private/non-FCERM-GiA sources).

By way of example, the CCAPG (Halcrow, 2015) includes a matrix to aid and guide consideration of funding efforts when developing locally-specific adaptation approaches (Figure 4.5). Cornwall Council should actively seek partnerships with developers/businesses/communities to raise funds to adaptation measures.



Note: This matrix is intended as an initial guide to help direct fundraising efforts. If project- or area- specific knowledge suggests a funding source may have greater or lesser potential than is suggested by this matrix then such evidence should take precedence.

(1) 'Refers to 'soft' measures which improve a community's ability to respond and recover effectively; for example community flood plans, flood wardens, etc. Structural resilience measures such as individual property protection are included in reduced flood risk to existing homes

Figure 4.5 Example of a matrix of potential funding sources (from Halcrow, 2015).

4.3 Plan of Action

Table 4.1 provides a summary of the recommended actions at Par Sands discussed in Section 4.2. Reference should also be made to the site actions summary map (see Figure 4.6 or Appendix E) that indicates where on the site specific actions relate to.

Table 4.1 Recommended actions for Par Sands

Issue	Recommended Management Action	Timing	Who Should Action	Risk Identification		When by?	Reference:
				Risk	Mitigation		Links all correct when accessed on 29th July 2016
Potential for dune erosion in the future and exposure of a historic landfill site.	• Implement stabilisation techniques in key locations such as planting, and willow fencing where necessary matting/ binding to stabilise vulnerable areas.	• Planting in Spring – prior to peak tourist season. In general planting tends to be most successful in early March.	Cornwall Council, in discussion with Natural England.	• Planting does not establish.	• Select robust species. Plant when conditions are most favourable (early Spring).	Annually each Spring from 2017	
	• Investigate and plan relocation of development, car park and historic landfill. • Define CCMA in line with NPPF. • Define a strategy for relocation of development, historic landfill and other assets.	• Short / Medium term.	Cornwall Council	• If no CCMA defines, increases risk of inappropriate development occurring that will then need to be relocated.	• Develop and implement CCMA to guide planning decisions.	Develop CCMA by December 2017. Implementation to be guided by CCMA.	COASTAL CHANGE ADPATATION PLANNING GUIDE FOR ENGLAND – https://lgacoastalsig.com/resources/coastal-guidance-and-manuals/ NPPF GUIDANCE – https://www.gov.uk/government/publications/national-planning-policy-framework--2
	• Communication with local interest group and general public.	• Ongoing	Cornwall Council	• Local groups / public less likely to support management if not engaged.	• Actively engage local groups / public to gain buy in and support to management measures.	Ongoing from 2016	
Lack of information / data relating to dune erosion and beach levels to inform management.	• Implement monitoring scheme and response regime. • Coastal processes to continue to be monitored as part of SWRCMP, ideally incorporating additional requirements identified (refer to Section 4.4.1.1). • Asset condition to be assessed by regular walkover visual inspections, supported by fixed aspect photography and reporting (refer to Section 4.4.1.2).	• Post storm inspections/surveys to occur within one or two tidal cycles of storm event. • Coastal processes monitoring to be as per SWRCMP programme (refer to Section 4.4.1.1). • Walkover inspections at least each spring and autumn and after notable storm events, with report produced after each inspection (refer to Section 4.4.1.2).	Cornwall Council in conjunction with Plymouth Coastal Observatory.	• Requirement for post storm survey not identified soon enough and beach profile has readjusted. • Lack of appropriate data to make informed decisions to manage coastal risk.	• Identify threshold storm conditions to initiate post storm surveys. • Work with SWRCMP to ensure capture required coastal processes data. • Liaise with Plymouth Coastal Observatory to ensure Par Sands is a key site for post storm surveys. • Ensure summary reports are produced after each visual walkover inspection and that these document actions to be taken.	Ongoing from 2016	SOUTH WEST REGIONAL COASTAL MONITORING SCHEME - http://www.channelcoast.org
Uncontrolled public access within the dunes resulting in dune erosion and trampling.	• Fence off vulnerable areas and set up planned access routes. • Construct boardwalks/steps at key erosion focus points. • Implement a zoning scheme discouraging	• Establish fencing and access routes prior to main tourist season. • Planting in Spring – prior to peak tourist season. In general planting tends to be.	Cornwall Council, in discussion with Natural England.	• Exclusion zones not abided by. • Beach users do not follow zoning and continue to barbeque and camp in fenced	• Robust fencing and signage to discourage beach users from vulnerable areas. • Educational information signs and liaison with beach users to ensure the role and importance of the exclusion zones are understood.	Annually each Spring form 2016	

Issue	Recommended Management Action	Timing	Who Should Action	Risk Identification		When by?	Reference:
				Risk	Mitigation		Links all correct when accessed on 29th July 2016
	visitors from vulnerable zones and providing facilities such as barbeque areas in less vulnerable zones. • Where bare sand areas do not re-establish implement stabilisation techniques such as planting and where necessary matting/ binding to stabilise vulnerable areas.	most successful in early March.		off area Planting does not establish.	• Select robust species. Plant when conditions are most favourable (early Spring).		http://lizardandpenrose.blogspot.co.uk/2012/03/under-boardwalk.html
	• Education of beach users so the sensitivity of the dunes is understood. • Design information boards and leaflets outlining the importance of the dunes and the vulnerability of the dune system. • Place boards and repeater signage at strategic locations throughout the site. • Employ a designated warden to patrol the site.	• Design boards and display prior to main tourist season.	Cornwall Council	• Beach users do not read or abide by signage.	• Design clear, attractive signage which will catch the eye of beach users and provide easy to understand information. • Place signage at strategic locations to ensure they are seen by beach users.	Spring 2017	SIGNAGE - https://rnli.org/-/media/rnli/downloads/rnli-guide-to-beach-safety-signs-flags-and-symbols.pdf?la=en Warden scheme has successfully been implemented at Perranporth. Nature walks are implemented at Perranporth and Gwithian.
	• Liaise with regular beach users and owners of the leisure complex to improve understanding of the dune system and encourage users to be considerate of the dune system. • A local user group to be developed to facilitate this.	• Meet for discussions just before main tourist season to ensure messages are 'fresh' and can be implemented during the peak season.	Cornwall Council, working with local beach users.	• Regular beach users, local outdoor instructors and owners of the leisure complex are not interested in dune management and do not pass on the information to others. • The wrong people are identified and the message is not spread effectively.	• Identify the relevant persons who will be using or working at Par Sands and interacting with other beach users.	Ongoing from 2016	Successful liaison with mountain board instructors successfully reduced the impacts of mountain boarding on steep bare sand dunes at Gwithian Towans.
Littering and dog fouling.	• Increase provision of waste and dog fouling bins in strategic locations and accompanying signage. • Increase emptying of bins during the high season. • Provide adequate recycling facilities.	• Summer months.	Cornwall Council	• Littering and dog fouling pose risk of pollution and is not aesthetically pleasing to beach users, so poses risk to amenity use and subsequent impact on local economy.	• Promote dog owners to be responsible and pick up after their animals. • Promote beach users to be responsible and put rubbish in bins/take rubbish home. • Provide bins at access points along with signage to promote messages. • Undertake voluntary beach cleans to involve local community at least 1 or 2 times per year.	Annually each Spring from 2017	LITTER FREE COAST & SEA – https://www.dorsetforyou.com MARINE CONSERVATION SOCIETY BEACHWATCH – http://www.mcsuk.org

Issue	Recommended Management Action	Timing	Who Should Action	Risk Identification		When by?	Reference:
				Risk	Mitigation		Links all correct when accessed on 29th July 2016
Ensure sediment removal from the Polmear Stream remains in the beach-dune system.	• Clearance of sand from stream. • Place removed sand on the beach away from BAP habitat.	• As and when Polmear Stream is dredged.	Cornwall Council	• If sediment not retained in system, leads to net loss of sediment in longer term and increased vulnerability.	• Place dredged material on dune/beach.	As required, guided by inspection	MARINE LICENCE GUIDANCE – https://www.gov.uk/topic/planning-development/marine-licences
Control of non-native invasive species within dune vegetation.	• Remove non-native species by hand or mechanically and treat with a biodegradable herbicide. • Monitor dune vegetation.	• Short / Medium term.	Cornwall Council	• Further spread of non-native invasive species with subsequent deterioration in BAP habitat condition.	• Monitor and remove non-native invasive species.	Annually from 2017	
Dune habitat management.	• Develop and implement a wider dune management plan to guide all aspects of managing dune habitat for ecological gain.	• Medium term	Cornwall Council and Natural England.	• Potential for ecological gains limited if not managing habitat of whole dune system is a planned way.	• Develop and implement a wider dune management plan.	December 2018	
Limited funding to undertake management activities.	• Actively seek partnerships with developers / businesses / communities to raise funds.	• Short, medium and long-term	Cornwall Council	• If funding is not available to undertake FCERM activities when and how it is best to do so, then there is a risk that no works will occur, increasing risk of erosion as a result.	• Assess potential beneficiaries and develop a partnership funding strategy to guide discussions with potential funding partners. • Seek funding commitments from partners.	Ongoing from 2016	FCERM FUNDING GUIDANCE – https://www.gov.uk/guidance/flood-and-coastal-defence-funding-submit-a-project Partnership funding and collaborative delivery of local flood risk management: a practical resource for LLFAs – http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17085

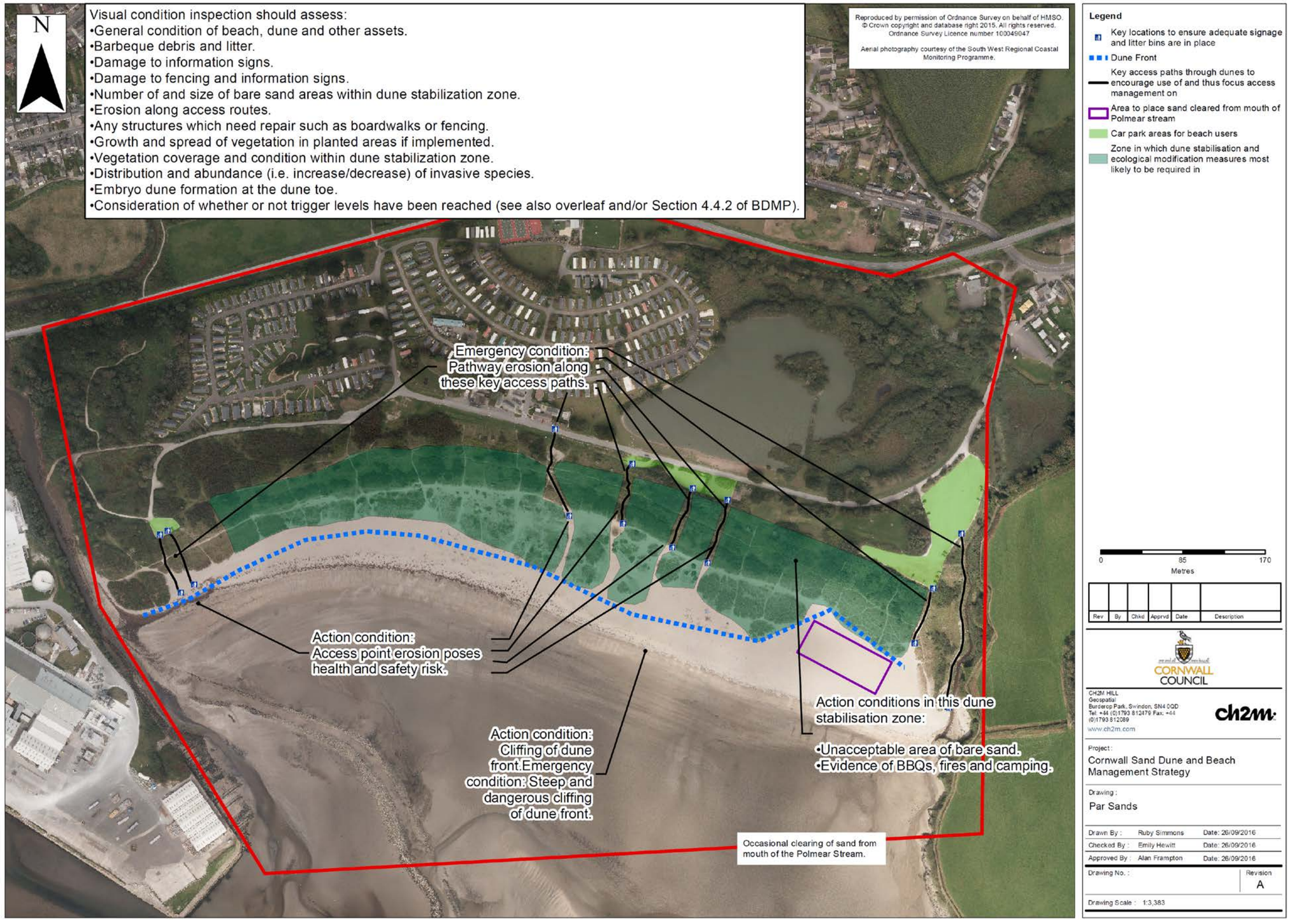


Figure 4.6 Site Actions Summary Map for Par Sands (copy also provided in Appendix E)

4.4 Monitoring and Response

4.4.1 Survey Requirements

4.4.1.1 Coastal processes monitoring

Monitoring of coastal processes is to continue to be undertaken until at least 2021 by the South West Regional Coastal Monitoring Programme (SWRCMP). The SWRCMP survey schedule for Par Sands is shown below in Table 4.2.

Table 4.2 SWRCMP survey schedule for Par Sands (from http://www.channelcoast.org; link correct when accessed on 29th July 2016).

Survey Schedule		
Survey Type	**Frequency**	**Profile Spacing / Survey Extent**
Topographic Baseline	1 Per 5 Year Phase	50m to MLWS
Topographic Interim	Spring and Autumn	150m to MLWS
Bathymetry	1 Per 5 Year Phase	50m Profiles to 1km Offshore
Aerial Photography	1 Per 5 Year Phase	MLWS
LiDAR	2011/12, 2013/14 and 2015/16	MLWS
Habitat Mapping	1 Per 5 Year Phase	As Required

Figure 4.7 shows the location of the baseline and interim beach profiles measured at Par Sands.

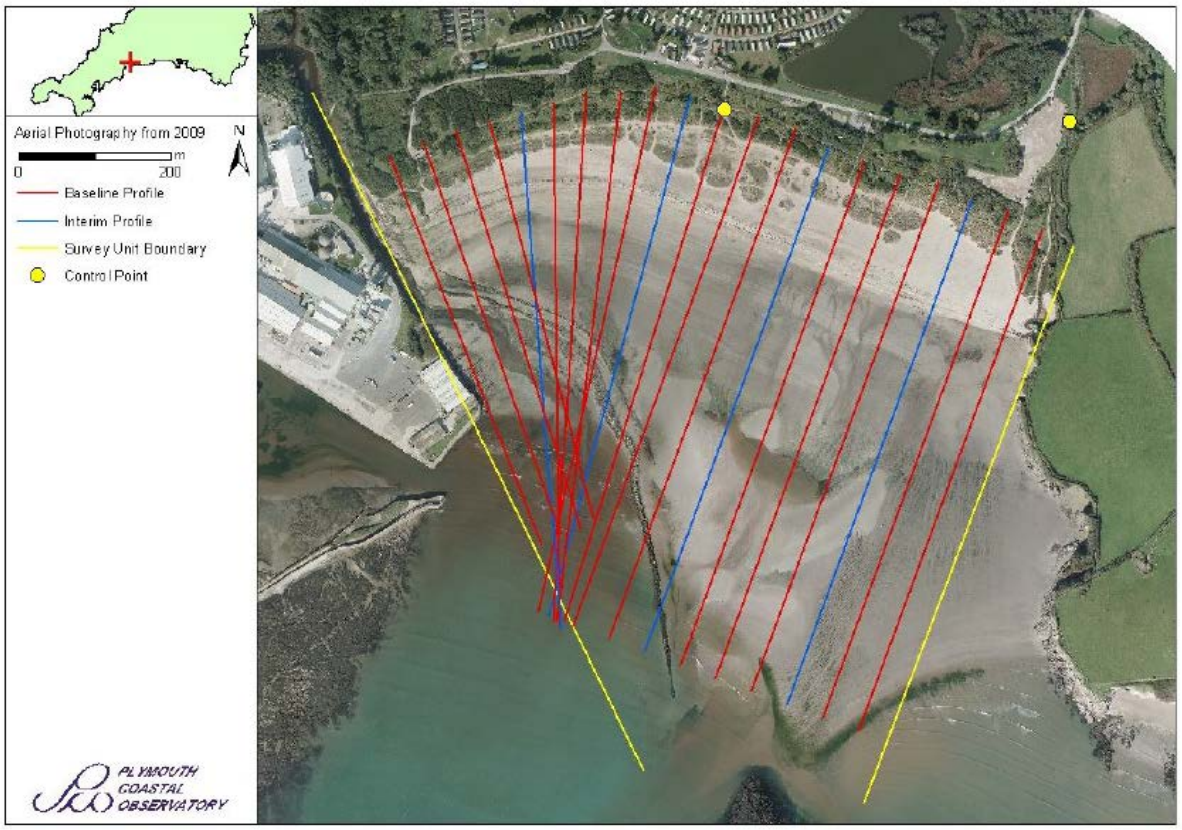


Figure 4.7 Location of beach profiles currently measured by the South West Regional Coastal Monitoring Programme at Par Sands (Source: Plymouth Coastal Observatory).

Whilst the work of the SWRCMP is to continue to be the primary means of monitoring the physical processes at Par Sands, Cornwall Council should liaise with the SWRCMP team to seek to ensure

survey data provides the information required at this location to inform future management decisions, namely:.

- A photograph should be taken of the dune face at the time of each profile. The photograph will provide information on vegetation cover and dune face characteristics such as slumping or cliffing.

This additional monitoring data will provide further information on aspects including the beach level, position of the dune front, and the dune shape which will aid future reviews of this BDMP.

4.4.1.2 Asset condition monitoring

In addition to the coastal processes monitoring data collected by the SWRCMP described in Section 4.4.1.1, Cornwall Council should undertake regular walkover surveys to monitor the issues identified in this report, and the success of any management measures implemented. This should include a visual assessment of aspects such as:

- General condition of beach, dunes and other assets.
- Barbeque debris and litter.
- Damage to information signs.
- Number of and size of bare sand areas.
- Erosion along access routes.
- Any structures which need repair such as boardwalks or fencing.
- Growth and spread of vegetation in planted areas.
- Vegetation coverage and condition.
- Distribution and abundance (i.e. increase/decrease) of invasive species.
- Embryo dune formation at the dune toe.
- Consideration of whether or not trigger levels, as defined in Section 4.4.2, have been reached.

These visual condition inspections should be undertaken at least each spring and autumn, and following notable storm events.

The condition of fencing should be monitored on a regular basis, particularly after storms, busy summer periods, and public events on the beaches.

These visual inspections should also include fixed aspect photography at key problem areas including access routes subject to erosion and also bare sand areas (i.e. take photos at the same location of the same view on each inspection).

Regular monitoring of implemented management techniques should be carried. Dunes are dynamic systems and the effectiveness of management techniques may not be consistent. Through monitoring, the dune management techniques in place can be regularly assessed and adapted to improve effectiveness and prevent the continuation of unsuccessful techniques that do not benefit the dune system.

A brief inspection report, including photos and summary of findings and actions to be taken, should be produced after each inspection and copies retained alongside this BDMP.

4.4.2 Trigger Conditions

Trigger conditions enable operating authorities to quickly assess whether intervention is required to maintain the existing dune system. The actions required when the trigger conditions are reached should be considered in light of the conditions immediately prior to, during and predicted to follow the assessment.

The beach and dunes will be inspected following a storm event. However, the dune system will typically experience erosion during a storm event and usually recover to near the pre-storm level following a period of calmer conditions. It is therefore recommended that unless further storm conditions are predicted, the dunes should be allowed a period to recover after a storm event before remedial action is taken. Similarly, erosion will be significant in summer when visitor numbers are high, but vegetation may show some recovery during the quieter seasons if conditions allow.

Beach profile data was available from Spring 2007 to present. Due to the short time period involved, this dataset does not provide enough information for specific measured trigger levels to be defined at this time. Action and Emergency trigger states have therefore been developed for the dunes based on assessment of the data available, the dune characteristics and engineering judgement. These trigger levels are to be reviewed and refined when the BDMP is next reviewed, taking into account the greater amount of monitoring data that is expected to be available by that point (assuming that the monitoring needs defined in Section 4.4.1 are implemented).

4.4.2.1 Action conditions

The Action State is defined as the beach/dune level at which intervention is required. At Par Sands this is defined as the point at which erosion of the dune system reaches a stage at which it is unable to recover to pre-erosion condition without further management.

Table 4.3 outlines the key indicators for action conditions and the criteria for assessing whether action conditions have been reached. Refer also to the site actions summary map in Figure 4.6 above.

When Action Conditions are observed, the specific problem should first be assessed to identify the appropriate response. Responses to Action Condition Indicators are suggested in Table 4.3.

Table 4.3 Action conditions and responses

Criteria	Likely consequence	Response
Unacceptable area of bare sand		
• Area is of significant size and/ or depth to cause concern and is unlikely to recover without management. • Area of bare sand has been present for more than one year without recovering. • Area of bare sand is increasing in size.	• Area of bare sand is present at the start of the peak season and is likely to increase through the tourist season as a result of trampling erosion.	• **Fence off bare sand areas to prevent access and enable recovery.** • **If vegetation does not establish following fencing, and area of bare sand is of concern, implement dune stabilisation planting following discussion with Natural England.** • **Implement rotation of access routes to aid recovery.**
Access Points eroded to a level at which they cause a health and safety risk.		
• Access points eroded to form a high step which is not safe for pedestrians and is at high risk of causing injury. • Access point has been eroded to form a steep cliffed step for more than one season. • Erosion is continuing and access is becoming more difficult and/or a greater health and safety risk.	• Access is eroded at start of the peak season and is likely to be worsened by high foot traffic throughout the peak season.	• **Construct boardwalks or steps along eroded access paths.** • **Consider re-routing pathways away from the eroded area where possible. Fence off and stabilise the eroded access route to enable it to recover.**
Missing Management Infrastructure		

Criteria	Likely consequence	Response
• Infrastructure removed or damaged by beach users such as; signage removed or vandalised, planks taken from board walks, fencing removed. • Due to missing infrastructure beach management measures are impaired. • Trend is continuing with more infrastructure being removed or damaged by visitors.	• Missing infrastructure noted immediately prior to and during the peak season, and more is likely to be removed/ damaged until the end of the season.	• **Assess why management has been damaged/ removed and whether an alternative form of management would be more successful. Replace missing infrastructure with the same or an improved form to enable management measures to be effective.** • **Implement/ increase educational signage and leaflets and ensure liaison with beach users and local instructors to encourage visitors to consider the need for dune management and the implications of damaging/ removing management techniques.** • **Implement/increase presence of dune warden.**
Evidence of barbeques, campfires and camping within exclusion zones		
• Debris indicates numerous barbeques and/or camp fires are being held on the dunes (e.g. more than 3). Camping within the dunes is observed. • Evidence of barbeques, camping and campfires over a period of three months or more. • Number of barbeques, people camping and campfires being held is consistent or increasing.	• Barbeques and campfires anticipated to increase over future months.	• **Implement/increase presence of dune warden.** • **Provide barbeque zone for permitted barbeques.** • **Ensure clear educational signage is visible stating that these activities are not allowed.**
Cliffing of dune front		
• Cliffing of the dune front as a result of wave action is at a height that can cause a health and safety risk and is present along a significant length of frontage which cannot be easily avoided by visitors. • Cliffing of the dune front has been present for more than one season and hence is not likely to be a post storm response followed by recovery during calmer conditions. • Cliffing is becoming steeper and higher as erosion continues with no sign of recovery. • Cliffing erodes dune back to a point where there is an imminent risk of loss of assets.	• Further storm conditions predicted which are likely to cause further erosion of the dune front and increased cliffing, and potentially pose risk of loss of assets to erosion.	• **Ensure monitoring of dune front is carried out to provide information on trends in the dune front position and to monitor whether cliffing worsens to emergency state.** • **If erosion of beach and dunes is a consistent issue, commission study to assess whether beach nourishment or another soft engineering solution is justified.** • **Fence off area that forms a health and safety issue and apply dune stabilisation measures such as planting to reduce instability and make the dunes more resilient against erosion. Most suitable if significant storm conditions are not predicted in the immediate future and dune front is not exposed to constant wave action.**

Criteria	Likely consequence	Response
		• **If assets are deemed to be at imminent risk of loss, implement coastal adaptation measures (to be defined in CCMA that Cornwall Council is to produce).**

4.4.2.2 Emergency conditions

The Emergency State is defined as the beach/dune state at which emergency remedial action should be undertaken as soon as practicable. At Par Sands the Emergency State may be reached following a very severe storm event, or as a result of a significant health and safety risk forming during the peak tourist season when visitor numbers are high. Table 4.4 outlines the key indicators for Emergency Conditions and the criteria for assessing whether emergency conditions have been reached.

If emergency conditions are reached, re-profiling of the beach and dunes may be considered to ensure the safety of beach users and pathways may need to be temporarily re-routed. Further studies should then be carried out into long term solutions. Responses to Emergency Condition Indicators are suggested in Table 4.4.

Table 4.4 Emergency conditions and responses

Criteria	Likely consequence	Response
Steep and dangerous cliffing of dune front		
• Cliffing of the dune front leads to unstable dune front, possible with an overhang, which causes a health and safety issue. • Steep dangerous cliffing present during tourist season when high visitor numbers predicted.	• Danger of sand falling onto beach/ dune users.	• **Re-profiling of the beach and/or dunes. Bulldozers can be used to move sand from lower down the beach to eroded areas, to remove dangerous overhangs from the cliffed dune face or to make the dune face less steep. The requirement for this should be carefully assessed to ensure economic justification and minimum damage to the dune system.** • **Fence off dangerous areas until a solution is implemented or the dune face readjusts.**
Pathways eroded leading to erosion of dune system and unsafe pathways		
• Pathways eroded to form a very steep path or significantly cliffed path which causes significant health and safety risk to beach users such as the elderly or children. • Access point/ pathway has eroded to the magnitude stated when beach visitor numbers are significant.	• Beach/ dune users could fall and be injured in the immediate future.	• **Re-route access pathways to avoid eroded areas using fencing and signage. Fence off eroded areas to enable recovery with planting and dune stabilisation methods applied as necessary.** • **If erosion is close to beach, and sand is available, carry out re-profiling of pathway by adding sand to eroded areas to remove unsafe cliffing and large steps.**
Missing or Damaged Management Infrastructure		
• Infrastructure removed or damaged by beach users resulting in management	• Dune management techniques are ineffective e.g.	• **Replace or repair management infrastructure as soon as**

Criteria	Likely consequence	Response
techniques being ineffective such as: o signage removed or vandalised, o planks taken from board walks o fencing removed. • Infrastructure lost or damaged during peak season when high visitor numbers are forecast.	o Fencing is removed allowing access to vulnerable areas o Wooden planks missing from boardwalks cause significant health and safety hazard.	**possible to ensure effective management can continue.** • **Increase presence of dune warden.**

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Appendix A
Sand Dune Management Techniques & Preliminary Decision Support Tool v2.0

(NB: See accompanying CD to access the tool, which is only provided in digital format)

Appendix B
An Overview of Coastal Sand Dunes

Appendix C
Baseline Report

Appendix D
Options Appraisal

Appendix E
Site Actions Summary Map

Appendix F
Summary Leaflet