

Action Plan for the Continuing Implementation of the Adaptive Management Policy



East Head Spit Chichester Harbour

East Head Coastal Issues Advisory Group

Introduction

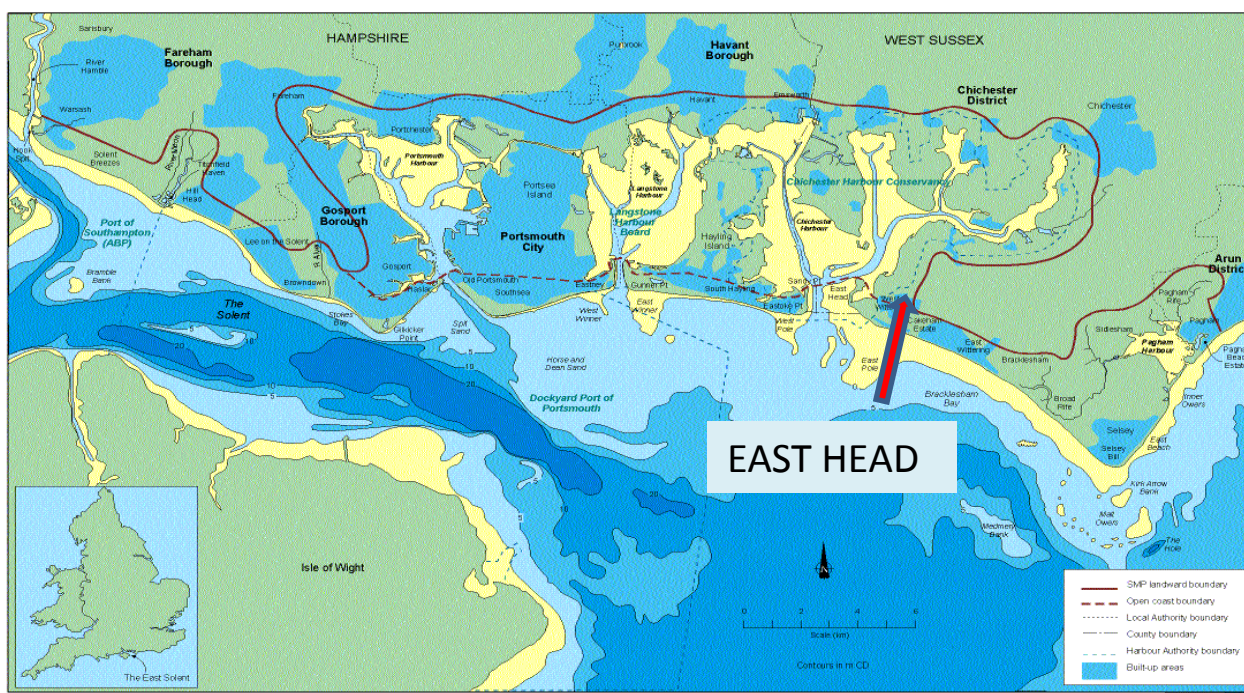
EHCIAG is a working group of stakeholders set up in response to the Pagham to East Head Coastal Defence Strategy adopted in 2009. The nature of the group is unique in its composition as so many organisations have been drawn together at one time to develop coastal management policy of East Head. EHCIAG consists of delegates from Chichester District Council, Environment Agency, Chichester Harbour Conservancy, Natural England, National Trust, West Wittering Parish Council, West Wittering Estate Plc, Woodger Trust, Cakeham Manor Estate Ltd. The purpose of EHCIAG is to monitor changes at East Head and to react to these changes. EHCIAG's role is purely advisory and seeks to ensure decisions taken by operating authorities are well informed and are based on the best available information.

Adaptive Management is defined by East Head Coastal Issues Advisory Group (EHCIAG) as:-

'The aim of Adaptive Management will be to preserve the social, economic, environmental, navigation and amenity value of East Head to the community for the life of the Strategy. The emphasis will not be on trying to lock the feature in its present size, shape and location, nor should it be encouraging orientation in a pre-determined direction'

The Strategy referred to is the current "Pagham to East Head Coastal Defence Strategy" adopted in 2009. The strategy has no defined life period for review but will be subject to re-examination if material changes occur.

Location Plan



Current Policy

After extensive studies and consultation carried out on this frontage, the policy adopted for future management was “**Adaptive Management**” for East Head under the Pagham to East Head Coastal Defence Strategy (PEHCDS) in 2009. The policy was confirmed in 2010 under the North Solent Shoreline Management Plan

The usual options available for selecting a management policy were initially limited to four: -

- 1) Do Nothing
- 2) Advance the Line
- 3) Hold the Line
- 4) Retreat the Line.

None of these were considered suitable for this complex area which involves many different coastal processes. A policy of Adaptive Management was adopted because it gives the opportunity to react to changes in a positive way.

An overview of the site’s history, which demonstrates the reasoning behind this decision, is provided as an appendix to this action plan. (Appendix E Pagham to East Head Coastal Defence Strategy)

General Arrangement of East Head



The Issue

There is a finite amount of sediment within the harbour entrance complex and when beaches are unstable, erosion and accretion are natural consequences. At “The Hinge”, located between groynes C20 and C24, at the southern end of East Head the shingle and finer sediments are unable to reach a point of stability because the hard breastwork defences are too far seaward. The robust wave pattern results in larger waves being reflected by the vertical surface of the breastwork which means the beach material is disturbed and more susceptible to movement by the current. This is particularly true of sand and grit but it is noted that larger shingle is unable to settle for prolonged periods and the beach is regularly drawn down, exposing the underlying clay. Given time the process will result in undercutting the breastwork and creating a need for ever stronger, more resilient structures.

Dr Malcolm Bray is an independent coastal geomorphologist currently employed at Portsmouth University and has a long running association with the spit and EHCIAG. In a presentation on East Head, to Chichester Harbour Conservancy 4th July 2013 he postulates that the present accretion phase on the East Head side of the harbour is likely to come to an end soon, possibly within 6 years, but reworking of existing deposits may continue to supply sediment to East Head for several years. It should be noted that the uncertainties surrounding the predictions of future sediment movements mean that Adaptive Management is the best way to deliver sustainable coastal management.

The alignment of the breastworks represents a discontinuity in the coastal frontage. This leads to instability and erosion of the lower foreshore and adjoining frontages, a process known as “terminal scour” and is more noticeable in the direction in which sediment moves. When the cyclical sediment supply diminishes, which is anticipated to begin over the coming decade, the terminal scour could result in erosion similar to that experienced in 2004. There have been significant fluctuations of sediment over past years and there is no reason to suspect they will not continue.

Shoreline sediments are extremely valuable and are likely to go through periods of scarcity. It is imperative that stores on the upper beach are maintained and if possible enhanced by dune management or similar processes. Great care is needed to minimise terminal scour and beach lowering caused by hard, rebuttive defences. There is no intention to shorten the groynes; on the contrary it may prove necessary to extend the inner ends in order to maintain beaches in The Hinge area.

East Head is also covered by a number of designations, including: nationally as a Site of Special Scientific Interest (SSSI) and internationally designated as a Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar and Area of Outstanding Natural Beauty (AONB). Natural England is the Government’s adviser on the natural environment, and has a statutory role in protecting and conserving such sites. One of the primary reasons for the designations at East Head is the sand dune system and the coastal geomorphology. Natural England’s full position on Adaptive Management at East Head can be found in the annex at the back of this document. Further information on the designations and the legislative framework which help protect these sites can be found in the glossary.

The following cross sections originate from Dr Bray’s presentation and demonstrate the recent changes in beach volumes over the Nearshore, Foreshore and Upper Beach of the frontage

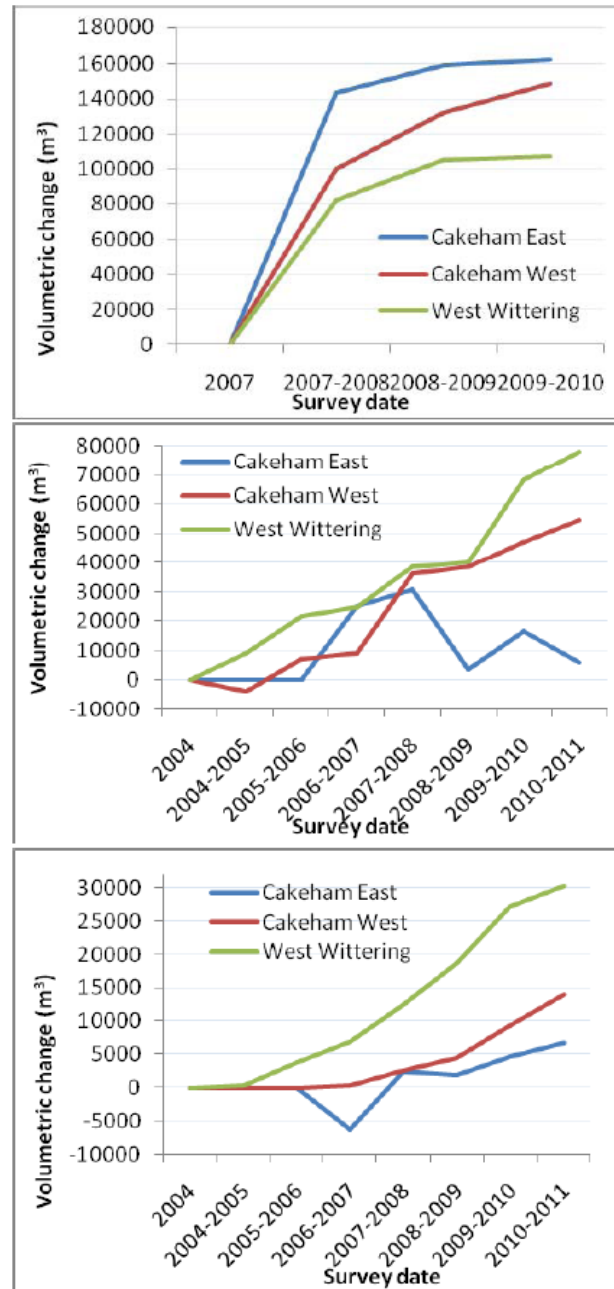
Changes in Beach Volumes

(Source: - M Bray [after R Fitzgerald] presentation to CHC 4th July 2013)

Nearshore: gains diminishing after 2008 suggesting exhaustion of sediment supply. Estimated that inputs to foreshore cease in 6 years.

Foreshore: major inputs continue, but rate may reduce in future when nearshore supplies become exhausted. Erosion possible in 6-10 years' time;

Upper Beach: continuing to accrete strongly. Unlikely to cease accreting until foreshore in front is affected by lack of sediment. Eventually likely to revert to erosion in around 8-10 years.



Overall the picture is likely to be one of diminishing supply as the cycle turns from accretion to erosion and it is essential that as much material as possible is retained in the area of the hinge. To achieve this, action will be taken to gradually allow a more stable beach profile to develop.

The timber breastworks have long been recognised as frail and have, in effect, come to the end of their working life, especially at the top where shingle movement has exposed the planks and resulted in their loss. Temporary works have been carried out but a longer term solution is required. There is an opportunity to allow change to happen in a controlled manner that will maintain the benefits that East Head offers in terms of risks to coast protection, amenity, natural environment and navigation.

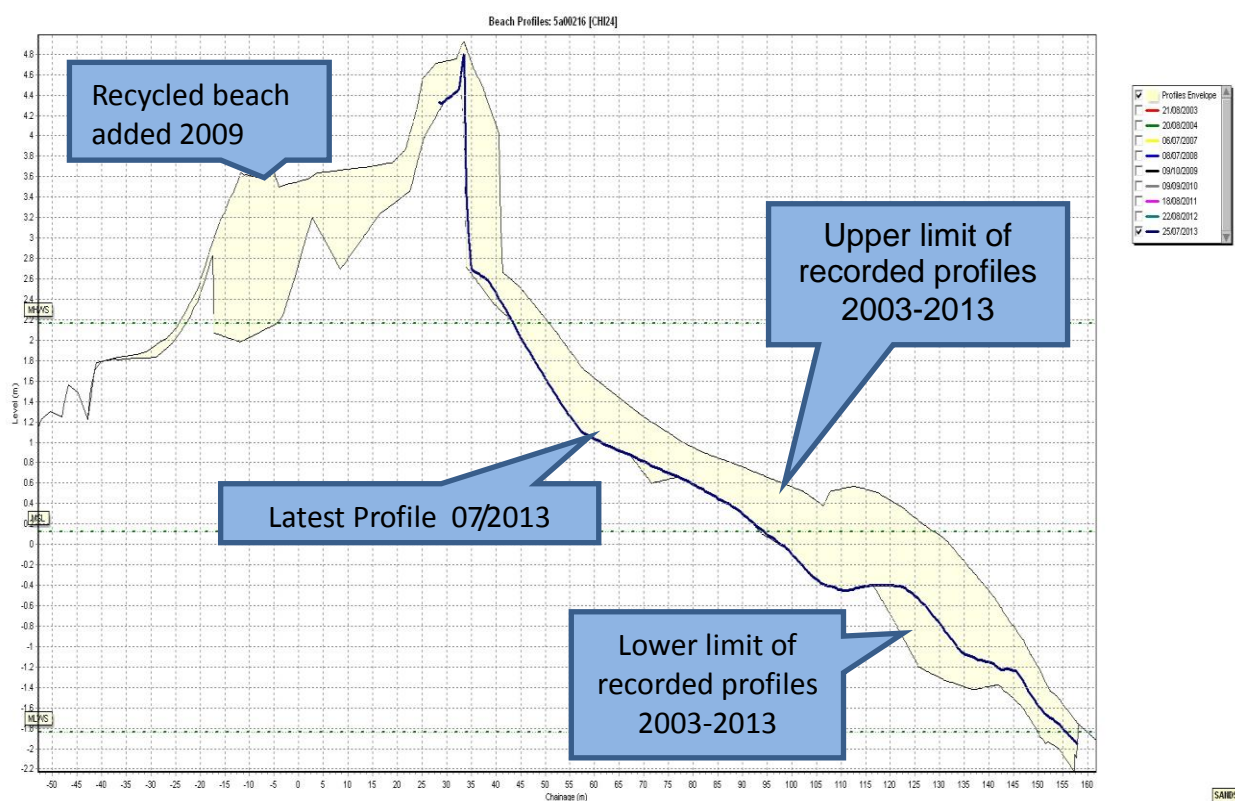
There is a risk that reducing the height of the breastworks will result in rapid erosion and “cliffing” (vertical face exposure) behind the defences.” However, the removal of over half the length of gabion baskets in the groyne bay C23 –C24 as part of the works already carried out has resulted in a gentle, wave absorbing slope, developing over the winter months. This demonstrates that beaches can adapt and create sustainable and much less intrusive profiles once hard defences are no longer present.

Coastal Monitoring

The whole coast of England is subject to the Strategic Regional Monitoring Programme. This frontage is surveyed twice a year and information is stored at the Channel Coastal Observatory and is freely available on their website: www.channelcoast.org/

An example of the detail available is shown below.

Cross section CHI 24 (beach profile just north of groyne C22)



The section shows the “envelope” of profiles recorded over the past 10 years with the latest data (07/2013) shown in dark blue. It should be noted that the current levels are at or about the minimum recorded during the 10 year timeframe. This is interesting as levels were taken before the extreme period of storms experienced during winter 2013/14

Against this background the EHCIAG will continue to seek improvements to the frontage in order to secure a more stable beach that can respond positively to changes.

BEACH VOLUME CHANGE

Map 1: 2004-2014

Year	Volume of Accretion (m ³)
2004-2014	63,950

Map 2: 2009-2014

Year	Volume of Accretion (m ³)
2009-2014	55,343

Map 3: 2013-2014

Year	Volume of Accretion (m ³)
2013-2014	29,858

Legend:

- Change in Beach Elevation (m): Color scale from blue (loss) to red (gain).
- Area of Volume Calculation: Red outline.
- Model Extent: Yellow outline.

Scale: 0 to 400 m.

North Arrow: N

Source: Aerial Photography: CCO (2013)

Project: EAST HEAD SPIT

Drawn By: CW

Checked By: SC

Date: 10/04/2015

Coastal Eastern Solent Partnership

Next Steps

There are methods available that will secure the long term stability of East Head and meet the needs of the public and satisfy the requirements of environmental legislation.

The East Head Group has decided in the first instance to add to the reinforced beach behind the Hinge by either importing additional shingle or, as in 2009, recycling material from the northern end of East Head Spit.

This would allow flexibility in the evolution of the coast at the southern end while maintaining access and preventing the formation of a tidal breach. In effect it would provide a back stop in the event of a collapse of the hard defence and rapid erosion.”

It must be stressed that this is a process, not a “once and for all” solution. The commitment of all parties is essential to the success of Adaptive Management and in the following section we set out the sort of things likely to be required.

It is not possible to be definite about exactly when and where we will act because the process will be reactive and seek to maintain the benefits of East Head for all interested parties.

Adaptive Management Options

Complete Removal of Breastworks – Considered to be unnecessary and the risk of removal in a single process would have the potential to cause accelerated erosion and would be a non-reversible action.

Partial Removal of Breastworks – The group’s preferred approach is to manage a natural failure of the breastworks because this will allow the beach to change gradually in response to coastal processes.

Geo-textile Sill – This option is still on the table but the group consider that the installation of such a structure is unnecessary at the present time owing to the recycling operations already undertaken that have considerably reduced the risk of a tidal breach. The construction would be damaging to the salt marsh habitat but the risks and benefits will be assessed if the sill is deemed necessary in the future.

Groyne Lowering – This offers an opportunity to regulate the rate at which shingle is transported through the frontage. There are no current plans to reduce the height of groynes.

Groyne Raising – This option has been actively by the group in order to retain shingle within the site particularly between groynes C23 and C24.

Groyne Shortening – Because of the offshore deep water channel which the groynes prevent from moving landward this option is not viable and will not be pursued.

Groyne Lengthening – There is no option to extend the groynes seaward because of the depth which will result in them being ineffective. Extending the groynes landward (towards the harbour) is an option that is being considered as a response to the migration of the beach crest and the need to control the volume of shingle.

Beach Recycling – This is the groups preferred method of managing a sustainable beach. There has been an adequate supply of material at the northern end of the spit which has

been used to enhance the width and volume of beaches both at the neck and immediately behind the hinge.

Beach Renourishment – This option involves the importation of new material which would need to match the existing material. Renourishment would be considered in the event that insufficient supply was available for recycling.

Access – The group's unanimous agreement is that public access to East Head is maintained. It may be necessary to restrict access to particular pathways and there is an option to introduce a boardwalk to facilitate this.

Actions

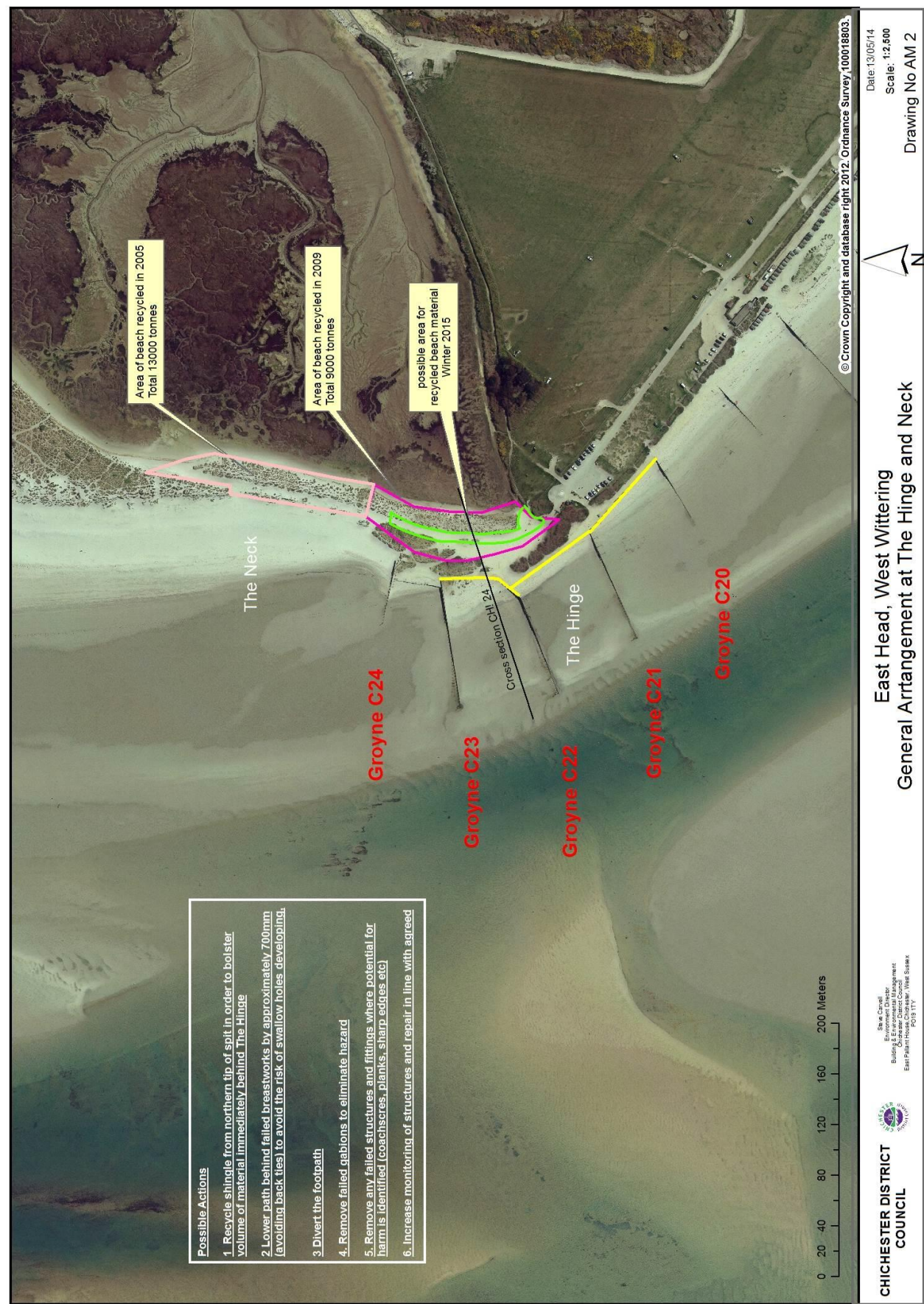
The future actions noted in the table below are dependent on funds being available. It is unlikely that any of these works will attract Flood Defence Grant in Aid (FDGiA) from central government.

Action	Description	Lead	Est. Date
	Completed: - Recycle 9000t of beach material from N end of spit to area behind hinge in order to provide resilience and stability in the event of overwashing or failure of the breastworks C21-C23. Elevation set at 3.5m Above Ordnance Datum (AOD) to allow overwashing without erosion and to connect with 13000t recycling carried out in 2005 to the immediate north.	CHC/ CDC	2009
	Completed: - Remove failed gabions between C23-C24, monitor results which show beach has achieved a stable profile although the crest has been established some 5 m landward of the original structure. In contrast to the foreshore fronting the remaining gabions there is evidence to show the less reflective profile has allowed the beach to stabilise	CDC	Autumn 2013
	Completed:- Raise planking on inner end of C24 to retain material and repeated when beach levels improved	CDC	Autumn & Winter '13
	Completed:- Reduce height of planking on C22 to allow more material to move northwards	CDC	Autumn 2013
	Completed:- Repair groyne C22 to seal lower section after being undermined during storms on 2 separate occasions	CDC	Jan 2014 Mar 2014
	Completed: - Carry out temporary repairs to upper section of timber breastworks C21-C22 where exposed, aged planking had been exposed and failed.	WWE	Autumn 13 Jan 2014
	Future Actions		
1	Continue monitoring of East Head and surrounding foreshore/saltmarsh in order to maintain record and identify trends of sediment movement.	Havant /BC CCO	Ongoing
2	Prepare planning application for submission to planning authority to obtain consent to recycle beach material from northern end of spit with the proviso that there is sufficient material available and with the landowners permission (both National Trust and West Wittering Estate [NT & WWE])	CDC	Summer 2015
3	Seek guidance from Marine Management Organisation (MMO) on licence for recycling shingle as and when required to unspecified locations within the general site of the Hinge and Neck of East Head	CDC	Summer 2015
4	Subject to completion of the recycling in 2, allow storm events to prevail and wait for failure to be re-established, in which case the following triggers will come into force	All	Winter 2015

The next steps are to put in place a “Rolling” planning consent covering works we may, or may not need to do and to secure from the Marine Management Organisation (MMO) permission to recycle material rapidly, as and when it is required with the proviso that material is available within the system

Assuming these permissions are in place the group has identified actions that can be taken in response to various scenarios. The aim is to ensure a safe transition to a less damaging alignment. The intention is to maintain the groynes but if the timber breastworks remain, the increasing probability is that the foreshore would continue to lower and the groynes fail by undermining. The Triggers set out, section by section, shown on the following plan are deliberately non- specific because we will not predict where, when and how much work is involved during each episode of change. The principle is to establish a process whereby the benefits of East Head are secured for the future so they can be enjoyed by all.

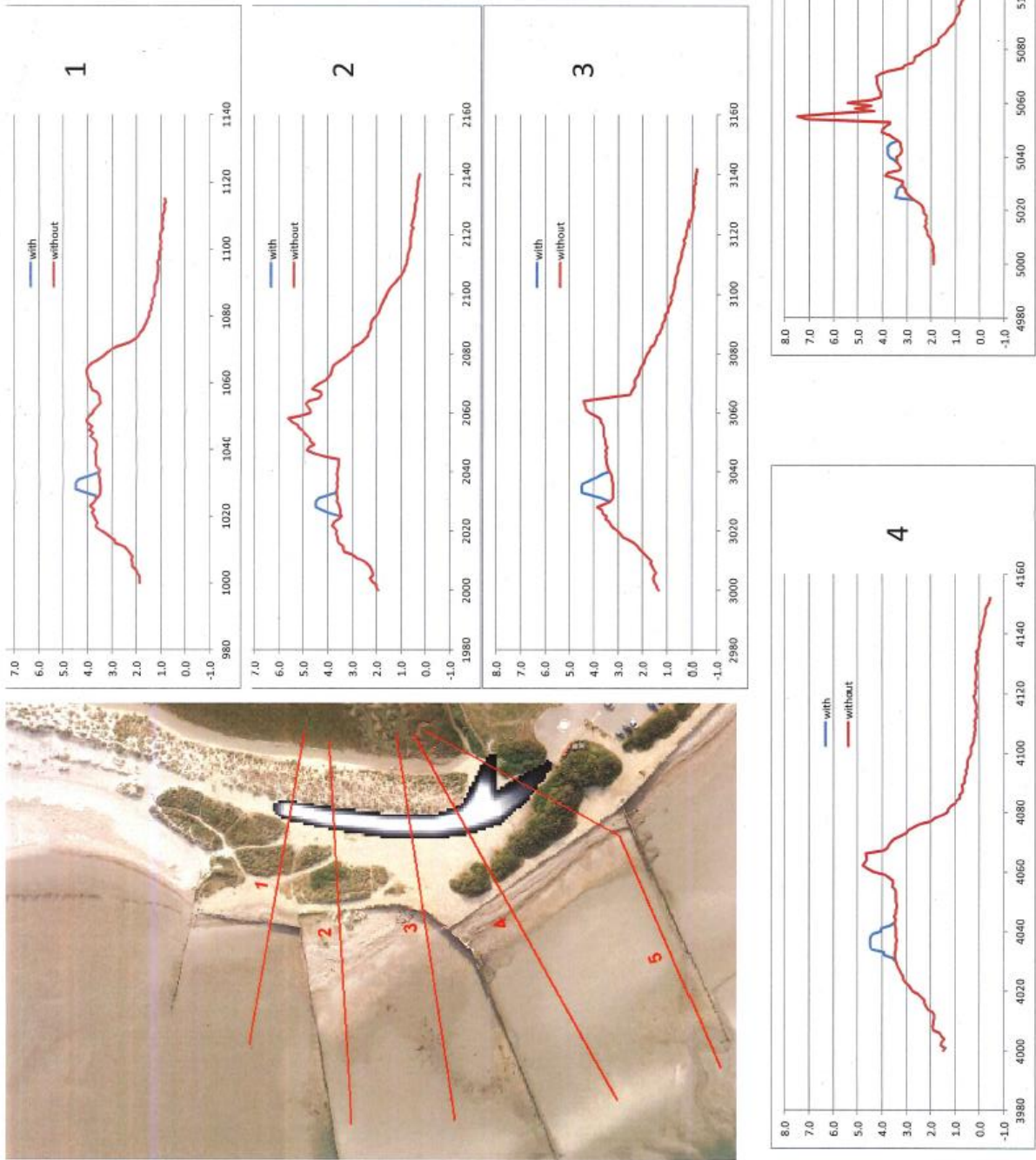
The following image shows in greater detail the arrangement of defences at The Hinge and the proposed location of the reinforcing bund.



Draft - Adaptive Management East Head – Action Plan Triggers

Trigger	Groyne Bay C20 - C21, Section A-A	Groyne Bay C21 - C22, Section B-B	Groyne Bay C22 - C23, Section C-C	Groyne Bay C23 - C24, Section D-D	Up to 150 metres north of Groyne C24
1. Clay substratum: periodic exposure.	Keep watching brief – monthly check (WWE)	Keep watching brief – monthly check (WWE)	Keep watching brief – monthly check (WWE)	-	-
2. Clay substratum: persistent and increasing exposure (over 3 month's exposure).	Increase watching brief to fortnightly checks + post storm. Seek advice from Chichester District Council's engineers (WWE)	Increase watching brief to fortnightly checks + post storm. Seek advice from Chichester District Council's engineers (WWE)	Increase watching brief to fortnightly checks + post storm. Seek advice from Chichester District Council's engineers (WWE)	-	-
3. Timber breastworks: failure of up to 5 planks.	CDC to replace planks under coastal defence maintenance contract. CDC to discuss funding with EHCIAG, should coastal defence maintenance budget be exhausted (CDC)	Do not replace, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Do not replace, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	-	-
4. Timber breastworks: failure of more than 5 planks	Make safe / undertake temporary repairs (WWE) Determine approach at meeting of EHCIAG	Do not replace, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Do not replace, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	-	-
5. Buried Gabions: exposure	Carry out asset assessment (CDC) undertake minor repairs or removal.	Carry out asset assessment (CDC) undertake minor repairs or removal.	-	Carry out asset assessment (CDC) undertake minor repairs or removal.	-
6. Clay Substratum: erosion threatening undermining of timber breastworks	Increase monitoring of breastwork, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Increase monitoring of breastwork, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Increase monitoring of breastwork, Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE) Consider lowering groyne C23 to increase sediment transport	-	-
7. Clay Substratum: erosion threatening undermining of timber groynes	Increase monitoring (WWE) , install lower planking subject to coastal budget availability (CDC)	Increase monitoring (WWE) , install lower plank subject to coastal budget availability (CDC)	Increase monitoring (WWE) , install lower plank subject to coastal budget availability (CDC)	Increase monitoring (WWE) , install lower plank subject to coastal budget availability (CDC)	-
8. Timber breastworks: failure of pile.	Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	Make safe and isolate / re-profile ground to manage any resulting swallow holes (WWE)	-	-
9. Outflanking of timber groynes	Make safe / isolate area (WWE), lower planking to match remaining beach level. Monitor and consider options at EHCIAG meeting including extending or shortening/lowering the landward end of groyne C21.	Make safe / isolate area (WWE), lower planking to match remaining beach level. Monitor and consider options at EHCIAG meeting including extending or shortening/lowering the landward end of groyne C22.	Make safe / isolate area (WWE), lower planking to match remaining beach level. Monitor and consider options at EHCIAG meeting including extending or shortening/lowering the landward end of groyne C23.	Make safe / isolate area (WWE), lower planking to match remaining beach level. Monitor and consider options at EHCIAG meeting including extending or shortening/lowering the landward end of groyne C24.	-
10. Over washing: of saltwater from open coast into saltmarsh.	Keep safe, signage, re model beach to maintain access Weekly / post storm monitoring and update EHCIAG meeting (WWE)	Keep safe, signage, re model beach (WWE) to maintain access. Weekly / post storm monitoring to asses risk of breach (WWE/CDC).	Keep safe, signage, re model beach (WWE) to maintain access. Weekly / post storm monitoring to asses risk of breach (WWE/CDC).	Keep safe, signage, re model beach (WWE) to maintain access. Weekly / post storm monitoring to asses risk of breach (WWE/CDC).	Keep safe, signage, re model beach (WWE) to maintain access. Weekly / post storm monitoring to asses risk of breach (WWE/CDC).
11. Landward Erosion up to 5m	Subject to breastwork repair fill swallow holes, otherwise same approach as C21-24 (WWE) Relocate car park if surface significantly affected (WWE)	Keep safe, signage, manage but maintain access and monitor weekly. Determine approach at EHCIAG meeting within 2 weeks (EHCIAG) Divert access away from breastworks. (WWE)	Keep safe, signage, manage but maintain access and monitor weekly. Determine approach at EHCIAG meeting within 2 weeks (EHCIAG)	Keep safe, signage, manage but maintain access and monitor weekly. Determine approach at EHCIAG meeting within 2 weeks (EHCIAG)	Monitor weekly and update EHCIAG meeting (NT)
12. Erosion / lowering of ground height: resulting in less than a 10m strip of land above 3.6m OD between open coast and saltmarsh.	-	Keep safe, signage; maintain access, and monitoring at least weekly. (WWE) Prepare planning permission and contract documents for recharge/recycling (CDC/WWE)	Keep safe, signage; maintain access, and monitoring at least weekly. (WWE) Prepare planning permission and contract documents for recharge/recycling (CDC/WWE)	Keep safe, signage; maintain access, and monitoring at least weekly. (WWE) Prepare planning permission and contract documents for recharge/recycling (CDC/WWE)	Keep safe, signage; maintain access, and monitoring at least weekly. (WWE) Prepare planning permission and contract documents for recharge/recycling (CDC/WWE)
13. Tidal Breach	WWE to seal with locally won material on behalf of CDC as Coast Protection Authority (WWE/CDC/NE) Initiate special EHCIAG site meeting within 1 week. Act to ensure access is maintained and make safe.	WWE to seal with locally won material on behalf of CDC as Coast Protection Authority (WWE/CDC/NE) Initiate special EHCIAG site meeting within 1 week. Act to ensure access is maintained and make safe.	WWE to seal with locally won material on behalf of CDC as Coast Protection Authority (WWE/CDC/NE) Initiate special EHCIAG site meeting within 1 week. Act to ensure access is maintained and make safe.	WWE to seal with locally won material on behalf of CDC as Coast Protection Authority (WWE/CDC/NE) Initiate special EHCIAG site meeting within 1 week. Act to ensure access is maintained and make safe.	WWE to seal with locally won material on behalf of CDC as Coast Protection Authority (WWE/CDC/NE) Initiate special EHCIAG site meeting within 1 week. Act to ensure access is maintained and make safe.
14. Safety Concern	Any member of the group shall be entitled to call a meeting if they consider there to be a safety concern.	Any member of the group shall be entitled to call a meeting if they consider there to be a safety concern.	Any member of the group shall be entitled to call a meeting if they consider there to be a safety concern.	Any member of the group shall be entitled to call a meeting if they consider there to be a safety concern.	Any member of the group shall be entitled to call a meeting if they consider there to be a safety concern.

Cross Sections showing proposed additional beach material



Background Information for the Continuing Implementation of the Adaptive Management Policy

Environment Agency
In partnership with



enhancing... improving... cleaning... restoring...
changing... tackling... protecting... reducing...
create a better place... influencing... inspiring...
advising... managing... adapting...

Pagham to East Head Coastal Defence Strategy Strategy Appraisal Report

Appendix E
East Head Working Group Information
A01

May 2008

[ea/br/q/std/vs](#)

Full document available on the West Wittering Parish Council Website

EHCIAG Questions to Independent Geomorphologist

Answers by Dr M. Bray to a series of questions from East Head Coastal Issues Advisory Group (EHCIAG)

Prior to addressing these questions I re-read the report entitled: *MANAGEMENT OF EAST HEAD: GEOMORPHOLOGY EXPERTS RESPONSES TO EHWG QUESTIONS* prepared by A Brampton, I Townend and M Bray in 2007. In my opinion almost all of the points made in relation to the possible future evolution of the Hinge and the Spit neck still hold. The report provides an extremely useful background to our present discussions of the future of the Hinge. The main area of additional information is that the onshore transport of sand occurring at Cakeham/West Wittering since 2005 has become a little better understood. The material appears to be derived from south eastern parts of the Chichester ebb tidal delta and is likely to be an episodic process driven by waves and especially tidal conditions. That is the input from seaward is likely to be finite and likely to become exhausted perhaps in as little as 5 years, although the uncertainty in relation to the timing is high. It means that the present freely available sand at Cakeham and West Wittering may start to reduce in future with a corresponding, but slightly delayed, reduction in sand availability to the Hinge and East Head Spit. It means that conditions could in future revert to the sediment deficient state that prevailed up to 2005 and led to the overwashing of the spit neck in October 2004.

The EHCIAG Questions are set out in Italics each followed by M. Bray's answer.

1) Is the long term realignment of the frontage from C20 to C24 likely to result in greater or less stability for this section of coast?

There will obviously be greater instability in the short-term as the constraints upon processes imposed by the defences reduce and/or are removed and the shoreline adjusts accordingly. This can be addressed by appropriate management involving, for example, installing a "safety barrier" such as a sand berm (implemented in 2009) or geotextile "sill" (suggested by 2007 report but superseded by sand berm in 2009) set back behind the Hinge to prevent overwashing and recycling of sand to restore adequate beach elevations where localised problems arise. This recycling should be implemented within an adaptive management framework underpinned by effective monitoring.

In the long term the realignment should generate a wider, lower gradient foreshore capped by a gravelly sand berm similar in form to the restored neck of East Head Spit. It should be more efficient at dissipating wave action than the steep profiles held by the defences at the Hinge at present. Once this configuration has developed it may still be subject to erosive episodes and possibly even overwashing if any prolonged erosion occurs, but it is envisaged that its health could readily be monitored and maintained if needed by small scale beach management operations. Once established I estimate that it should be more stable and require less maintenance than the existing steep shoreline at the Hinge although effective monitoring will continue to be necessary.

2) Given the current width of beach at the Hinge is there a significant increase in the risk of a permanent breach being formed if the breastworks are allowed to fail and reliance is placed on timely intervention by recycling material.

A permanent breach is possible if the defences were allowed to fail and no other actions were taken. This is because the relatively deep headwater of the axial channel of Snow Hill Creek is present behind groyne C22 at the Hinge. If the Hinge were overwashed and lowered substantially then it is conceivable that a tidal exchange could become established between this Creek and the shore face. Even then, a permanent breach might not result since drift would tend to seal any breach. However, this is a realistic breach scenario that should be taken seriously although its probability of occurrence is uncertain.

Fortunately, I estimate that there should be several indicators that should give timely warning of any impending breach as follows: (A) lowering of the ground/berm levels to beneath 3.0m OD (storm

overwashed level) to 2.2mOD (onset of tidal exchange); (B) any evidence of regular tidal exchange and sealing by drift. Provision of a sand berm or geotextile “sill” set back behind the Hinge which could prevent indicator A from occurring was considered, but I believe this would result in unnecessary encroachment into the salt marsh. A better option is to develop a commitment to recycle sediment to maintain crest levels which could, whenever indicator A is triggered, prevent indicator B from occurring. So long as the beach is monitored and there is a commitment to act swiftly when indicators are triggered there should be no increase in risk of breaching. A further measure could be to consider the possibility of establishing a small stockpile of sand to act as an emergency source from which to fill any potential breach channel before it can enlarge. This would assure the capability of an immediate reaction if that were ever needed. In practice, I still feel that monitoring would provide good warning of the any imminent risk of breaching.

3) *If the failed gabions between C23- C24 were removed, what would you expect the short and long term changes to be? Specifically with respect to shoreline position change.*

The shore would retreat a little more quickly in the short term, but in the medium term it would simply assist a swifter realignment to the more stable long term condition indicated in answer to Q1.

4) *What is the likely scenario in relation to C20-C24 if we were to lower the groynes? Particularly looking at transport of material to the Hinge and the effect on the life of the breastwork.*

Removing additional planking from the groynes is likely to allow a little more of the gravels presently within the inter-groyne compartments to overtop and become transported northwards or north westwards such that the gravel levels against the revetments were lowered. There may be lesser effects at groynes 20 and 21 as gravel levels are already low against these. The gravel beaches appear to provide protection to the timber revetment when beach levels are high, but at mid to low levels the gravels probably act as tools that would accelerate deterioration of the revetment. The seaward portions of the groynes may however perform a useful function as they may reduce a tendency identified for landward recession of the tidal channel at the beach toe.

5) *How long do you consider it would take for the defences from C20 to C24 to fail and become obsolete?*

Parts of the revetment and some gabions are already failing so more widespread failure is likely in 0 to 5 years? The groynes probably have significantly longer life. I’m not an engineer so I do not feel qualified to comment further.

6) *What affect would extending C24 towards Snowhill Creek have? Is this effect desirable when looking for a long term stable coastline?*

It would tend to intercept gravel on the upper beach and the accreting ramp thus formed could possibly act as a conduit for landward transport of windblown sand if sand is available in surplus (as the groynes at Cakeham do). It would tend to induce a zone of scour immediately to its north, although perhaps this could be controlled by experimental removal/additions of planking to obtain an appropriate rate of sediment overtopping. That of course assumes groyne extension using timber, although rock could also be considered. I would estimate that it should not be necessary to extend the groyne in this manner if the measures outlined in Qs 1 and 2 are followed and in any event it should only be considered as a short to medium term measure. The scenario for deployment would be as an emergency measure if high rates of drift were to make it impossible to hold sediment by any other means. It is not desirable in the long term.

7) *Is the build-up of material on this frontage related to the renourishment works on Hayling Island?*

No, that is very unlikely to be the source. The sediment build-up is due to onshore migrating swash bars of sand originating from the Chichester ebb tidal delta. This delta has a volume of some 25

million cubic metres of sediment which is very large compared to the modest replenishment volumes. Also Hayling is west of the main tidal channel that passes through the delta and it is difficult, but not impossible for sediment to bypass such a feature.

8) *Ideally, the group would like to make small reversible changes to allow for the consequent effects to be monitored and, if necessary stopped. Those representing the village are particularly keen to minimise the risk of unexpected erosion resulting from the removal of hard defences. Your thoughts on how this might be achieved would be welcome.*

Broadly the first sentence of Q8 summarises the concept of adaptive management well, but it is also important to recognise beneficial processes and attempt to encourage them. Short term readjustments involving unpredictable erosion and recovery events are typical of beaches, especially those where there are changes in the nature of management as would be expected in the early stages of realignment. These changes will be important to allow if an eventual readjustment to a more stable configuration is to be achieved. The problem is distinguishing between “beneficial” readjustments and potentially unwanted/detrimental longer term changes. Again, I would suggest that processes/conditions that could lead to a permanent breach might be considered detrimental yet those that could sustain the formation and slow landward recession of a gravely-sand berm set back from the present Hinge could be promoted. It should be possible to distinguish between the two so as to act accordingly. The main thing will be to attempt to maintain the integrity of the berm rather than attempting to hold its spatial position – i.e. it should be free to move and alter configuration.

9) *There is a proposal that “rip-rap” is used instead of relying on beach recycling material and we would appreciate your thoughts on the advisability of using this material and whether it would be stable enough to be effective.*

We cannot at this stage predict the most stable configuration for the shore at the Hinge. The solution is to ensure that sediment is available and to provide relatively unconstrained space for the shoreline to evolve into a form that will best dissipate wave energy. Once that form is apparent then it can be supported by beach management activities. To start by adding constraints using rip-rap would make it more difficult for the shore to evolve to a stable configuration and make it more difficult for us to identify a potentially stable configuration so it is not recommended. A scenario for use of rip-rap could be as an emergency action to help to control a detrimental process. For example, groyne C24 could be extended landward if there were unexpectedly rapid northward drift at the Hinge that threatened stability of the setback berm. Thus, I would recommend rip-rap only as a short term emergency response to deal problems arising that cannot be solved by recycling.

10) *There is also the question of location of any rip-rap placed, in that some thought has been given to replacing the breastworks, as they fail, with this material, your comments would be appreciated. I attach the proposal submitted by West Wittering Estates.*

The answer given above I think makes a strong case against proceeding with this idea. At best, replacement of the breastworks with rip rap would do no more than delay by a number of years the need for an eventual realignment. In my view the purpose of adaptive management is to facilitate an eventual realignment of the shoreline and not to facilitate holding the line to which it is not ideally suited. The key point remains the same as in 2007 which is that the Hinge is not a location at which it remains sustainable to attempt to hold the line and future management should be directed towards alternative approaches.

I hope that my statements are clear and make some sort of sense as responses to your questions. Please get back to me if you require any clarifications or if I have misinterpreted any of the questions.

Best wishes

Dr Malcolm Bray, Department of Geography, University of Portsmouth

GLOSSARY OF TERMS

This glossary is intended to provide the reader with definitions of some coastal terminologies which may have been encountered in this document, or which may be useful for coastal zone management.

Accretion

The deposition of sediment, sometimes indicated by the seaward advance of a shoreline indicator such as the water line, the berm crest, or the vegetation line.

Active Beach

The portion of the littoral system that is frequently (daily or at least seasonally) subject to transport by wind, waves and currents.

Area of Outstanding Natural Beauty (AONB)

Designated at a national level to ensure that the natural beauty and character of these areas are protected. The legal framework for Areas of Outstanding Natural Beauty is provided by the Countryside and Rights of Way Act 2000. Further information on AONBs and on Chichester Harbour AONB can be found via the following links.

<http://www.landscapesforlife.org.uk/>

<http://www.landscapesforlife.org.uk/chichester-harbour-aonb.html>

<http://www.conservancy.co.uk/>

<https://www.gov.uk/government/publications/areas-of-outstanding-natural-beauty-natural-englands-role>

Longshore

Parallel to and near the shoreline

Beach Crest

Highest point on a beach face, breakwater, or seawall.

Beach Face

The section of the beach normally exposed to the action of the wave uprush.

Beach Loss

A volumetric loss of sand or shingle from the active beach.

Beach Nourishment

The technique of placing sand and shingle fill along the shoreline to widen the beach.

Beach Profile

A cross-sectional plot of a shore-normal topographic and geomorphic beach survey, usually in comparison to other survey dates to illustrate seasonal and longer-term changes in beach volume.

Beach Width

The horizontal dimension of the beach measured normal to the shoreline and in the case of East Head the distance between Mean High Water Marks.

Berm

A geomorphological feature usually located at mid-beach and characterized by a sharp break in slope, separating the flatter backshore from the seaward-sloping foreshore.

Boardwalk

Light construction that provides pedestrian access without trampling dune vegetation.

Breach or Tidal breach

A channel cut through a defence which is open to the flow of water at all states of the tide.

Bund An embankment, a bank of earth or stone built to prevent flooding

Coastal Defence

General term used to encompass both coast protection against erosion and sea defence against flooding.

Coastal Erosion

The wearing away of coastal lands, usually by wave attack, tidal or littoral currents, or wind. Coastal erosion is synonymous with shoreline (vegetation line) retreat.

Coastal Geomorphology

The morphological development and evolution of the coast as it acts under the influence of winds, waves, currents, and sea-level changes. Further information on coastal geomorphology sites can be found via the link below. <http://jncc.defra.gov.uk/page-3012>

Coastal Plain

The low-lying, gently-sloping area landward of the beach often containing fossil sands deposited during previously higher sea levels.

Coastal Processes

Collective term covering the action of natural forces such as wind, tide, current and waves on the shoreline, and near shore seabed

Cobble (Cobblestone)

A rock fragment between 64 and 256 mm in diameter usually rounded.

Conservation

The management of a natural resource for the protection, maintenance, rehabilitation, restoration, and/or enhancement of populations and ecosystems.

Current, Coastal

One of the offshore currents flowing generally parallel to the shoreline in the deeper water beyond and near the surf zone; these are not related genetically to waves and resulting surf, but may be related to tides, winds, or distribution of mass.

Current, Littoral

Any current in the littoral zone caused primarily by wave action; e.g., longshore current, rip current.

Current, Longshore

The littoral current in the breaker zone that moves essentially parallel to the shore. Usually generated by waves breaking at an angle to the shoreline.

Downdrift

Flow in the direction of net longshore sediment transport.

Downstream

Along coasts with obliquely approaching waves there is a longshore (wave-driven) current.

Dredging

The practice of excavating or displacing the bottom or shoreline of a water body.

Dune

A landform characterized by an accumulation of wind-blown sand, often vegetated

Dynamic Equilibrium

A system in flux, but with influxes equal to outfluxes.

Environmental Impact Assessment (EIA)

A process by which the consequences of planned development projects are evaluated as an integral part of planning the project. The analysis of biological, physical, social and economic factors to determine the environmental and social consequences of a proposed development action. The goal of the EIA is to provide policy makers with the best available information in order to minimize economic costs and maximize benefits associated with a proposed development.

Erosion

The loss of sediment, sometimes indicated by the landward retreat of a shoreline indicator such as the water line, the berm crest, or the vegetation line.

Foreshore

The seaward sloping portion of the beach within the normal range of tides.

Gabion

Steel wire-mesh basket to hold stones or crushed rock to protect a bank or bottom from erosion. Structures composed of masses of rocks, rubble or masonry held tightly together usually by wire mesh so as to form blocks or walls. Sometimes used (although not recommended) on heavy erosion coastal areas to retard wave action.

Geotextile sill

Large sand-filled geotextile tubes used in coastal protection projects.

Groyne

Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain littoral material. Most groynes are of timber and extend from the backshore, well onto the foreshore and rarely even further offshore.

Groyne Field

A series of groynes acting together to protect a section of beach.

Habitat

The physical space where an organism, population or species lives. Habitats are usually categorized by particular physical or biological characteristics.

Hard Defences

General term applied to impermeable coastal defence structures of concrete, timber, steel, masonry, etc, which reflect a high proportion of incident wave energy.

Intertidal zone (often called littoral zone)

The part of the shoreline that is submerged at high tide and exposed at low tide.

Littoral

Of or pertaining to a shore, especially of the sea. Often used as a general term for the coastal zone influenced by wave action, or, more specifically, the shore zone between the high and low water marks.

Littoral Budget

The sediment budget of the beach consisting of sources and sinks.

Littoral Transport

The movement of beach material in the littoral zone by waves and currents. Includes movement parallel (longshore drift) and sometimes perpendicular (cross-shore transport) to the shore; Also referred to as littoral drift.

Littoral Zone

In beach terminology, an indefinite zone extending seaward from the shoreline to just beyond the breaker zone.

Longshore

Parallel to and near the shoreline; Also referred to as alongshore.

Longshore Drift

Movement of (beach) sediments approximately parallel to the coastline.

Longshore Transport

Sediment transport down the beach (parallel to the shoreline) caused by longshore currents and/or waves approaching obliquely to the shoreline.

Monitoring

Periodic collection of data to study changes in an environment over time.

Nearshore

In beach terminology an indefinite zone extending seaward from the shoreline well beyond the breaker zone.

The zone which extends from the swash zone to the position marking the start of the offshore zone, typically at water depths of the order of 20m.

Nourishment

The process of replenishing a beach. It may occur naturally by longshore transport, or be brought about artificially by the deposition of dredged material or materials trucked in from upland sites.

Offshore

The portion of the littoral system that is always submerged.

Overtopping

Passing of water over the top of a structure as a result of wave run-up or surge action.

Overwash

Transport of the sediment landward of the active beach by coastal flooding during a severe storm event with extreme waves.

The part of the uprush that runs over the crest of a berm of a structure and does not flow directly back to the ocean or lake.

Overwash Fan

Sediment deposited inland of a beach by over wash processes.

Pagham to East Head Coastal Defence Strategy

Detailed study of the coast resulting in setting policy for future coastal management

Pebbles

Beach material usually well-rounded and between about 4mm to 64mm diameter.

Pile

A long, heavy timber or section of concrete or metal that is driven or jetted into the earth or seabed to serve as a support or protection.

Protected Area

A geographically defined area that is designed and managed to achieve specified environmental objectives.

Ramsar Sites

Wetland sites designated for their habitats and species which are of international importance. They are designated under the Ramsar convention. Further information on Ramsar sites and on Chichester and Langstone Harbours Ramsar can be found via this link:

<http://jncc.defra.gov.uk/page-1390>

Reflected Wave

That part of an incident wave that is returned seaward when a wave impinges on a steep beach, barrier, or other reflecting surface.

Reflection

The process by which the energy of the wave is returned seaward.

Refraction (of water waves)

The process by which the direction of a wave moving in shallow water at an angle to the contours is changed: the part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours.

Revetment

A sloping type of shoreline armouring often constructed from large interlocking boulders. Revetments tend to have a rougher (less reflective) surface than seawalls.

Ridge, beach

A nearly continuous mound of beach material that has been shaped by wave or other action. Ridges may occur singly or as a series of approximately parallel deposits.

Riprap

A protective layer or facing of quarry stone, usually well graded within wide size limit, randomly placed to prevent erosion, scour, or sloughing of an embankment or bluff; also the stone so used. The quarry stone is placed in a layer at least twice the thickness of the 50 percent size, or 1.25 times the thickness of the largest size stone in the gradation.

Rock

An aggregate of one or more minerals; or a body of undifferentiated mineral matter. The three classes of rocks are: (a) igneous - crystalline rocks formed from molten material (e.g. granite and basalt); (b) sedimentary - resulting from the consolidation of loose sediment that has accumulated in layers (e.g. sandstone, shale and limestone); (c) metamorphic - formed from pre-existing rock as a result of burial, heat and pressure.

Salt

A marsh periodically flooded by salt water.

Marsh

Sand

Sediment particles, often largely composed of quartz, with a diameter of between 0.062mm and 2mm, generally classified as fine, medium, coarse or very coarse. Beach sand may sometimes be composed of organic sediments such as calcareous reef debris or shell fragments.

Scarping

The erosion of a dune or berm by wave attack during a storm or a large swell, to leave a near vertical face.

Scour

The removal of underwater material by waves and currents, especially at the base or toe of a shore structure.

Scour Protection

Protection against erosion of the seabed in front of the toe.

Sediment Sink

Point or area at which beach material is irretrievably lost from a coastal cell, such as an estuary, or a deep channel in the seabed.

Sediment Store

Point or area at which beach material is temporarily held within a coastal cell.

Sediment Source

Point or area on a coast from which beach material is supplied, such as an eroding cliff, or river mouth.

Shingle

Loosely and commonly, any beach material coarser than ordinary gravel, especially any having flat or flattish pebbles.

Strictly and accurately, beach material of smooth, well-rounded pebbles that are not roughly the same size. The spaces between pebbles are not filled with finer materials.

Shore

The narrow strip of land in immediate contact with the sea, including the zone between high and low water lines. A shore of unconsolidated material is usually called a beach.

Also used in a general sense to mean the coastal area (e.g. to live at the shore).

Also sometimes known as the littoral.

Shoreline Management

The development of strategic, long-term and sustainable coastal defence and land-use policy within a sediment cell.

Site of Special Scientific Interest (SSSI)

Wildlife and geological sites, which conserve and protect some of our best natural heritage. Sites of Special Scientific Interest are given legal protection under UK legislation. Full range of information on these sites, and Natural England's role can be found via the following link:

<https://www.gov.uk/protected-or-designated-areas>

Information on Chichester Harbour SSSI, including the reasons for why the site was notified, the current condition of the site and the conservation objectives can be found here:

<https://designatedsites.naturalengland.org.uk/SiteSearch.aspx>

Special Areas of Conservation (SAC) and Special Protection Areas (SPA)

These are international designations, and include the best examples of habitats and species within the EU, many of which are rare and threatened. They are protected under the EU habitats directive, and have been transposed into English and Welsh law through the Conservation of Habitat and Species Regulations 2010. Further information on these designations, and specifically on the Solent Maritime SAC and Chichester and Langstone Harbours SPA can be found here:

http://jncc.defra.gov.uk/ProtectedSites/SACselection/SAC_list.asp?Country=E

<http://jncc.defra.gov.uk/page-1401>

Spring Tide

A tide that occurs at or near the time of new or full moon and which rises highest and falls lowest from the mean sea level.

Stakeholders

Individuals, groups of individuals and non-governmental and government entities that have either a direct or indirect interest or claim which will, or may, be affected by a particular decision or policy.

Storm Surge

A temporary rise in sea level associated with a storm's low barometric pressure and onshore winds.

Survey, topographic

A survey which has, for its major purpose, the determination of the configuration (relief) of the surface of the land and the location of natural and artificial objects thereon.

Swash Zone

The zone of wave action on the beach, which moves as water levels vary, extending from the limit of run-down to the limit of run-up.

Tidal Breach

A channel cut through a defence which is open to the flow of water at all states of the tide.

Toe

Lowest part of seawall or breastwork, generally forming the transition to the seabed.

Terminal Scour

Intensification of erosion focussed at the end of any hard defence on the coast. Generally more pronounced on the downdrift side of littoral movement

Updrift

The direction opposite that of the predominant movement of littoral materials.

Natural England Statement

Submission to East Head Working Group – 31 October 2007.

Reviewed May 2015. - Natural England's position on proposals for East Head:

1. Natural England supports management options for East Head that respect the conservation interest of the SSSI, SAC and SPA and the landscape of the AONB. We believe that the sustainable conservation and management of all of these features needs to recognise that they are dynamic and will continue to evolve in response to wind, waves, tides and a changing sediment supply.
2. We support allowing natural processes to continue shape the way East Head evolves. We acknowledge the legacy of past sea defence works which means that there is a desire to manage the transition to a more sustainable regime that can be largely self-adapting as the coast continues to evolve.
3. We support further recharge on the back of the hinge to mimic overwash. Given the perceived risk of a breach we see no reason why this should not happen in the immediate future. Such an additional recharge matches our support for restoration of a more natural system. (Ref: As was suggested by English Nature in 2004 and is detailed within the expert panel report of June 2007).
4. We support management of the existing groynes to control the evolution of alignment of the tidal channel immediately offshore from groynes 21-23. (Ref: Supplementary document July 2007, para 3.1)
5. We support managing groynes 20 to 24 by gradually lowering their height in order to manage, and create a smoother transition, from defended to undefended coast.
6. We support the removal of the gabions, between groynes 23 and 24, as and when they fail. We do not object to minor repairs to them. (Ref: M Bray's 10 Oct 07 e-mail). These have now been removed.
7. As the coast evolves we support the management of the wooden breastworks, between groynes 20 and 23, through their gradual removal and/or as and when they fail or become unsafe, to support the shift of the coastline to a more sustainable alignment. (Ref: experts panel June 2007 report, para 4.3 bullets 5 and 8). Natural England believes that there is sufficient information in the experts' panel report, along with on-site observations to demonstrate that the spit is on the wrong alignment and needs to begin to move to a more natural alignment.
8. We support an appropriate monitoring regime and the regular reviewing of management options as the coastline continues to evolve. (Ref: experts panel report June 2007, para 4.3 bullet 9).
9. We support addressing outflanking of groyne 24 by recharge as outlined in 3 Above.