SMP7 Policy Review, Slaughden, Suffolk (phase 3)

East Suffolk Council

Strategic environmental screening appraisal

1 | 3

July 2019

PO-029266

For consultation

Document history and status

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0	March 2019	Template for distribution to statutory stakeholders	H Jay, D Townsend, C Morgan	H Jay	H Jay
1	April 2019	Comments from statutory consultees incorporated and assessment tables completed.	H Jay, D Townsend, C Morgan	H Jay	H Jay
2	May 2019	Comments from Natural England and Alde and Ore Estuary Partnership incorporated and assessment tables revised.	H Jay, C Morgan	H Jay	H Jay
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SMP7 Policy Review, Slaughden, Suffolk (phase 3)

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1. Purpose of report

East Suffolk Council (formerly Suffolk Coastal District Council) are reviewing the coastal management policy previously proposed in the Suffolk Shoreline Management Plan 2 (SMP) for Slaughden in Suffolk, where current policy may need revision. This report has been produced to support that decision process.

The SMP policy unit being reviewed is ORF15.1 'Sudbourne Beach, south of the Martello Tower' (see Chapter 2 'Location') where the current SMP policy determined a Hold the Line in the short term but no formal policy for the medium and long term. Instead an interim policy of No Active Intervention from the medium term was set, "*pending an agreed management and investment plan for the Alde and Ore area*" and it was anticipated by the SMP that the policy would be reviewed and, if necessary, amended as part of the development of the Alde and Ore Estuary Plan.

An estuary management plan (Alde and Ore Estuary Partnership (AOEP) Estuary Plan) has since been endorsed by the Local Authorities, which sets out the preferred management approach for the Alde and Ore Estuary, but this did not provide any recommendations or details on how the coastal frontage should be managed. Since development of the SMP there has also been recent coastal change meaning that in places the existing shingle barrier backing the intertidal area along the study frontage has become more vulnerable, which has led to questions regarding the sustainability of the present approach to management. Both the latest data and the endorsement of the AOEP Estuary Plan (2016) has therefore prompted the need for this current review of SMP policy.

Following review and approval of reports produced in Phases 1 and 2 of the project, a recommendation was made by Client Project Review Group (CPRG)[1] to the Suffolk Coast Forum (SCF) that, subject to further studies, a headline policy change for the policy unit to Managed Realignment was appropriate. This phase has therefore focussed on assessing the strategic environmental effects of a change in SMP policy to one of Managed Realignment, through the appraisal of a number of alternative measures and this report has been prepared to:

- provide a background to the study and SMP policy change
- present the possible alternative approaches to delivering a change in policy for the Suffolk SMP
- present a strategic environmental screening assessment of the alternative approaches against Strategic Environmental Assessment (SEA) receptors (environmental topics) (taking account of criteria in Schedule 1 of the SEA Regulations).

At this stage, the intention is not to define a preferred approach, but to identify whether a change in SMP policy would be environmentally appropriate and to advise on which approaches would be more environmentally acceptable.

A draft template for this report was shared with statutory consultees Natural England (NE), Environment Agency, Historic England and the Marine Management Organisation (MMO) in March 2019 and the approach to the assessment was discussed at a consultee workshop on 13 March 2019. All feedback received from the consultees has been incorporated.

A draft version of the revised screening report was circulated to the Client Project Review Group (CPRG) and presented at meeting held on 25 April 2019. All feedback received from the CPRG has been incorporated into this revised screening report and specifically, the appraisal table has been agreed with representatives from Natural England and the Alde and Ore Estuary Partnership.

[1] CPRG comprises Environment Agency, Natural England, Suffolk County Council, Water Management Alliance and representatives from the Alde and Ore Estuary Partnership.

For consultation

2. Location

The SMP Policy Unit considered by this study is Policy Unit ORF15.1, which begins at the termination of the concrete wall that fronts the Martello Tower and extends southwards to a point midway along the Lantern Marshes North (see Figure 2). This unit is located south of Slaughden (Policy Unit ALB14.4, for which the long term SMP policy is hold the line) and forms part of the larger geomorphological feature of Orford Ness, which can be considered as the shoreline between Aldeburgh marshes and the end of Orford spit (see Figure 3). Orford Ness encloses the Alde-Ore Estuary but in places the shingle barrier that separates the estuary from the open sea is very narrow (Figure 1), which poses a threat to the future of the estuary system in its current form. Management of this coastline is therefore intrinsically linked to future management plans for the estuary.

The coastline, together with the Alde-Ore estuary system it helps protect, supports a wide range of internationally designated habitats and sits within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty and Suffolk Heritage Coast. The wider area is a popular tourist destination and a wide range of business rely on the estuary and the activities it supports, such as sailing clubs, boat-related businesses, fisheries, leisure and holiday rentals. Much of the natural flood plain of the Alde / Ore estuary is reclaimed and lies behind extensive flood defences. This land is an important agricultural area, which relies on freshwater being available for irrigation and a particular threat to farming and abstraction in the Alde-Ore area is seawater ingress. Although many properties in Orford and Aldeburgh lie on higher ground and outside flood risk areas, it has been reported (AOEP Estuary Plan, 2016) that between 300 and 1,400 houses could be at risk of flooding.

This is a very dynamic coastline; the current issues of erosion are not new but are a legacy of the large-scale geomorphological evolution of Orford Ness, which has been shaped by continued longshore transport and an irregular supply of shingle, due to both waning natural reserves and management of the coast to the north. Since the 1980s until recently, the shingle ridge along this policy unit has been maintained as a haul road route partly to enable the recycling of material from Sudbourne Beach (to the south of this policy unit) to the Slaughden frontage. This has resulted in the creation of a higher more artificial ridge, which is less susceptible to regular overtopping and washover events, but more at risk from erosion of the front face and subsequent catastrophic failure.

Figure 1: The narrow shingle barrier along the study frontage. Photograph on left was taken in July 2017, the photograph on the right was taken in December 2018.

Consultation

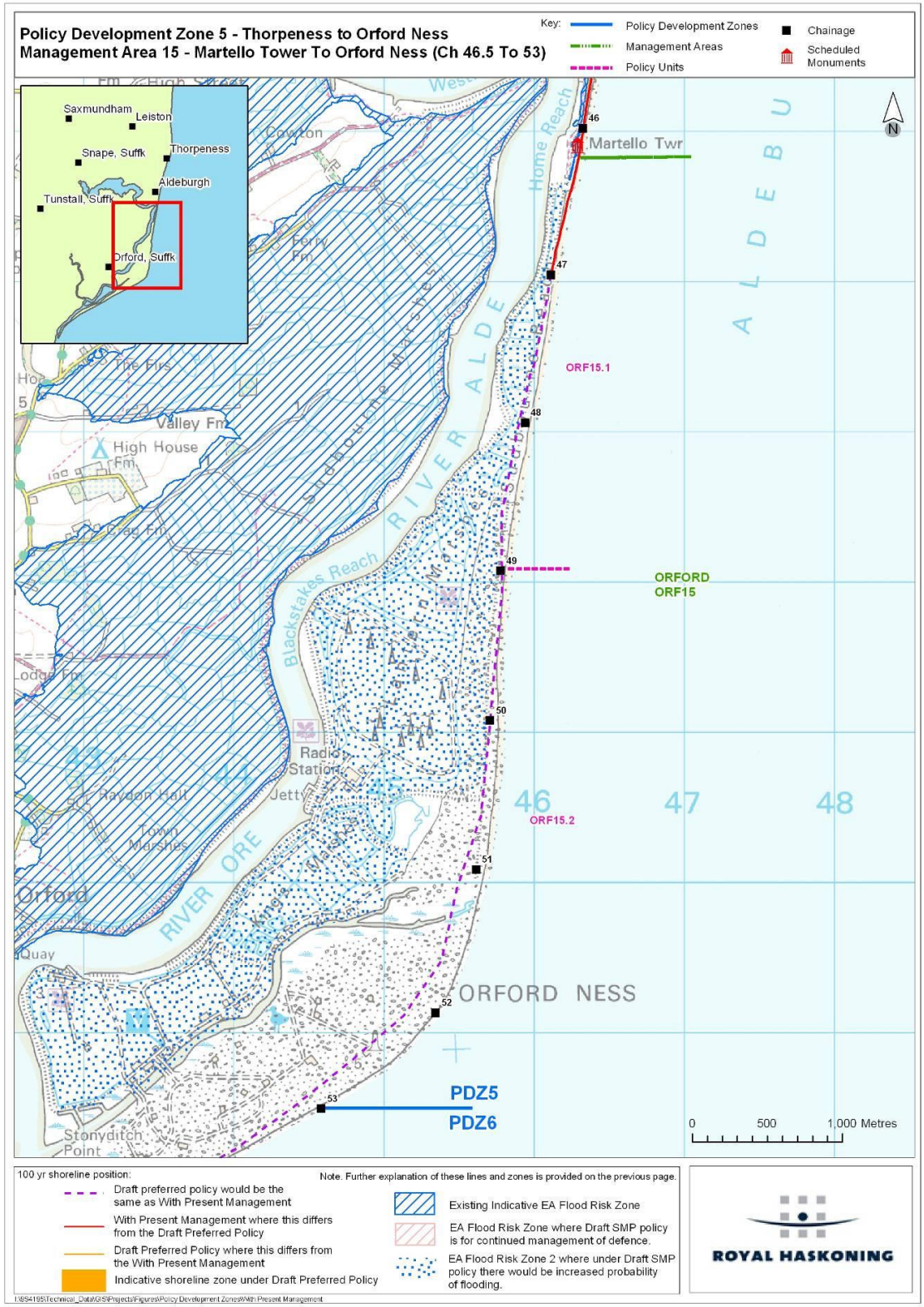

Figure 2: Location map. Taken from the SMP (Royal Haskoning, 2010).

Figure 3: Wider coastal setting, showing location of Policy Unit ORF15.1, within management area ORF15. Taken from the SMP (Royal Haskoning, 2010).

3. Background to study

3.1 Overview

As lead authority for the Suffolk Shoreline Management Plan (SMP), East Suffolk Council (formerly Suffolk Coastal District Council) is working with a sub-set of the SMP Client Steering Group (CSG)[2] to review coastal management policy at Slaughden, where current policy may need revision. Section 3.2 explains the SMP policy change process that must be followed should a change in policy be concluded.

The Suffolk Shoreline Management Plan 2 (SMP) from Lowestoft Ness to Felixstowe Landguard Point was adopted in November 2011 by the lead authority Suffolk Coastal District Council (SCDC), Waveney District Council (WDC) (now combined as East Suffolk Council), Environment Agency (EA) and endorsed by the Anglian River and Flood Coast Committee (RFCC). This report discusses SMP Policy Unit ORF15.1 (Sudbourne Beach, south of the Martello Tower) (see Figure 2): the current SMP policy for this unit is Hold the Line in the short term but no formal policy was defined for the medium and long term. Instead an interim policy of No Active Intervention from the medium term was set, "*pending an agreed management and investment plan for the Alde and Ore area*" and it was anticipated by the SMP that the policy would be reviewed and, if necessary, amended as part of the development of this plan.

An estuary management plan (Alde and Ore Estuary Partnership (AOEP) Estuary Plan) has since been endorsed by the Local Authorities, which sets out the preferred management approach for the Alde and Ore Estuary. This has been produced by the Alde and Ore Estuary Partnership, which comprises representatives from key stakeholders in the estuary, representing parishes, landowners, farmers, river users, environment expert and businesses. It covers a wider geographical area than the study frontage, including parishes which contain part or all of the 14 flood cells and any parishes with land affected by the December 2013 surge. The AOEP Estuary Plan does not specifically include the study frontage and, as such, does not provide any recommendations or details on how the coastal frontage should be managed. It does, however, include the overall vision that the estuary should remain as it is now and seeks to ensure that defences within the estuary are of a standard necessary to withstand overtopping in a 1 in 200-year event. In support of this, the plan states that "*a significant outcome of the consultation was the community's prime concern to keep the estuary as it is now*".

Since development of the SMP, there have been further studies undertaken to look at the coastline. There has also been recent coastal change meaning that in places the existing shingle barrier backing the intertidal area along the study frontage has become more vulnerable, due to recent wave conditions. This, together with the further studies, has led to questions regarding the sustainability of the present approach to management. Both the latest data and the endorsement of the AOEP Estuary Plan (2016), has therefore prompted the need for this current review of SMP policy.

3.2 SMP policy change process

Should a change in SMP policy be identified there is a formal process to be followed, shown in the flow diagram below (Figure 4).

Any change in SMP policy requires approval from the Suffolk Coast Forum (SCF), who, with agreement from the Cabinets of SCDC and WDC, have taken over the responsibility of the Elected Members Forum originally set up to approve the development of the SMP. The responsibility of the SCF is to ensure that any changes to the SMP are consistent with the national framework guidelines, reflect the often complex and different pressures on the coast, are legal and also aware of any precedence that a change may create.

[2] Comprises the Environment Agency (EA), Natural England (NE), Suffolk County Council (SCC), National Trust (NT) and the Water Management Alliance (WMA) Representing East Suffolk Internal Drainage Board

For consultation

To inform this policy change process, Jacobs (formerly CH2M) have been commissioned to undertake high-level assessments of the implications of possible changes in policy for consideration by the Client Steering Group (CSG) and enable local officers to make a recommendation as to whether existing policies should remain or be updated.

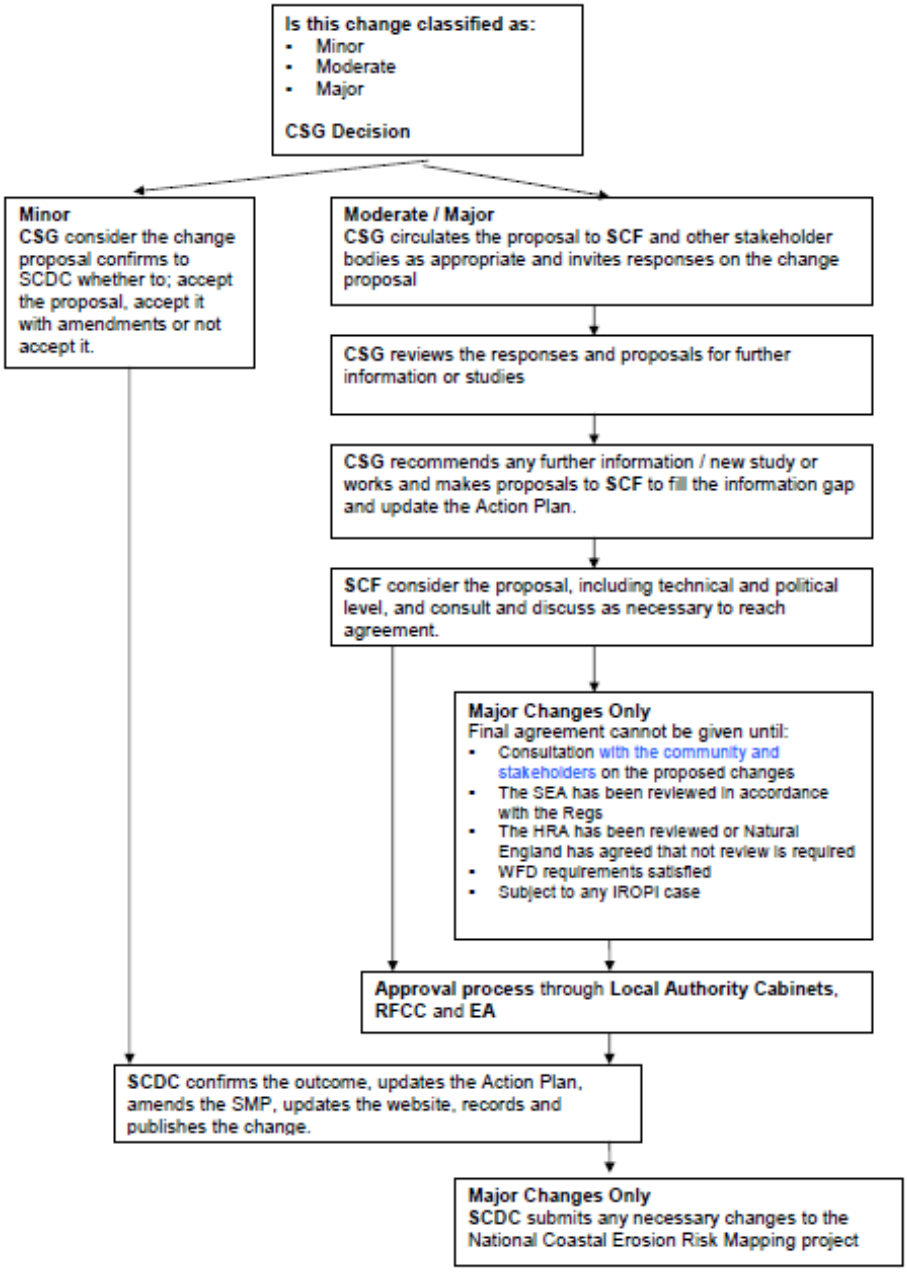

Figure 4: Flow diagram, taken from Suffolk guidance on the SMP change process.

4. SMP policy review

4.1 Existing SMP policy

The four options considered for shoreline management in the SMPs are presented in Table 1.

Table 1: SMP option descriptions.

SMP option	Description of option
Hold the line (HTL)	Hold the existing defence line by maintaining or changing the standard of protection. This policy will cover those situations where work or operations are carried out in front of the existing defences (such as beach recharge, rebuilding the toe of a structure, building offshore breakwaters and so on), to improve or maintain the standard of protection provided by the existing defence line. Included in this are other policies that involve operations to the back of existing defences (such as building secondary floodwalls) where they form an essential part of maintaining the current coastal defence system.
Advance the line (ATL)	Advance the existing defence line by building new defences on the seaward side of the original defences. Using this policy should be limited to those policy units where significant land reclamation is considered.
Managed realignment (MR)	Managed realignment by allowing the shoreline to move backwards or forwards, with management to control or limit movement (such as reducing erosion or building new defences on the landward side of the original defences).
No active intervention (NAI)	No active intervention, where there is no investment in coastal defences or operations.

Within the development of an SMP, an epoch (time period) based approach is used for planning purposes, with the three epochs being: 0 to 20 (up to 2025), 20 to 50 (2025 – 2055) and 50 to 100 (2055 – 2105) years.

The following excerpts are from the SMP policy statement for Management Area 15 (see Figure 2), which includes both the study frontage covered by this report (ORF15.1) and the coastline to the south (ORF15.2) (Figure 5):

For consultation

SUMMARY OF PREFERRED PLAN RECOMMENDATIONS AND JUSTIFICATION

PLAN: The aim of the plan is to maintain the important natural character of Orfordness. There remains uncertainty with respect to management to the area south of the Martello Tower through to the Lantern Marshes. This needs to be resolved through an estuary management plan. There is a commitment by the Suffolk Coast ICZM Initiative[2] to develop with local communities and interested groups a Management and Investment Plan for the Alde and Ore. This area will include the Alde and Ore estuary and its adjoining coastline. This plan will take account of the conclusions of the SMP, will review the recommended SMP policy and, if necessary, amend this accordingly. In the meantime it is important to have an interim policy for the coastline. From the perspective of purely managing the shoreline, a policy of No Active Intervention would be concluded. Present management relies on recycling shingle from further south on Orford Ness. There is currently an agreed emergency plan to recharge the shingle bank, if required, that is under constant review. Subject to continued monitoring this practice would continue in the short term. An alternative method may need to be developed later in the first epoch to avoid damaging the Orfordness shingle ridges. South of Lantern Marshes the intent would be for No Active Intervention. The Orfordness lighthouse is located on a highly dynamic feature and is now vulnerable to coastal process. Options for its future are currently being considered and these need to take into account the dynamic nature of the shingle feature, as well as environmental importance.

SUMMARY OF SPECIFIC POLICIES

Policy Unit		Policy Plan			
		2025	2055	2105	Comment
ORF 15.1	Sudbourne Beach (south of the Martello Tower)	HTL	NAI	NAI	An interim policy pending an agreed Management and Investment Plan for the Alde and Ore area.
ORF 15.2	Orford Ness	NAI	NAI	NAI	
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment					

Figure 5: Excerpts from the SMP policy statements (Royal Haskoning, 2010).

For Consultation

4.2 Current review of policy

4.2.1 Work undertaken to date

We are now undertaking Phase 3 of a three-stage approach (see below).

Phase 1:	Development of a baseline appreciation of aspects that are key to identification of a viable SMP policy, with a focus on implementation measures. This phase concluded with a presentation of findings to the CPRG that enabled the CPRG to determine a preferred way forward, i.e. whether to pursue any policy change and what the nature of that change might be.
Phase 2:	Further detailed 'high level' assessments of alternative approaches to implementing the policy changes that considered the Conservation of Habitat and Species Regulations 2017 (i.e. preliminary Habitat Regulations style assessment) and the Water Environment (Water Framework Directive) Regulations 2017, to fully appraise the proposed policy change.
Phase 3 (this stage):	Further environmental study comprising the appraisal of the alternative measures against Strategic Environmental Assessment (SEA) receptors (taking account of criteria in Schedule 1 of the SEA Regulations). Upon completion of the necessary studies, the proposals will be subject to wider consultation, to review and agree the policy changes. Subject to the outcome of the consultations, this will be followed by adoption and dissemination of the policy change.

Phase 1

In Phase 1, potentially viable management approaches were considered for the policy unit (PU), considering the SMP policy options of Advance the line, Hold the Line, Management Realignment and No Active Intervention (see Table 1). A high-level assessment was also undertaken of the possible environmental, social and economic impacts of such approaches, based upon existing information. The Phase 1 report and appendices are provided in Appendix A.

The coastline covered by the policy unit changes in characteristics, as such different coastal management approaches are likely to be required. In recognition of this, Phase 1 recommended that the unit be considered as three sub-units (see Figure 6), as follows:

- Sub-unit A is currently defended but present evidence of damage and stress on this length of shoreline suggests that improvements to the current defence measures are going to be necessary if a breach along this sub-unit is to be prevented.
- Sub-unit B is undefended and eroding; it comprises a single narrow ridge and should be considered as susceptible to breach. Evidence of recent changes along this coastline indicates that where there has been increased pressure on the system the response has been for erosion of the face of the berm resulting in a net narrowing of the berm crest width, rather than the barrier rolling landwards by overwash and overtopping.
- Sub-unit C is undefended and accreting; here there is virtually no risk of breach, at least not for many decades and only then if the current accretional trend reverses to become one of rapid erosion of the multiple ridges, which is not currently anticipated.

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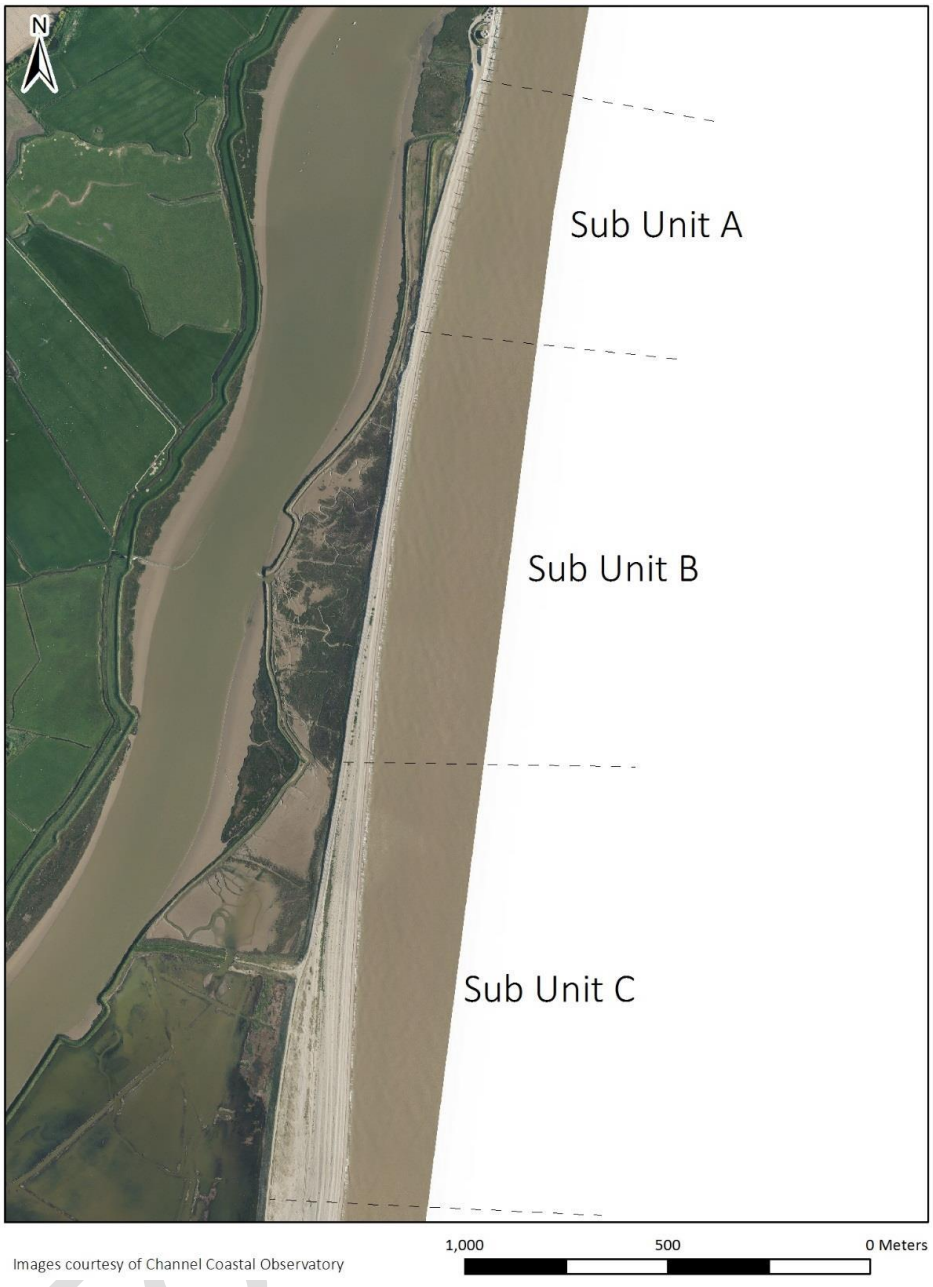

Figure 6: Division of Policy Unit ORF15.1 into three sub-units, A, B and C. Taken from CH2M (2017) Phase 1 report.

Phase 1 considered a range of implementation measures for each unit and the technical viability of these; Table 2 indicates which measures were rejected at this initial stage and why.

Table 2 Implementation measures considered in Phase 1.

Unit	Measure		Taken forward for further assessment?
A	A1	Do nothing	Yes (for comparison purposes)
	A2	Maintain/ develop a beach	No – unlikely that any measures would be effective in preventing a breach due to issues with shingle retention along the study frontage.
	A3	Maintain/ improve the existing revetment structure	Yes
	A4	New seawall	No – there are problems already evident with this measure at the Martello Tower and existing issues of retaining a beach.
	A5	Widen the defence	Yes
	A6	New embankment along estuary channel	Yes
	A7	Terminal structure	Yes
B	B1	Do nothing	Yes
	B2	Beach nourishment	Yes
	B3	Interventions to hold a beach	No – unlikely that any of measures would be effective in preventing a breach due to issues with shingle retention along the study frontage.
	B4	Widen the shingle ridge	Yes
	B5	'Natural' shingle ridge management	Yes
	B6	Extend the existing revetment structure along the shoreline	Yes
	B7	New embankment along estuary channel	Yes
	B8	New embankment - alternative alignments	Yes
C	C1	Do nothing	Yes
All		Shingle Engine	Yes

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Future management of this whole policy unit will involve combinations of these measures, but ultimately there are three possible outcome scenarios:

- Breach - a permanent opening along the shingle barrier, which will produce significant changes in the wider estuary system and adjacent shorelines. This will be the result of No Active Intervention either along the entire length or partial length of the policy unit.

- No Breach – this would involve maintaining a continuous barrier between the river and open coast although not necessarily along the same alignment as today and would relate to a policy of Hold the Line, or Managed Realignment followed by Hold the Line. Measures could include creating a more robust shingle barrier or construction of an artificial defence to prevent any breach forming.
- Temporary Breach - although a barrier will remain in some form between the river and open coast, it may be occasionally breached, meaning a temporary interaction between the coast and estuary. This would involve approaches that address repair and reinstatement of damage to the ridge but would also require acceptance of a lower standard of protection. This would fall under the policy option of Managed Realignment.

Considering the different combinations of measures, Phase 1 defined nine approaches, shown in Table 3, which also indicates whether the likely outcome is breach, no breach or temporary breach.

For each of the proposed approaches, Phase 1 appraised the anticipated shoreline response, resultant change in coastal form and the potential technical implications of this. The possible impacts on the wider coastal environment and the interests it supports were then appraised at a high level, considering:

- Biodiversity, geology and geomorphology features
- Water and hydromorphology
- Historic environment and landscape
- Communities, economy and material assets.

Finally, the costs of each approach were estimated.

Table 3 The eight approaches considered in Phase 1.

	Approach 1	Approach 2	Approach 3	Approach 4	Approach 5	Approach 6	Approach 7	Approach 8	Approach 9
A	A1 – Do nothing	A7 - Terminal structure	A3 - Maintain/ improve the existing revetment structure or A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure or A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure or A5 - Widen the defence	A6 - New embankment along estuary channel	A3 - Maintain/ improve the existing revetment structure or A5 - Widen the defence	A6 - New embankment along estuary channel	Shingle Engine
B	B1 – Do nothing	B1 – Do nothing	B1 – Do nothing	B6 - Extend the revetment structure along the shoreline	B7 - New embankment along estuary channel or B8 - New embankment - alternative alignments	B7 - New embankment along estuary channel or B8 - New embankment - alternative alignments	B2 - Beach nourishment or B4 - Widen the shingle ridge or B5 - 'Natural' shingle ridge management	B2 - Beach nourishment or B4 - Widen the shingle ridge or B5 - 'Natural' shingle ridge management	
C	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	
	Breach	Breach	Breach	No Breach	No Breach	No Breach	Temporary Breach	Temporary Breach	No Breach

For consultation

The key outcomes from Phase 1 were:

- Approaches 1, 2 or 3 would result in a *breach* and would mean a permanent opening along the shingle barrier, which would produce significant changes in the wider estuary system and adjacent shorelines. This is therefore not compatible with the objectives of the AOEP Estuary Plan, but is generally in line with the long term SMP policy (i.e. policy for epochs 2 (20 to 50 years) and 3 (50 to 100 years); therefore it would not require any policy change, although further studies would be required as part of a need to revisit the AOEP Estuary Plan, which could be significantly altered by those approaches.
- Approaches 4, 5, 6 and 9 would result in *no breach* and would be compatible with the AOEP Estuary Plan; although this represents a change from SMP policy, estuary-wide impacts would not result. However, these approaches would be typically more expensive that the other approaches. All options presented would also have significant environmental risks associated with them.
- Approaches 7 and 8 would result in a temporary breach and may be compatible with the AOEP Estuary Plan, but there would need to be a greater acceptance of risk and there may need to be some further consideration regarding the ability of the existing river defences to withstand a breach event. There are considerable differences between the different measures in terms of the cost involved in implementing the various measures, environmental risk and in the level of uncertainty regarding the likelihood of a breach forming. With all of the temporary breach approaches there is correlation between the level of investment and the level of breach risk. Although some of the measures incorporated within these two approaches would represent a continuation of current management, these approaches would require a change in headline policy to managed realignment.

Phase 2

Phase 2 involved a preliminary assessment of SMP approaches against the Habitat Regulations and Water Framework Directive (WFD). Appendix B includes the main report and WFD report from Phase 2.

As approaches 1, 2 and 3, which would result in a permanent breach, do not represent a change from the current SMP policy for epochs 2 (20 to 50 years) and 3 (50 to 100 years) it was considered that the high-level assessments undertaken for Phase 1 for Approaches 1 to 3 were sufficient.

Approach 9 (Shingle Engine) was also excluded from further assessment. Such a large-scale scheme would be likely to have wide-ranging effects and would require a detailed investigation and monitoring; this would be the responsibility of the promoters of that scheme to undertake. The assessments do, however, identify potential risks and impacts which that approach would likely need to consider if it is progressed.

For approaches 4 to 8, each approach was appraised against both Habitat Regulations and the WFD, taking account of the individual implementation measures. Based on these appraisals and feedback from representatives from Natural England, Environment Agency and the Alde and Ore Estuary Partnership, the level of environmental risk associated with each approach was determined, recognizing that under each approach, there are different combinations of implementation measure that could be adopted which could result in variations in the impacts.

In summary, Phase 2 concluded that:

- At scheme stage a Habitat Regulations Assessment (including Appropriate Assessment) and Water Framework Directive assessment will be required for all approaches.
- Approach 4 (depending on the implementation measures adopted in the approach) represents a *high* environmental risk. This approach is likely to have an adverse effect on Natura 2000 sites, which is unlikely to be mitigated, and there may be other alternative approaches that could be implemented to avoid adverse effects on the designated sites. Additionally, it may not be possible to compensate for the loss of

For consultation

internationally designated habitat, and therefore it may not be possible to make a case for formal Secretary of State approval through the Habitat Regulations on grounds of overriding public interest.

- Approaches 5, 6, and 8 represent a *moderate to high level* of environmental risk. These approaches are likely to result in the loss of internationally designated habitat. It may be possible to mitigate for the loss of some shingle habitat, but the loss of saltmarsh habitat is likely to result in an adverse effect on integrity of the Natura 2000 site. Consequently, alternative approaches that could be implemented to avoid adverse effects on the designated sites would require further consideration. If one of these approaches is progressed as the re-alignment approach works with coastal processes over the longer term, compensatory saltmarsh habitat is likely to be required, and formal Secretary of State approval through the Habitat Regulations on grounds of overriding public interest would be required.
- Approach 7 (assuming certain implementation measures) works with natural processes and so has *low to moderat*e environmental risk, such that it may be possible to conclude 'no adverse effect' on the integrity of Natura 2000 sites with mitigation. This could potentially be the most environmentally acceptable approach in terms of the Habitat Regulations, depending on the specific implementation measures adopted.
- In terms of the WFD, Approaches 4 and 7 are likely to comply with the objectives considered. Approaches 5, 6 and 8 are not likely to meet the objectives in the absence of mitigation, as they could affect the input of water and sediment flux to the saltmarsh, which may result in the deterioration of the aquatic ecosystem. However, with appropriate mitigation built into the scheme (for example, measures to ensure the tidal exchange of saline water into the site), these approaches are unlikely to result in the deterioration of any water bodies. However, any individual scheme taken forward will require further, more detailed WFD assessment.

4.3 Phase 3 (this phase)

Following review and approval of Phase 1 and 2 reports by the CPRG, a recommendation was made to the SCF that subject to further studies a headline policy change for the policy unit to Managed Realignment (MR) was appropriate. The 'intent for management' that underpins the headline policy is to '***provide resilience against erosion whilst working with a dynamic coast***'.

This Phase (Phase 3) therefore focusses on assessing the strategic environmental effects of a change in SMP policy to one of Managed Realignment, through an appraisal of alternative approaches against Strategic Environmental Assessment (SEA) receptors (taking account of criteria in Schedule 1 of the SEA Regulations). This will be followed by stakeholder and public consultation on the proposed policy changes.

4.3.1 Alternative approaches screened out of this screening assessment

Approaches 1 to 3 do not represent a change from the current SMP policy for epochs 2 (20 to 50 years) and 3 (50 to 100 years); therefore, these have not been assessed further.

Approach 4, which involves an extension of the existing revetment along the currently undefended shoreline in unit B would equate to a hold the line policy and was also concluded to represent a *high* environmental risk as it would likely result in the loss of internationally designated habitat that cannot be compensated for, and there are other solutions that could potentially avoid an adverse effect on site integrity. For these reasons, this approach has not been considered further in this assessment.

Approaches 5 to 9 could all be considered to implement a policy of Managed Realigned. However, Approach 9 (Shingle Engine) has not been appraised further in this assessment as this approach would require considerable studies to look into wider impacts, which are considered beyond the scope of this study.

For consultation

4.3.2 Approaches subject to further appraisal for this screening assessment

Along sub-unit A, Approaches 5 and 7 would involve maintaining or improving the existing revetment structure (A3) or widening the defence (A5) by adding a buffer of shingle on the rear face of the ridge. Provided this were substantial enough, it would be there to prevent a breach from occurring during single storm events and provide time for repair following damage due to overtopping and erosion.

An alternative approach along sub-unit A would be to construct a set back embankment along the estuary channel (A6), which is considered in Approaches 6 and 8. This could involve either reusing some of the material presently used to armour the existing ridge to armour the front face of the new embankment, or simply leaving the existing defences in place, which would continue to provide some wave protection even as it fails.

Along sub-unit B, various implementation measures could be considered under a policy of Managed Realignment, as follows:

1) constructing a new set back embankment in different locations (B7 and B8), which would allow the unconstrained movement of the shingle ridge in front; or

2) managing the existing shingle ridge. In Phase 1, three implementation measures were considered; B2 (beach nourishment), B4 (widening the shingle ridge) and B5 ('Natural' Shingle Ridge Management).

   B2 involves introducing more beach material to the foreshore to build up the ridge and create a more substantial barrier along the current alignment. It would be highly intensive and would require considerable quantities of shingle, meaning that, given restrictions on removal of shingle from the current source area of Sudbourne beach, imported material would be required, with significant cost implications. For these reasons this measure ***has not been taken forward*** to this phase.

   B4 involves recharge along the landward edge of the ridge, providing a wider barrier. The intent would be to replicate the natural process of barrier rollback rather than trying to hold the existing alignment. In this way it may be possible to achieve a more quasi-stable position.

   B5 allows some ongoing natural movement of the ridge whilst maintaining its integrity, through post-storm repairs to the ridge as and when required and measures to support any rollback rather than maintaining in position. Careful management of the transition zone between sub-units A and B will be required.

In summary, this phase will consider the following measures, which have been taken forward for environmental assessment:

Sub-unit A

A3 – maintain and improve the existing revetment. Works will be required to bolster and improve this structure, which will require the import of additional rock or armour units to strengthen it, together with provision of a more robust toe. It may be more effective to rebuild the structure, using the existing and new materials, in a form that is going to be more resilient to increased storm exposure in decades to come. In the future works to maintain the crest of the ridge will be required, potentially having to replace the current block mattress.

A5 – widen the defence. Either alone, or in combination with A3, this would involve adding a buffer of shingle on the rear face of the ridge. This could help defer or reduce the need substantial works along the seaward face and would enable some realignment of the existing defence. The quantity of additional shingle required to enable this option would be lower than the current recycling operations from Sudbourne Beach but would require a higher amount to be removed in a single operation and therefore it may be necessary to import this shingle from another source, most likely offshore dredging.

For consultation

A6 - new embankment along estuary channel. Due to the ground conditions this is likely to be technically difficult and as such may involve substantial works and high costs. It would have the benefit of effectively setting back the existing defended 'line', potentially improving the transition with sub-unit B. Existing defences could either be removed and reused to create the new structure or left in place to continue to provide a residual defence function for some time.

Sub-unit B

B4 – widen the shingle ridge. Shingle will be added along the landward edge of the ridge to reduce risk of a breach from occurring during single storm events and give time for repair to overtopping erosion damage to then be undertaken. The quantity of shingle required to enable this option would be considerably more than the current recycling operations from Sudbourne Beach and would also require a higher amount to be removed in a single operation. It is questionable whether this level of removal would be permissible, therefore it is likely that it would be necessary to import this shingle from another source, most likely offshore dredging.

B5 - 'natural' shingle ridge management. Instead of operations designed to hold the shingle bank in its present position, it will allow some landward roll back of that position, also allowing it to adopt a lower crest elevation as nature determines. This could involve implementation of B4 at selected locations. There will need to be an acceptance of an increase in risk with this approach; whilst there is therefore a possibility that a lower wider barrier will result in increased overtopping there would be more frequent over-washing. It is anticipated that any shingle required to help maintain and manage the barrier could possibly be sourced locally, i.e. not imported from offshore dredging.

B7 – new embankment along estuary channel. This likely to take the form of an earth embankment, engineered to resist any potential erosion on the river and tidal flows within the estuary. Note that over the northernmost 250 m length, adjacent to sub-unit A, there is no space available for managed realignment, so although an additional flood embankment might be constructed, this is effectively a widening of the existing defence line rather than providing a second line of defence.

B8 – new embankment along an alternative alignment. As a variation to B7, it is possible that a new earth embankment could be constructed along a different line, although the minimum extent for any such realignment should be a distance greater than the anticipated natural change in shoreline position, so that the shingle beach can continue to evolve naturally and unimpeded.

Each measure will be appraised individually, before considering possible in-combination impacts of implementing specific measures in each sub-unit.

5. Environmental changes since the SMP

5.1 Overview

This section considers any environmental changes along the Slaughden coastline since the production of the SEA Environmental Report for the SMP (Royal Haskoning 2010) that could affect or be affected by changes in approach to coastal management. These include changes in:

- Environmental baseline and issues (section 5.2)
- Environmental legislation and planning policy (section 5.3)
- New or proposed development (section 5.4)

For consultation

5.2 Changes in environmental baseline and issues

This section of the report defines the known changes in the environmental characteristics at Slaughden following a review of the 'Natural and Built Environment Baseline' (Appendix D) produced for the SMP, environmental issues in the SMP Strategic Environmental Assessment (SEA) Environmental Report and environmental studies completed since publication of the SMP.

The review focuses on a 10 km inclusion zone, as defined during Phase 2 of this study (see Figure 7), and only considers those receptors scoped in by the SMP. Receptors are features on which any impact can be measured such as biodiversity, landscape, population, etc.

This section has been structured to align with the SMP assessment presented in the SEA Environmental Report (Appendix F of the SMP). Where no changes have occurred to environmental baseline characteristics since the SMP, this is indicated.

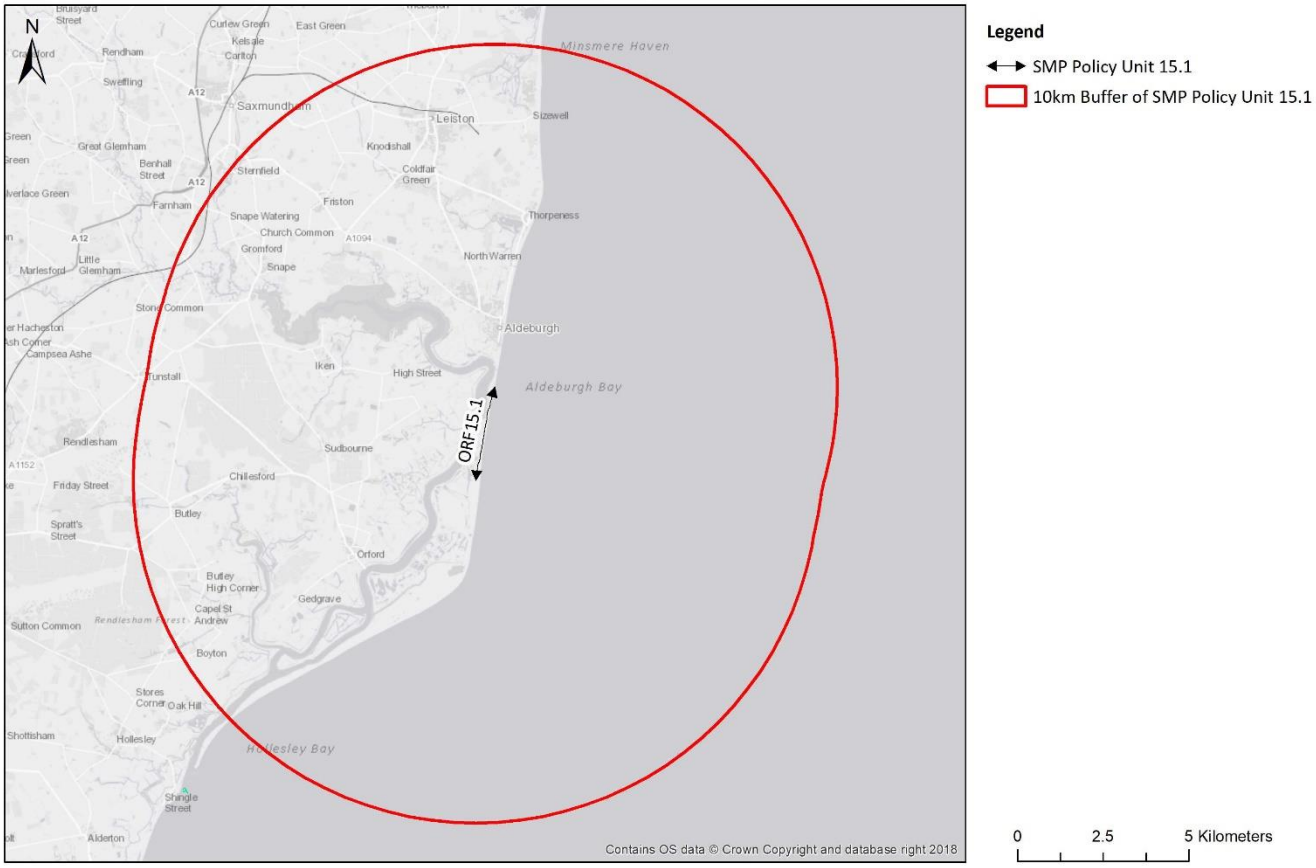

Figure 7: Policy Unit ORF15.1 and 10 km inclusion zone.

5.2.1 Biodiversity, fauna and flora

Conservation designations

The SMP recognised the following designations in management area 15: Alde-Ore Estuary SSSI, Alde-Ore Estuary Ramsar site, Alde-Ore SPA, Orford Ness and Shingle Street SAC and Alde-Ore & Butley Estuaries SAC. Orford Ness is also a nationally important nature reserve (Orford Ness NNR), with an RSPB site at Havergate.

There have been no changes to existing statutory designations since the SMP.

There are, however, new proposed/classified marine designations:

- **Outer Thames SPA (classification date 31/10/2017)**

  The SPA lies along the east coast of England in the southern North Sea and extends northward from the Thames Estuary to the sea area off Great Yarmouth on the East Norfolk Coast (JNCC, 2017a). It is classified for the protection of the largest aggregation of wintering red-throated diver (*Gavia stellata*) in the UK, an estimated population of 6,466 individuals, which is 38% of the wintering population of Great Britain. It also protects foraging areas for common tern (*Sterna hirundo*) and little tern (*Sternula albifrons*) during the breeding season.

- **Southern North Sea Marine Protected Area** (designated **candidate Special Area of Conservation/Site Conservation Interest** (cSAC date: 30/01/2017, SCI date: 12/12/2017).

  Located to the east of England, this site stretches from the central North Sea (north of Dogger Bank) to the Straits of Dover in the south, covering an area of 36 951 km^2 (JNCC, 2017b). The majority of this site lies offshore, but it does extend into coastal areas of Norfolk and Suffolk. A mix of habitats, such as sandbanks and gravel beds, are included in the site. The Southern North Sea cSAC has been identified as an area of importance for harbour porpoise. This site includes key winter and summer habitat for this species and covers an area over 3 times the size of Yorkshire, making it the largest cSAC in UK and European waters at the point of designation in 2017.

- **Orford Inshore proposed Marine Conservation Zone (pMCZ)**

  This is an inshore site that covers an area of approximately 72 km². The site is located off the Suffolk coast in the Southern North Sea approximately 14 km offshore from the Alde Ore Estuary. The Orford Inshore site is dominated by habitats composed of subtidal mixed sediments. These sandy, gravelly sediments are important as nursery and spawning grounds for many fish species including Dover sole, lemon sole and sand eels. Colourful species of burrowing anemones can be found within the sediment, alongside sea cucumbers, urchins and starfish. Several nationally important shark species are found within the site, including the small spotted catshark. The area is also important for foraging seabirds and harbour porpoise are often spotted passing through.

SSSI status

Since the SMP, Natural England have carried out further condition assessments on the Alde Ore Estuary SSSI and changes to the condition summary are presented in Table 4. It should be noted however, that the number of units has reduced from 45 to 35; it is not known whether some units were removed from the SSSI designation or amalgamated together. Similarly, under the condition assessment for Unit 17 noted the following (which implies targets have changed over time): "*Targets have previously been adjusted to suit Orfordness limited strandline diversity, historically effect perennial vegetation and merger of zones; at least one species frequent*."

In the SMP the Alde Ore SSSI was regarded as generally in favourable condition, with only a minority of units (11 out of 45 units) considered in unfavourable condition. However, there has been a change in the overall condition of the site to unfavourable (see Table 4). 18 of 35 units are currently unfavourable and of those, 12 are unfavourable recovering and 6 unfavourable no change. Previously coastal squeeze was identified as the main cause of decline in habitat quality, with the exception of unit 13 which was being damaged by unsuitable shingle management practices; however additional issues have been identified:

- Current areas of coastal squeeze have largely been offset in the estuary: this has likely contributed to the shift from unfavourable declining to unfavourable recovering.

For consultation

- Unit 13 – has not recovered from a change in shingle management practices and is classified as 'unfavourable – no change'.
- Unit 12 – the relatively new saltmarsh to the rear of the shingle beach is meeting all targets but cannot yet achieve favourable status as it is too immature (the marsh was only connected to the intertidal area in 1999).
- Four of the units were damaged by fishermen and shingle extraction in the past and are still recovering. The damage to one of these four was so extensive it cannot yet be classified as recovering and instead is labelled 'unfavourable – no change'. These units are also noted to have reduced in extent from natural shingle 'roll-back'.
- Three units have/are suffering from recreational pressures.
- There has been a major decrease in the number of Lesser Black-backed Gull breeding numbers overall within the SSSI. Reasons for the collapse of the gull population on Orfordness have not been concluded but are thought to be due to: predation by foxes (key), habitat change, increased use of roof top nest sites in industrial and urban areas, disturbance of nest sites by recreational boaters, walkers and fisherman, reduction in available food through decrease in pig production and changes in landfill practice, and potential effect of the rapid increase in Chinese Water Deer.
- The increase in the number of non-native invasive species has also been noted on Orfordness.

Table 4: Change in condition summary for Alde Ore Estuary SSSI: 2010 data compared to 2019.

Date of Search	Meeting targets	Favourable	Unfavourable Recovering	Unfavourable no change	Unfavourable declining	Partially Destroyed	Destroyed	Not Recorded
04/09/2007 (SMP, 2010)	75.06	75.96	2.10	0.59	21.36	-	0.00	-
31/01/2019	86.26	51.68	34.58	13.74	0.00	0.00	0.00	0.00

Biodiversity

Since the SMP, the UK BAP has been superseded by a new Biodiversity Strategy - Biodiversity 2020: A strategy for England's wildlife and ecosystem services (2011), which sets out action areas to deliver national biodiversity outcomes. The objectives of the UK BAP are now delivered through the Natural Environment and Rural Communities (NERC) Act 2006 (as well as by planning policy including the National Planning Policy Framework (NPPF) and National Policy Statements). Under the NERC Act 2006, an England Biodiversity List of habitats and species of principal importance was developed; this is based on, and replaces, the UK BAP list of priority habitats and species. In addition, a review of the Suffolk BAP was carried out in 2010/2011 (post SMP), and the Suffolk Local BAP was produced in 2012 (Suffolk Biodiversity Partnership, 2012) with detailed lists of priority species and habitats in Suffolk produced in 2015. The Action Plan Targets outlined in the Suffolk Local BAP are:

1) Ensure development avoids adverse impacts on biodiversity

2) Where avoidance is not possible, mitigate residual impacts of developments.

3) Where mitigation is not possible, compensate for losses incurred during development.

4) Enhance developments for biodiversity.

5) Ensure biodiversity is taken into consideration during, and after, the construction phase of development.

For consultation

Of the 14 priority habitats that were previously included within the SMP, the following habitats lie along the study frontage and could be affected by any change in coastal management policy.

- coastal and floodplain grazing marsh
- coastal saltmarsh
- mudflats
- coastal vegetated shingle
- coastal lagoons.

5.2.2 Coastal processes

A full review of coastal changes since the SMP is provided in the Phase 1 report for this study (see Appendix A). This concluded that between the Martello Tower and Sudbourne Beach data prior to 2010 suggests a fairly stable situation, with present issues along this stretch of coast a fairly recent concern. Since the SMP (2010) there has been progressive year on year erosion with the most significant loss occurring between February 2013 and February 2014, when the crest width narrowed by up to 15 m in places. Beach profile data indicates that along this stretch the face of the ridge was eroded and removed, with little evidence that any of this material was rolled landwards or overwashed.

More recently erosion has resulted in further narrowing of the shingle ridge (see Figure 8) and damage to the end of the defended section (sub-unit A), where the interlocking revetment has failed and the beach to the south is beginning to outflank the end of the linear defence (see Figure 9).

Figure 8: Start of sub-unit B in December 2017 illustrating the narrow width of the shingle barrier at this location.

Figure 9: Interlocking block revetment failure, sub-unit A in January 2019 (Provided by G Watson, Environment Agency).

5.2.3 Water

A separate Water Framework Directive (WFD) assessment has been undertaken as part of this study (Phase 2; see Appendix B for the report). This has taken account of the reclassification of water bodies since the SMP using the latest data from the EA Catchment Explorer database and will be used to inform this appraisal.

The River Alde is a designated shellfish protected area; this area was previously designated under the repealed Shellfish Waters Directive and is now specified under the Water Framework Directive. There is no specific mention of this protected area within the SMP.

5.2.4 Landscape

Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB)

There has been no change to the Suffolk Coast and Heaths AONB since the production of the SMP. The current management plan covers the period 2018-2023, with the overarching aim to 'secure the purposes of the AONB designation, to conserve and enhance Natural Beauty'. This document is reviewed every 5 years and recommended management objectives relating to landscape, coasts and estuaries, land use and wildlife, recreation and partnership working (Suffolk Coasts & Heath AONB, 2018).

Additionally. as part of the development of the Sizewell B project EDF Energy worked with the AONB Partnership, SCDC (now East Suffolk Council) and SCC to set out the Natural Beauty and Special Qualities of the Suffolk Heath AONB (EDF Energy, 2016). This work followed Natural England's guidance for assessing landscapes for designation as National Parks or Areas of Outstanding Natural Beauty (Natural England, 2011).

Suffolk Heritage Coast

In 2012 a Landscape Character Assessment was carried out as part of the Touching the Tide project. The project aimed to inspire and engage people with Suffolk's Heritage Coast, enabling them to play an active and informed role in shaping the future of the landscape. The preparation of the landscape character assessment provided a robust context for Touching the Tide to develop and deliver initiatives as part of the Heritage Lottery Funded.

The Landscape Character Assessment broke the Heritage Coast into distinct Coastal Character Areas (Figure 10). For each Coastal Character Area unique landscape features were identified as well as describing coastal change in an accessible way covering aspects of its past evolution, its present day character, current values, and how change may occur in the future. The assessment also made recommendations on how the changes could be managed.

For consultation

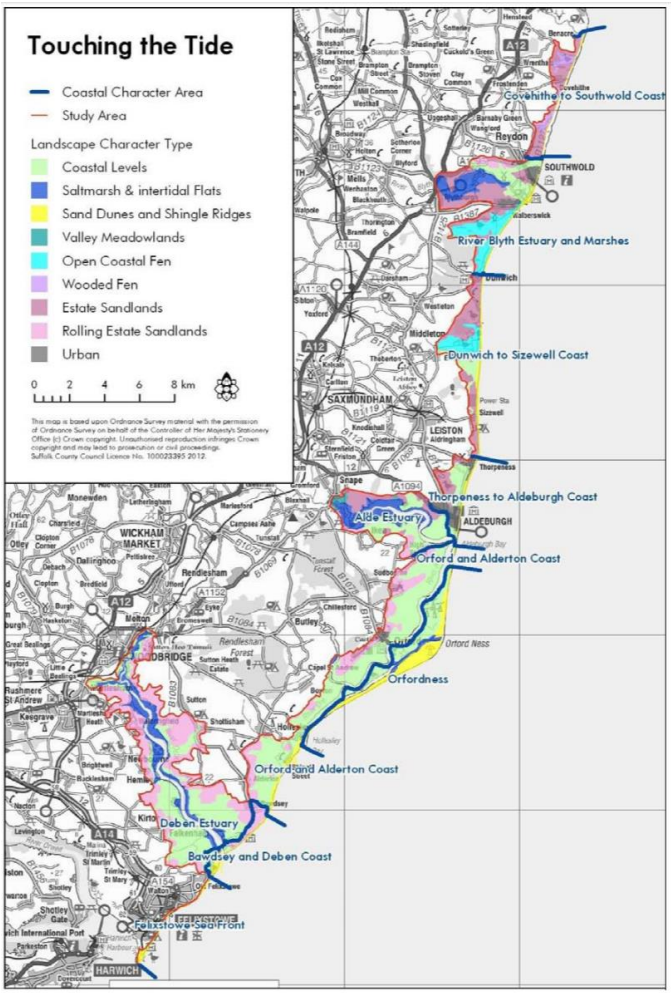

Figure 10 Touching the Tide, study area and individual Coastal Character Areas.

Suffolk Coast and Heaths National Character Area

Since the SMP, Natural England has completed a National Character Area (NCA) project, which creates profiles for each of England's major landscape areas (Natural Areas), based on characteristic landscape, wildlife, cultural and geological features.

The baseline landscape character of the study area has been assessed by Natural England as lying within the Suffolk Coast and Heaths NCA with a new landscape profile published in 2015.

The key characteristics of the Suffolk Coast and Heaths NCA of relevance to the study area (Natural England, 2015) are:

- A predominantly low-lying landscape with some areas along the coastal plain below or at sea level. A dynamic coast, shaped by long, sweeping bays, cut by the series of more sheltered estuaries. The shoreline is defined by shingle beaches and structures, sea defence features (and in places low, soft crumbling cliffs).
- Estuaries support internationally important salt marshes and intertidal flats with large numbers of waders and wildfowl, while their open waters are busy with pleasure and commercial craft.

For consultation

- Expansive coastal level grazing marshes divided by drainage dykes contain internationally important reedbeds and fens. Many are managed as nature reserves owing to their rich biodiversity, which includes a nationally important concentration of breeding bittern.
- The coastal levels are largely devoid of trees.
- High-quality vegetable production and outdoor pig units are distinctive agricultural land uses. Beef cattle graze the coastal levels although drainage has led to the conversion of many of the grazing marshes to arable production.
- A rich archaeology includes Saxon burial mounds, medieval rabbit warrens and numerous country house estates. The coast supports Napoleonic Martello towers, Second World War pillboxes and the Orford Ness Cold War testing area with its distinctive 'pagodas'.
- Settlement is sparse, with small, isolated villages and farmsteads. Larger urban settlements are confined to the north and south (Lowestoft, Ipswich and Harwich). Distinctive coastal towns (such as Aldeburgh) enjoy a relatively unspoilt atmosphere.
- Traditional buildings utilise soft-hued red bricks with straw thatch, pantiles or peg tiles. Some are rendered and painted (often in 'Suffolk Pink') while others (including churches) use locally occurring split or knapped flint. Brightly painted beach huts line the coastal resort seafronts.
- Public access is extensive both on the land and on the rivers. The sense of tranquillity and wildness is integral to the distinctiveness of the NCA, inspiring many writers, artists and naturalists, and supports the area's popularity as a recreation and tourist destination.

The statements of opportunity for the NCA (Natural England 2015) includes the following objective of relevance to the study area:

SEO 1: Manage the nationally significant coastal landscapes, ensuring that coastal management decisions take full account of landscape, environmental and visual impacts as part of an integrated approach working with coastal processes. Improve people's understanding of the process of coastal change.

- Supporting the Estuary Partnerships in establishing a programme of community engagement, to explain the vulnerability of the National Character Area to coastal change and the interdependence between coastal erosion and a naturally functioning coast. Identify local concerns and aspirations to inform adaptation planning and encourage and promote local volunteering opportunities to further public engagement with the natural environment.
- In line with the Shoreline Management Plan 7, working in partnership to ensure that dynamic coastal processes continue to provide a coast protection function (for example, salt marsh creation in front of sea walls and natural evolution of coastal vegetated shingle and sand dunes) to enhance important habitats, the quality of the coastal landscape and natural coastal defence features.
- Delivering climate change and coastal change adaptation measures, through habitat enhancement and creation, managed realignment and habitat replacement where appropriate. This will be necessary where flood defences are currently inadequate and further defence work may result in losses to existing wetlands. Use the ecosystems services approach to develop wider understanding of the operation of natural processes.
- Ensuring that the coastal habitats, in particular vegetated shingle and coastal dunes, are conserved and protected from damage by recreational pressure, so that they continue to function as a natural coastal flood defence. Develop a strategy for coastal public access management, to protect coastal habitats.
- Raising awareness and improving the quality of understanding and enjoyment of the sensitive habitats and wildlife (for example, coastal heathlands, salt marsh, vegetated shingle and little tern nesting sites),

For consultation

through working in partnership with the Area of Outstanding Natural Beauty (AONB) and Estuary Partnerships and through clear signposting and interpretation.

- Facilitating community adaptation to coastal change, seeking new opportunities for access enhancements to the coast, estuaries and river valley flood plains and planning for the effects on local features of cultural heritage importance.
- Promoting and enhancing land management practices that help to restore natural features and support the active processes of the water environment that absorb floods and are beneficial for the rural economy and biodiversity (for example, reversion of flood plain arable land to grazing marsh and fen).

Proposed England Coast Path

Under the Marine and Coastal Access Act 2009, a new National Trail extending the length of the coast in England, approximately 2,800 miles, is currently being developed by Natural England.

As part of this work, Natural England are identifying a 'Coastal Margin' which shall include all land between the trail and the sea. In some cases, the margin will extend landwards of the trail too, namely when existing access rights exist under the Countryside Rights of Way Act 2000 or where Natural England and the landowner come to an agreement to use a physical feature to act as a boundary. In the coastal margin there shall be new rights to enjoy areas like beaches, although this will not extend to all areas i.e. saltmarsh/cliffs, in the sake of public safety.

Within the study area, the route of the England Coast Path is currently being investigated. Figure 11 shows the search area for the proposed route. It is anticipated that the path will become operational by April 2020.

For consultation

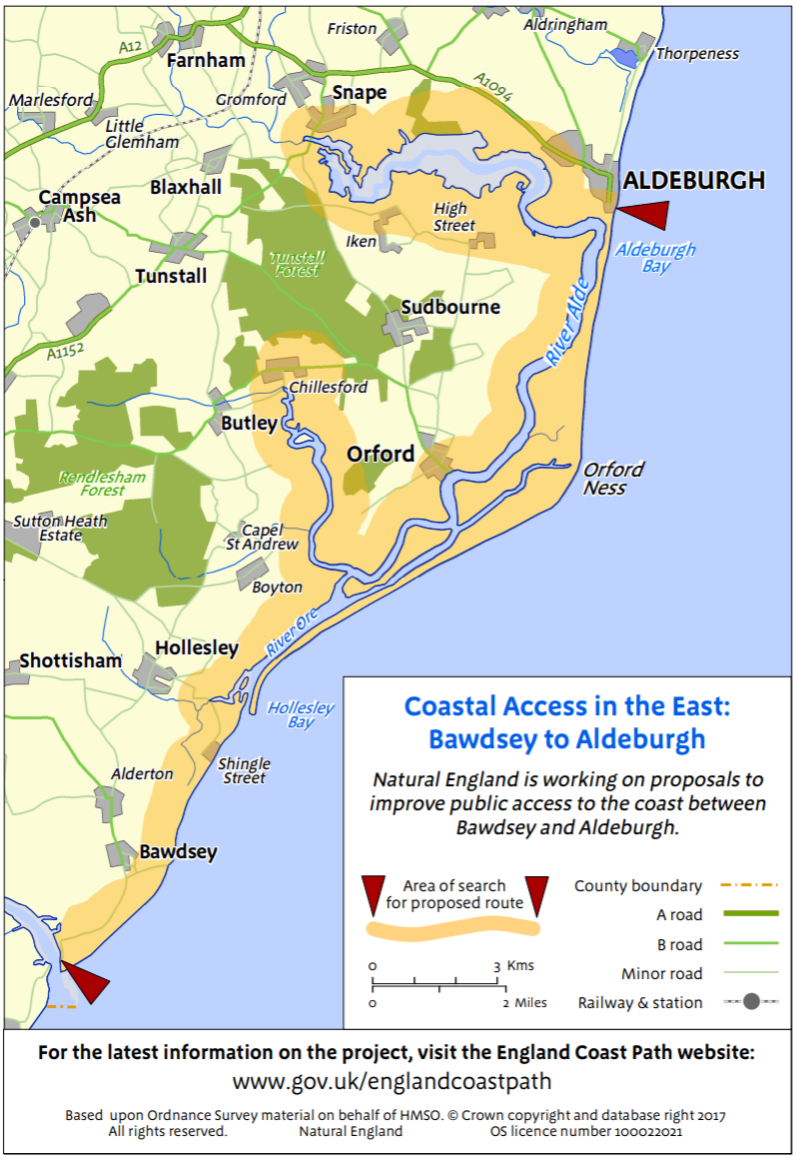

Figure 11 Search area for proposed England Coast Path (Natural England, 2018).

5.2.5 Cultural heritage

There have been no known changes or additions to the recorded heritage assets and historical designations.

Sudbourne marshes contain prehistoric, Roman and medieval coastal related sites and there is therefore potential for new finds to be discovered as the shoreline evolves.

5.2.6 Population & communities (including human health, critical infrastructure)

Coastal communities and critical infrastructure were not assessed by the SMP for the final policy for this management area.

For consultation

Locally there are no human and built environment assets at risk; but the shingle barrier contributes to protection of a wider area within the Alde-Ore estuary. This appraisal is only considering implementation measures that will prevent a permanent breach, therefore large-scale impacts on the wider estuary will be avoided. Other than the first few hundred metres, there is currently no public right of way as an access route to Orford Ness.

Natural England are proposing a new right of public access to the English coast (the England Coast Path), but details of the route are not yet available (see section 4.3.1.3).

In terms of critical infrastructure, there have been the following developments since production of the SMP:

- The Greater Gabbard Offshore windfarm is now in operation, land fall is at Sizewell B.
- Four offshore windfarm developments of Suffolk and Norfolk at various stages of planning and construction: East Anglia One (under construction), East Anglia Three (post-planning), East Anglia One North and East Anglia Two (both pre-application).
- The Sizewell C nuclear power station project is currently in the fourth stage of public consultation, which is due to close on 27th September 2019.

Given the distance of these from the study frontage under consideration and that there is no direct link in terms of either coastal processes or flooding, it is not considered likely that these will affect management decisions along the policy unit.

5.2.7 Coastal management

Shingle recycling has been carried out at Sudbourne beach for over two decades and in this period management practices have been carefully monitored and reviewed to provide what is thought to be the most sustainable management practice at the time. Historical gravel extraction had caused damage to the vegetated shingle communities as well as relict beach ridges, which form the cuspate foreland. The licence conditions set out by Natural England in 2017 for the subsequent five year period, following an appropriate assessment, are:

1. The shingle extraction area shall be confined to the area identified in the plan submitted 01.08.2017 (see Figure 12). Only material from the most active ridge, below the drift line zone shall be removed.

2. Extraction shall be undertaken between 1 September and 31 October in any calendar year and shall not extend beyond 31 October 2022. In the event that two consecutive years extraction is undertaken the works shall not proceed in the third year without confirmation in writing from the District Council, as the Competent Authority, that such works may continue. In reaching a conclusion on such a request the District Council will have regard to the monitoring information available and the advice of Natural England.

3. Only existing access tracks running across the site, as previously agreed and marked out, shall be used. Dumper trucks shall track as close to the sea as possible once they are full and exit at the next convenient access track and use a single run. Drivers should be advised to limit stopping and departure from vehicles to limit adverse impacts upon the local bird population.

4. The Slaughden ridge shall be re-profiled to a width of 8 m. Where shingle is to be placed it will be re-profiled to an angle less than 45 degrees. Where possible/practicable this will be flattened to 20 degrees which is a more natural profile. When the work is completed and as machines exit the site a layer of shingle about 0.5 to 1 m in depth shall be placed on the ridge to deter foot traffic and 4x4 vehicles. Shingle will be placed on the back of the ridge in the defined 600 m zone to a maximum of 5 m width, in one operation over the 5 year consent, subject to review.

5. The previous monitoring regime shall be continued and additional monitoring undertaken as set out in the supplementary information supplied by the Environment Agency and shall include monitoring of locations,

For consultation

height and form of placements on the back of the ridge. The existing 200 m transects will be extended to include the back face of the ridge. Additional monitoring of beach profiles, lorry haul routes, and photographic surveys should be undertaken. Any monitoring shall be freely available to all interested parties and the Environment Agency should seek to discuss any monitoring data with the relevant landowners, District Council, Natural England and the National Trust.

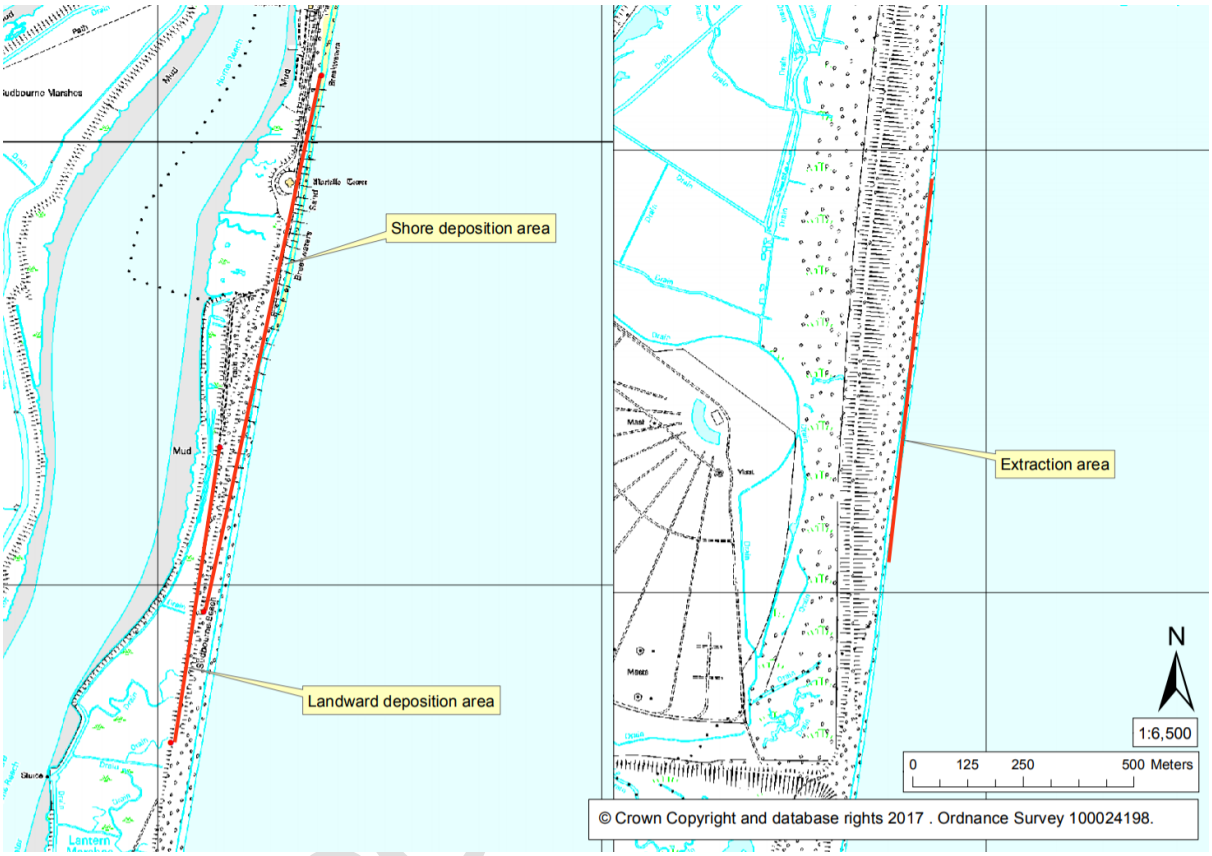

Figure 12 Plan showing permitted extraction zones.

5.3 Changes in environmental legislation, planning context and policy

5.3.1 Environmental legislation

Since the SMP was produced there have been a number of changes in legislation and national guidance with regard to: the habitats regulations, funding, consideration of climate change and consideration of flood and erosion risk. The Flood and Water Management Act was introduced in 2010 and made changes to how flood risk is managed in England. The Marine and Coast Access Act was introduced in 2009 and sets out new powers to protect the marine zone.

The following changes in legislation and guidance have been taken into account in this environmental assessment of policy changes, where appropriate.

The Conservation of Habitats and Species Regulations 2017 and subsequent case law

These regulations, which came into force on 27 November 2017 consolidate and update the Conservation of Habitats and Species Regulations 2010. These regulations aim to protect biodiversity through the conservation of natural habitats and species of wild fauna and flora and have been taken into account in this assessment.

Since the production of the SMP, there has also been new environmental case law and rulings in the UK and the Court of Justice of the European Union (ECJ). Of particular note is a ruling by ECJ on 12 April 2018 (the People Over Wind and Sweetman v Coillte Teoranta (Case C-323/17)) on the treatment of mitigation for development, which represents a significant shift in the way that competent authorities are allowed to deal with screening under the Habitats Regulations.

Flood and Water Management Act 2010

Under the Flood and Water Management Act 2010, Regional Flood and Coastal Committees (RFCC) were established in 2011, replacing the former Regional Flood Defence Committees. The study frontage sits within the Anglian Eastern RFCC.

Marine and Coastal Access Act 2009 - Marine Plans

The Marine and Coastal Access Act 2009 established the Marine Management Organisation (MMO) to produce marine plans, administer marine licensing and manage marine fisheries in English waters. It introduced marine planning in the UK through production of a marine policy statement and more detailed marine plans setting spatial policy at a more local level. Marine plans are statutory and must be used in all planning decisions for the sea, coast, estuaries and tidal waters (which sometimes extend a long distance inland), as well as developments that impact these areas, such as infrastructure. This means that any new operations below mean high water springs are likely to require a marine licence.

Marine plans cover 20 years. Of the 11 marine plan areas covering English waters, two cover the study frontage: East inshore (Area 3) and East offshore (Area 4) (see Figure 13). The East Marine Plans were published on 2 April 2014 and reviewed in 2017. The East Inshore Marine Plan area covers 6,000 square kilometres of sea from mean high water springs to 12 nautical miles offshore off the coastline between Flamborough Head and Felixstowe. The East Offshore Marine Plan area extends from the outer boundary of the East Inshore area to England's borders with the Netherlands, Belgium and France.

Marine and Coastal Access Act 2009 - Coastal access

The coastal access provisions in Part 9 of the Marine and Coastal Access Act 2009 introduced a new right of public access to the English coast so that people can walk along the length of the coast and have a right of access to other coastal land for outdoor recreation. See section 5.2.4 for further details.

For consultation

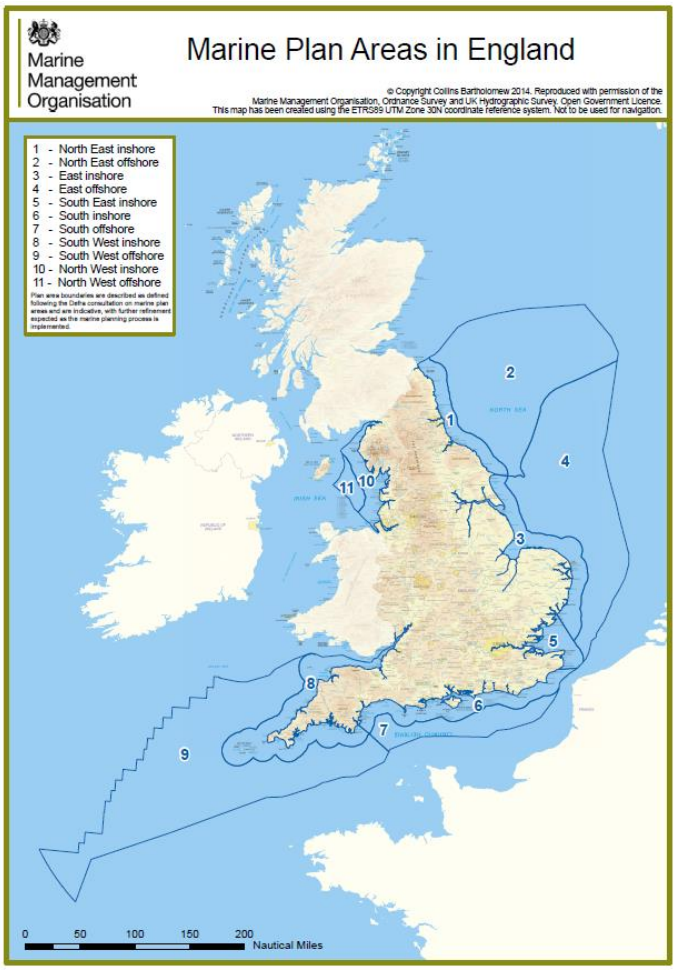

Figure 13: Marine Plan areas in England, taken from https://www.gov.uk/government/organisations/marine-management-organisation

5.3.2 Planning context and plans

Since the production of the SMP2, there have been significant changes to the planning context of the study area with both new national guidance and local plan reviews.

National flood and coastal erosion risk management strategy for England

The national flood and coastal erosion risk management (FCERM) strategy for England provides the overarching framework for future action by all Risk Management Authorities (RMAs) to tackle flooding and coastal erosion risk in England. The overall aim of the strategy is to ensure the risk of flooding and coastal erosion is properly managed by using the full range of options in a co-ordinated way. The current strategy was published in May 2011, i.e. post the SMP, but it is due to be revised this year (2019).

National Planning Policy Framework

The National Planning Policy Framework was published on 27 March 2012 and sets out the government's planning policies for England. It must be taken into account in the preparation of local and neighbourhood plans and is a material consideration in planning decisions. Paragraphs 93 to 98 specifically refers to "Meeting the challenge of climate change, flooding and coastal change" and Paragraph 106 states that Local Planning Authorities (LPAs)

For consultation

should reduce risk from coastal change by avoiding inappropriate development in vulnerable areas or adding to the impacts of physical change to the coast, which can be delivered through Coastal Change Management Areas (CCMAs).

AOEP Estuary Plan

The Alde and Ore Estuary Partnership (AOEP) Estuary Plan was produced in 2016 to provide a strategy for maintaining the integrity of the Alde-Ore area (see Figure 14), protection of the local economy, including agriculture, tourism and leisure pursuits, housing and the unique landscape and environment quality of the area and all that this supports, with new solutions for creating more resilient flood defences throughout the estuary.

The final documents are available online: http://aoep.co.uk/index.php/estuary-plan/.

The key objectives of the Estuary Plan are summarised as follows:

- To manage the estuary and its river defences as a whole, taking account of the impact of changes affecting one flood cell on other flood cells, as well as river flows, property, economic factors, environmental considerations, including habitat needs and saltmarshes, and regulations against the background of sea level changes.
- Where defences require upgrading, rather than altering seek to upgrade these to a standard to withstand overtopping in a 1 in 200 year event. The approach would allow for overtopping from time to time but recovery from overtopping should be very quick unlike the longer term damage which would arise from breaches in the walls.
- Set priorities for upgrading or changing or modifying defences.
- Monitor the state of the estuary and review the plan in the light of results.
- To secure the necessary locally-raised funding.

The Estuary Plan does not specifically address management of the study frontage but recognizes that this defence is "*absolutely crucial to the continuation of the estuary in its current form*".

A key recommendation of the Estuary Plan was that "*the time has now come for the SMP to be reviewed to ensure consistency between the stretches of the coastline north and south of Martello and with the overall estuary plan*".

For consultation

Figure 14: Administrative area covered by AOEP Estuary Plan, which covers the 20 parishes which contain part or all of the 14 flood cells and any parishes with land affected by the December 2013 surge. Taken from AOEP, 2016. The yellow square indicates the Policy Unit ORF15.1 considered in this study.

Local Plan

The current local plan for the Suffolk Coastal district, as set out in the Core Strategy and Development Management Policies documents, was adopted in 2013. Work is currently being undertaken to undertake an early review of that document prepare a new Local Plan – this is due to be adopted in 2019.

The SMP was based upon an interim version of the existing local plan – it is not certain whether modification to the plan following the public consultation process significantly altered those policies identified to have the potential for in-combination effects with the SMP. However, given that locally there are no human or built environment receptors affected and that this appraisal is only considering implementation measures that will prevent a permanent breach, thereby avoiding large-scale impacts on the wider estuary, it is not anticipated that any changes in the local plan since the SMP would have a significant impact on management decisions.

5.4 New or proposed development

There are no significant developments proposed within the study area which would affect management decisions along the study frontage.

For consultation

5.5 Summary

The focus of this appraisal is to consider the potential impacts on alternative approaches to implementing a different SMP policy from that currently presented in the SMP. Based on a review of changes in the environmental baseline, the key changes that may affect management decisions along Policy Unit ORF15.1 are:

- The increased vulnerability of the shingle barrier, which questions some of the original conclusions within the SMP that under no active intervention there would be stability of the system.
- The AOEP Estuary Plan, which identifies the overall vision that the estuary should remain as it is now – future management of the study frontage will be crucial to achieving this.

This appraisal will also take account of:

- New and proposed designations: Outer Thames SPA, Southern North Sea Marine Protected Area and Orford Inshore proposed Marine Conservation Zone.
- Priority habitats, as defined by Suffolk Local BAP.
- Changes in SSSI status.
- Alde shellfish protected area.
- Objectives of the NCA.

6. Environmental assessment of alternative approaches

6.1 The need for a Strategic Environmental Assessment

A Strategic Environmental Assessment (SEA) was undertaken for the SMP, following the approach set out under Directive 2001/42/EC of the European Parliament and European Council on the assessment of the effects of certain plans and programmes on the environment ('the SEA Directive'). Although a SEA for a SMP document is not a statutory requirement, SMPs do set a framework for future development and therefore have much in common with the kind of plans and programmes for which the Directive is designed; therefore, Defra recommended that the assessment of SMP policies using the approach described in the Directive was adopted.

The SEA for the SMP considered the potential impact of the proposed policies on the scoped-in receptors. This current study is now considering the need to revise SMP policy and has considered possible implementation measures that could be used to deliver an alternative policy option. It was therefore been agreed by the CPRG that further environmental screening is required to appraise the potential strategic impacts of these measures to ensure the most appropriate and environmentally acceptable solutions and locations are selected, as well as helping to ensure that resulting schemes comply with legislation and other environmental requirements.

6.2 Assessment methodology

A non-statutory SEA was undertaken of the SMP2 policies following the requirements of the Environmental Assessment of Plans and Programmes Regulations 2004 ('SEA Regulations') and documented in an Environmental Report (Appendix F of the SMP). As far as possible the assessment methodology for this study will follow the methodology outlined in Appendix F (Section 2) of the SMP, including identification of environmental issues and use of assessment criteria and indicators in the SEA assessment tables.

The appraisal for the whole SMP area considered the following receptors (as defined by SI 1633), which will also be assessed as part of this study:

- Biodiversity, fauna and flora

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- Soil
- Water
- Air
- Climatic factors
- Landscape
- Cultural heritage, including architectural and archaeological heritage; and
- Population & communities (including human health, critical infrastructure etc)
- Material assets (considered in receptor above in SMP).

As air and climatic factors were scoped out by the SMP through consultation as it was determined that the SMP policy would not have an influence on these receptors, these have been screened out of further assessment in this study.

The SEA for the SMP included consultation with the Environment Agency, Natural England, English Heritage (now Historic England), Suffolk Coastal District Council, Waveney District Council and Suffolk County Council (now jointly East Suffolk Council), who have and will continue to be consulted during this study.

As for the SMP, the approach to this study will be evidence-based and use expert judgement using the source-pathway-receptor model. It should be recognised that although this study is considering a specific frontage, the assessment will be undertaken at SMP-level and will lack the detail of an actual scheme.

In following the SMP approach this appraisal will consider potential environmental effects and likely significance for each measure, using the definitions described in the SEA of the SMP (see Table 5 and Table 6). However, note that some of the colours representing the 'negative' significance of impacts have been amended slightly in our assessment table (Table 9), at the request of key consultees, to provide greater clarity when reading.

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Table 5: Potential effect: extract from Appendix F of the SMP (Royal Haskoning, 2010).

- Value and sensitivity of the receptors;
- Is the effect permanent / temporary;
- Is the effect positive / negative;
- Is the effect probable / improbable;
- Is the effect frequent / rare;
- Is the effect direct / indirect; and
- Will there be secondary, cumulative and / or synergistic effects.

Table 6: Potential significance: extract from Appendix F of the SMP (Royal Haskoning, 2010).

Significance of SMP Policy	
	SMP policy is likely to result in a significant positive impact on the environment.
	SMP policy is likely to have a positive or minor positive impact on the environment (dependent on scheme specifics at implementation).
	SMP policy is likely to have a neutral or negligible effect on the environment.
	SMP policy is likely to have a negative or minor negative impact on the environment (dependent on scheme specifics at implementation).
	SMP policy is likely to have a significant negative impact on the environment.
	The relationship between the SMP policy and the environment is unknown or unquantifiable.
	The assessment criterion is not applicable to the SMP policy

Further guidance was provided in the SMP regarding the attribution of significance levels (see Table 7). Based on environmental changes to the baseline since the SMP, the assessment criteria and significance criteria have been updated for the current study, as shown in bold in Table 7. The guiding principle for policy assessment was as follows: "*The assessment is based on a guiding principle of scoring minor positive or negative if the effect of a 'policy' is only realised as a result of sea-level rise (i.e. ongoing background change rather than more definitive or active management intervention*)."

Table 7 Additional guidance provided by the SMP on how the significance of SMP effects was established. Taken from the SMP (Royal Haskoning, 2010).

Assessment criterion	How the significance of SMP effects was established
ISSUE - Maintenance and enhancement of biodiversity on a dynamic coastline	
Will SMP policy provide a sustainable approach to habitat management?	Where SMP policy would enable the development of a natural mosaic of coastal habitat, a positive score would be provided. If the policy provides for a shift in management (from the present position) that would actively enable a more natural development of coastal habitat, a major positive score would be provided. Where the effects of policy would provide for a continuation of management that supports the development of natural coastal habitat, a minor positive score would be provided. Negative scores would be provided for ongoing management that prevents the development of a range of coastal habitat (minor negative) or provides for a shift in management that would not work with coastal processes and prevent the development of coastal habitat (major negative).
Will SMP policy have an adverse effect on the integrity of any international sites (**including new proposed/classified marine sites designated since the SMP)?**	If the effect of a policy would lead to an adverse effect on an international site (as defined through the statutory HRA), a major negative score would be provided. A minor negative score would be provided if the effects of policy would not prevent an adverse effect from occurring based on impacts of coastal processes or sea level rise. Minor

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Assessment criterion	How the significance of SMP effects was established
	positive scores would be provided where the effects of policy would prevent an adverse effect from occurring through maintaining an existing policy position or coastal process trend. The provision of a new management position (for example from HTL to MR) to avoid an adverse effect would provide a major positive score. This assessment must consider the potential for double-counting with other biodiversity criteria
Will SMP policy have an adverse effect on the integrity of any Annex 1 priority habitat **or Habitat of Principal Importance**	If the effect of a policy would lead to an adverse effect on Annex 1 priority habitat (defined through a statutory HRA) or **Habitat of Principal Importance**, a major negative score would be provided. A minor negative score would be provided if the effects of policy would not prevent an adverse effect from occurring based on impacts of coastal processes or sea level rise. Minor positive scores would be provided where the effects of policy would prevent an adverse effect from occurring through maintaining an existing policy position or coastal process trend. The provision of a new management position (for example from HTL to MR) to avoid an adverse effect would provide a major positive score. This assessment must consider the potential for double-counting with other biodiversity criteria.
Has SMP policy provided sustainable management for emerging saline lagoon habitat?	If the policy provides for a shift in management (from the present position) that would actively enable development of saline lagoon habitat, a major positive score would be provided. Where the effects of policy would provide for a continuation of management that supports the development of a saline lagoon habitat, a minor positive score would be provided. Negative scores would be provided for ongoing management that prevents the development of saline lagoon habitat (minor negative) or provides for a shift in management that would not work with coastal processes and prevent the development of saline lagoon habitat (major negative). This assessment must consider the potential for double-counting with other biodiversity criteria.
Will there be no net loss of **habitats of principal importance** within the SMP timeline up to 2100?	The principle guiding the assessment is one of no overall net loss of **habitats of principal importance**. Where there is no net loss of habitat, scores would be provided as positive based on the degree to which policy maintains a natural balance of habitat in a dynamic context. Major or minor negative scores would be provided where the effects of policy would lead to a loss of habitat (the actual determination of major or minor is based on the extent of loss, considered within the context of the overall extent of habitat in the system)
Will SMP policy contribute to further SSSIs falling into unfavourable condition and address the causal factors of existing units that are in unfavourable declining condition (due to coastal management) wherever possible?	For SSSIs, the same principles apply as for habitats **of principal importance**. However, due to the nature of management obligations under the CRoW Act, major negative scores would only be provided where the effects of policy would cause a site to move into unfavourable condition
ISSUE - Maintenance of balance of coastal processes on a dynamic linear coastline with settlements at estuary mouths	
Will SMP policy maintain an overall level of balance across the Suffolk coast with regard to coastal processes, which accepts dynamic change as a key facet of overall coastal management?	Where SMP policy would enable natural coastal processes, a positive score would be provided. If the policy provides for a shift in management (from the present position) that would actively enable a more natural development of the coast, a major positive score would be provided. Where the effects of policy would provide for a continuation of management that supports coastal processes, a minor positive score would be provided. Negative scores would be provided for ongoing management that prevents the development of natural coastal processes (minor negative) or provides for a shift in management that would not work with coastal processes (major negative).
Will SMP policy increase actual or potential coastal erosion or flood risk to communities in the future?	If the policy provides for an enhanced level of protection (in real terms, in addition to sea level rise), a major positive score would be provided. If the policy maintains the existing level of defence (in the face of sea level rise), a minor positive score would be provided.

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Assessment criterion	How the significance of SMP effects was established
	If the policy would reduce the level of defence, a negative score would be provided. The extent to which the negative extent would be determined as minor or major would depend on whether there would be a need for properties to be relocated (major negative) or if properties would be maintained at a lower level of overall protection (minor).
Will SMP policy commit future generations to spend more on defences to maintain the same level of protection?	A decision has been taken in relation to the likely future financial burden, qualitatively assessed against the current burden. If policy will increase the burden then negative scores would be provided, while decreasing the burden would lead to positive scores being provided.
Does the policy work with or against natural processes?	Where SMP policy would enable natural coastal processes, a positive score would be provided. If the policy provides for a shift in management (from the present position) that would actively enable a more natural development of the coast, a major positive score would be provided. Where the effects of policy would provide for a continuation of management that supports coastal processes, a minor positive score would be provided. Negative scores would be provided for ongoing management that prevents the development of natural coastal processes (minor negative) or provides for a shift in management that would not work with coastal processes (major negative).
ISSUE - Maintenance of water supply in the coastal zone	
Will SMP policy maintain structures to defend water abstraction infrastructure and to avoid any exacerbation of levels of saline intrusion into freshwater aquifers?	Where SMP policy would maintain the present abstraction infrastructure, a minor positive score would be provided. Where the policy provides for enhanced levels of protection for abstraction infrastructure (which may come under threat from erosion or sea level rise), a major positive score may be provided. Typically, SMP policy seeks to maintain such features by holding existing lines, possibly requiring improvement to defences (to address sea level rise). Under such a scenario a minor positive score would be provided. Where abstraction infrastructure would be lost as a result of policy, the determination would consider whether the entire function of the abstraction infrastructure would be lost (major negative) or whether it could be maintained by providing an amended abstraction point in a more landward position (minor negative).
ISSUE - Maintenance of the vales of the coastal landscape and Area of Outstanding Natural Beauty (AONB)	
Will SMP policy maintain a range of key natural, cultural and social features critical to the integrity of the Suffolk coastal landscape?	In establishing the effects on the coastal landscape, considerations are based on the maintenance or loss of key features that contribute to the landscape and the need to ensure that the dynamic behaviour of the coast is maintained. Where a policy would lead to the loss of significant features within the coastal landscape, a major or minor negative score would be provided, depending on the extent of the effects of such a loss. Where policy would enable the coast to function 'naturally' (as above) or would enable key features to be maintained, the policy would be minor positive. A major positive score would be provided where the effects of policy lead to the maintenance of features or processes that actively contribute to the coastal landscape.
Will SMP policy lead to the introduction of features that are unsympathetic towards the character of the landscape	If policy led to the removal of unsympathetic features, a positive score would be recorded. The introduction of features that lead to a reduction in the character of the landscape would provide negative scores. If the landscape character is maintained, the score would be neutral. This assessment must consider the potential for double-counting with the criterion above.
ISSUE - Potential loss of historic and archaeological features on a dynamic coastline	
Will SMP policy maintain the fabric and setting of key historic listed buildings and conservation areas?	Where policy would lead to the loss of a designated historic asset (defined in the main report), a negative score would be provided. A major negative score would be provided if the effect of policy would be to actively shape management in a new direction leading to such a loss. A minor negative score would be provided for the loss of assets in

For consultation

Assessment criterion	How the significance of SMP effects was established
	locations where defence may not be sustainable, or where previous management practice is maintained that may lead to the loss of assets that have come under threat. Minor positive scores would be provided for policy that protects assets as a continuation of management in response to sea level rise. Major positive scores would be provided for new management directions specifically to protect historic assets.
Will SMP policy provide sustainable protection of archaeological and palaeoenvironmental features (where appropriate) and ensure the provision of adequate time for the survey of archaeological sites where loss is expected?	Where policy would lead to the loss of areas where archaeological assets are considered likely, a negative score would be provided. A major negative score would be provided if the effect of policy would be to actively shape management in a new direction leading to such a loss. A minor negative score would be provided for the loss of areas where archaeological assets are considered likely in locations where defence may not be sustainable, or where previous management practice is maintained that may lead to the loss of such areas that have come under threat. Minor positive scores would be provided for policy that protects areas where archaeological assets are considered likely as a continuation of management in response to sea level rise. Major positive scores would be provided for new management directions specifically protecting areas where assets are considered likely.
ISSUE - Protection of coastal communities and culture	
Protection of coastal towns and settlements	
Will SMP policy maintain key coastal settlements in a sustainable manner, where the impact of coastal flooding and erosion is minimised and time given for adaptation?	The assessment here is underpinned by the guiding principle outlined above. Major scores (either positive or negative) would be provided where the effect of policy would be either to enhance or reduce the actual level of protection offered, accounting for sea level rise. Minor positive scores would be provided where the policy maintains the level of defence, by increasing the actual defence offered by sea walls to account for sea level rise. This is considered a minor positive rather than a neutral effect since, as a result of policy, actions would follow to maintain levels of defence for coastal communities
Will SMP policy protect the 'coastal character' of communities that have historically been undefended	Where relevant, policy driven by this would be scored major positive. Where character is maintained as a result of the preferred policy, the score would be minor positive to neutral. Negative scores would be recorded where the character is not maintained according to the scale of loss.
Will SMP policy maintain the form or function of features located outside established settlements that are essential to the economy and quality of life of key coastal settlements	Where key features are maintained, a minor positive score would be provided if policy maintains this protection in response to sea level rise. If the plan provides for additional levels of protection, a major positive score would be provided. Losses would be scored as minor negative if the features lost would still maintain the overall function of such features, or major negative if the loss would lead to a substantive reduction on the function of such features in that area.
Protection of key coastal infrastructure	
Will SMP policy maintain road-based transport connectivity between settlements on the Suffolk coast	Where SMP policy would maintain the presence of a road, a minor positive score would be provided. Where the policy provides for enhanced levels of protection for a road (which may come under threat from erosion or sea level rise), a major positive score may be provided. Typically however, SMP policy seeks to maintain such features by holding existing lines, possibly requiring improvement to defences (to address sea level rise). Under such a scenario a minor positive score would be provided. Where a road would be lost as a result of policy, the determination would consider whether the entire function of the road would be lost (major negative) or whether it could be maintained by providing an amended route (minor negative).

For consultation

Assessment criterion	How the significance of SMP effects was established
Will SMP policy maintain rail-based transport connectivity between the Suffolk coast and the national rail network?	The same principle as roads above.
Will SMP policy maintain or enhance levels of access along or to the Suffolk coast and estuaries?	The same principle as roads above.
Will SMP policy protect Sizewell nuclear power station in situ.	The same principle as roads above.

6.3 Data gaps, assumptions and uncertainties

Although focused on a particular stretch of coast (the study frontage only) and whilst considering possible implementation measures, this appraisal will be carried out at SMP-level as the primary purpose of this study is to assess the environmental implications of a change in SMP policy rather than detailed assessment of an individual management unit (which would not be consistent with the remaining policy units in the SMP). The appraisal has therefore used professional judgement to outline changes since the SEA of the SMP, resulting from a change in SMP policy. This report is not being used to support a request for a formal SEA screening opinion of a preferred approach along the study frontage at this time. Further environmental assessment may be required once a preferred approach has been selected to include a strategic and/or scheme level Habitat Regulations Assessment. Similarly, this report does not detail environmental monitoring of a preferred approach, should it be required.

For this appraisal, no additional data searches have been undertaken since production of the SMP; instead consultation has been used to help identify any additional changes in baseline. Only the implementation measures identified in Section 4.3.2 will be appraised against the SMP baseline and latest changes identified in Section 5.2. It should be recognised, however, that the outcome of this study will not directly inform a scheme design and as such other implementation measures could be considered in the future to deliver the SMP policy.

Air and climate have been screened out of this assessment following the conclusion in the SMP that no instances were identified where SMP policy could have any impact, positive or negative, on air quality or climate. It should be noted, however, that at any scheme-level appraisal this will need to be reviewed.

6.4 Environmental assessment

6.4.1 Environmental assessment of SMP

Table 8 has been extracted from the SMP Environment Report (Appendix F to the main SMP document) and summarises the environmental appraisal previously undertaken for the preferred policy options for Management Area 15 in the SMP, which includes the policy unit considered by this study.

This appraisal, did not, however, consider the possibility of a breach occurring under a policy of No Active Intervention. Since the SMP, the risk of this has increased. Therefore, in the appraisal of alternative approaches undertaken for this phase of the SMP Review, the original conclusions from the SMP have been reassessed.

For consultation

Table 8 SMP assessment table for preferred policy options: ORF15.1 – 15.2. Taken from the SMP Environmental Report (Appendix F) (Royal Haskoning, 2010).

Issue	Assessment criteria	Determination
ISSUE - Maintenance and Enhancement of Biodiversity on a Dynamic Coastline		
The interaction between the maintenance of designated freshwater or terrestrial habitat protected by defences and designated coastal habitat seaward of defences.	Will SMP policy provide a sustainable approach to habitat management?	Designated sites in this management area are Alde-Ore Estuary SSSI, Alde-Ore Estuary Ramsar/SPA, Orford Ness and Shingle Street SAC and Alde-Ore & Butley Estuaries SAC. Policy seeks allow a natural evolution of the coastline with the northern section being held in Epoch 1 and then allowed to evolve naturally. The overall intent is to provide a sustainable natural frontage and the overall the policy is considered to be **minor positive**.
Coastal squeeze and changes to coastal processes has the potential to adversely affect the integrity of international sites (Ramsar sites and areas designated under the Habitats and Birds Directives).	Will SMP policy have an adverse effect on the integrity of any international sites?	The policy of NAI is considered contributory to the natural evolution of the site, which accepts natural changes as a key facet of this dynamic habitat. Therefore, the effect is **neutral**.
The potential loss of Annex I Priority habitat on the Suffolk coast, which may be at risk from natural coastal processes or coastal policy which seeks to protect public health and safety.	Will SMP policy have an adverse effect on the integrity of any Annex 1 Priority Habitat	N/A
Coastal squeeze has the potential to lead to the loss of UK BAP (priority & broad) coastal habitat. Alternative sites for habitat creation are required to help offset the possible future natural losses.	Will there be no net loss of UK BAP habitat within the SMP timeline up to 2100?	The BAP habitat in this area includes: Shingle, Mudflat and Saline Lagoons and on the landward side of the estuary some fringing areas of Coastal Floodplain and Grazing Marsh. The management area promotes a natural development of the coast. The shingle ridge will roll back landward at a slow rate, which may lead to the loss of saline lagoons (an ephemeral habitat which are also likely to form again in this area further landward). The overall effect is **minor positive**.
Coastal squeeze has the potential to lead to coastal SSSIs falling into unfavourable condition.	Will SMP policy contribute to further SSSIs falling into unfavourable condition and address the causal factors of existing units which are in unfavourable declining condition (due to coastal management) wherever possible?	The SSSIs in this management area is designated for mudflat, saltmarsh, vegetated shingle and coastal lagoons. The management area provides for a more natural management of the coast and the effect on SSSIs therefore **minor positive**.

For consultation

Issue	Assessment criteria	Determination
ISSUE - Maintenance of balance of coastal processes on a dynamic linear coastline with settlements at estuary mouths		
The Suffolk coast is a complex system of dynamic and static shingle, beach frontages, urban areas and estuary mouths. The system has been maintained in recent years to provide relative stability to the system in order to protect coastal assets. The effects of sea level rise require a more strategic approach to shoreline management, but the relative stability of the plan area needs to be maintained albeit within a dynamic context.	Will SMP policy maintain an overall level of balance across the Suffolk coast in regard to coastal processes, which accepts dynamic change as a key facet of overall coastal management? Will SMP policy increase actual or potential coastal erosion or flood risk to communities in the future? Will SMP policy commit future generations to spend more on defences to maintain the same level of protection? Does the policy work with or against natural processes?	The Policy seeks to provide a dynamic coastal system which supports the integrity of the estuary and the dynamism of the ness. The overall effect is considered **minor positive**. The policy will not increase flood risk. The overall effect therefore is **neutral** The management area will not require management past the first epoch and therefore the cost of this defence is **minor positive**. The overall intent of the management area is to promote a natural evolution of the coast. The overall effect is therefore **minor positive**.
ISSUE - Maintenance of water supply in the coastal zone		
Agriculture on the Suffolk coast is dependent on the maintenance of a freshwater supply from groundwater aquifers. The delivery of this supply is threatened by intrusion of salt water into freshwater aquifers and from the loss of boreholes at risk from erosion – will SMP policy maintain structures to defend water abstraction infrastructure and to avoid any exacerbation of levels of saline intrusion into freshwater aquifers.	Will SMP policy maintain structures to defend water abstraction infrastructure and to avoid any exacerbation of levels of saline intrusion into freshwater aquifers?	The management area will lead to the ongoing stability of the estuarine system and will allow the ness to move naturally. The overall effect is therefore **minor positive**.
ISSUE - Maintenance of the values of the coastal landscape & Area of Outstanding Natural Beauty (AONB)		
The maintenance of the coastal landscape in the face of coastal change on a dynamic coast and estuary system. A key factor being the potential change in the landscape in response to shifts in coastal habitat composition and form.	Will SMP policy maintain a range of key natural, cultural and social features critical to the integrity of the Suffolk coastal landscape? Will SMP policy lead to the introduction of features which are unsympathetic towards the character of the landscape?	The management area will provide for the natural development of the ness and will not lead to the human features on the ness being at any significant in the timeline of the plan. Overall the benefits of this are **neutral**. The management area will not lead to any new features. Overall the effect is considered to be **neutral**.
ISSUE - Protection of historic and archaeological features on a dynamic coastline		
The coastal zone in Suffolk contains a range of archaeological and palaeoenvironmental features which may be at risk from loss from erosion within the timeline of the SMP	Will SMP policy maintain the fabric and setting of key historic listed buildings and conservation areas? Will SMP policy provide sustainable protection of archaeological and palaeoenvironmental features (where appropriate) and ensure the provision of adequate time for the survey of	SMP policy in this area is for NAI across all areas and epochs, except for Sudbourne Beach, which is NAI for epoch one. Sudbourne marshes contain prehistoric, Roman and medieval coastal related sites, while Orford Ness possesses a major group of 20th century military structures. However, due to the stability in the system, these are not considered to

For consultation

Issue	Assessment criteria	Determination
	archaeological sites where loss is expected?	be affected during the lifetime of the plan and the effect is therefore **neutral**.
ISSUE - Protection of coastal communities and culture		
The Core Strategies of Waveney Council and Suffolk Coastal District Council identify key coastal settlements which are important to the quality of life locally and the integrity of the economy of the area. These settlements are likely to face a higher level of risk from coastal flooding and loss due to erosion in response to sea level rise.	Will SMP policy maintain key coastal settlements in a sustainable manner, where the impact of coastal flooding and erosion is minimised and time given for adaptation? Will SMP policy protect the coastal character of communities which have historically been undefended?	N/A
Coastal communities in Suffolk may be dependent on key features which are located outside of the settlement area (for example the relationship of Southwold Harbour (on the Blythe Estuary) to the economy of Southwold). There is a need therefore to ensure that features which support communities are maintained, or the actual utility is maintained).	Will SMP policy maintain the form or function of features located outside of established settlements, which are essential to the economy and quality of life of key coastal settlements?	N/A
The Suffolk coast is served by a network of roads along the coast (primarily the A12) and a network of smaller roads to coastal settlements. The maintenance of these roads is important in regard to the utility it provides for the coastal economy and quality of life etc. The roads themselves are of secondary importance (they could be replaced), the important feature is the actual access provided as a social and economic function. The potential exists for this network to be affected by coastal processes.	Will SMP policy maintain road-based transport connectivity between settlements on the Suffolk coast?	N/A.
The Suffolk coast is served by rail network primarily links Lowestoft and Felixstowe with the national rail network. The network is critical to the functionality of the ports at these centres, supports commuting to London and tourism and runs through the 1 in 1000 year floodplain. The potential exists for areas of the network to be impacted by coastal processes at Felixstowe (adjacent to the port) and Lowestoft (at Oulton Broad).	Will SMP policy maintain rail-based transport connectivity between the Suffolk coast and the national rail network?	N/A
The Suffolk coast is visited by a large number of tourists and residents every year. Access to and along the coast is provided by a range of coastal footpaths (the primary footpath being the Suffolk Coasts and Heaths Footpath). The provision of this access, rather than the actual footpaths themselves supports a range of values which contribute to the quality of life and local economy of the Suffolk coastal area. Paths are often located close to the foreshore	Will SMP policy maintain or enhance levels of access along or to the Suffolk coast?	The policy would not lead to any loss of continued access along the coast and the effect is therefore **neutral**.

For consultation

Issue	Assessment criteria	Determination
in areas at risk from coastal erosion (or within potential areas for managed realignment)		
The nuclear power station at Sizewell is located close to the foreshore. The protection of the power station in situ is important in the national interest and essential for the protection of the environment from contamination.	Will SMP policy protect in situ, Sizewell Nuclear power station?	N/A

6.4.2 Environmental assessment of alternative approaches to deliver SMP policy change

Table 9 presents the assessment of potential environmental effects of the alternative approaches (and current SMP policy) against the assessment criteria identified during the development of the SMP. The significance rating of each impact has been agreed with representatives from Natural England and the Alde-Ore Partnership. It should be noted that the SEA assessment methodology adopted from the SMP does not give any separate consideration of issues relating to long-term sustainability such as carbon footprint, which is considered fundamental in agreeing and selecting the preferred approach to SMP policy revision. Where appropriate under the assessment criteria of '*Does the policy work with or against natural processes',* some commentary is provided as to whether the approach is considered sustainable in the long-term.

For consultation

Table 9 SEA assessment of alternative approaches to policy implementation using criteria from the SMP, with modification (shown in blue) where appropriate. Note that the colour scheme has been amended to improve readability.

Key:

Significance of SMP Policy	
	SMP policy is likely to result in a significant positive impact on the environment.
	SMP policy is likely to have a positive or minor positive impact on the environment (dependent on scheme specifics at implementation).
	SMP policy is likely to have a neutral or negligible effect on the environment.
	SMP policy is likely to have a negative or minor negative impact on the environment (dependent on scheme specifics at implementation).
	SMP policy is likely to have a significant negative impact on the environment.
	The relationship between the SMP policy and the environment is unknown or unquantifiable.
	The assessment criterion is not applicable to the SMP policy

Issue	Scoped in Baseline In formation	Assessment Criteria	Indicator	Current policy (HTL in the short-term followed by NAI).	A3 – Maintain and improve the existing revetment	A5 – Widen the defence	A6 – New embankment along estuary	B4 – widen the shingle ridge	B5 – natural shingle ridge management	B7 - New embankment along estuary channel	B8 – New embankment along an alternative alignment
ISSUE – Maintenance and enhancement of biodiversity on a dynamic coastline											
The interaction between the maintenance of designated freshwater or terrestrial habitat protected by defences and designated coastal habitat seaward of defences.	Locations where freshwater or terrestrial designated habitat lies behind a coastal defence (or maintained semi-natural feature) which is in turn fronted by designated coastal habitat. All examples to be within the 1 in 1000 year coastal flood plain.	Will SMP policy provide a sustainable approach to habitat management?	Number of schemes which address the potential loss or change of terrestrial, freshwater and coastal habitat adjacent to defences or maintained structures.	Current management in the short-term maintains existing habitats. Should a breach occur under NAI there would be widespread changes in habitat, including likely loss of designated habitat in the short term, with unknown long-term effects. The coastline would evolve naturally but with narrowing of the shingle ridge.	Ongoing management would prevent the interaction of coastal habitat landward and seaward of the defence. Continued coastal squeeze impact on Alde-Ore Estuary designated site, due to change within the estuary but protection of intertidal habitat from coastal erosion.	Widening the defence replicates natural roll-back process allowing shoreline to realign to a more natural orientation, so loss of intertidal habitat due to this mechanism is considered natural. A continued source of shingle would be required (although less frequently than at present) – impacts would depend on the source of this material. Would continue to protect saltmarsh landward of defence from coastal erosion.	A new embankment would allow a naturally functioning shingle ridge to evolve seaward of the embankment along a more sustainable alignment. Could result in coastal squeeze due to changes within the estuary by constraining the saltmarsh response. Would not require further nourishment, therefore potential improvements to Sudbourne Beach compared to current, depending on management in sub-unit B.	Widening the defence replicates natural roll-back process whilst allowing shoreline to realign to a more natural orientation. This would continue to protect saltmarsh landward of defence. It is assumed that due to volumes of shingle required, this would need to be sourced from elsewhere, e.g. offshore.	Natural shingle ridge management would allow the coast to function naturally with minimal intervention. A continued source of shingle would be required – impacts would depend on the source of this material.	A new embankment would allow a naturally functioning fronting shingle ridge. However there would be direct loss of saltmarsh habitat due to construction. On the estuary side, could result in additional coastal squeeze by fixing the bank position and constraining the saltmarsh response. Would not require further nourishment, therefore potential improvements to Sudbourne Beach compared to current. There are some uncertainties about the long term effects on habitats under continued sea level rise due to effective removal of marsh from the system, but it is assumed this approach would only be adopted if scheme level review confirms it is sustainable.	A new embankment would allow a naturally functioning fronting shingle ridge. However there would be direct loss of saltmarsh habitat due to construction. On the estuary side, could result in additional coastal squeeze by fixing the bank position and constraining the saltmarsh response. Would not require further nourishment, therefore potential improvements to Sudbourne Beach compared to current. There are some uncertainties about the effects on habitats under continued sea level rise due to effective removal of marsh from the system, but it is assumed this approach would only be adopted if scheme level review confirms it is sustainable.
Coastal squeeze and changes to coastal processes has the potential to adversely affect the integrity of international sites (Ramsar sites and areas designated under the	All international sites located in the 1 in 1000 year flood plain.	Will SMP policy have an adverse effect on the integrity of any international sites, (including new proposed/classified	Number of international sites recorded as not meeting conservation objectives for the sites.	Current management maintains existing habitats. Should a breach occur under NAI there would be a more naturally functioning coast with significant	Approach would provide continued protection to the wider estuary with similar impacts to current. Would not change longshore transport,	Approach would result in a loss of saltmarsh and vegetated shingle habitat in the footprint of the shingle placed to the rear of the defence and continued sourcing	Prevention of breach will provide continued protection to the wider estuary from change. The approach also supports longer-term functioning of	Prevention of breach will provide continued protection to the wider estuary from change. There will be some loss of saltmarsh habitat in the footprint of the	Maintaining a lower level of protection involving and less frequent nourishment will be less damaging to the vegetated shingle communities as	Prevention of breach will provide continued protection to the wider estuary from change. The approach also supports longer-term functioning of	Prevention of breach will provide continued protection to the wider estuary from change. The approach also supports longer-term functioning of

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Habitats and Birds Directives). [It should be noted that current coastal squeeze issues within the estuary are addressed in the Alde-Ore Estuary Plan. It is assumed that these effects are offset by new intertidal habitat at Hazelwood Marshes; however this does not consider possible losses along the rear face of the shingle barrier].		marine sites since the SMP)?		changes to habitats within the Alde-Ore Estuary complex including likely loss of designated habitat in the short term, with unknown long-term effects. .	therefore minimal impact on adjacent sites. No anticipated impacts within sub-unit A as recreational disturbance means site not used by breeding birds and direct loss of habitat likely to be minimal.	of shingle. However, this will be replicating the natural rollback process so impact considered minimal. Prevention of breach will provide continued protection to the wider estuary from change. Would not change longshore transport, therefore minimal impact on adjacent sites.	designated sites allowing fronting shingle ridge to help achieve a more natural profile. Would not require further nourishment, therefore potential improvements to Sudbourne Beach compared to current, depending on management in sub-unit B. However, there is potential for uncertain impacts on the Alde Ore Estuaries complex by enclosing the saltmarsh area and reducing transfer of brackish water. There will be direct loss of saltmarsh habitat in the footprint of new embankment and could result in coastal squeeze due to changes within the estuary by constraining the saltmarsh response.	shingle placed to the rear of the defence. However, this will be replicating the natural rollback process so impact minimal. This measure would require shingle recharge. Impacts would therefore depend upon the source of shingle – it is likely that this would require larger volumes than present and therefore it is anticipated that it would be necessary to import this shingle from another source, most likely offshore.	this approach will limit the number of recycling operations. Measures provide continued protection to the wider estuary and supported habitats.	designated sites allowing ridge to help achieve a more natural profile. Would not require further nourishment, therefore potential improvements to Sudbourne Beach (depending on measures in sub-unit A). However, there will be direct loss of saltmarsh habitat in the footprint of new embankment and uncertain impacts on the Alde Ore Estuaries complex resulting from enclosing the saltmarsh area and reducing transfer of brackish water. Could result in coastal squeeze due to changes within the estuary by fixing the bank position and constraining the saltmarsh response.	designated sites allowing ridge to help achieve a more natural profile. Would not require further nourishment, therefore potential improvements to Sudbourne Beach (depending on measures in sub-unit A). However, there will be direct loss of saltmarsh habitat in the footprint of new embankment and there is uncertain impacts on the Alde Ore Estuaries complex resulting from enclosing the saltmarsh area and reducing transfer of brackish water. Could result in coastal squeeze due to changes within the estuary by fixing the bank position and there is a risk that without measures to manage the shingle barrier this could narrow in the long term, increasing future risk.
The potential loss of Annex I Priority habitat or **Habitats of Principal Importance** on the Suffolk coast, which may be at risk from natural coastal processes or coastal policy which seeks to protect public health and safety.	All international sites located in the 1 in 1000 year flood plain.	Will SMP policy have an adverse effect on the integrity of any Annex 1 Priority Habitat, based upon Suffolk Local BAP or **Habitats of Principal Importance**?	Number of Annex 1 Priority Habitat features not meeting conservation objectives.	Current management maintains existing habitats. Should a breach occur under NAI there would be a significant change in priority habitats/ habitats of principle importance including likely loss of designated habitat in the short term, with unknown long-term effects. .	No direct impact on saline lagoons, perennial vegetation or vegetated shingle, as none present at current time. Long term, maintaining defence in current alignment would result in coastal squeeze on seaward side.	Minor loss of saltmarsh in footprint of widened defence, but this would protect the wider saltmarsh area. Initial loss of vegetated shingle behind defence, but recovery anticipated. It would require shingle recharge. Impacts would therefore depend upon the source of shingle – it is likely that this would require larger volumes than present and therefore it	Loss of saltmarsh in footprint of new embankment (note that losses are likely to be smaller than would be experienced in footprint of B7 and B8). Possible change in priority habitat type, due to change in saltwater intrusion. Potentially allows development of improved shingle habitat in front.	Loss of saltmarsh and backface vegetated shingle in footprint of placed shingle, but considered to replicate natural process. Potential to improve habitat for perennial shingle. Assumed source of shingle would need to be from offshore.	Potential loss of saltmarsh as ridge rolls landwards, but any changes to saltmarsh would be considered natural and not attributable to the B5 approach. Potential for continued damage to priority habitats from shingle recycling from Sudbourne Beach, unless alternative identified, but lesser	Direct loss of saltmarsh in footprint of new embankment and associated access. Possible change in priority habitat type, due to change in saltwater intrusion. Potential to allow development of improved shingle habitat in front.	Direct loss of saltmarsh in footprint of new embankment and associated access. Possible change in priority habitat type, due to change in saltwater intrusion. Potential to allow development of improved shingle habitat in front.

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						is likely that it would be necessary to import this shingle from another source, most likely offshore. Long term, maintaining defence in current alignment would result in coastal squeeze on seaward side.			impacts than B4 and A5.		
New coastal lagoons (EU Annex I habitat) have been created further back from the coast on the Benacre to Eastern Bavents SPA. JNCC have recommended that management actions to decrease the rate of erosion should be addressed through the SMP process with rates to enable the sustainable relocation of habitat.	Sites for the creation of coastal lagoons adjacent to Kessingland and land seaward of such sites.	Has SMP policy provided sustainable management for emerging saline lagoon habitat?	Decreased rates of erosion on this frontage - to be agreed.	Saline lagoon habitat found within sub-unit C which is currently naturally accreting. Should a breach occur under NAI it is not known whether the change to this habitat will be positive or negative.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.	Saline lagoon habitat found within sub-unit C unlikely to be affected.
Coastal squeeze has the potential to lead to the loss of habitats of principal importance (priority & broad) coastal habitat. Alternative sites for habitat creation are required to help offset the possible future natural losses.	All UK BAP habitat within the 1 in 1000 year flood zone with the potential to be impacted by coastal squeeze.	Will there be no net loss of habitats of principal importance within the SMP timeline up to 2100, based on Biodiversity 2020 habitats and Suffolk Local BAP?	Area of habitats of principal importance lost and created.	Should a breach occur under NAI it is unknown how the estuary would respond. Therefore potential for gains/losses over the course of the century cannot be estimated.	Continued long term loss of saltmarsh through coastal squeeze from sea level rise, as at current.	Continued long term loss of saltmarsh through coastal squeeze from sea level rise, as at current.	Change in type of BAP habitat and continued loss of saltmarsh through coastal squeeze from sea level rise, but set back defences reduces risk from coastal squeeze on seaward side.	Continued loss of saltmarsh through coastal squeeze from sea level rise on seaward side but more resilient shingle barrier created.	Not a formal defence therefore coastal squeeze not an issue.	Introduction of new structures will potentially result in loss of saltmarsh through coastal squeeze from sea level rise, although set back defences could be a more sustainable approach to managing the open coast.	Introduction of new structures will potentially result in loss of saltmarsh through coastal squeeze from sea level rise, although set back defences could be a more sustainable approach to managing the open coast.
Coastal squeeze has the potential to lead to coastal SSSIs falling into unfavourable condition. For example, approximately 50 of 100 SSSI units assessed at the Minsmere - Walberswick Heaths and Marshes SSSI are in unfavourable condition, although the majority of these (36) are in an unfavourable recovering condition. Factors attributable to the	All SSSIs within the 1 in 1000 year flood zone with the potential to be impacted by coastal squeeze.	Will SMP policy contribute to further SSSIs falling into unfavourable condition and address the causal factors of existing units which are in unfavourable declining condition (due to coastal management) wherever possible, taking account of latest status?	Number of SSSI units in unfavourable declining condition as a result of coastal management.	Under current HTL policy, 11 out of the 45 Alde & Ore SSSI units are in unfavourable condition due to coastal squeeze. Should a permanent breach occur it is likely that in the short-term the SSSI units will become unfavourable as the estuary adjusts to a new regime.	Minimal change from current situation. Ongoing coastal squeeze losses of SSSI saltmarsh and mudflat within estuary will be addressed through the Estuary Plan. The requirement for vehicle tracking along the sea wall will depend on the chosen management approach in sub-unit b, however this measure alone has the potential to reduce	Minimal change from current situation. Ongoing coastal squeeze losses of SSSI saltmarsh and mudflat within estuary will be addressed through the Estuary Plan. Would require continued source of shingle – potential impact on Sudbourne Beach from sourcing locally unless alternative identified.	Direct loss of SSSI saltmarsh and mudflat from construction and embankment would constrain saltmarsh response to sea level rise. Would not require further nourishment, therefore potential improvements to Sudbourne Beach, depending on management in sub-unit B.	Approach would help to provide a naturally functioning ridge, which would improve the condition of the SSSI. Would require continued source of shingle – potential impact on Sudbourne Beach from local sourcing unless alternative identified.	Approach would help to provide a more naturally functioning ridge, which would improve the condition of the SSSI. This measure will allow a more natural beach profile to emerge, which (with a lower crest, better sorted shingle and shallower slopes should encourage vegetated shingle communities. Temporary recycling	Direct loss of SSSI saltmarsh and mudflat in footprint. Introduction of new structures could constrain natural response of saltmarsh to sea level rise. Would not require further nourishment, therefore potential improvements to Sudbourne Beach (depending on measures in sub-unit A).	Direct loss of SSSI saltmarsh and mudflat in footprint. Introduction of new structures could constrain natural response of saltmarsh to sea level rise. Would not require further nourishment, therefore potential improvements to Sudbourne Beach (depending on measures in sub-unit A).

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unfavourable declining condition relating to the SMP, are cited as coastal squeeze.					tracking and allow vegetated shingle to colonise along the back of the defence. Neutral impact on SSSI condition.	Neutral impact on SSSI condition.			works will require plant to track along beach but at a reduced frequency to present.		
ISSUE - Maintenance of balance of coastal processes on a dynamic linear coastline with settlements at estuary mouths											
The Suffolk coast is a complex system of dynamic and static shingle, beach frontages, urban areas and estuary mouths. The system has been maintained in recent years to provide relative stability to the system in order to protect coastal assets. The effects of sea level rise require a more strategic approach to shoreline management, but the relative stability of the plan area needs to be maintained albeit within a dynamic context.	All coastal and estuarine areas of Suffolk	Will SMP policy maintain an overall level of balance across the Suffolk coast in regard to coastal processes, which accepts dynamic change as a key facet of overall coastal management?	Professional expert judgment required on the overall integrity and balance on the coast	Current recycling operations provide a balance between maintaining the Slaughden frontage and allowing the coast to function naturally as the movement of shingle is not restricted. However, should a permanent breach form under NAI the estuary system would be subject to major rapid changes which could affect the wider plan area.	This will maintain the current situation and will prevent any breach forming along this frontage. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	By placing material on the back of the slope a more natural and sustainable shoreline alignment may be achieved. This measure will prevent a breach forming and therefore larger impacts on estuary are avoided. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	By adopting a new set-back line of defence the fronting shingle barrier can function naturally and a more natural and sustainable shoreline alignment may be achieved. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	By placing material on the back of the slope the natural roll back of the shingle ridge is replicated and a more natural and sustainable shoreline alignment may be achieved. A permanent breach will be avoided therefore larger impacts on estuary are avoided. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	The aim is to provide a more naturally functioning ridge in a more sustainable alignment. A permanent breach will be avoided therefore larger impacts on estuary are avoided. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	By adopting a new set-back line of defence the fronting shingle barrier can be allowed to function naturally. However saltmarsh response on the estuary side will be constrained. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.	By adopting a new set-back line of defence the fronting shingle barrier can be allowed to function naturally. However saltmarsh response on the estuary side will be constrained, with areas of active marsh becoming enclosed. In the long term there is uncertainty regarding future shoreline change and sediment movement along the frontage.
		Will SMP policy increase actual or potential coastal erosion or flood risk to communities in the future?	Projected future risk levels for communities (existing or emerging).	Current management does not increase flood risk. However under NAI should a permanent breach occur there would be a major shift in the estuary system. This may leave areas at greater/lower risk than they are within the present estuary system.	No change in flood risk anticipated.	No change in flood risk anticipated.	No change in flood risk anticipated.	No change in flood risk anticipated.	Temporary breaches could occur, but it is assumed works would be undertaken if necessary to ensure a permanent breach does not form.	No change in flood risk anticipated.	No change in flood risk anticipated.
		Will SMP policy commit future generations to spend more on defences to maintain the same level of protection?	Projected figures for anticipated future coastal defence works.	In the medium term, no further spend on the ORF15.1 frontage would be required. However, it is highly likely that further defences may be required within the estuary in response to	High initial cost, but low long term maintenance requirements / costs (less than £500k up to 2055, £500k beyond this).	Ongoing work required approximately every 10 to 20 years. In the region of £1 to £2 million up to 2055, £6 to £8 million beyond this).	High initial cost, but low to moderate long term maintenance requirements / costs (less than £500k up to 2055, £500k to £1 million beyond this).	Ongoing work required approximately every 10 to 20 years. In the region of £1.5 to £2.5 million up to 2055, £5 to £7 million beyond this).	Ongoing work required at unknown frequency, but low to moderate costs (less than £500k up to 2055, up to £1.5 million beyond this). However this could increase to up to £4.5	High initial cost, but low long term maintenance requirements / costs (less than £500k up to 2055, £500k beyond this).	High initial cost, but low long term maintenance requirements / costs (less than £500k up to 2055, £500k beyond this).

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				a permanent breach to protect against the changing flood/erosion risk.					million if shingle is not sourced locally.		
		Does the policy work with or against natural processes?	Professional expert judgment required on the overall approach to management.	From the medium term, under NAI the estuary would be allowed to evolve naturally (although arguably within a highly modified stretch of coast).	The shore parallel revetment does not act as a barrier to longshore drift, yet the currently alignment is out of line with the rest of the coast (although this could be remedied under this approach). This approach would prevent the natural 'roll-back' of the shoreline at the northern end.	This approach would enable some realignment of the existing defence to a more sustainable alignment, which should reduce pressure on the frontage as a whole. It will however, continue to prevent natural response of the frontage.	The realignment of the main line of defence to the estuary edge would allow the fronting shingle ridge to behave naturally and reduce pressure on the interface between sub units A and B, which could potential improve sediment connectivity. However, it may constrain saltmarsh response so it is important that links to the saltmarsh are still maintained.	Shingle will be added along the landward edge of the ridge to reduce risk of a breach from occurring during single storm events and give time for repairs. This measure allows the seaward face to develop a more natural profile in a setback alignment than it has previously been held at. It would however involve more substantial volumes of shingle than at present.	Instead of operations designed to hold the shingle bank in its present position, this measure will allow some landward roll back of that position, also allowing it to adopt a lower crest elevation as nature determines. Lower volumes of shingle would be required than B4.	The realignment of the current defence to the estuary edge would allow the shingle ridge in front to behave naturally and prevent increased pressure on the estuary. It is important that links to the saltmarsh are still maintained. In the context of the approaches under consideration, this measure would likely provide longer-term sustainability, reducing coastal squeeze losses on the seaward side, and avoiding sourcing of shingle and future nourishment operations (thus minimising carbon footprint).	The realignment of the current defence to the estuary edge would allow the shingle ridge to behave naturally and prevent increased pressure on the estuary. It is important that links to the saltmarsh are still maintained. In the context of the approaches under consideration, this measure would likely provide longer-term sustainability, reducing coastal squeeze losses on the seaward side, and avoiding sourcing of shingle and future nourishment operations (thus minimising carbon footprint).
ISSUE - Maintenance of water supply in the coastal zone											
Agriculture on the Suffolk coast is dependent on the maintenance of a freshwater supply from groundwater aquifers. The delivery of this supply is threatened by intrusion of salt water into freshwater aquifers and from the loss of boreholes at risk from erosion.	1. Freshwater aquifers within the 1 in 1000 year flood plain 2. Boreholes considered at risk from coastal erosion.	Will SMP policy maintain structures to defend water abstraction infrastructure and to avoid any exacerbation of levels of saline intrusion into freshwater aquifers?	1. Number of boreholes on the Suffolk coast lost to erosion. 2. Changes of salinity in the freshwater aquifer attributable to SMP policy.	No boreholes are at risk of erosion under the current HTL policy. Under NAI, as the estuary could be expected to change significantly following a potentially permanent breach, there would be increased risk of saline intrusion to aquifers as the estuary adapts to the new hydrological regime.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. It is assumed that any breach is temporary. Therefore wide impacts on estuary are assumed to be minimal.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.	There are no water abstraction points seaward of the new alignment therefore water abstraction maintained. Prevention of breach prevents any change within estuary.
ISSUE - Maintenance of the vales of the coastal landscape & Area of Outstanding Natural Beauty (AONB)											
The maintenance of the coastal landscape in the face of coastal change on a dynamic coast and estuary system. A key factor being	The view of the Suffolk coast.	Will SMP policy maintain a range of key natural, cultural and social features critical to the integrity of the	Within the context of a naturally evolving coastline, the maintenance of relative proportions and	Current soft engineering approach maintains the integrity of the Suffolk coastal landscape.	Works to improve the revetment structure will prevent the coastal landscape changing	Widening the shingle ridge prevents a breach and therefore maintains the integrity of the Suffolk coastal	This approach prevents a breach and therefore maintains the integrity of the Suffolk coastal	This approach prevents a breach and therefore maintains the integrity of the Suffolk coastal	This approach prevents a breach and therefore maintains the integrity of the Suffolk coastal	This approach prevents a breach and therefore maintains the integrity of the Suffolk coastal	This approach prevents a breach and therefore maintains the integrity of the Suffolk coastal

FINAL

Issue	Scoped in Baseline In formation	Assessment Criteria	Indicator	Current policy (HTL in the short-term followed by NAI).	A3 – Maintain and improve the existing revetment	A5 – Widen the defence	A6 – New embankment along estuary	B4 – widen the shingle ridge	B5 – natural shingle ridge management	B7 - New embankment along estuary channel	B8 – New embankment along an alternative alignment
the potential change in the landscape in response to shifts in coastal habitat composition and form.		Suffolk coastal landscape?	diversity of the key features (social, historic and natural) in the Suffolk coastal landscape.	Under NAI, if a permanent breach were to develop, there would be significant changes within the estuary landscape including potential loss of social, historic and natural landscape features and landmark features.	naturally and dynamically. However, this approach prevents a breach and therefore maintains the integrity of the Suffolk coastal landscape in the hinterland.	landscape in the hinterland.	landscape in the hinterland.	landscape in the hinterland.	landscape in the hinterland.	landscape in the hinterland. It allows a flexible approach to the management of the coastal landscape, allowing the open coast to respond dynamically to natural change.	landscape in the hinterland. It allows a flexible approach to the management of the coastal landscape, allowing the open coast to respond dynamically to natural change.
		Will SMP policy lead to the introduction of features which are unsympathetic towards the character of the landscape, taking account of NCA key characteristics?	Number of introduced features (as a result of SMP policy) which are out of character with the local landscape.	No new unsympathetic features /coastal structures would be introduced under this policy.	Landscape character maintained through the maintenance of existing structure. Any new rock or armour works are assumed to be similar to those already present.	Shingle is to be added to rear face, but minimal change from current situation is anticipated.	This would involve construction of a new clay embankment in a set back position and possible removal of the existing defence. There are therefore possible landscape benefits.	This would involve no new structures and shingle would be placed at rear of barrier therefore minimal change from current situation is anticipated.	This would involve no new structures and works would only be undertaken as required. A more natural barrier would be encouraged to develop, with possible landscape benefits.	This would involve construction of a new embankment structure and allows for fronting shingle beach to function naturally with a more natural open coast landscape allowed to develop.	This would involve construction of a new embankment structure and allows for fronting shingle beach to function naturally with a more natural open coast landscape allowed to develop.
ISSUE - Protection of historic and archaeological features on a dynamic coastline											
The Suffolk coast contains a range of historic settlements and harbours typically located on the open coast and mouths of estuaries (for example, Southwold - Walberswick, Aldeburgh, Shingle Street etc). These settlements may be at higher levels of risk from coastal flooding as a result of climate change or levels of erosions along the coast.	1. Sites and buildings of national and regional historic and architectural significance. 2. Conservation. 3. Listed Buildings within the context of historic settlements.	Will SMP policy maintain the fabric and setting of key historic listed buildings and conservation areas?	Number, condition and integrity of listed buildings or historic features lost or impacted by inundation or erosion	Under current HTL management no breach will maintain the historic environment of the wider estuary. Under NAI should a permanent breach occur, the flood risk within the estuary will change which might affect historic sites (unlisted) within the marsh area and other historic and archaeological assets within the wider estuary as flood events change in frequency and size.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.	Maintains the historic environment of the wider estuary.
The coastal zone in Suffolk contains a range of archaeological and palaeoenvironmental features which may be at risk from loss from erosion within the timeline of the SMP	Features listed of being of archaeological significance in the Suffolk Rapid Coastal Zone Assessment.	Will SMP policy provide sustainable protection of archaeological and palaeoenvironmental features (where appropriate) and ensure the provision of adequate time for the survey of archaeological sites where loss is expected?	Number and condition of archaeological features lost to coastal processes prior to survey.	Wider estuary maintained at present, however should a permanent breach occur there may be increased erosion as the estuary adapts to the new morphological regime. This unmanaged change could potentially be rapid providing	Potential for loss of Anti Boat Landing Obstacle (1420709) and any undiscovered archaeological and palaeoenvironmental features during works/ from erosion however this should allow adequate time for surveys to be carried out. Other Rapid	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features, from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features, from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features	Potential for loss of Anti Boat Landing Obstacle (1420709), and any undiscovered archaeological and palaeoenvironmental features from erosion however this should allow adequate time for surveys to be carried out. Other Rapid Coastal Zone features

FOR CONSULTATION

Issue	Scoped in Baseline In formation	Assessment Criteria	Indicator	Current policy (HTL in the short-term followed by NAI).	A3 – Maintain and improve the existing revetment	A5 – Widen the defence	A6 – New embankment along estuary	B4 – widen the shingle ridge	B5 – natural shingle ridge management	B7 - New embankment along estuary channel	B8 – New embankment along an alternative alignment
				insufficient time for investigation and adaptation.	Coastal Zone features in the estuary will continue to be protected by maintenance/improvement of this defence.	in the estuary will continue to be protected by maintenance of this defence.	in the estuary will continue to be protected by maintenance/improvement of this frontage.	in the estuary will continue to be protected by maintenance/improvement of this frontage.	in the estuary will continue to be protected by maintenance of this frontage.	in the estuary will continue to be protected by maintenance/improvement of this frontage.	in the estuary will continue to be protected by maintenance/improvement of this frontage.
ISSUE - Protection of coastal communities and culture											
Protection of coastal towns and settlements											
The Core Strategies of Waveney Council and Suffolk Coastal District Council identify key coastal settlements which are important to the quality of life locally and the integrity of the economy of the area. These settlements are likely to face a higher level of risk from coastal flooding and loss due to erosion in response to sea level rise. There is a need therefore to ensure that the settlements below are protected for the duration of the SMP.	All major settlements (see SEA Table 3.5 (Haskoning, 2010) within a 1 in 1000 year flood zone.	Will SMP policy maintain key coastal settlements in a sustainable manner, where the impact of coastal flooding and erosion is minimised and time given for adaptation?	1. Maintenance of key coastal communities. 2. Provision of appropriate standard of protection for key coastal communities. 3 Number of new developments located in unsustainable coastal locations. Maintenance of the character of undefended settlements	Current recycling operations maintain the existing level of defence. Under NAI this level of protection would be reduced, with increased likelihood of a permanent breach which could affect key settlements, Aldeburgh, Iken and Orford.	No change in flood risk anticipated.	No change in flood risk anticipated.	No change in flood risk anticipated.	No change in flood risk anticipated.	Temporary breaches could occur, but it is assumed works would be undertaken if necessary to ensure a permanent breach does not form.	No change in flood risk anticipated, although additional estuary modelling may be required to confirm no change in tidal prism and therefore flood risk within estuary.	No change in flood risk anticipated, although additional estuary modelling may be required to confirm no change in tidal prism and therefore flood risk within estuary.
		Will SMP policy protect the 'coastal character' of communities which have historically been undefended, taking account of NCA key characteristics?	1. Maintenance of key coastal communities. 2. Provision of appropriate standard of protection for key coastal communities. 3 Number of new developments located in unsustainable coastal locations. Maintenance of the character of undefended settlements	N/A – no historically undefended communities affected	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coastal communities in Suffolk may be dependent on key features which are located outside of the settlement area (for example the relationship of Southwold Harbour (on the Blythe Estuary) to the economy of Southwold). There is a need therefore to ensure that features which support communities	Features which are essential to the sustainability and quality of life of coastal communities.	Will SMP policy maintain the form or function of features located outside of established settlements, which are essential to the economy and quality of life of key coastal settlements?	Maintenance of key features* located outside or key coastal settlements or maintenance of the function or utility of such features. *Features essential for the sustainability or quality of life of key coastal communities.	N/A – there are no significant features within the study area which the local economy depends.	N/A	N/A	N/A	N/A	N/A	N/A	N/A

For comment

Issue	Scoped in Baseline In formation	Assessment Criteria	Indicator	Current policy (HTL in the short-term followed by NAI).	A3 – Maintain and improve the existing revetment	A5 – Widen the defence	A6 – New embankment along estuary	B4 – widen the shingle ridge	B5 – natural shingle ridge management	B7 - New embankment along estuary channel	B8 – New embankment along an alternative alignment
are maintained, or the actual utility is maintained).											
Protection of key coastal infrastructure											
The Suffolk coast is served by a network of roads along the coast (primarily the A12) and a network of smaller roads to coastal settlements. The maintenance of these roads is important in regard to the utility it provides for the coastal economy and quality of life etc. The roads themselves are of secondary importance (they could be replaced), the important feature is the actual access provided as a social and economic function. The potential exists for this network to be affected by coastal processes.	All roads within the 1 in 1000 year floodplain	Will SMP policy maintain road-based transport connectivity between settlements on the Suffolk coast?	Loss of any major route to coastal settlements on the Suffolk coast.	Under current HTL policy infrastructure maintained as no breach. Should a permanent breach form under NAI, it is likely that the hydrodynamics within the estuary would change which would have the potential to alter the flood risk within the estuary.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.	N/A – no routes at risk within policy area and estuary-wide impacts avoided. Any temporary breach assumed to be repaired.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.	N/A – no routes at risk within policy area and estuary-wide impacts avoided.
The Suffolk coast is served by rail network primarily links Lowestoft and Felixstowe with the national rail network. The network is critical to the functionality of the ports at these centres, supports commuting to London and tourism and runs through the 1 in 1000 year floodplain. The potential exists for areas of the network to be impacted by coastal processes at Felixstowe (adjacent to the port) and Lowestoft (at Oulton Broad).	All rail links within the 1 in 1000 floodplain	Will SMP policy maintain rail-based transport connectivity between the Suffolk coast and the national rail network?	Loss of any active rail links on the Suffolk coast.	Under current HTL policy infrastructure maintained as no breach. Should a permanent breach form under NAI, it is likely that the hydrodynamics within the estuary would change which would have the potential to alter the flood risk within the estuary.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided. Any temporary breach assumed to be repaired.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.	N/A – no rail links at risk within policy area and estuary-wide impacts avoided.
The Suffolk coast is visited by a large number of tourists and residents every year. Access to and along the coast is provided by a range of coastal footpaths (the primary footpath being the Suffolk Coasts and	All footpaths which contribute to coastal or foreshore access the 1 in 1000 year floodplain	Will SMP policy maintain or enhance levels of access along or to the Suffolk coast?	Loss of rights of way routes on the Suffolk coast.	Under current HTL policy access along the crest (which is used as a haulage route) is maintained. In the next epoch access would not be maintained between	Access along beach would remain possible.	Access along beach would remain possible.	Access along beach would remain possible.	Access along beach would remain possible.	Access along beach would remain possible, except during temporary breach conditions.	Access along beach would remain possible.	Access along beach would remain possible.

For consultation

Issue	Scoped in Baseline In formation	Assessment Criteria	Indicator	Current policy (HTL in the short-term followed by NAI).	A3 – Maintain and improve the existing revetment	A5 – Widen the defence	A6 – New embankment along estuary	B4 – widen the shingle ridge	B5 – natural shingle ridge management	B7 - New embankment along estuary channel	B8 – New embankment along an alternative alignment
Heaths Footpath). The provision of this access, rather than the actual footpaths themselves supports a range of values which contribute to the quality of life and local economy of the Suffolk coastal area. Paths are often located close to the foreshore in areas at risk from coastal erosion (or within potential areas for managed realignment).				Aldeburgh and Orfordness if a permanent breach occurred.							
The nuclear power station at Sizewell is located close to the foreshore. The protection of the power station in situ is important in the national interest and essential for the protection of the environment from contamination.	N/A as not within same flood cell.	Will SMP policy protect in situ, Sizewell Nuclear power station?	Maintenance of Sizewell Power station.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.	N/A – Sizewell is not within the same flood cell as this frontage.

For consultation

6.5 In-combination effects

6.5.1 Interaction of intervention measures in sub-cells

There is potential for in-combination impacts resulting from combinations of implementation measures on the following environmental receptors:

Biodiversity, fauna and flora

- Measures which involve the set-back of defences, either through construction of new embankments (A6, B7 and B8) or widening of the defence (A5 and B4) will lead to the direct loss of designated mudflat/saltmarsh in the footprint of the works. Those measures that are intended to replicate the natural roll back of the shingle barrier, namely A5 and B4 are, however, considered to be less significant as a similar process would occur if the shingle ridge was unmanaged. Measures A6, B7 and B8 are considered to have a significant impact and the direct loss of habitat would require compensatory habitat to be created. The extent of loss under these measures would increase where any of these measures are combined.
- New embankments may also result in segregation of mudflat, reducing connectivity between saltmarsh area and intertidal areas. Compared to the current situation they would, however have the benefit of reducing the need for shingle recharge, resulting in a potential improvement in status of Sudbourne Beach and both annual and perennial shingle vegetation along the shoreline.
- Under measures A5, B4 and B5 there would remain a need for shingle recycling, although there is a possibility of obtaining this from an alternative source (albeit it this would considerably increase costs). Comparatively B5 would involve smaller volumes, but in a responsive manner meaning that stockpiling would need to be considered.

Coastal processes

- All alternative measures considered aim to work with natural processes whilst preventing the occurrence of a permanent breach and none of the measures in sub-unit B are expected to have a significant impact on alongshore movement of shingle. B5 (natural shingle ridge management) is the most ‘natural approach’, but carries an increased risk in terms of breach potential and may also require additional works at the interface with sub-unit A, particularly if combined with A3 (maintain and improve the existing revetment), which would maintain the alignment of the existing defence to the north.
- Measures which involve the set-back of defences, either through construction of new embankments (A6, B7 and B8) or widening of the defence (A5 and B4) could improve sediment connectivity along the frontage, as this would mean that the fronting shingle beach would not require management. They would, however, effective fix the estuarine shoreline and their construction would remove saltmarsh resource. There is also some uncertainty regarding long term sustainability as the fronting shingle beach would be unmanaged.

Landscape

- Combinations of measures A3 (maintain or improve the existing revetment) and A5 (widen the defence), with B4 (widen the shingle ridge) and B5 (natural shingle ridge management) would mean very little change in terms of landscape.
- Measures involving the construction of new embankments (A6, B7 and B8) would mean a change in landscape, but based on the assessment criteria are considered to have a minor positive impact on the landscape (including AONB) as they would allow the beach profile to develop naturally and under A6, there could be removal of existing defences.

For consultation

Access

- Under all alternative measures, access along the beach and/or structures should be maintained, although under A5 (natural shingle ridge management) there is a risk that this could be disrupted temporarily.

6.5.2 In-combination effects with other policies, plans and programmes

The identification and assessment of the cumulative effects of other plans, programmes, strategies and ongoing or planned future development proposals was undertaken during the SEA of the SMP and has not been repeated here. It is assumed that relevant policies in recent local development plans since the SMP seek to protect the environment and will therefore be compatible with the objectives of a SMP policy revision at Slaughden.

However, since submission of the SMP, the AOEP Estuary Plan has been produced. The approaches considered in this review of SMP policy at Slaughden were developed to ensure that they are compatible with the vision of the AOEP Estuary Plan and its overall vision that the estuary should remain as it is now and ensure that defences within the estuary are of a standard necessary to withstand overtopping in a 1 in 200-year event.

6.6 Discussion

6.6.1 Biodiversity, fauna and flora

The measures appraised that involve constructing a set back embankments along the estuary edge or along an alternative embankment alignment (A6, B7 and B8) will provide continued protection to the wider estuary from change and have good potential to improve the functioning and natural profile of the fronting shingle barrier beach with no management of the ridge required. Therefore from an open coast aspect, they can provide benefits. However, these measures will result in a direct loss of designated saltmarsh and mudflat, and would enclose areas of marsh, affecting the transfer of brackish water. They would also lead to coastal squeeze by constraining response to sea level rise and changes within the estuary. They are therefore considered to have a significant negative impact overall.

Maintaining and improving the revetment in sub-unit A (measure A3) will provide continued protection to the wider estuary but maintaining an artificially advanced position will constrain the natural functioning of the coastal habitats. This represents a continuation of current management, and therefore is considered to have an overall neutral or minor negative impact overall.

The measures involving placement of shingle at the rear of the ridge/ defence line (B4 and A5) will minimise impacts on the saltmarsh (although a small loss in the footprint of the widening will occur) and will also allow a more natural beach profile to develop. However, these measures will require ongoing shingle recharge and impacts will depend upon the source of this shingle. Due to the volumes involved it is likely that this will have to be obtained from an alternative source, such as offshore dredging, which would reduce impact on Sudbourne Beach but has significant cost implications. Although there would remain disturbance to vegetated shingle, creating a more robust structure should reduce the frequency of recycling required.

The natural shingle ridge management measure (B5) will result in no direct or indirect loss of saltmarsh or mudflat habitat. The intention of this approach is that through maintaining a lower level of protection and less frequent disturbance than at present, the shingle ridge will become more resilient as the material will be better sorted (less fines), with a lower and wider crest to allow more frequent overtopping and dissipating waves. This measure is also likely to be less damaging to the vegetated shingle communities than under current management. However, this carries a higher risk in terms of flood defence function and will still require shingle recharge. As for B4 and A5, this shingle could be sourced from elsewhere, but this would have cost implications.

For consultation

6.6.2 Working with coastal processes

All measures considered here are intended to prevent a breach, which otherwise could have significant impacts on the wider estuary. As such, they prevent the coastal system evolving naturally. Whilst set back embankments (measures A6, B7 and B8) would minimise the need for intervention along the fronting shingle beach, they would have consequences in terms of constraining the estuary evolution. There is also a possible long term risk associated with not managing the reserve of shingle along this frontage.

Along sub-unit B, the alternative is to continue to manage the shingle barrier to maintain its integrity and minimise risk of breach, through either proactively adding shingle to the rear face (B4) or reactively responding to breaches (B5). Both require shingle recharge, but would allow redistribution of this by waves. B5 promotes a more natural management approach, but could potentially involve more ongoing management than creating a more robust barrier, under measure B4. Along sub-unit A, some realignment of the current defences could be achieved through measure A5, which should enable a more sustainable alignment, whereas the alternative measure of maintaining the existing defence would mean a continuation of the present situation.

6.6.3 Water

All measures considered will maintain existing water abstraction infrastructure and prevent saline intrusion into inland freshwater aquifers by preventing a breach.

6.6.4 Landscape

All measures considered will maintain the integrity of the Suffolk Coast and Heaths landscape in the hinterland of the existing defences and shingle ridge by preventing a breach, with some measures (e.g. realignment to an alternative alignment) providing greater flexibility in the future management of the coast and allowing the open coast to respond more naturally. Measures that involve removing the existing hard revetment (A6) and those that allow natural roll-back of the shingle ridge (B4 and B5) may have beneficial impacts on the AONB and local landscape character.

6.6.5 Historic and archaeological features

All measures will maintain the historic environment in the wider estuary by preventing a breach but there is potential for the loss of archaeological, paleoenvironmental features and the anti-boat landing obstacle identified in the Suffolk Rapid Coastal Zone Assessment as none will prevent retreat along the open coast.

6.6.6 Coastal communities and culture

Under all measures considered there would be little or no change in coastal flood risk anticipated to the key coastal settlements. However, under B5 (natural shingle ridge management) there would need to be acceptance of a slightly higher risk and measures that involve construction of set-back embankments (particularly B7 and B8) would require further study to confirm no impact on tidal prism within the estuary.

6.6.7 Coastal infrastructure

The measures considered will maintain access along defence structures or beach realigned. However, there may be disruption to the route should a temporary breach form under measure B5 (natural shingle beach management).

It is difficult to make a direct comparison between this appraisal and the appraisal of the existing policy as recorded in the original SMP SEA, as this did not consider the potential for a breach under a policy of No Active

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Intervention, which, under recent conditions, has become a high risk. There is considerable uncertainty regarding the consequence of a breach (as recognised in the assessment table above (Table 9)), but this could have a large-scale impact on the estuary and implications for environmental sites, landscape, communities and businesses.

The Phase 1 report of this SMP Review (Appendix A) identified that before these implications can be qualified there needs to be better understanding of how a breach will change water levels, flows, sediment distribution and flood risk. Various breach scenarios would also need to be considered, as it is understood from previous work that the location of breach is a key factor in determining how flows and water levels may change. Following these additional studies, flood risk to properties would need to be re-appraised and data from the models would also need to be used to more fully explore implications for designated (and non-designated) sites within the estuary.

7. Mitigation and monitoring

The SEA directive sets out that "*member states shall monitor the significant environmental effects of the implementation of plans and programmes to identify at an early stage, unforeseen negative effects, and to be able to undertake appropriate remedial action*" (Article 10.1).

The key principles of monitoring are to:

- Ensure that mitigation measures are fully implemented and are effective;
- Monitor all the significant environmental effects identified during assessment. This includes all significant positive, negative, foreseen and unforeseen environmental effects;
- Identify any unforeseen environmental effects: and
- Avoid duplication of monitoring by utilising existing monitoring programmes.

Monitoring is important in evaluating any foreseen or unforeseen cumulative effects and can also be used to address any uncertainties or gaps in the data through the provision of a more detailed baseline.

Chapter 6 of the SEA Environmental Report and the Action Plan for the SMP2 sets out the proposed mitigation and monitoring for the proposed policies in the SMP. The measures to avoid an adverse effect on the environmental receptors along the Suffolk Coast outlined in the Environmental Report for the SMP (see Table 11 below), are also applicable to the identified approaches for policy revision at Slaughden.

Table 11 sets out any additional monitoring (not previously identified as part of the SMP) required to implement any of the alternative approaches considered.

Table 11 Monitoring identified by the SMP and additional monitoring required for alternative approaches to SMP policy revision at Slaughden

Monitoring and management identified in SMP (note that these cover the wider frontage)	Additional monitoring requirements
Loss of BAP Habitats One of the main effects of SMP policy will be the shift in transitional habitat composition, due in part to the promotion of natural change under a scenario of rising relative sea levels. There is a need, therefore, to ensure that existing monitoring of BAP habitat in the plan area is provided in a manner which will highlight shifts in BAP habitat extent, and informs the BAP	**Habitats of principal importance** Monitor changes in distribution, condition, species composition and extent of habitats of principal importance/priority habitats. Monitor success of implementing any approaches that move towards a more naturally functioning coast (managed realignment approach) by better understanding changes in intertidal habitat through survey and aerial photography.

For consultation

recording process. This mechanism is required to ensure that wider mechanisms exist for BAP habitat creation which addresses emerging requirements based on the effects of the SMP.

Impacts on SSSIs

The SMP has the potential to affect the condition of SSSIs through changes in habitat and coastal management (due to the number of SSSIs on the coast), with knock-on effects on the high level targets relating to SSSIs in favourable condition. A key tool, therefore, in managing and monitoring change on the Suffolk coastline is the continued monitoring of SSSI units, which enables an early determination of where favourable condition may be threatened by inappropriate coastal management (SMP policy). It is considered that the existing monitoring programme undertaken by Natural England would be sufficient for this purpose, but there is a need to feed any initial findings into the SMP Action Plan and the development of subsequent SMP policy at the earliest stage.

Site specific action plan for Orfordness

The policy at East Lane seeks to provide stability to the wider, complex system of Orfordness and the River Alde with a minimum of intervention. It in order for the collective effects of the policy within this system to be understood (and where appropriate reviewed and amended over time) there is a need for a site specific study to monitor geomorphological change and the rate of that change to establish how the coast and coastal habitat are responding to the management policies proposed by the Suffolk SMP. The results of this study will then actively feed into the next review of the SMP.

In addition to monitoring and reporting, the study would need to provide action measures where immediate or short term adverse effects on habitat or species as a result of management are identified. This development and specification of this study will be provided as an element of the SMP Action Plan.

Expenditure on coastal defence

The SMP provides policy direction which is indicative of expenditure required on the coast. Simply, where SMP policy relates to the provision, enhancement or replacement of defences, the SMP policy will be instrumental in securing funding for schemes, since it is a key consideration in the determination of applications for funding. It is not the intent or role of the SMP to secure funding, as a mechanism for policy. It therefore follows that in providing policy direction, the SMP fulfils its role in identifying the areas where funding will be required. To this end, it is considered outside of the scope of the SMP to provide funding as mitigation for policy.

Investigation of coastal and archaeological sites

Coastal/geomorphological change

Monitor trends in coastal processes, sediment movement within and around the system, levels of erosion and accretion, and changes in geomorphological features, which may affect designated conservation sites and shellfish waters.

England Coast Path

Continued consultation with Natural England and liaison with regard to the alignment of the England Coast Path, if and when a revised policy is adopted for this coastal frontage. This will help to ensure that there are no negative in-combination impacts and any in-combination opportunities are identified.

Landscape change

Seek to ensure at scheme level that approaches are implemented in a manner consistent with the recommendations of Suffolk's Landscape Character Assessment and Touching the Tide initiatives.

Shingle recycling

See Section 5.2.7 for monitoring requirements relating to shingle recycling.

Water quality

Monitor water quality at scheme level in conjunction with the monitoring requirements of the Estuary Plan.

Consultation

Where the implementation of SMP policy would lead to the loss of sites/features which are important to the historic environment, two options are available: 1. Relocation of features to a more sustainable location; and 2. Provision of a site investigation to investigate and record the content and value of sites. The Suffolk SMP has only identified two sites where a SAM would be lost – Leiston Abbey and the Hospital of the Holy Trinity. There may however be other 'unknown' sites which may only come to light as the SMP is implemented or indeed as the coast erodes. Within the SMP Action Plan therefore, English Heritage will be instrumental in establishing what the specific nature of losses may be, and where losses are known, a figure for investigation established so that this funding can be sought from Government. The intent of addressing this matter within the SMP Action Plan will be to ensure that English Heritage are provided with funds, in advance to investigate threatened sites. In addition to the loss of these heritage assets, there will also be a concomitant impact on the landscape value that these features provide.	

Mitigation would be required for all approaches, namely to prevent damage to existing habitat:

- Key mitigation for the approaches considered which involve the construction of a new set back embankment would include ensuring that saltmarsh habitat is not cut off from the intertidal area, as this would cause the indirect loss of this habitat.
- Under approaches which require shingle recycling and construction plant to track across the shingle ridge, mitigation would be required to minimise damage to the vegetated shingle communities. This will include measures defined under the Environment Agency's recycling operations, as outlined in Section 5.2.7.

8. Conclusions

The objective of the overall project, of which this report is part of Phase 3, is to appraise and inform the need for a change in policy along the Slaughden frontage, following changes in coastal risk and production of the Alde-Ore Estuary Plan.

Following review and approval of Phase 1 and 2 reports by the CPRG, a recommendation was made to the SCF that subject to further studies a headline policy change for the policy unit to Managed Realignment was appropriate. This report has therefore focussed on assessing the strategic environmental effects of a change in SMP policy to one of Managed Realignment, through the appraisal of a number of alternative measures that could be used to implement the policy in sub-units A (the defended section up to the Martello Tower) and B (undefended and eroding section from Martello Tower down to Sudbourne Beach):

- A3 – maintain and improve the existing revetment
- A5 – widen the defence, by adding a buffer of shingle on the rear face of the ridge
- A6 - new embankment along estuary channel

- B4 – widen the shingle ridge by adding shingle to the landward side of the ridge
- B5 - 'natural' shingle ridge management, minimising intervention but still maintaining and managing the barrier to minimise risk of a permanent breach

For consultation

- B7 – new embankment along estuary channel
- B8 – new embankment along an alternative alignment.

Note that along sub-unit C, which covers the wider and accreting section of beach, do nothing has been assumed.

From an appraisal of the various measures, the following can be concluded:

- The intent of all measures considered are to prevent a permanent breach in the shingle barrier, which would result in wide scale changes to the wider estuary system. As such, under all measures the significance of the potential impact on communities, infrastructure, landscape and heritage is either neutral or minor positive.
- Direct comparison with the current SMP policy of No Active Intervention (from the medium term) is difficult as the SMP did not fully consider the consequences of a breach as result of implementing the policy. However, it is anticipated that a permanent breach would have a large-scale impact on the estuary and therefore significant and potentially unacceptable implications for environmental sites, landscape, communities and businesses.
- All measures are compatible with the AOEP Estuary Plan and its overall vision that the estuary should remain as it is now and ensure that defences within the estuary are of a standard necessary to withstand overtopping in a 1 in 200-year event.
- Whilst measures that involve the construction of set-back defences in the form of embankments (A6, B7 and B8) provide benefits in terms of reducing future management requirements along the open coast and thereby potentially representing a more sustainable solution, they are likely to result in the direct loss of internationally designated saltmarsh habitat and could result in additional coastal squeeze along the estuary edge. As such these approaches are likely to have an adverse effect on integrity of the Natura 2000 site and would need to factor in the need to provide compensatory habitat, and to make a case for IROPI (Imperative Reasons of Overriding Public Interest).
- The alternative approaches that involve maintaining the ridge in a form in which it will prevent a permanent breach, by either adding shingle to the rear face or through monitoring and reactively repairing are more likely to be environmentally acceptable.

Therefore, dependent on the measures adopted and their implementation, a change in SMP policy to Managed Realignment would be environmentally acceptable; however, it is recommended that further appraisals are undertaken at a scheme stage, with specific focus on potential loss or damage to internationally designated habitats within the site.

For consultation

9. References

Natural England, 2011. Guidance for Assessing Landscapes for Designation as National Park or Area of Outstanding Natural Beauty in England

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For consultation

Appendix A. Phase 1 report

For consultation

F I N A L

SMP7 Policy Review Study at Slaughden, Suffolk (phase 1)

Policy unit 15.1 Sudbourne Beach

Prepared for

Suffolk Coastal District Council

November 2017

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Introduction

1.1 Scope of study

As lead authority for the Suffolk Shoreline Management Plan (SMP 7), Suffolk Coastal District Council (SCDC) is working with the Environment Agency (EA) and other stakeholders, notably the Alde and Ore Estuary Partnership (AOEP), to review coastal management policy at Slaughden, where current policy may need revision.

As part of this process, CH2M (Halcrow Group Ltd) have been commissioned to undertake some high-level assessments for consideration by the Client Steering Group (CSG) and enable local officers to make a recommendation as to whether existing policies should remain or be updated.

Potentially viable management approaches have been considered for this policy unit (PU), considering the SMP policy options of Advance the line, Hold the Line, Management Realignment and No Active Intervention. A high-level assessment has also been undertaken of the possible environmental, social and economic impacts of such approaches, based upon existing information. This report does not, however, make any recommendations on the need to change existing SMP policy and the high-level appraisals are not intended to replace SEA and WFD assessments, which may need to be undertaken as required at subsequent phases depending on the way forward (see below).

This is the first of three phases to consider policy review:

Phase 1 (this report):	High-level review and assessment to provide a baseline appreciation of aspects that are key to identification of a viable policy, with a focus on implementation measures, concluding with a presentation of findings to the CSG. Informed by this high-level assessment the CSG can conclude a preferred way forward, i.e. whether to pursue any policy change and what the nature of that change might be.
Phase 2:	Further detailed assessments, including more detailed environmental appraisals to be undertaken as required to fully appraise the proposed policy change, including formal engagement with statutory consultees required as part of that process.
Phase 3:	Upon completion of necessary studies the proposals will be subject to wider consultation, to review and agree the policy changes. Following this, and taking responses into account, the policy change process can be finalised accordingly.

1.2 Background

This report discusses policy unit ORF15.1 (Sudbourne Beach, south of the Martello Tower). This unit is located south of Slaughden (policy unit 14.4 for which the long term SMP policy is hold the line) and forms part of the larger geomorphological feature of Orford Ness, which can be considered as the shoreline between Aldeburgh marshes and the end of Orford spit (see Figure 1 below). Orford Ness encloses the Alde-Ore Estuary but in places the shingle barrier that separates the estuary from the open sea is very narrow, which poses a threat to the future of the estuary system in its current form. Management of this coastline is therefore intrinsically linked to future management plans for the estuary.

The coastline, together with the Alde-Ore estuary system it helps protect, supports a wide range of internationally designated habitats and sits within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty and Suffolk Heritage Coast. The wider area is also a popular tourist destination and a

wide range of business rely on the estuary and the activities it supports, such as sailing clubs, boat-related businesses, fisheries, leisure facilities and holiday rentals.

Much of the natural flood plain of the Alde / Ore estuary is reclaimed and lies behind extensive flood defences. This land is an important agricultural area, which relies on freshwater being available for irrigation and a particular threat to farming and abstraction in the Alde-Ore area is seawater ingress. Although many properties in Orford and Aldeburgh lie on higher ground and outside flood risk areas, it has been reported (AOEP Estuary Plan, 2016) that between 300 and 1,400 houses could be at risk of flooding.

This is a very dynamic frontage; the current issues of erosion are not new but are a legacy of the large scale geomorphological evolution of Orford Ness, which has been shaped by continued longshore transport and an irregular supply of shingle, due to both waning natural reserves and management of the coast to the north. Since the 1980s, the shingle ridge along this policy unit has formed a haul road route to enable the recycling of material from Sudbourne Beach (to the south of this policy unit) to the Slaughden frontage. This has resulted in the creation of a higher more artificial ridge, which is less susceptible to regular overtopping and washover events, but more at risk from erosion of the front face and subsequent catastrophic failure.

The Shoreline Management Plan covering the frontage, SMP7, was completed by Royal Haskoning in 2010. The overall aim of the plan was to maintain the important natural character of Orfordness. Due to uncertainty with respect to future management, an interim policy for policy unit 15.1 was defined, "*pending an agreed Management and Investment Plan for the Alde and Ore area*":

2025	2055	2105
Hold the line (HTL)	No active intervention (NAI)	No active intervention (NAI)

The SMP proposed that under this policy, the practice of recycling shingle from further south to this frontage will continue in the short term, subject to continued monitoring. It recognised, however, that an alternative practice could be required later in the first epoch to avoid damage to the Orford Ness shingle features. Beyond the short term, it was envisaged that the policy will change to one of no active intervention.

It was anticipated by the SMP that the policy will be reviewed and, if necessary, amended as part of the development of the Management and Investment Plan for the Alde and Ore. An Estuary Plan for the Alde and Ore has now been produced by the Alde and Ore Estuary Partnership (AOEP Estuary Plan 2016). However, this does not include the coastal frontage and, as such, does not provide any recommendations or details on how the coastal frontage should be managed, although it is clear that decisions on how to address defence issues here are crucial to the effectiveness of the Estuary Plan. In essence, the agreed plan seeks to ensure that river defences are of a standard necessary to withstand overtopping in a 1 in 200 year event, based upon the anticipated sea level rise by 2050. In support of this, the plan states that "*a significant outcome of the consultation was the community's prime concern to keep the estuary as it is now*".

Since development of the SMP, there have been further studies undertaken to look at the coastline and more recent change (see Appendix A). These have indicated that in places the barrier is more vulnerable than it has been previously, due to recent wave conditions. This has therefore led to questions regarding the sustainability of the current approach to management (see Appendix A for a description of current management and defence condition). This more recent data, together with the adoption of the AOEP Estuary Plan (2016) has therefore prompted the need for this current review.

1.3 Baseline information

Appendix A provides more details on the baseline conditions at the site, considering:

- Coastal processes and shoreline change

- Environmental, social and economic considerations
- Flood risk and
- Economic benefits

Information has been drawn a range of recent studies. The key reports appraised are as follows:

- Slaughden Sea Defences Coastal Process Study. Report prepared for the Environment Agency, Halcrow, 2002
- Southern North Sea Sediment Transport Study, HR Wallingford, 2002
- Thorpeness to Hollesley Strategy Plan - Coastal Processes Report. Report prepared for the Environment Agency, Halcrow, 2005
- Alde and Ore Estuary Flood Management Strategy – Assessment of background evidence and recommendations for further action. Report for the Alde and Ore Association, Ken Pye Associates Ltd., 2005
- Shoreline Management Plan 7 - Lowestoft Ness to Felixstowe Landguard Point. Prepared for Suffolk Coastal District Council, Royal Haskoning, 2009
- Alde and Ore Futures – Managing the Coast. Report prepared for the Environment Agency, Halcrow, 2011
- Advice note in respect of future management of Slaughden (Suffolk) coastal gravel barrier (incomplete). Report for Natural England, Andy Bradbury, 2014
- Geomorphological Advice in respect of future management of Slaughden (Suffolk) coastal gravel barrier. Report for Natural England, Julian Orford, 2014
- Alde-Ore Economic Study. Report for the Alde and Ore Association, RPA, 2014
- Comments on report by Professor Julian Orford entitled “Geomorphological Advice in respect of future management of Slaughden (Suffolk) coastal gravel barrier”. Report for the Alde and Ore Association, Ken Pye Associates Ltd, 2015
- Aldeburgh Coastal Defences Reinstatement – concept report, ENBE Ltd, 2015
- Aldeburgh Coastal Defences Reinstatement – options assessment report, ENBE Ltd, 2015
- Comments following a site visit to the breach in the American Wall, Lantern Marshes, on 7th October 2015. Report prepared for the Alde & Ore Association, Ken Pye Associates Ltd., 2015
- Sandscaping Feasibility Assessment - Suffolk Shingle Engine, Slaughden site. Report prepared for Crown Estates, HR Wallingford, 2016
- Slaughden sea defences. Report prepared for the Environment Agency, CH2M, 2016
- Geomorphological Assessment of SMP2 Coastal Management Area ORF15.1: Martello Tower to Orford Ness. Report prepared for the Alde & Ore Association, Ken Pye Associates Ltd., 2016
- Alde and Ore Estuary Partnership (AOEP) Final Estuary Plan, 2016.

Additional information on Slaughden defences and observations of change has been provided by G Watson (Environment Agency).

The environment, social and economic appraisals also take account of recent advice provided by Natural England in response to environmental risks and opportunities association with the Suffolk Shingle Engine (Natural England letter, 2016).

It is recognised that there may have been updates to designated areas since production of the SMP and Estuary Plan; therefore, any subsequent SEA will need to take account of such changes.

Figure 1 Policy unit location: this report is considering policy unit 15.1. Taken from SMP7, Royal Haskoning, 2010

Future management options

2.1 Introduction

Policy unit (PU) 15.1 begins at the termination of the concrete wall that fronts the Martello Tower which lies to the north of this policy unit, and extends to a point midway along Lantern Marshes North (see Figure 1). Although this is a single policy unit and is characterised by a shingle barrier throughout, its characteristics, current status and associated risks differ, meaning that approaches to future management also vary along its length. Therefore, for this appraisal, the coastline has been considered in three sections, sub-units A, B and C (Figure 2).

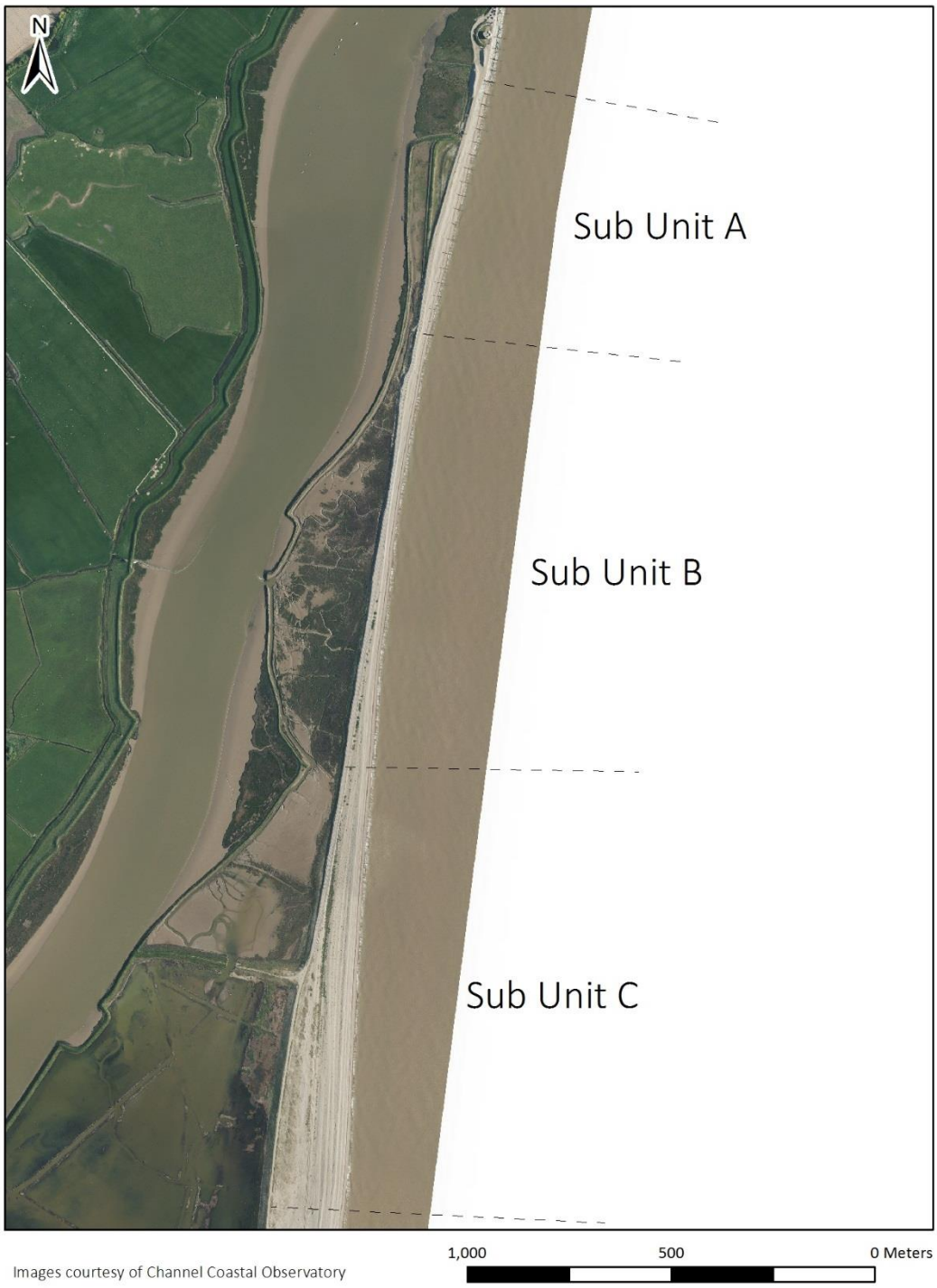


Figure 2 Map of the area showing the sub-division of the coast used in this appraisal.

2.2 Outcome scenarios

There are four SMP-level policy options to consider: Advance the Line, Hold the Line, Managed Realignment, No Active Intervention. A number of different measures could be used to implement these policies, but ultimately there are three possible outcome scenarios:

Breach

A permanent opening along the shingle barrier, which will produce significant changes in the wider estuary system and adjacent shorelines.

This will be the result of no active intervention either along the entire length or partial length of the policy unit.

The lateral extent and depth of any permanent breach will be dependent upon location and may develop quickly or take several years to form. Ultimately, however, the definition of breach applied here is one which would eventually result in a cut between the sea and the estuary at most if not all states of the tide.

No Breach

There will continue to be a continuous barrier between the river and open coast, although not necessarily along the same alignment as today.

This will involve measures to create a more robust shingle barrier or construction of an artificial defence to prevent any breach forming.

The possibility of a Shingle Engine has been considered separately – although the intention will be to achieve a No Breach scenario, this is a very different method from the traditional measures appraised to achieve the above and will apply to the whole policy unit.

Non-Permanent Breach

Although a barrier will remain in some form between the river and open coast, it may be occasionally breached, meaning a temporary interaction between the coast and estuary.

These might occur for example where severe storms result in a sunbstantial lowering or cut through the shingle ridge, such that water might flow through on the higher states of the tide. But these breaches would not be allowed to fully develop into a deep channel between the sea and the estuary, as the approaches to management would include the repair and reinstatement of damage to the ridge before that could occur.

This ‘resilience approach’ is therefore likely to require a responsive management following storms, whilst accepting a lower standard of protection.

2.3 Implementation measures

The three outcome scenarios above could be reached through a range of different approaches, involving combinations of different implementation measures for each sub-unit. A fuller technical assessment of each measure is provided in Appendix B.

Table 1 below summarises the implementation measures considered for each unit, and the following section defines how these have been considered in combination to develop nine different approaches to managing the whole policy unit.

In some cases, it has been concluded that for technical reasons, an implementation measure will not be appropriate. These are identified in Table 1 below and have not been considered further.

Table 1 Possible implementation measures

Measure		Description and works required
A1	Do Nothing	The revetment and haul road will not maintained. The cycle of reduced protection and increased destabilisation will continue. There will be a need to consider construction of a hard point at the boundary with PU14.4, to prevent outflanking, but this has not been appraised here.
A2	Maintain/ develop a beach	This could involve construction of new timber or rock groynes, or offshore breakwaters, with or without shingle renourishment and/or increased levels of recycling. It is unlikely, however, that any of these approaches will be sufficiently effective due to issues with shingle retention along the frontage. **REJECTED ON TECHNICAL GROUNDS**
A3	Maintain/ improve the existing revetment structure	Works will be required to bolster and improve the existing structure, which will require the import of additional rock/armour units to strengthen it. A more robust toe will also be required to address the issue of falling foreshore levels and the potential slumping of that structure. To maintain this line in the future, work to maintain the crest of the ridge will be required, including having to replace the current block mattress.
A4	New seawall	This will involve works to replace, or supplement, the existing revetment with a concrete/sheet piled seawall – extending the structure that currently exists along the Slaughden management unit, to the north (14.4). This is not considered appropriate as there are problems already evident with this measure at the Martello Tower and due to the existing issues of retaining a beach this will simply extend the same issue. **REJECTED ON TECHNICAL GROUNDS**
A5	Widen the defence	This will involve works to widen the defence line by adding a buffer of shingle on the rear face of the ridge. This will not in itself prevent the damage occurring to the revetment on the seaward side or prevent some overtopping and scouring of the crest from occurring, but it will reduce risk and enable time for post repair to overtopping erosion damage to be undertaken. This may not, however, provide a long-term solution and more substantial works could be required in the future to bolster the revetment.
A6	New embankment along estuary channel	This will involve construction of a new clay embankment structure along the marsh side edge of the estuary channel, which will also become the new access route between Slaughden and Orford Ness. There is limited space available due to the proximity of the estuary channel on the landward side of the ridge, a likelihood of poor soil conditions and risk of river and tidal flow erosion, all of which need to be taken into consideration. There are two variations: 6a - to protect this new structure against wave attack, reclaim some of the material used to armour the existing ridge, and place this on the front face of the new embankment. 6b - leave the rock and concrete armour block on the existing alignment to provide added protection. Although they will become overtopped and slump over time, those remains will still serve as a low breakwater and reduce wave action on the new structure.

A7	Terminal structure	The SMP proposes construction of a new long rock groyne (training wall), with the aim of holding up sediment to the north and therefore reducing flood and coastal erosion risk at Slaughden and beyond.
B1	Do nothing	No works undertaken.
B2	Beach nourishment	This will involve regularly re-nourishing the beach with shingle. An initial major campaign might be needed to build up a sufficiently robust barrier width, with regular recycling to address areas where the beach becomes depleted – volumes required will depend upon prevailing conditions. There will also need to be re-profiling if the current level of the haul road were to be maintained, as this sits above the natural crest level.
B3	Interventions to hold a beach	This could involve construction of new timber or rock groynes, or offshore breakwaters, with shingle renourishment and subsequent recycling. It is unlikely, however, that any of these approaches are likely to be sufficiently effective due to issues with shingle retention along the frontage, although the offshore profile and water depths, combined with some change in alignment of the shoreline further southwards may result in greater success than in sub-unit A. **REJECTED ON TECHNICAL GROUNDS**
B4	Widen the shingle ridge	This will involve recharge along the landward edge of the ridge – artificially replicating the natural process of barrier rollback. This will not in itself prevent some natural reprofiling and potential erosion on the seaward side or prevent some overtopping and scouring of the crest from occurring, but it will reduce risk and allow time for any overtopping damage to be repaired before a full breach forms.
B5	'Natural' shingle ridge management	This 'resilience' approach would allow the ridge to evolve and move more naturally with minimal intervention. This might involve some initial works to reprofile the ridge to a more natural form and to allow landward roll back of the feature. Whilst allowing natural movement, ensuring a critical standard of protection (albeit lower than present) is maintained will be achieved through reactively reworking or adding shingle to repair storm damage and re-establishing the haul road when necessary. A stockpile of shingle will be required to ensure such emergency works could be undertaken as required.
B6	Extend the revetment structure along the shoreline	This will involve extending the current revetment in sub-unit A southwards, but will probably require a more robust structure than to the north (deeper toe, larger armour units, thicker revetment and potentially higher elevation). It is unlikely that measures to build or retain the beach in front of this, such as nourishment or groynes, will be effective, given evidence of poor sediment retention in sub-unit A. A phased approach could be adopted – e.g. initially extending the revetment for some distance only, e.g. 500 to 800m, and managing the unprotected ridge over the remaining length, only extending the revetment further south as and when the need arises.
B7	New embankment along estuary channel	This will involve construction of a new clay embankment structure along the marsh side edge of the estuary channel. Compared to sub-unit A, there is more space available for construction of a set bank artificial embankment (apart from at the boundary with A), but works will still be

		required to resist any potential erosion by river and tidal flows and address potentially poor ground conditions.
B8	New embankment - alternative alignments	As for B7, this will involve construction of a new clay embankment structure, but along alternative alignments, thereby avoiding the need to construct directly along the estuary channel. The minimum extent for any such re-alignment should be more than the predicted 100m shoreline movement, so that the unmanaged shingle beach in front of this can continue to evolve naturally and unimpeded.
C1	Do nothing	No works undertaken – beach material allowed to move naturally and unimpeded in this sub-unit.
All	Shingle Engine	The approach will be to create a large mass of shingle (around 1.2 Million cubic metres) centred approximately 200m south of the Martello Tower.

2.3.1 Other considerations

Additional constructions

Depending upon the approach implemented, rock armour may be required to secure the termination point of the seawall directly to the north of sub-unit A, and prevent that unit from being outflanked. Likewise, some works may be required at the southern end of sub-unit A to prevent outflanking of this unit as a consequence of whatever approach is implemented in sub-unit B. In that respect, the creation of a 'hard point' spanning sub-units A and B may be appropriate if any realignment were considered to north and/or south of this point. This will then also provide a wider area which is more conducive to sediment trapping and a more natural shingle beach forming seaward of the realigned flood embankments.

As part of enabling a more naturally functioning coastline to evolve south of Slaughden, Bradbury (2014) suggested the construction of a hardpoint at a location between the Martello Tower and the end of the groyne field. The concept will be to encourage the development of a bay south of the defended frontage, with the aim of enabling a more naturally functioning shoreline to develop, through some reorientation of the beach to the south. This suggestion will follow the same principle but the proposal will be to create that hardpoint where the distance between the sea and estuary is narrowest, i.e. along the 350 to 400m spanning sub-units A and B. That could also help support a managed realignment approach to the north of this point too, i.e. in sub-unit A, by helping to stabilise any beach material that might accumulate in front of a retired line. This will most likely take the form of a shore parallel rock headland structure positioned along the current shoreline.

A variation could be to maintain the revetment line in sub-unit A, extending that southwards for 250-300m, and then adopting one of the other approaches for sub-unit B such as realigning to the south of that with a new embankment, rather than the full extension considered in B6.

Re-routing the Alde

Re-routing the Alde was considered by Orford (2014) as a possible way that 'accommodation space' could be provided for barrier retreat and involved the artificial breaching of the meander spur to allow realignment of the Alde channel landwards. This will seek to remove pressure north of the Martello Tower where the river meander meets the shoreline. This was promoted as a concept only, with no discussion of costs or impacts. In his review, Pye (2015) dismissed the idea due to the expensive of this option and the detailed studies which will be required to support it.

Pye also considered the pressure at Slaughden resulting from the estuary on the landward side of the shingle barrier. He considered that the construction of a bypass channel at Sudbourne Marshes may offer a viable means of relieving this pressure and enabling landwards realignment of the shingle barrier by up to 50m. This might be a consideration for any managed realignment option here too.

2.4 Management approaches

Table 2 below sets out the approaches developed, based upon combinations of the implementation measures discussed in the section above. These are not exhaustive, and other combinations of measures may exist, but illustrate some of the more likely combinations that might be considered and the potential consequences and costs of those.

Table 2 Management approaches and outcome scenarios: for each unit, the applicable implementation measures have been identified

Sub-unit	Approach 1	Approach 2	Approach 3	Approach 4	Approach 5	Approach 6	Approach 7	Approach 8	Approach 9
A	A1 – Do nothing	A7 - Terminal structure	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	Shingle Engine
B	B1 – Do nothing	B1 – Do nothing	B1 – Do nothing	B6 - Extend the revetment structure along the shoreline	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	
C	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	
	Breach	**Breach**	**Breach**	**No Breach**	**No Breach**	**No Breach**	**Temporary Breach**	**Temporary Breach**	**No Breach**

Appraisal of future management options

For each of the proposed approaches, the physical impact on the shoreline and associated technical issues have been considered first. This appraisal has considered the anticipated shoreline response, resultant change in the form of the coastline and potential technical implications of this.

The impact on the wider coastal environment and the interests it supports have then been appraised under the following themes:

- Biodiversity, geology and geomorphology features
- Water and hydromorphology
- Historic environment and landscape
- Communities, economy and material assets

These appraisals draw upon previous studies, which are listed in Section 1.3. A summary of this baseline information is included in Appendix A, with technical details and costs in Appendix B.

3.1 Approach 1 – Outcome scenario: Breach

Summary of approach (Figure 3)

A1 Do nothing	B1 Do nothing	C1 Do nothing

No works will be undertaken throughout the policy unit: recycling will cease immediately and no repairs or maintenance works will be carried out on the haul road or revetment in sub-unit A.

To secure the end of the seawall to the north, works associated with the SMP policy of Hold the Line for that policy unit could be required here.

Technical appraisal

It is unlikely that the current situation will improve along this frontage and although under a prolonged period of southerlies there could be short-term improvement to the beaches in sub-unit A, overall it is anticipated that over time there will be increased exposure and displacement of the concrete block mattress at the southern end and the armour units will continue to slump. During periods of lower beach levels and high water levels there will be frequent overwashing of the slope and erosion of the crest.

Eventually the defence structure itself in sub-unit A is likely to become destabilised and may collapse, enabling further cutback of any remaining shingle ridge until the erosion reaches the back face of the barrier, at which point overwashing may occur and ultimate a breach of the ridge. Any remaining shingle may result in the formation of a thin washover fan across the low-lying marshes behind. It is considered likely that the remains of the defences may help prevent a full depth breach from forming at this location, but regular overflowing at high tide is anticipated.

It is likely that prior to any failure of defence in sub-unit A, a breach will develop along sub-unit B. This is most likely to occur close to the interface of sub-units A and B; here there is a discontinuity between the defended and undefended sections and the ridge has already narrowed in recent years. The artificially high ridge along this section is unlikely to be able to roll back naturally through a process of overwashing. Instead, during periods of lower beach levels, the beach ridge will be subject to erosion of the face resulting in narrowing of the ridge until a critical point is reached at which the ridge may suffer catastrophic failure through waves scouring a hole through the narrow ridge. Shingle will be pushed onto the marshes between the barrier and river Alde. Exposure of the river wall to waves means it is also likely to fail fairly rapidly.

Calculations by Pye (2016) suggest that the development of a permanent breach may take more than 20 years to develop, as it will involve the gradual downcutting of underlying marshes to a level which enables waves to pass through at mean sea level, causing further scour and development of an open inlet. Prior to this, there will be regular overwashing with potential loss of shingle into the river, should the river wall be breached. It is possible that under conducive conditions a lower barrier could develop, but it is likely that this will remain susceptible to periodic breach.

Changes here will result in increased pressure of adjacent defences in front of the Martello Tower, with the end of the seawall being particularly at risk. The SMP anticipated that with a breach at the Martello Tower, the subsequent loss of the beach will cause an unravelling of the defence back to Fort Green and that this defence could fail within 20 to 50 years, unless works are undertaken to prevent this. There will also be implications in terms of sourcing shingle to place in front of the Martello Tower, as access to the source site will become increasingly difficult as defences start to collapse.

A permanent inlet will also have consequences for Orford Ness as it will be likely to have an impact on wider sediment linkages along the coast.

Potential Impact	
Although no active intervention may create a more functioning coastline in the long term, the development of a permanent breach will have significant implications for the wider estuary.	
Biodiversity, geology and geomorphology features	A more naturally functioning coast in the very long term may ultimately be beneficial to the overall objectives of the environmental designations, however there will be a radical change to the habitats supported within the Alde-Ore estuary complex as a result of a permanent inlet developing. This will affect the tidal regime within the estuary, affecting water levels and sediment transport. This in turn will affect the type of habitats supported both along the open coast and within the estuary complex. The geomorphology of the entire site will also alter with implications for SSSI designations and support of priority habitats along the coastal fringe. With current information, it is not possible to identify whether there will be net gain or loss and further work, looking at implications on wave penetration, flows and sediment distribution and implications for estuary defences, would be necessary.
Water and hydromorphology	It is anticipated that in the short term there will be more frequent overwashing where the ridge breaches, but this is not likely to have a significant impact on the local waterbody. A permanent open breach will mean waves are able to penetrate new areas of the estuary from the open coast, which will have implications on the tidal regime within the estuary, water levels, flows and sediment transport and distribution. There is some dispute within the literature regarding the impact of a breach on water levels within the estuary; Pye (2016) argues that maximum water level will be likely to increase north of any breach, with potential increased flood risk between Slaughden and Snape and also suggested that a slight increase in maximum high water levels around Orford might also occur. However, modelling undertaken as part of the Alde and Ore Futures (2011) suggested that a breach at Slaughden could actually reduce water levels within the estuary. Changes in water levels and flow are likely to be sensitive to the location of any breach, therefore further modelling is required to fully assess different breach scenarios. The designated shellfish protected area within the River Alde is also likely to be affected by any changes in flow or sediment distribution. The flood cell along the western bank of the Alde River reportedly contains several freshwater abstraction points for upland irrigation. Any long term increase in flood risk in this area could therefore have wider negative implications on these abstraction sites.
Historic environment and landscape	In the short term, there are sites (unlisted) of historical interest that lie within the marsh area behind the ridge that may be affected due to overwashing of material. Once a permanent inlet forms there will be implications for areas of historical interest in the wider estuary, particularly should flood risk at sites such as Aldeburgh and Orford increase as a result (see discussion above). There will also be increased pressure on the defence at the Martello Tower, to the north of this policy unit, which is a Scheduled monument (although it is assumed HTL will continue to be implemented here).

	A permanent breach will constitute a significant change to the current landscape, which may be incompatible with the defining qualities of the AONB.
Community, economy and material assets	In the short term, no properties will be directly at risk. Although more frequent overtopping is anticipated, this will be unlikely to increase the flood risk to properties, as changes to the overall Alde-Ore estuary system are anticipated to be small until a permanent breach develops. Access along the coast would be lost, including the ability for any vehicles and plant required to maintain assets on Orford Ness. There could be navigation issues associated with overwashing of shingle into the river, once the river wall fails, although it is anticipated that flows within the river will mean this will remain along the edges of the river. Failure of defences along sub-unit A will increase pressure on adjacent defences, up to Aldeburgh. It is assumed that the SMP policy of HTL will continue, but this could involve increasing resource and expenditure. Once a permanent inlet develops there could be significant implications for both properties within the wider estuary area and use of the estuary itself for fishing and recreational activities. The number of properties that will be at increased risk of flooding is not possible to define at present, as it depends upon how water levels within the estuary will be affected, which would require further modelling and assessment of the vulnerability of the current river defences.

Costs

There are **no costs** associated with implementing this approach for this policy unit.

However, to secure the policy unit to the north (14.4), where there is an SMP policy of Hold the Line, additional works could be required. This is estimated to be in the region of £100,000 to £200,000 initially, with a similar amount required going forward for future maintenance and repair.

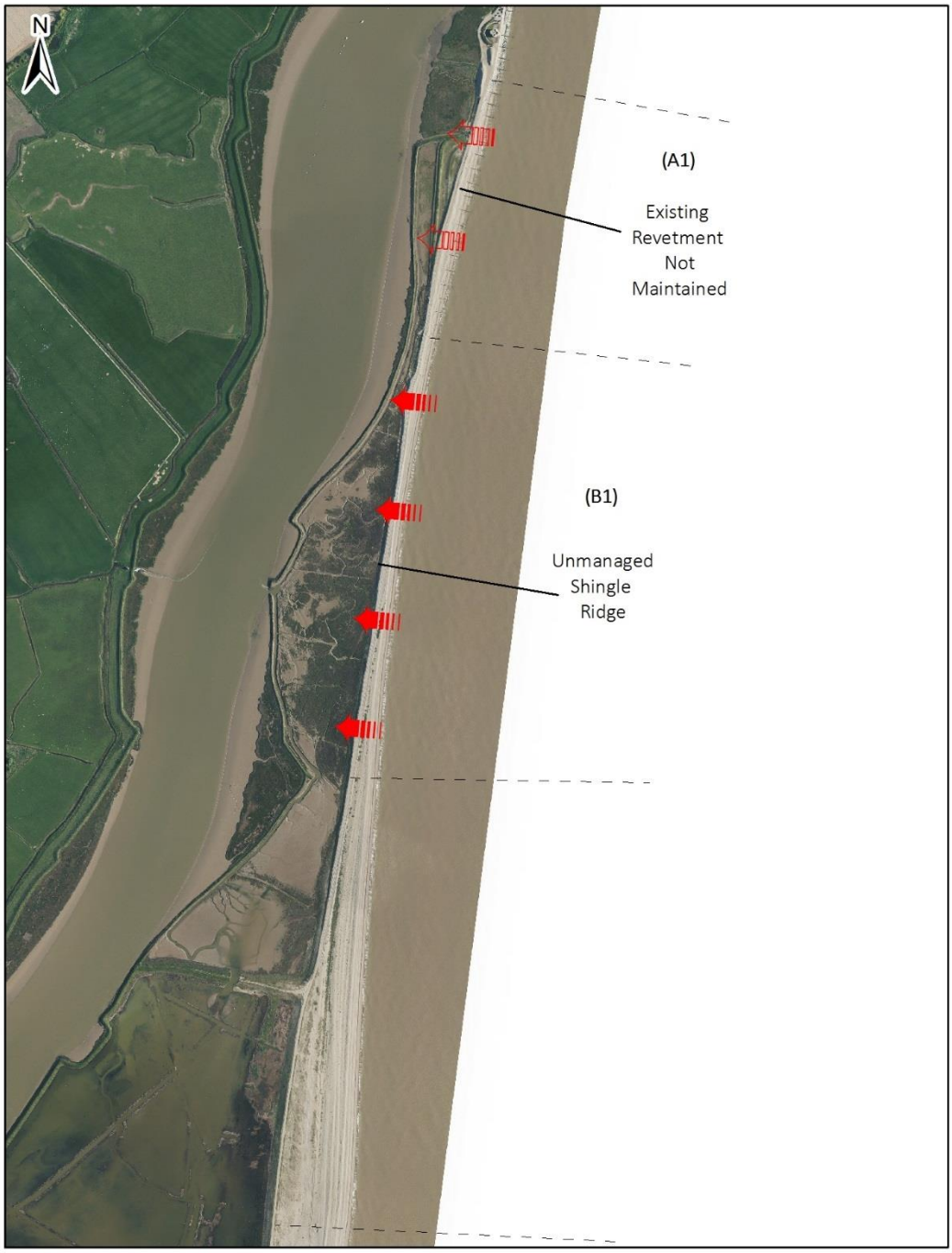


Figure 3 Approach 1 - Outcome scenario: Breach

3.2 Approach 2 – Outcome scenario: Breach

Summary of approach (Figure 4)		
A7 Terminal Structure	B1 Do nothing	C1 Do nothing

A terminal structure will be constructed within sub-unit A. There may also be works necessary to maintain the existing revetment depending upon the success of the terminal structure in retaining beach material.

Along sub-units B and C, no works will be undertaken.

Technical appraisal

The principle of the measure in sub-unit A is that construction of a terminal groyne will enable sediment build up updrift of the groyne, reducing flood and coastal erosion risk at Slaughden, although the rate of erosion is likely to increase downdrift of the structure. This will be in support of the HTL policy at Slaughden.

In the SMP, two locations for this structure were proposed; one at the interface with the concrete seawall at the northern end of sub-unit A, the other at the termination of the rock/armour revetment at the southern end of sub-unit A. Only the second option is discussed here.

As with Approaches 1 and 2, although the 'line' will continue to held along sub-unit A, there will still be a discontinuity at the interface with sub-unit B. There is a risk that timing of a breach along sub-unit B will be accelerated by construction of a terminal structure as it will inhibit sediment supply (albeit limited) from the north.

Compared to Approach 1, continuing protection along sub-unit A should mean slightly less pressure on the adjacent frontages to the north.

Potential Impact

There will be short term and temporary impacts on the environment during construction of a terminal groyne, due to disturbance of the beach and seabed and potential release of fines. Following construction, in the short term, there could be some slight improvement to continued defence of sub-unit A due to reduced disturbance but there will be implications for downdrift areas of Orford Ness, due to the reduced sediment connectivity.

In the long term, although no active intervention in sub-unit B will create a more functioning coastline, the development of a permanent breach will have significant implications for the wider estuary.

Biodiversity, geology and geomorphology features	Whilst the measures employed to hold the shoreline along sub-unit A could mean less disturbance to this section of shoreline due to the reduced need for recycling, this approach works against the wider principles of working with natural processes. Once a permanent breach forms along sub-unit B, the consequences on the wider estuary will be as for Approach 1.
Water and hydromorphology	There will be a short term, temporary impact on the coastal water body during construction of the terminal groyne. Once a permanent breach forms along sub-unit B, impacts will be similar to Approach 1.
Historic environment and landscape	Along sub-unit A, historical interests within the backing marsh will remain protected, as a result of encouraging beach build up along the coastal face of the ridge. There will also be less pressure on the defence at Martello Tower compared to Approach 1 or 3. Once a permanent breach forms along sub-unit B, the wide scale impacts on the estuary will be similar to Approach 1.
Community, economy and material assets	In the short term, no properties will be directly at risk. This Approach will be more compatible with the hold the line policy for the frontage to the north, than Approach 1 or 3. Once a permanent breach forms along sub-unit B, the wide scale impacts on the estuary will be similar to Approach 1.

Costs	
Initial costs to implement:	Expected to be approximately £2 million
Total costs (to 2055):	Approximately £2 million to £3 million
Total costs (100 years):	Approximately £6 million to £7 million

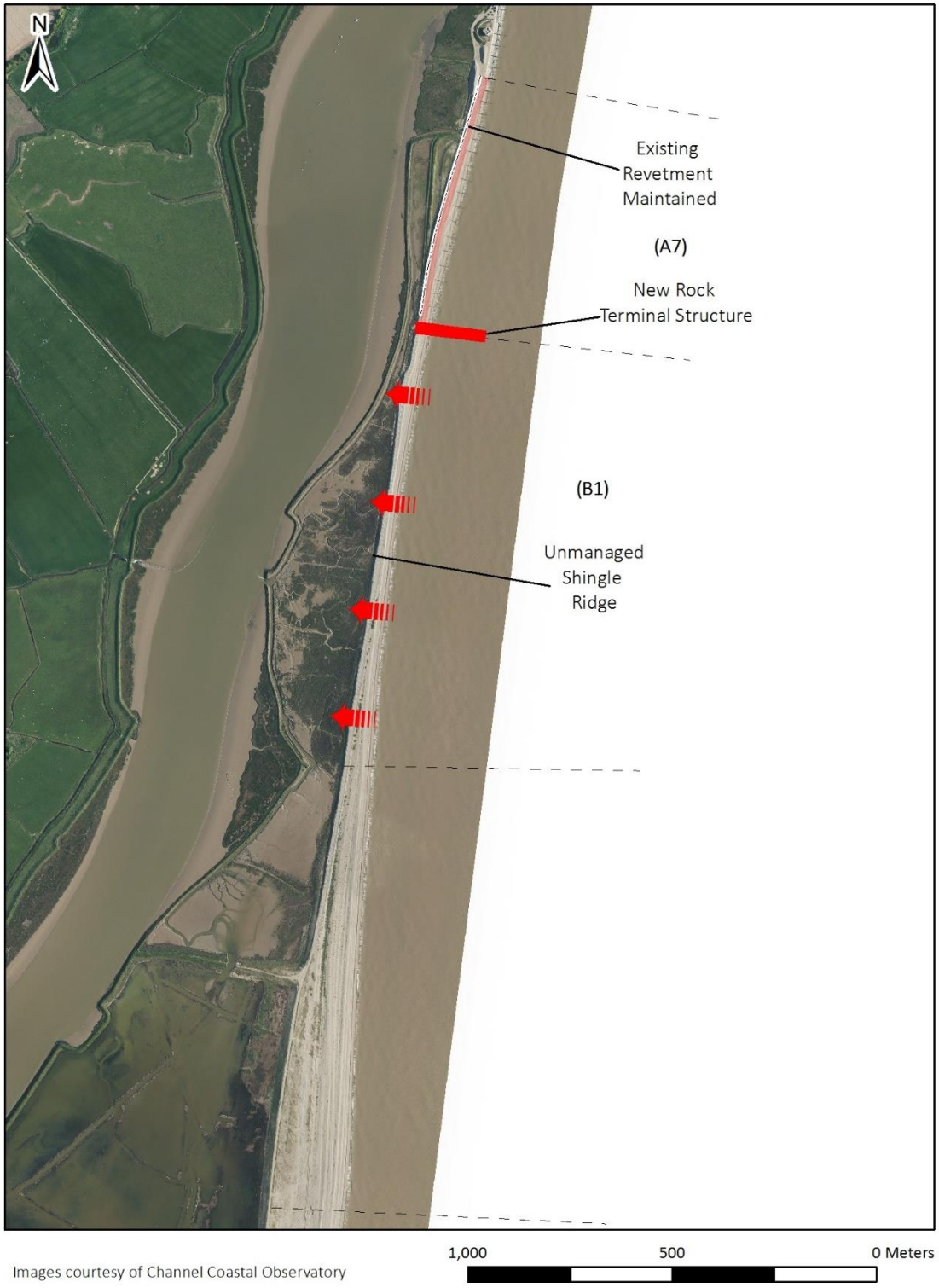


Figure 4 Example of Approach 2 - Outcome Scenario: Breach

3.3 Approach 3 – Outcome scenario: Breach

Summary of approach (Figure 5)		
A3 Maintain revetment **or** A5 Widen defence	B1 Do nothing	C1 Do nothing

Works will be carried out the maintain the defence line within sub-unit A - these could involve either:

- Adding rock or armour to bolster the existing defences and strengthening the defence toe (A3), or
- Adding a buffer of shingle to the landward side and repairing the crest following storms (A5).

Along sub-units B and C, no works will be undertaken.

Technical appraisal

Works to widen the defence (A5) will require an initial nourishment campaign, followed by regular repairs to ensure the integrity of the defence is maintained. This approach will require a source of shingle, with Sudbourne Beach being the most obvious option; it also therefore needs a haul route to be maintained to allow the transport of shingle. The advantage of this measure is that the nourishment material, once placed at the rear of the shingle ridge, will not be eroded and removed by longshore transport; however, this measure does not prevent erosion of the fronting beach from continuing. The volumes involved are, however, more substantial than currently extracted for the recycling campaigns (currently limited to no more than 10,000 m^3 every 3 years), with volumes required to initially implement A5 around 3 to 4 times this. It is assumed for this approach outcome of Breach, that importing shingle from another source, e.g. dredging, would not be considered economically viable.

Although the 'line' will continue to held along sub-unit A, there will still be a discontinuity at the interface with sub-unit B, under either implementation measure. There will be no additional sediment feed from this frontage to sub-unit B, therefore this section will remain at risk of breach.

The timing and development of a breach will be similar to Approach 1, although it is possible that the formation of a permanent inlet could be more rapid as the two sections of coast become increasingly disconnected.

Once a breach forms, further investment will be required to secure the termination point at the end of the revetment. Compared to Approach 1, continuing protection along sub-unit A should mean slightly less pressure on the adjacent frontages to the north.

Following a breach along sub-unit B, it will no longer be possible to source any nourishment material from Sudbourne Beach, meaning that no further widening works will be possible as part of measure A5 without importing material from elsewhere – it may therefore be necessary to construct a revetment (as A3).

Potential Impact

In the short term, continued defence of sub-unit A will mean little or no improvement to the environmental status in this area, and there will be implications for downdrift areas of Orford Ness, due to the reduced sediment connectivity.

As for Approach 2, in the long term, although no active intervention in sub-unit B will create a more functioning coastline, the development of a permanent breach will have significant implications for the wider estuary.

Biodiversity, geology and geomorphology features	In the short term, continued maintenance of defences within sub-unit A will result in little or no improvement in the SSSI status along this section, with continued pressure on the priority vegetated shingle habitat. Under measure A3 (maintain/ improve existing defence), construction of defences will result in significant disturbance to intertidal and beach habitats and by holding the shoreline in an artificially advanced position, there will be coastal squeeze. Measure A5 (widen the defence) will mean that material will need to be sourced from Sudbourne Beach. A haul route will also need to be maintained. The implications of this on the habitat and geomorphology at Sudbourne Beach has been questioned by others (see Orford, 2015 and Pye, 2015, 2016), but there is

	general concern regarding the long-term damage of this practice due to damage caused to vegetated shingle habitats and the geomorphological elements of the feature. The SSSI site units at Slaughden are already currently in an unfavourable condition as a result of shingle re-cycling activities. The volumes required for the initial campaign will be substantially more than current extracted, and there will be regular (maybe every 10 to 20 years) repairs potentially required to maintain the structure to an adequate standard. There is also likely to be some loss of designated fringing marsh that lies between the coast and the river bank, due to shingle being placed along the landward face of the shingle ridge. Once a permanent breach forms along sub-unit B, the consequences on the wider estuary will be as for Approach 1.
Water and hydromorphology	There will be a short term, temporary impact on the coastal water body during construction works necessary for A3 (maintain/ improve existing defence), whilst Measure A5 (widen the defence) will have a continued impact along the shingle source area at Sudbourne Beach. Once a permanent breach forms along sub-unit B, impacts on the wider estuary will be similar to Approach 1.
Historic environment and landscape	Continuing to defend sub-unit A may mean slightly less pressure on the defence at Martello Tower compared to Approach 1. Once a permanent breach forms along sub-unit B, impacts on the wider estuary will be similar to Approach 1.
Community, economy and material assets	In the short term, no properties will be directly at risk. Once a permanent breach forms along sub-unit B, impacts on the wider estuary will be similar to Approach 1.
Economic appraisal (costs)	
Initial costs to implement:	Between approximately £1 million and £4 million, depending upon implementation measures and material sources.
Total costs (to 2055):	In the range approximately £2 million to £5 million
Total costs (100 years):	Approximately £5 million to £10 million.

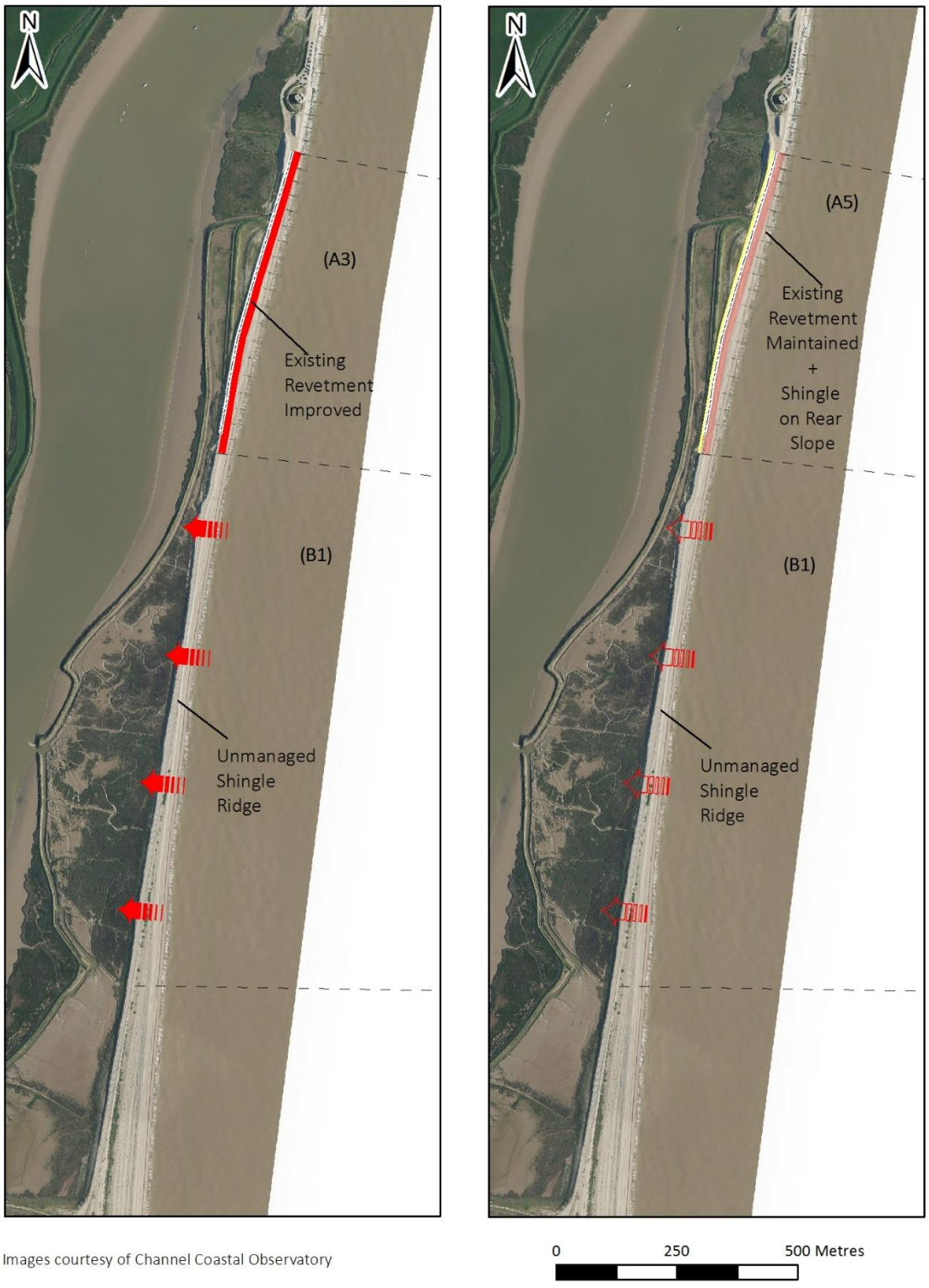


Figure 5 Examples of Approach 3 - Outcome Scenario: Breach

3.4 Approach 4 – Outcome scenario: No breach

Summary of approach (Figure 6)

A3 Maintain/improve revetment **or** A5 Widen the defence	B6 Extend the revetment	C1 Do nothing

Works will be carried out the maintain the defence within sub-unit A - these could involve either:

- Adding rock or armour to bolster the existing defences and strengthening the defence toe (A3), or
- Adding a buffer of shingle to the landward side and repairing the crest following storms (A5).

In sub-unit B, works will also be carried out to improve the defence function of the shingle ridge through:

- Construction of a new revetment, extending the structure that exists along sub-unit A (B6).

Along sub-unit C, no works will be required.

Technical appraisal

The aim of the approach is to minimise the risk of a breach along the whole policy unit through improving the standard of protection provided by the existing man-made and natural defences along the existing alignment.

Works to maintain/improve the existing revetment (A3) will be required to bolster and improve it, as existing damage already shows that structure alone is not adequate to provide a robust line of defence in the longer term. But, that alone will not address the issue of falling foreshore and the potential slumping of that structure, and a more robust toe will be required.

Works to widen the defence (A5) will require an initial nourishment campaign, followed by regular repairs to ensure the integrity of the defence is maintained. Although Sudbourne Beach is the most obvious option to source this material, the initial volumes involved are 3 to 4 times greater than permitted to be extracted for the current recycling campaigns, with further material required in the future. Given the potential limitations of removing larger volumes of shingle and the long-term commitments required, it is assumed for the No Breach outcomes that this shingle may need to be imported from another source, i.e. dredging.

Measure B6 (Extend the revetment) will address the discontinuity issue by extending the hard defences southwards, i.e. something similar to the revetment structure in sub-unit A. However, based upon damage and erosion observed recently along sub-unit A, this will need to be a more robust structure than its existing counterpart (deeper toe, larger armour units, thicker revetment and potentially higher elevation). This could possibly be undertaken in a phased approach in response to levels of risk along sub-unit B frontage. It is also likely that extending the defence will acerbate the issue of foreshore erosion, resulting in coastal squeeze along much of sub-unit B.

Potential Impact

This approach is to minimise the risk of breach, therefore impacts on the wider estuary are averted. There will however be impacts locally along the open coast frontage of the Orford Ness complex.

Biodiversity, geology and geomorphology features	In the short term, continued maintenance of defences within sub-unit A will result in little or no improvement in the SSSI status along this section, with continued pressure on the priority vegetated shingle habitat. Under measure A3 (Maintain/ improve existing defence), construction of defences will result in significant disturbance to intertidal and beach habitats and by holding the shoreline in an artificially advanced position, there will be coastal squeeze. For measure A5 (Widen the shingle ridge) the source of nourishment is uncertain. There may be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches. There is also likely to be some loss of designated fringing marsh that lies between the coast and the river bank, due to shingle being placed along the landward face of the shingle ridge.

	Measure B6 (Extend the revetment) will artificially fix the shoreline position, increasing potential for coastal squeeze along the foreshore. It will, however, protect the marshes (and supported priority habitat) on the seaward side of the ridge. B6 (Extend revetment) also provides more certainty of ensuring no breach develops in the shingle ridge. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided.
Water and hydromorphology	There will be a short term, temporary impact on the coastal water body during construction works necessary for A3 (maintain/ improve existing defence) and B6 (Extend revetment), whilst measures A5 (Widen the defence) will have a continued impact on the coastal water body adjacent to the shingle source area at Sudbourne Beach. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected.
Historic environment and landscape	There will be potential impacts on historical interests within the fringing marshland between shingle ridge and river banks, as a results of works associated with A5 (Widen the defence). Any increase in erosion and barrier roll back within sub-unit C will also potential result in loss of historical features. Construction of additional defences, particularly under measure B6, may not be compatible with the AONB objectives and will require further consideration. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This should therefore be compatible with the objectives of the AONB for the estuary area.
Community, economy and material assets	As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This approach is therefore in-line with the overarching objectives of the AOEP Estuary Plan.

Costs	
Initial costs to implement:	Likely to be in excess of £15 million.
Total costs (to 2055):	In the range £15 million to £20 million.
Total costs (100 years):	In excess of £25 million.

Figure 6 Examples of Approach 4 - Outcome Scenario: No Breach

3.5 Approach 5 – Outcome scenario: No breach

Summary of approach (Figure 7)		
A3 Maintain/improve revetment **or** A5 Widen the defence	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	C1 Do nothing

Works will be carried out the maintain the defence within sub-unit A - these could involve either:

- Adding rock or armour to bolster the existing defences and strengthening the defence toe (A3), or
- Adding a buffer of shingle to the landward side and repairing the crest following storms (A5).

In sub-unit B, works will also be carried out to improve the standard of protection through construction of artificial defences, through creating a new embankment that either:

- Follows the river channel (B7) or
- Follows an alternative set back alignment (B8).

Along sub-unit C, no works will be required.

Technical appraisal

The key difference in approach from Approach 4 is that instead of hardening the front line to provide protection from breach and flooding along sub-unit B, new embankments will be built. The advantage of this approach is that for much of sub-unit B (with the exception of the narrow section at the interface with sub-unit A) the shingle barrier will be allowed to evolve naturally as this will no longer constitute the only defence. Some initial works might be undertaken to create a more natural profile and enable the ridge to become more resilient than it is in its current artificially steep form, but will be limited to that intervention only.

The interface between sub-units A and B would be vulnerable if not addressed, so under this approach additional works will be undertaken through the construction of a 'hard point' in the form of a shore parallel rock structure extending south from the end of the existing defence line in sub-unit A.

As the beach along sub-unit B is likely to become more mobile in form, it may mean that sub-unit A may become starved of sediment from either the north (already limited) and south (due to poor sediment connectivity between the two sections). A breach may form in the shingle ridge, to the south of the bolstered defences at the interface through similar process to those described for Approach 1 (do nothing in all sections). Through subsequent overwashing shingle will be spread across the marshland behind, but will be retained by the new embankments. Ultimately the whole shoreline along sub-unit B will be expected to realign.

Measure B7 (New embankment along estuary channel) will require repair of the breach along northern Lantern Marshes. This will have obvious consequences on the saltmarsh restoration works already underway in this area. Whilst this provides the maximum accommodation space for the shingle ridge to realign, an alternative measure is B8, which will involve construction of a new embankment across the saltmarsh plain. There are, however, significant technical difficulties with this approach to be overcome, namely: poor soil conditions and exposure to river and tidal flows within the estuary.

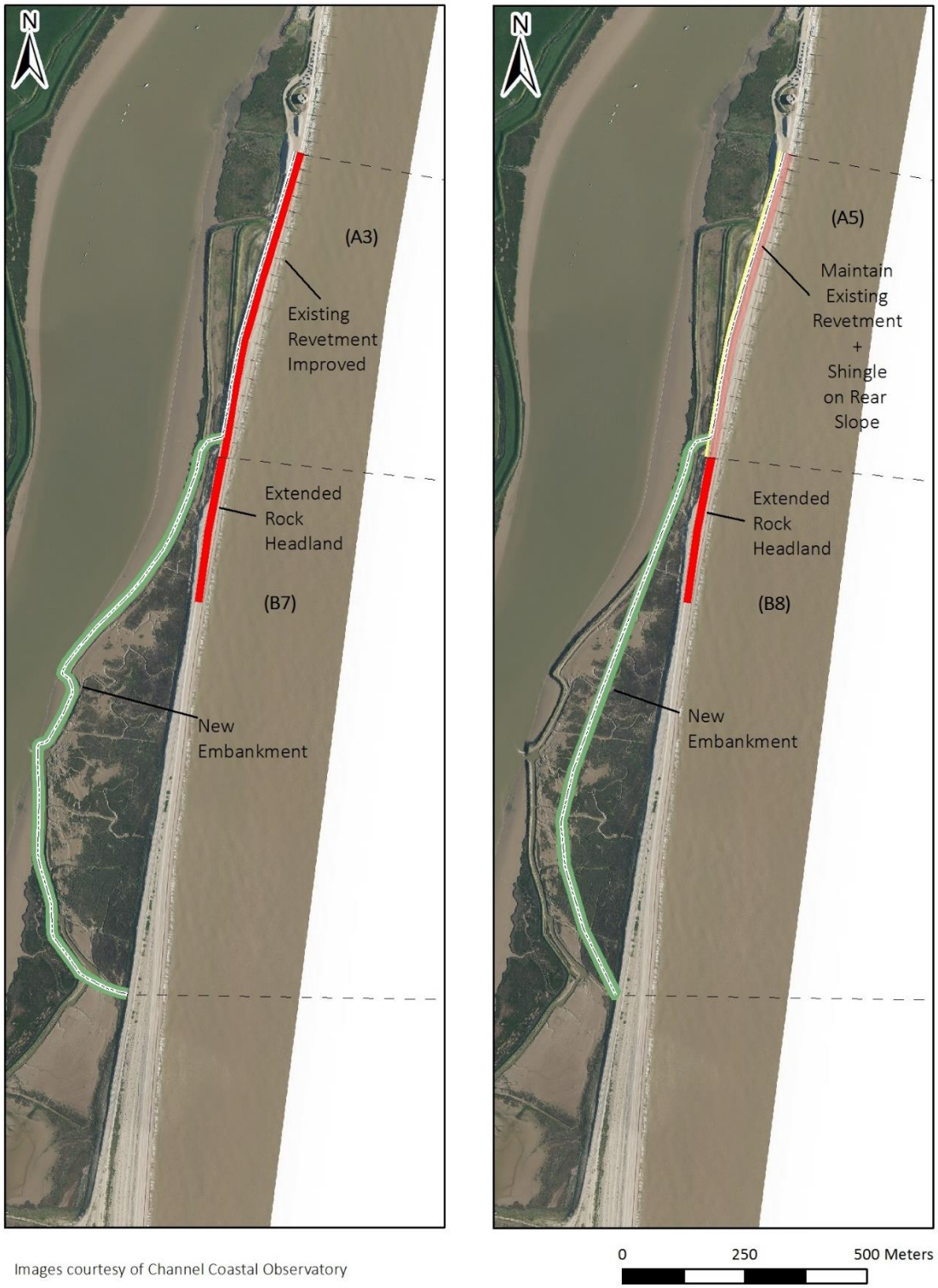
Potential Impact

As for Approach 4, this approach is to minimise the risk of breach, therefore impacts on the wider estuary are averted. There will however be impacts locally along the open coast frontage of the Orford Ness complex and across Lantern Marshes North.

Biodiversity, geology and geomorphology features	A key benefit to this approach is that the shingle barrier will be able to reach a new, potentially more sustainable, alignment along the sub-unit B. If combined with A3 (Maintain/improve revetment), there will no longer be a need to rely on shingle recycling to sustain defences, thereby potentially improving the status of Sudbourne Beach. There will still be potential for coastal squeeze, as any rollback of

	the ridge will ultimately be limited by setback defences – but this impact of this will depend upon which alignment is chosen. There will, however, be impacts on the recent saltmarsh regeneration scheme along Lantern Marshes North, as the new embankment will either follow the line of the river defences (and will require the 1999 breach to be resealed) or extend across the marsh, which will allow some room for saltmarsh development on the seaward side, but will reduce the overall area of potential saltmarsh regeneration and effectively will re-enclose part of the marsh. This will also have impacts on the overall tidal prism of the estuary. There is potential for any scheme to consider introducing flow control structures to provide an opportunity for regulated tidal exchange and associated habitat development. Both B7 and B8 will also need to work in conjunction with management plans for Lantern Marsh South. A 25m breach in the seawall that separates Lantern Marshes South (and the Cobra Mist site) from Lantern Marshes North (known as the American Wall) was created in the Wall during the December 2013 surge tide. Flood and ebb tides reach the Lantern Marshes South mainly via the deep tidal channel which runs behind the Upper Lantern Marshes North river wall from the breach near its northern end (Pye, 2015). This link will be affected by construction of new set back embankments. The breach in the American Wall was repaired in Many 2016 and the installed sluices are being removed. The pre-breach habitat is extant, so unlikely to be further modified by small scale flood relief water unless there is a long-term breach and it becomes intertidal/sub-tidal. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided.
Water and hydromorphology	Along sub-unit B the implementation measures will involve construction of new defences. As these will cross Lantern Marshes North, an area allowed to breach to enable saltmarsh to regenerate (as part of a scheme running until 2019), there will be an impact on the status of the water body in this location, which changes in flows and sediment distribution through this area. As discussed above, there are, however, opportunities to design the embankments to consider managing water storage and habitat development. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided.
Historic environment and landscape	Continuing to defend sub-unit A may mean slightly less pressure on the defence at Martello Tower compared to Approach 1. There will be potential impacts on historical interests within the fringing marshland between shingle ridge and river banks along sub-unit A as a result of works associated with A5 (Widen the defence). Construction of embankments will also impact on historical interests within Lantern Marshes, including possible historic oyster pits. Construction of the embankments may not be compatible with the AONB objectives for the open coast and will require further consideration. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This should therefore be compatible with the objectives of the AONB for the estuary area.
Community, economy and material assets	There are limited assets at risk at a local scale. The new embankments would have to be appropriately designed if a vehicular route is still required, e.g. for either recycling of shingle to areas further north, or for plant required to maintain assets on Orford Ness. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This approach is therefore in-line with the overarching objectives of the AOEP Estuary Plan.
Costs	

Initial costs to implement:	Various combinations range between approximately £9 million and £13 million
Total costs (to 2055):	Likely to be in the range £10 million to £15 million
Total costs (100 years):	Likely to be in the range £15 million to £20 million



Images courtesy of Channel Coastal Observatory

Figure 7 Examples of Approach 5 - Outcome Scenario: No Breach

3.6 Approach 6 – Outcome scenario: No breach

Summary of approach (Figure 8)		
A6 - New embankment along estuary channel	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	C1 Do nothing

Through both A and B, the main flood defence will be provided through construction of new embankments. In A, this will need to be constructed along the estuary channel (due to the limited accommodation space), whilst in sub-unit B, the new embankment could either:

- Follow the river channel (B7) or
- Follow an alternative set back alignment (B8).

Along sub-unit C, no works will be required.

Technical appraisal

The key difference in approach from Approach 5 is that there will be a continuous realigned embankment through both A and B. As for Approach 5, the key advantage of this approach is that throughout sub-unit B the shingle barrier will be allowed to evolve more naturally than under approaches where the ridge continues to form the main defence. Again, some initial works might be undertaken to create a more natural profile to enable the ridge to become more resilient than it is in its current artificially steep form. There will also be a need to bolstering the shoreline at the interface between sub-units A and B, creating a shore parallel rock headland to provide additional protection along the meander where the estuary channel is closest to the sea. This will protect the rear embankment both directly and through trapping shingle in its lee.

Breaches may form in the ridge along sub-unit B through similar process to those described for Approach 1 (do nothing in all sections). Through subsequent overwashing shingle will be spread across the marshland behind, but will be retained by the new embankments. Ultimately the whole shoreline along sub-unit B will be expected to realign.

Options for creating a more sustainable alignment along the whole frontage are limited by pressures from the estuary meanders which mean that there are pinch points which limit where new embankments can be constructed. There is however, slightly more flexibility than under Approach 5 to create a shoreline that is easier to maintain at a required standard of protection.

With all of the realignment measures there will be addition technical issues to address, including:

- likelihood of poor soil conditions and settlement of any new structures;
- exposure to potentially erosive river and tidal flows within the estuary;
- some continued (albeit lesser) exposure to wave action along seaward edge, particularly along sub-unit A where the embankment cannot be set back very far from the current coastal edge. One approach to help counter that would be to also leave the rock from the existing revetment in place as a wave break.

Potential Impact

As for Approach 4, this approach is to minimise the risk of breach, therefore impacts on the wider estuary are averted. There will however be impacts locally along the open coast frontage of the Orford Ness complex and across Lantern Marshes North, similar to Approach 5.

Biodiversity, geology and geomorphology features	The impacts of this approach are similar to those identified for Approach 5. The key difference is the management of sub-unit A. This will enable a more naturally functioning coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. As for Approach 5, there will no longer be a need to rely on shingle recycling to sustain defences, thereby potentially improving the status of Sudbourne Beach. There will still be potential for coastal squeeze, as any rollback of the ridge will ultimately be limited

	by setback defences – but this impact of this will depend upon which alignments are chosen. In addition to the encroachment across Lantern Marshes North (as discussed in Approach 5), there will be encroachment on the marsh area that currently lies behind the shingle ridge along sub-unit A. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided.
Water and hydromorphology	The implementation measures will involve construction of new defences along new footprints. As for Approach 5, as these will cross Lantern Marshes North, an area which had recently (1999) been allowed to breach to enable saltmarsh to regenerate, there will be an impact on the status of the water body in this location. The design of the embankments could look at possible mitigation measures such as flow control structures. As coastal squeeze is reduced along sub-unit A, there could be an improvement in coastal water body status here. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided.
Historic environment and landscape	There is likely to be increased pressure on the Martello Tower (although works to secure the end of the existing seawall would be implemented, similar to that described for Approach 1). There will also be potential impacts on historical interests within the fringing marshland between shingle ridge and river banks along sub-unit A due to construction of the new embankment. As for Approach 5, construction of embankments will also impact on historical interests within Lantern Marshes, including possible historic oyster pits. Construction of the embankments may not be compatible with the AONB objectives for the open coast and will require further consideration. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This should therefore be compatible with the objectives of the AONB for the estuary area.
Community, economy and material assets	There are limited assets at risk at a local scale. The new embankments would have to be appropriately designed if a vehicular route is still required, e.g. for either recycling of shingle to areas further north, or for plant required to maintain assets on Orford Ness. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. This approach is therefore in-line with the overarching objectives of the AOEP Estuary Plan.

Costs	
Initial costs to implement:	Approximately £ 15 million.
Total costs (to 2055):	Approximately £15 million.
Total costs (100 years):	In the range £15 million to £20 million.

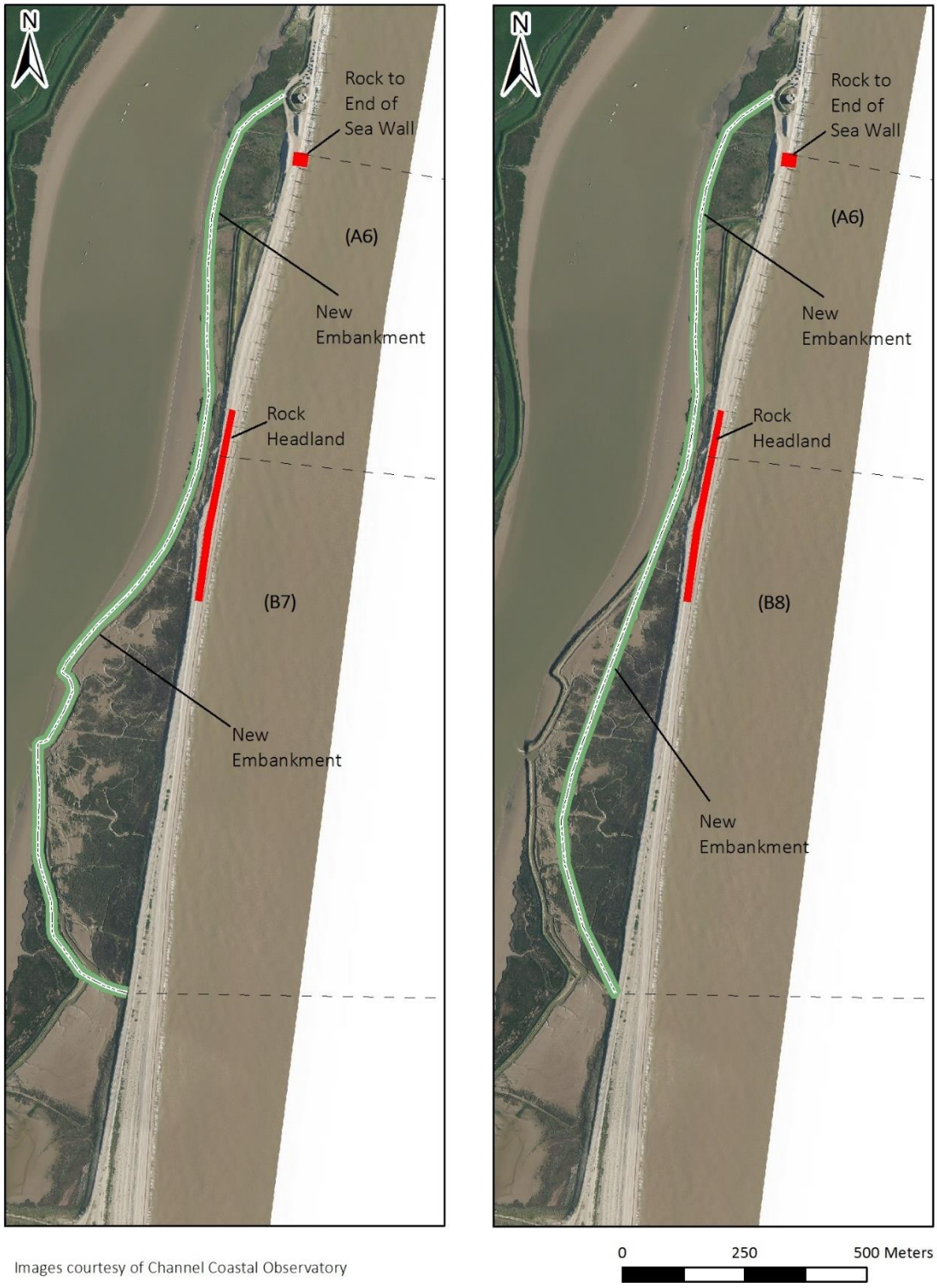


Figure 8 Examples of Approach 6 - Outcome Scenario: No Breach

3.7 Approach 7 – Outcome scenario: Temporary Breach

Summary of approach (Figure 9)		
A3 Maintain revetment **or** A5 Widen defence	B2 - Beach nourishment **or** B4 – Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	C1 Do nothing

Works will be carried out the maintain the defence within sub-unit A - these could involve either:

- Adding rock or armour to bolster the existing defences and strengthening the defence toe (A3), or
- Adding a buffer of shingle to the landward side and repairing the crest following storms (A5).

In sub-unit B, the resilience of the existing shingle ridge will be improved to reduce breach and flood risk through either:

- regularly re-nourishing the seaward (beach) face of the shingle ridge (B2), or
- widening the ridge through adding shingle to the landward face (B4), or
- managing realignment of the ridge, through reprofiling and repair (B5).

In addition, there would need to be an ongoing commitment to breach repairs through sub-unit B.

Along sub-unit C, no works will be undertaken.

Technical appraisal

The overall intention of this approach is to prevent a permanent breach from forming, whilst accepting a higher risk along sub-unit B than under the higher cost approaches of 4, 5 and 6. Although the 'line' will continue to be held along sub-unit A, the shingle ridge within sub-unit B will be managed under one of the implementation measures. That means that under extreme storms the ridge may become overwashed and a breach develops, but that would be matched by a commitment to repairing (through the reworking and/or addition of more shingle) so that breach is only temporary and not permanent. This is not dissimilar to the historic approach in this area.

A key difference between the three approaches would be that B2 and B4 would attempt to hold the ridge close to its present location and form, whereas B5 would accept a more natural lower and flatter ridge to evolve, which would have more natural resilience but also be likely to move further inland towards the estuary. Measure B2 (Beach nourishment) would be managed by adding more material to the foreshore on a regular basis, to counter longshore transport losses and ridge lowering. Measure B4 (Widen the shingle ridge) would see less frequent interventions and will not prevent erosion or damage occurring to the seaward side or prevent some overtopping and scouring of the crest from occurring, but will reduce the risk of a breach occurring during a single storm event.

In comparison, B5 ('natural' shingle ridge management), will require less intensive operations than seeking to hold the same alignment and profile, although given the ridge is already very narrow in places, it is assumed that an initial reworking of the existing shingle might be undertaken to lower and widen the feature. There is also no guarantee that a non-maintained barrier, left to roll back naturally, will maintain constant volume and crest height. There therefore needs to be an acceptance of an increase in risk (or frequency of) breach with this approach, and there is therefore a possibility that a lower wider barrier will actually result in more frequent over-washing (although there may be limited impacts of this). This measure will involve advance planning including stockpiled material and readily accessible plant and well-defined trigger levels for action. That additional material would, however, be less than currently extracted from Sudbourne Beach, and in keeping with the principle of this measure, it is assumed that this would not depend upon non-native material having to be sourced.

Measures B2 and B4 will require substantial amounts of nourishment material, both initially and ongoing, with volumes considerably higher (between 2 and 5 times) than presently extracted from Sudbourne Beach for recycling. The dynamic nature of this section of shoreline and the underlying long-term trend of erosion means that recharge for B2 will probably be needed on a very frequent basis (e.g.

less than 5 years between nourishment operations), whereas additional 'topping up' of shingle for B4 will be less frequent but still probably once every 10 years. Given the potential limitations of removing such significant volumes of shingle and the long-term consents required to do so, it is assumed for these measures that this shingle would have to be imported from another source, i.e. offshore dredging. Other issues with sourcing such large volumes from Sudbourne Beach include the need to maintain a haul route for heavier levels of traffic, in order to access the source area. This measure will be highly intensive and will require much greater flexibility on timing and volumes than currently permitted with the historic recycling campaigns at Slaughden.

Whilst B2 and B4 would involve monitor and manage the risk of breach through reprofiling and redistribution of sediment, B5 would be intervening solely when any breach repairs were required. In each case, although there is potential for a breach to 'self-heal', under these measures it is assumed that emergency works may need to be undertaken to repair the breach and prevent any further downcutting, which will result in a more permanent breach forming.

The sustainability and longevity of either B2, B4 or and B5 is not fully predictable, particularly in those areas where the shingle barrier is already narrow and constrained due to the proximity of the estuary channel. It will also depend upon future prevailing conditions and how areas of accretion and erosion may change in response.

Under these measures for sub-unit B, whether combined with either measure A3 or A5, there will remain a discontinuity between the hard defences and soft defences. It is likely, therefore that the transition zone between sub-units A and B will remain vulnerable, so this would be addressed through creating a shore parallel rock headland to provide additional protection along the meander where the estuary channel is closest to the sea. This will provide protection and an anchor for the shingle ridge, through trapping shingle in its lee.

Potential Impact	
The aim is to create a more naturally functioning shoreline, whilst accepting a higher level of breach risk. It is intended that any breach will be repaired, therefore impacts on the wider estuary should be limited and temporary.	
Biodiversity, geology and geomorphology features	Measures B2, B4 or A5, are expected to require shingle to be imported, i.e. from a dredged source. The source of that nourishment is uncertain, particularly given the significant volumes required. There may be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches. The alternative would be to engage on more intensive recycling from Sudbourne Beach for any of these measures. For B2 there would also be a need for mechanical reprofiling of the beach to ensure the standard pf protection remains adequate. The environmental implications of this on the habitats and geomorphological features at Sudbourne Beach has been disputed in the literature (see Orford, 2015 and Pye, 2015, 2016), but there is general concern regarding the long-term damage of this practice due to damage caused to vegetated shingle habitats and the geomorphological elements of the feature. The SSSI site units at Slaughden are already currently in an unfavourable condition as a result of shingle recycling activities. Although measure B5 promotes a more naturally functioning coastline along sub-unit B, there may still be a requirement to source some addition shingle from Sudbourne Beach (for breach repairs), which although considerably less than has historically and currently been extracted, may still result in these impacts. There will also be local loss of the backing marsh areas, as the shingle ridge is allowed to roll landwards across this area, whilst part of a natural process, it will result in squeeze due to the river defences constraining the landward extent of the marsh. Along sub-unit A there is likely to be little improvement in the environmental status, as the shoreline will continue to be held here. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on wider estuary will be avoided. However, under this approach

	there is potential for a breach to form, particularly where the ridge is already narrow and is constrained by the river channel meander: here works to widen the ridge will be limited and similarly, there is little accommodation space for a wider barrier to naturally form. As the intention is for emergency work to be undertaken to repair a breach, impacts on the wider estuary environment should be limited. However, at the pinch points, where the breach is most likely to occur there may be overwashing of shingle across the fringing marsh. Any recovery of this material may cause damage to the underlying surface and supported habitats.
Water and hydromorphology	During period of temporary breach there will be more frequent overtopping where the ridge breaches, but this is not likely to have a significant impact on the local waterbody. The exception could be the designated shellfish protected area within the River Alde, but sensitivity of this zone will need further consideration. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on wider estuary will be avoided.
Historic environment and landscape	There will be potential impacts on historical interests, including possible historic oyster pits, within the fringing marshland between shingle ridge and river banks along sub-unit B as the shingle bank encroaches on this area. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on the wider estuary will be avoided. This should therefore be compatible with the objectives of the AONB for the estuary area.
Community, economy and material assets	There are limited assets at risk at a local scale. Access along the coast may be compromised by measure B5, including the ability for any vehicles and plant required to maintain assets on Orford Ness. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on the wider estuary will be avoided. However, during the period of breach, there may be increased pressure of the river defences, therefore these higher risks will need to be taken into account within the estuary plan. Although this approach generally supports the overarching objectives of the AOEP Estuary Plan, there will need to be a greater acceptance of risk.
Costs	
Initial costs to implement:	Range between approximately £3 million to £8 million, depending upon combination of measures.
Total costs (to 2055):	Costs potentially in excess of £10 million for approaches that require importing larger quantities of shingle (B2 and B4). Approximately £5 million to £7 million for approaches requiring less intensive management (B5)
Total costs (100 years):	Potentially less than £10 million for approach including B5, but higher with other combinations, e.g. up to £20 million with B4.

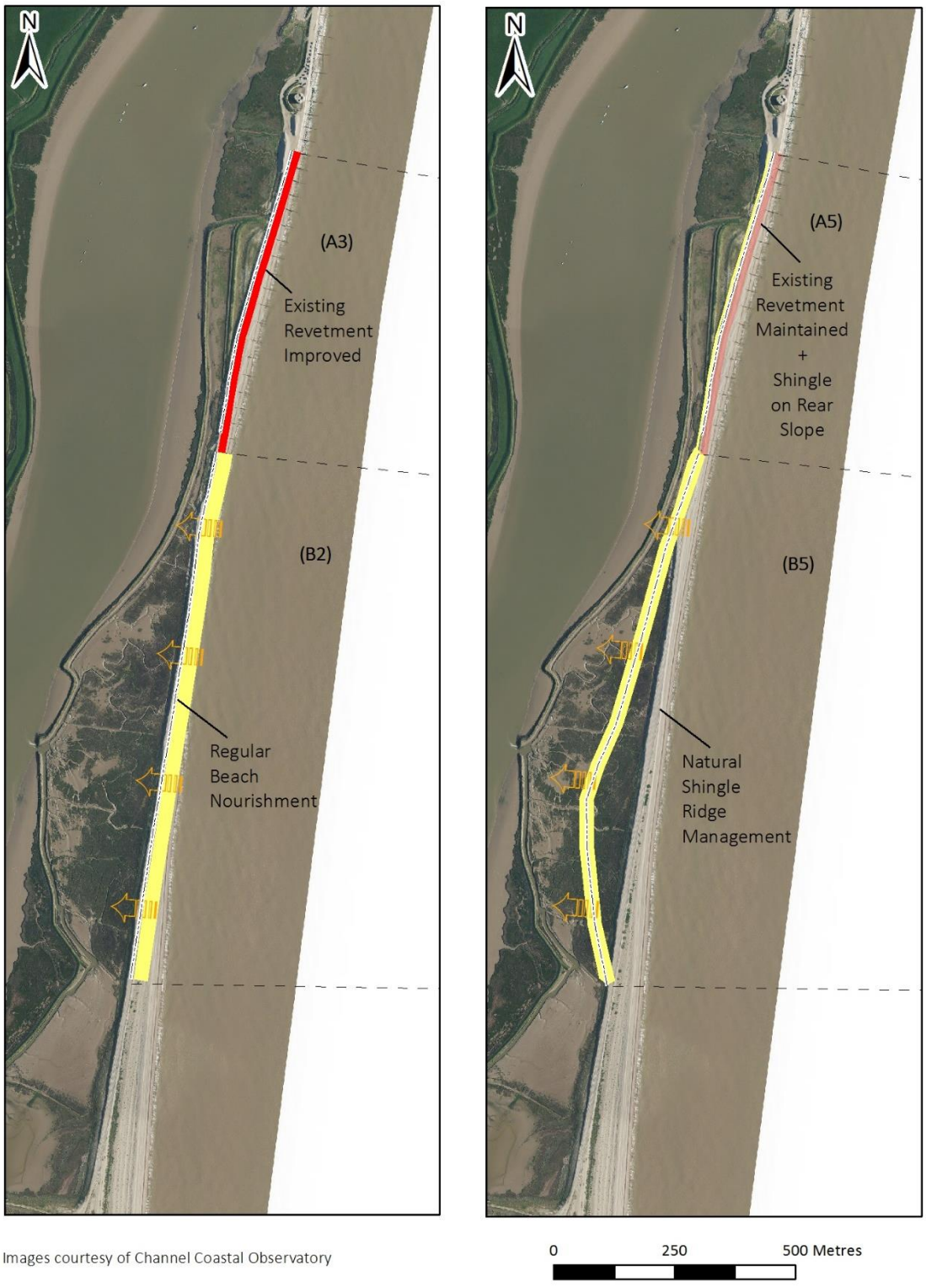


Figure 9 Examples of Approach 7 - Outcome Scenario: Temporary Breach

3.8 Approach 8 – Outcome scenario: Temporary Breach

Summary of approach (Figure 10)		
A6 - New embankment along estuary channel	B2 - Beach nourishment **or** B4 – Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	C1 Do nothing

Through sub-unit A, the main flood defence will be provided through construction of a new embankment, whilst in sub-unit B, the resilience of the existing shingle ridge will be improved to reduce breach and flood risk through either:

- regularly re-nourishing the face of the shingle ridge (B2), or
- widening the ridge through adding shingle to the landward face (B4), or
- managing realignment of the ridge, through reprofiling and repair (B5).

In addition, there would need to be an ongoing commitment to breach repairs through sub-unit B.

Along sub-unit C, no works will be undertaken.

Technical appraisal

As for Approach 7, the overall intention of this approach is to prevent a permanent breach from forming, whilst accepting a higher risk than under the higher cost approaches of 4, 5 and 6. The key difference from Approach 7 is how sub-unit A will continue to be defended.

The new embankment will be set back from the current alignment, which may reduce pressure on the interface between sub-units A and B. That area would also be protected through the inclusion of a rock knuckle or 'hinge point, as described elsewhere, to prevent outflanking and offer more protection at that pinch point.

As for Approach 7, along sub-unit B the dynamic nature of this section of shoreline and the underlying long term trend of erosion means that recharge will probably be needed on a regular basis if attempting to hold the current shoreline position (B2 or B4). That in turn will require shingle to be imported from offshore dredging on a regular basis (every 3 to 10 years) unless major extraction from Sudbourne Beach were permissible. This measure will be highly intensive and will require much greater flexibility on timing and volumes than currently permitted with the historic recycling campaigns at Slaughden.

In comparison, B5 ('natural' shingle ridge management), will require less intensive operations than seeking to hold the same alignment and profile. There therefore needs to be an acceptance of an increase in breach risk with this approach, and there is therefore a possibility that a lower wider barrier will actually result in more frequent over-washing (although there may be limited impacts of this).

Although in either case the ridge may become overwashed under extreme storms and a breach develop, that would be matched by a commitment to repairing (through the reworking and/or addition of more shingle) so that breach is only temporary and not permanent. This approach will involve advance planning including stockpiled material and readily accessible plant and well-defined trigger levels for action.

Potential Impact

The aim is to create a more naturally functioning shoreline, whilst accepting a higher level of breach risk. It is intended that any breach will be repaired, therefore impacts on the wider estuary should be limited and temporary.

Biodiversity, geology and geomorphology features	Impacts will be similar to Approach 7, apart from in sub-unit A. The measure here will enable a more naturally function coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on wider estuary will be avoided.

Water and hydromorphology	Impacts will be similar to Approach 7, apart from in sub-unit A. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on wider estuary will be avoided.
Historic environment and landscape	There is likely to be increased pressure on the Martello Tower (although works to secure the end of the existing seawall would be implemented, similar to that described for Approach 1). There will also be potential impacts on historical interests within the fringing marshland between shingle ridge and river banks along sub-unit A due to construction of the new embankment. As for Approach 7, there will also be potential impacts on historical interests, including possible historic oyster pits, within the fringing marshland between shingle ridge and river banks along sub-unit B as the shingle bank encroaches on this area. As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on wider estuary will be avoided. This should therefore be compatible with the objectives of the AONB for the estuary area.
Community, economy and material assets	There are limited assets at risk at a local scale. Access along the coast may be compromised by measure B5, including the ability for any vehicles and plant required to maintain assets on Orford Ness. As for Approach 7, As the purpose of the implementation measures is to prevent a permanent breach, large-scale impacts on the wider estuary will be avoided. However, during the period of breach, there may be increased pressure of the river defences, therefore these higher risks will need to be taken into account within the estuary plan. Although this approach generally supports the overarching objectives of the AOEP Estuary Plan, there will need to be a greater acceptance of risk.

Costs	
Initial costs to implement:	In the range approximately £8 million to £10 million.
Total costs (to 2055):	Approximate range £9 million to £13 million.
Total costs (100 years):	Approximate range £12 million to £20 million

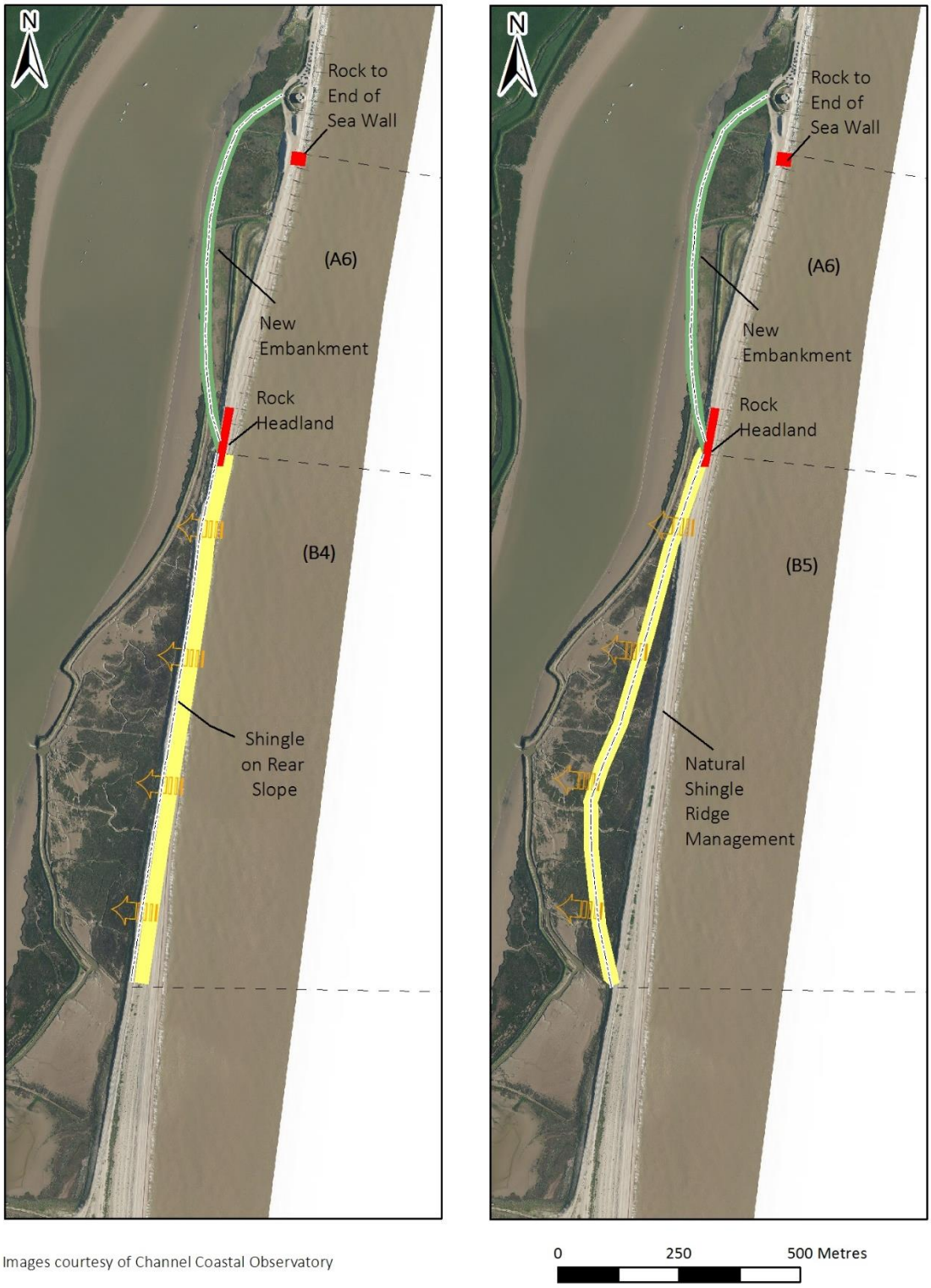


Figure 10 Examples of Approach 8 - Outcome Scenario: Temporary Breach

3.9 Approach 9 – Outcome scenario: No Breach

Summary of approach (Figure 11)

A, B, C - Shingle Engine

A large mass of shingle placed approximately 200m south of the Martello Tower, extending approximately 125m from the present shoreline and extend over a distance of 1000m to north and south of its centre point. This will have a 50 year design life.

Technical appraisal

A Shingle Engine is a mega-nourishment scheme, which involves placing a huge volume of sediment at one location along a coast and allowing it to be worked by wind, waves and currents to distribute the material along a coastal frontage. The approach will be to place shingle over an area centred just south of the Martello Tower at the start of sub-unit A, which will serve to feed material to both the north and south of the frontage. The aim of the approach is therefore to effectively widen the beach zone and thereby prevent a breach from forming.

Modelling by HR Wallingford (2016) highlights that success of this scheme in providing protection to the shoreline will depend upon the variability in nearshore wave climate along the shoreline and therefore the result net longshore drift rates. Behaviour of the Shingle Engine is also likely to be affected by evolution of the offshore bank, Aldeburgh Ridge, which is understood to be a key control on the nearshore wave climate. Behaviour of this ridge and its full role in affecting nearshore wave climates remains, however, uncertain. How the material is subsequently distributed will determine whether a breach will be prevented and until material moves south, the current narrow strip of shingle at the interface of A and B will remain vulnerable to a breach.

Given the large volumes of material required, it is assumed that this shingle could not be sourced locally, i.e. from Sudbourne Beach, and would need to be obtained through offshore dredging.

Potential Impact

The aim is to create a more naturally functioning shoreline, whilst minimising the risk of breach, therefore impacts on the wider estuary are averted. wider estuary should be limited and temporary. However, there will be impacts both locally along the open coast frontage of the Orford Ness complex and also potentially wider impacts as nourishment will take place in the intertidal zone rather than along the beach.

Biodiversity, geology and geomorphology features	This approach promotes a more naturally functioning coastline along sub-units A to C, feeding and interacting with the beaches and designated habitats to the north and south. There will also be potential for new habitats to be created/ supported, either naturally through creating wider beaches, or artificially, such as by creating saline lagoon areas. As material will no longer need to be sourced from Sudbourne Beach, there is also potential for an improvement in SSSI status here. There is however, a risk that such a large-scale nourishment could smother existing habitats, particularly within the intertidal and subtidal zones, as the sediment becomes redistributed by waves and tides. Depending upon the sediment grading of the nourishment material, there is a risk that increased levels of fines will be released into the water column. Placement of a significant mass of shingle within the intertidal and subtidal zones will also affect local currents and sediment pathways, the extent of which needs further study. The ultimate fate of the shingle will also need to be carefully modelled, as this has the potential to affect a much larger area than the more traditional approaches, beyond the Orford Ness shoreline. The source of nourishment is uncertain, particularly given the significant volumes required. There may be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided.

Water and hydromorphology	Redistribution of sediment and potential release of fines into the coastal water body may have a negative impact on water quality. The chemical and biological composition of the non-native nourishment material will also need to be carefully considered. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected.
Historic environment and landscape	Historical area of interest should be protected, depending upon the future mobility of the Shingle Engine. This approach will result in a significant change in the coastal landscape, which will need to be considered in more detail with respect to the AONB. As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided.
Community, economy and material assets	As the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. This approach is therefore in-line with the overarching objectives of the AOEP Estuary Plan. Although there may be recreational benefits associated with creating a wider beach area, access is already restricted to the site and without improvements to this, actually benefits may be limited. The potential impact on environmental sites due to additional visitors will also need to be considered.

Costs	
Initial costs to implement:	Based upon other large shingle nourishments, potentially in excess of £20 million
Total costs (to 2055):	In excess of £20 million
Total costs (100 years):	In excess of £30 million to £40 million

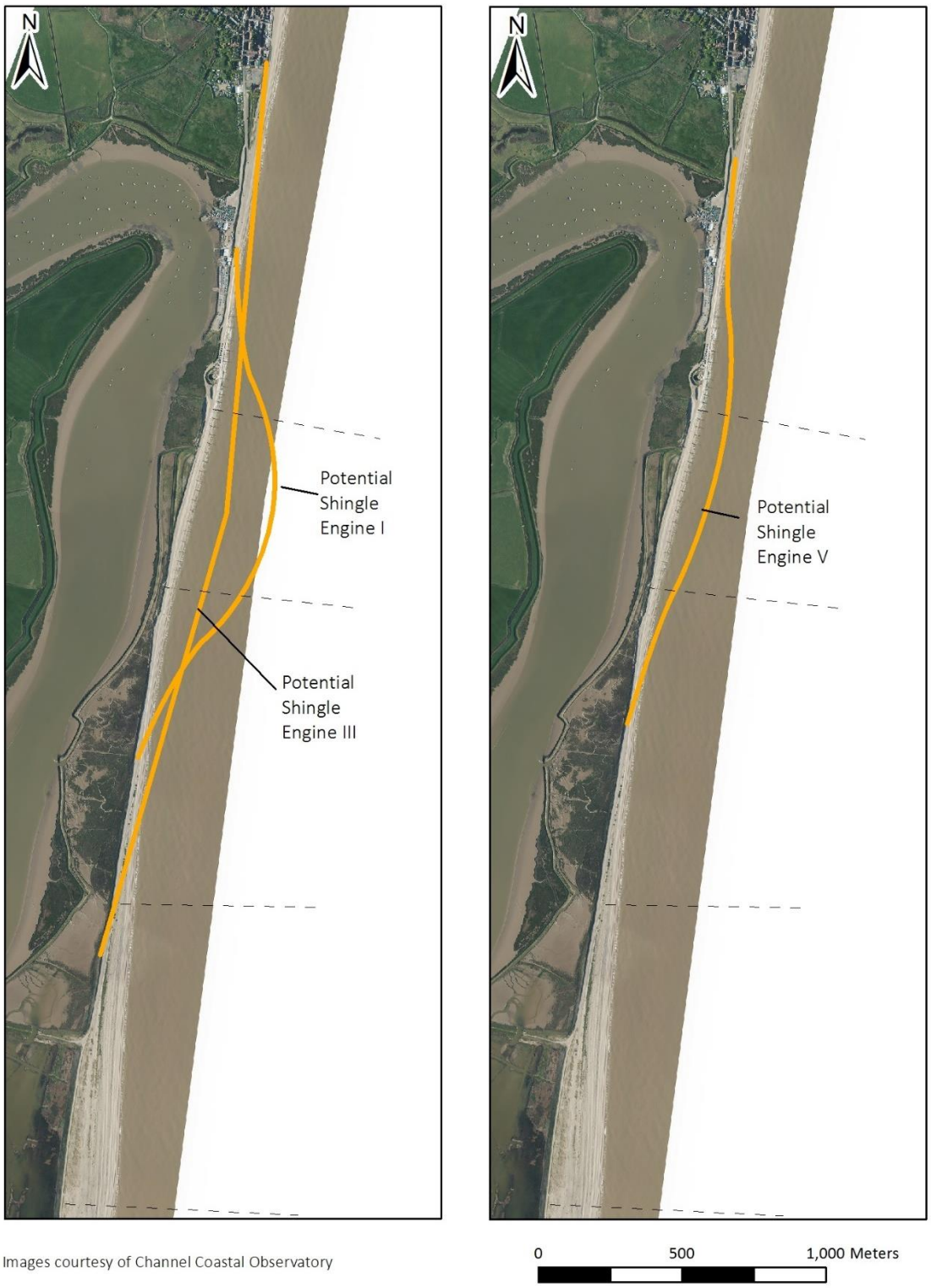


Figure 11 Approach 9 - Outcome Scenario: No Breach. Location of Shingle Engine I, III and V have been adapted from HR Wallingford, 2016.

Further Assessments

As described in Section 1.1, this current report presents only Phase 1 of this SMP policy review for Sudbourne Beach. The need for further detailed assessments will depend upon the way forward identified by the CSG, with a considerable level of additional work required to follow some paths,

but very little required to follow others. The aim of any additional studies to inform decisions on policy review would be to fill gaps in knowledge, in terms of potential impacts, and thereby improve confidence in future policy.

The nature of assessments that might be required include:

Impacts on estuary dynamics

- Potential for changes in water levels and impacts upon affected areas;
- Potential for morphological changes and to hydrodynamic regime.

Impacts on ecology

- Effects of changes in estuary dynamics, or resultant changes in estuary management to accommodate impacts of different outcomes;
- Effects of changes in coastal management practices on shoreline and marshes.

Impacts on socio-economic environment

- Flood risk to land and property;
- Tourism;
- Local use of the environment (e.g. boating);
- Heritage and archaeology;
- Agriculture.

It is important to stress that any appraisals will be at strategy rather than design level and the focus remains on identifying whether a change in policy for this unit should be implemented. If a change in policy is concluded, together with the appropriate implementation measures, then at this stage it may be necessary for further studies as part of the scheme design, including technical considerations, environmental appraisals and revised costings.

For the Breach scenarios (Approaches 1, 2 and 3) the key uncertainty is the large-scale impact on the estuary and implications for environmental sites, landscape, communities and businesses. Before these implications can be qualified there needs to be better understanding of how a breach will change water levels, flows, sediment distribution and flood risk. Pye (2016) reports previous modelling of water levels, flows and sediment transport within the estuary undertaken by HR Wallingford (1999), Black & Veatch (2006) and JBA (2011, 2012) used relatively simple 2D models of the estuary with limited validation and that the morphology of the estuary has also changed significantly since these modelling studies were undertaken. In addition, the earlier modelling by Black & Veatch did not fully assess the impacts of a potential breach at Sudbourne Beach. Pye (2016 also recommended that modelling of wave penetration into the estuary, and therefore implications for overtopping of the river walls and intertidal erosion along Sudbourne Marshes, is also required. A more in-depth examination of the models referred to above is first required to assess whether they remain fit for purpose or whether new models would be required. Various breach scenarios would then need to be considered, as it is understood from previous work that the location of breach is a key factor in determining how flows and water levels may change.

Following these additional studies, flood risk to properties would need to be re-appraised, taking account of the proposed management actions within the AOEP Estuary Plan. The data from the models can also be used to more fully explore implications for designated (and non-designated) sites within the estuary. The scope of such studies would need to be agreed with statutory consultees (Natural England, Environment Agency and Historic England).

For the No Breach Scenarios (Approaches 4, 5, 6 and 9) no modelling of estuary change would be required and similarly prior to design stage, appraisal of the approach is unlikely to require any

further modelling of the open coast. The exception to this is Approach 9 – Shingle Engine. As this is a new innovative approach to management and impinges on the subtidal zone, where only limited data exists, further studies would be required to assess both local and far scale impacts of this implementation measure, as also recognised by HR Wallingford in their 2016 appraisal.

Additional environmental studies would also be required in appraise the **No Breach** approaches, but with particular focus on impacts on local habitats. However, as the designated sites cover the whole of the estuary, the scope of studies for the No Breach Scenarios would need to be agreed with the statutory consultees. Indeed, all options presented have significant environmental risks associated with them and would require assessment under the Habitat Regulations.

The Temporary Breach scenarios (7 and 8) may not require the full estuary modelling outlined for the Breach scenarios, but work would be required to assess implications for overtopping of the river walls and intertidal erosion along Sudbourne Marshes. Although options which seek to work with natural processes to maintain a functioning, resilient ridge able to respond to coastal change are likely to have less environmental risk, as for the No Breach scenarios, a more detailed assessment of environment impacts would be required, with particular focus on the impact of extracting greater volumes of shingle from the current source area of Sudbourne Beach. The scope would need to be agreed with the statutory consultees, but where options might have impacts on the extent of estuary habitats, through coastal squeeze, land take, or shingle placement/roll over, then it is likely that this would need to be considered in a Habitat Regulations assessment.

A key aspect missing from existing documents is consideration of benefits that can be attributed to maintaining the current defence line along this unit. Without a tangible link being made between provision of defence and benefits provided it is not possible to produce a full economic justification. The modelling above would provide additional information on flood risks enabling an assessment to be made in terms of economic impacts on agriculture, tourism and other businesses. Any economic assessment would also need to include updated property valuations, in line with current FCERM guidance. As many benefits in this area are likely to be related to intangible assets, rather than properties, any economic appraisal should take account of the wider benefits, i.e. outside those considered by traditional economic appraisals, building upon the work already undertaken by RPA in 2014 and reported in the AOEP Estuary Plan 2016.

For this appraisal, indicative costs have been derived, based upon a number of assumptions. An Optimism Bias (OB) of 60% has been applied to the costs in each case, to allow for uncertainties in costs including items that fall outside of the primary costs, such as additional investigations, design fees and changeable factors such as increased costs of raw materials. Following feedback from the CSG, it may be possible to refine some of the costs to take more account of such risks to any change in approach or outline design. This could be appropriate for all approaches which constitute a change in policy option.

Summary

This appraisal has looked at potentially viable management approaches for the shoreline between the end of the seawall to the south of the Martello Tower and Sudbourne Beach covered by SMP policy unit 15.1, considering the SMP policy options of Advance the line, Hold the Line, Management Realignment and No Active Intervention. The current policy for this frontage is Hold the Line in the short term, to be followed by no active intervention from the medium term.

When the existing SMP policy was proposed, it was anticipated that a review would be undertaken, informed by the conclusions of an Alde and Ore Plan. An Estuary Plan for the Alde and Ore has now been produced by the Alde and Ore Estuary Partnership (AOEP Estuary Plan 2016). However, this does not include the coastal frontage and, as such, does not provide any recommendations or details on how the coastal frontage should be managed. It does, however, include the overall vision that the estuary should remain as it is now and seeks to ensure that river defences are of a standard necessary to withstand overtopping in a 1 in 200 year event.

For this review, a total of nine approaches which involve a combination of different measures for the three sub-units of shoreline have been outlined. There are however, only three main outcomes from these approaches: 'Breach', 'No Breach' or 'Temporary Breach'.

The Breach scenario, resulting from Approaches 1, 2 or 3, would mean a permanent opening along the shingle barrier, which would produce significant changes in the wider estuary system and adjacent shorelines. This is therefore not compatible with the objectives of the AOEP Estuary Plan, but is generally in line with the long term SMP policy, although there is clearly a need to ensure no inconsistencies with the policy unit directly to the north at Slaughden (14.4). Approaches 2 and 3 reflect that potential dependency and illustrate the need when considering the affordability of holding the line in policy unit 14.4, to consider any requirements in this policy unit (15.1) also. However, although these approaches would be consistent with the SMP, and therefore not strictly require any policy change, it would still be necessary to conduct further studies as part of a need to revisit the AOEP which could be significantly altered by those approaches.

The No Breach or Temporary Breach outcomes may both be compatible with the AEOP Estuary Plan; with the Temporary Breach scenarios there would need to be a greater acceptance of risk and there may need to be some further consideration regarding the ability of the existing defences to withstand a breach event. There are however, considerable differences in the cost involved in implementing the various measures and in the level of uncertainty regarding the likelihood of a breach forming.

Construction of new embankments along the sub-units A and B (measures A6, B7 and B8) would provide the greatest protection against the risk of breach and allow some realignment of the shingle, but bring some different technical challenges to address and the impact on the priority marsh habitats areas on which they would be constructed would need to be fully appraised. This would however come at considerable cost. A slightly cheaper alternative to an embankment for sub-unit A would be to maintain or improve the existing revetment (A3), but this will involve a longer-term and potentially increasingly expensive commitment to ongoing investment, whilst also offering a potentially higher level of risk.

Recharging the beach (measure B2) or widening the current shingle ridge (measures A5 and B4) provide slightly less certainty regarding the risk of breach. Costs would rise over time due to an increasing commitment to holding the line where it is at present if that were intended. A key issue with these approaches is the volume of shingle that would be involved in the initial bolstering the defence and subsequently maintaining it. These measures would require quantities far in excess of the current permitted extraction volumes at Sudbourne Beach, and therefore the full implications of this on the designated sites and habitats within the shingle source area would need to be discussed with Natural England. It is quite probable that to deliver these measures would instead require the importation of shingle from another source, i.e. offshore dredging.

If a higher risk of breach can be accepted, with the commitment to management when necessary, then a 'resilience approach of shingle ridge management (B5) could be considered. Natural ridge management in particular would be less intensive and thus considerably cheaper and more sustainable than other implementation measures, but will require an ongoing commitment to emergency repairs if and when the ridge is overwashed and unable to self-heal. With all of the temporary breach approaches there will be some correlation between the level of investment and the level of breach risk.

In summary, there are three basic outcomes, with different cost implications, as follows:

Breach

- Some approaches would not prevent a permanent opening forming along the shingle barrier, with significant changes in the wider estuary system and adjacent shorelines;
- There would be no direct costs for this policy unit, but some may be incurred to secure Slaughden frontage (policy unit 14.4) to the north.

No Breach

- Various approaches and combinations possible to continue to provide a continuous barrier between the estuary and the sea;
- Typically, initial costs range between £10 and £15 Million;
- Ongoing costs (to 2055) are typically a further £0.5 to £2 Million.

Temporary Breach (repaired)

- Although a barrier will remain in some form, it may be occasionally breached (in sub-unit B) meaning a temporary interaction between the sea and estuary, but there would be a commitment to the repairing that;
- Typically, initial costs would be between £5 and £8 Million;
- Ongoing costs (to 2055) range, but typically a further £2 to £3 Million.

There are quite different requirements for further analysis depending upon whether the approaches being considered further would lead to breach, no breach, or temporary breach. All outcomes will require an updated economic appraisal and some level of environmental appraisal. But the following differences also apply:

If preferred option is one with 'Breach' outcome

- Arguably, there is no change from provisional SMP policy, so further studies relating to a change in SMP policy are not necessary; however, the Alde Ore Estuary Management Plan would need to be revisited, and that would require extensive additional studies for that plan (rather than for the SMP).

If preferred option is one with ' No Breach' outcome

- Although this represents a change from SMP policy, the estuary-wide impacts do not result, so it is more likely that only assessments looking at local impacts may be required.

If preferred option is one with ' Temporary Breach' outcome

- This is little different from the existing management practice over recent years (where the occasional temporary breaches are not believed to have had any wider detrimental effects; in which case , the Estuary Management Plan should not need to be revisited and wider ranging additional studies are unlikely to be needed, with assessments only looking at local impacts more likely to be required.

The full extent of these requirements can only be determined once further direction on preferred outcomes, balanced against the cost implications, can be provided. This report is presented to help inform that discussion.

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Appendix A
Baseline information

Appendix A Baseline Information

This appendix includes the following:

- Overview of coastal processes and shoreline behaviour
- Environment, social and economic considerations

Overview of coastal processes and shoreline behaviour

Information used

Information on coastal processes and shoreline evolution has been mainly drawn from the recent study undertaken by CH2M (2016), which provided a summary of contemporary processes along the frontage, based upon a review of previous studies, including the SMP, and an analysis of recent beach monitoring and LiDAR data. The key documents appraised as part of this review are listed in the main body of this report.

Setting

Policy frontage 15.1 forms part of the large complex of Orford Ness, which can be considered as the shoreline between Aldeburgh marshes and the end of Orford spit (see Figure 12). Orford Ness encloses the Alde-Ore Estuary and forces the Alde - Ore River southwards. The present course of the river is constrained by river embankments, many of which date back several centuries (Pye, 2005). These embankments restrict any natural evolution of the channel in response to environmental changes. In several places the deep water channel impinges directly against the embankments; one example of this is the meander bend south of the Martello Tower.

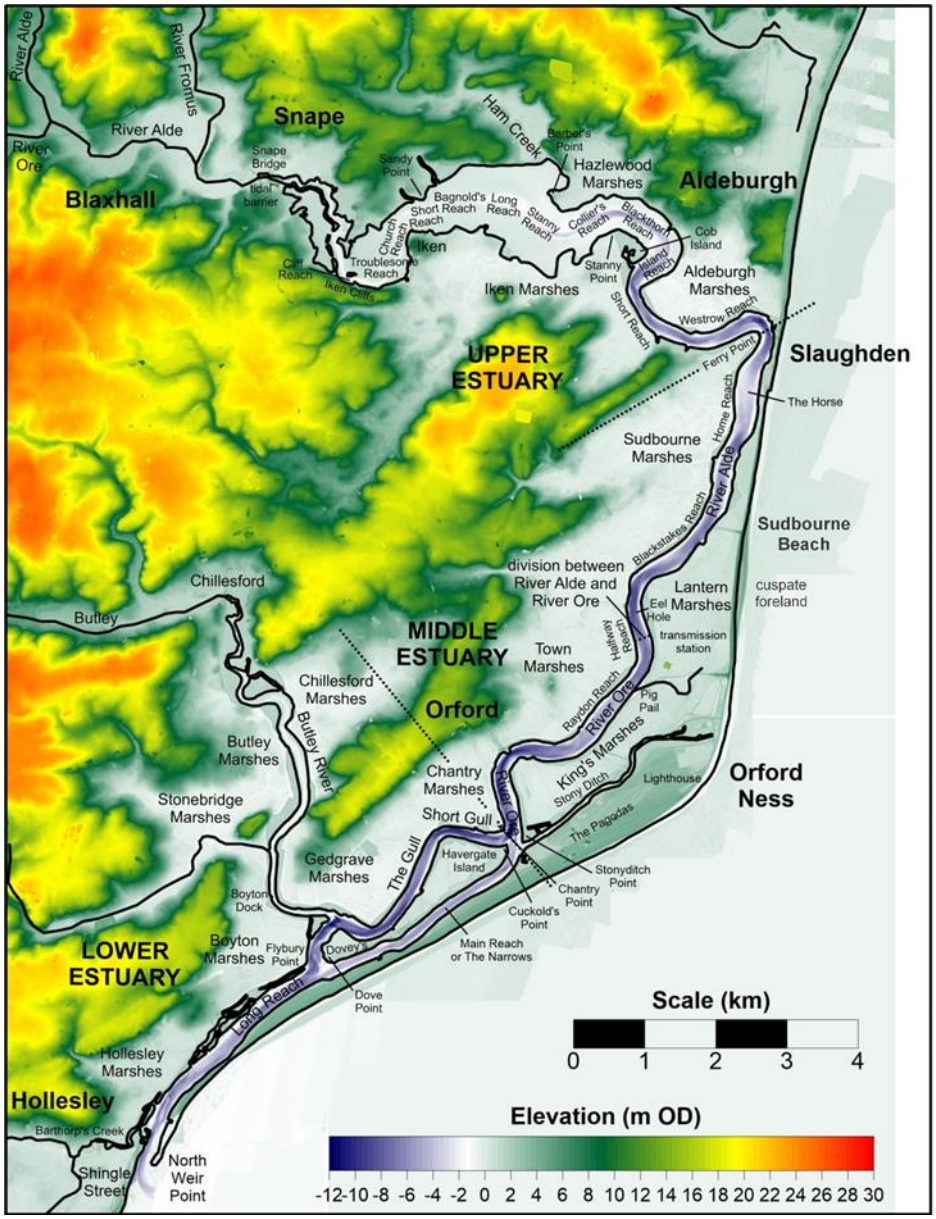


Figure 12 Location plan of the area. Reproduced from Pye and Blott (2015).

Physical environment

The wave regime along this is coast is bi-directional and as a result this shoreline experiences periods dominated by waves from the east-north-east alternating with periods of waves from the south-south-east. This has a significant effect on the net drift direction, which varies on several different timescales. Although short term variations within a year may not be significant, prolonged periods of waves from a single direction have more of an effect on the net distribution of material along the beach system and therefore on areas of growth and recession (HR Wallingford, 2016).

There are also subtle variations in the wave regime along the shoreline, which in part is likely to be due to changes in exposure and in particular the influence of Aldeburgh Ridge, an offshore sand bank which appears to be currently moving both northwards and onshore.

Figure 13 Wave roses for inshore locations at EA profile S046, generated from hindcast Met Office data set for 1980 – 2014. Reproduced from HR Wallingford (2016).

Mean spring tidal range is around 2.75m, but the frontage is susceptible to sizeable variations in water level due to factors including persistently strong winds, abrupt changes in wind direction, and storm surges.

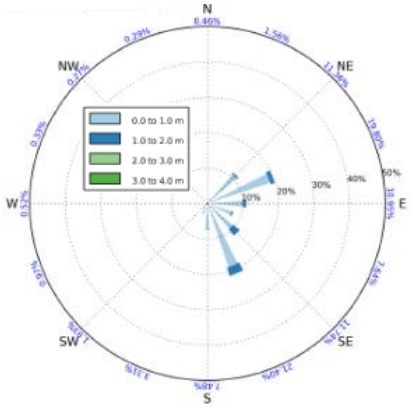
Movement of the sand portion of the beach is likely to be due to both waves and currents, whilst movement of the shingle is by waves alone. The most recent study of sediment transport has been undertaken by HR Wallingford (2016), as part of their shingle engine feasibility studies. This work concurred with previous studies and demonstrated that the gross rates of transport along this frontage are much larger than the net resultant transport rates. The work also showed that there was significant seasonal variability in drift rates, with much greater variability observed during winter months, as might be expected due to the prevalence of storms and therefore larger waves during winter months.

With respect to the frontage in question, HR Wallingford's work showed that between the Martello Tower and Sudbourne Beach, there was a net southerly drift in most years, although the drift direction was found to be very sensitive to the time period being examined. In contrast to some previous studies, the HR Wallingford modelling demonstrated a net northward drift between the nose of Orfordness and Sudbourne Beach, indicating that this location is an area of drift convergence.

There is very little mention of the role and significance of cross-shore transport in the various studies appraised.

Shoreline change

When considering the longer-term trend, this area has experienced net erosion over the last 180 years. The 2016 CH2M study examined beach profile data from 1992 up to February 2016. For the policy unit frontage, the works concluded that the frontage between the Martello Tower and Sudbourne Beach (the start of the cuspate feature) has experienced significant erosion in recent years. Profile data prior to 2010 is more sporadic but suggests a more stable situation, dating back to 1991, with present issues along this stretch of coast (between the groyne field and the recharge source area at Sudbourne Beach) understood to be a fairly recent concern.



Since 2010 there has, however, been progressive year on year erosion with the most significant loss occurring between February 2013 and February 2014, when the crest width narrowed by up to 15m in places. Beach profile data for this stretch indicates that along this stretch the face of the ridge was eroded and removed, with little evidence that any of this material was rolled landwards or overwashed. This is unsurprising given the maintained elevation of the ridge, which is typically

around 5 to 5.5mOD along this section (and higher to the north, along the groyned frontage), This means that overtopping and overwashing mechanisms cannot occur, therefore the barrier becomes fairly immobile as a feature and the steep shoreward face can result in greater reflection and beach scour. It has been estimated by others (e.g. Bradbury, 2014) that a more natural elevation would be 4.5 to 4.8mOD.

In some areas there has been some recovery since 2014, with material being pushed up the beach as a series of ridges, but no recovery in terms of the crest width, as this sits above 4.6mOD and above the reach of ordinary tides. The beach recovery of beach north of profile S044 may relate to predominance of northerly sediment transport in 2014, which may have moved material eroded from the frontage to the south into this area. Profiles SL043 and SL048 have, in contrast, progressively eroded and decreased in both width and cross-sectional area.

In contrast to this area of net erosion, immediately to the south there has been net accretion resulting in the development of a cuspate feature, which has been growing in size over the past thirty plus years. This is currently the source area for beach nourishment material, but despite the extraction of material the feature has continued to grow over time. Although there has been accretion along the whole of this feature, accretion has been greater along the northern edge. However it is difficult to distinguish whether this is a reflection of the feature growing northwards, or it is simply a result of more material having been sourced from the central and southern limits of the feature.

A crude calculation of volume change (based on the beach cross-section data) undertaken as part of the CH2M study suggests that the volumetric growth of this feature between 2002 and 2016 far surpasses the volume change along the frontage to the north (to South Aldeburgh) indicating that material to sustain the feature does not rely totally on erosion to the north. It should be noted, however, that the volume analysis does not distinguish between sand and shingle.

As a result of these changes, at the larger scale the coastline between the Martello Tower and Lantern Marshes the coastline has become more concave, forming an embayment between the end of the defences and the present cuspate feature.

The CH2M report concluded that the beaches between the Martello Tower and the cuspate feature at Sudbourne Beach are sensitive to variations in the direction of potential drift rates (based upon the data produced by HR Wallingford, 2016), which vary considerably over time. During periods of net southerly drift, it is likely that very little material is supplied by beaches at the Martello Tower (unless there has been a recent recycling operation) meaning that the beach immediately downdrift becomes starved of material. The data show that the trend for erosion then progresses southwards.

More material may be available during periods of net northerly drift, but the cuspate feature at Sudbourne Beach appears to be a store and therefore a partial sink for sediment that would otherwise be transported from the Orford Ness frontage that lies to the south. The cross-section data show that beaches between the Martello Tower and Sudbourne Beach were previously accreting. There is, however, insufficient information available to identify how much of this change might relate to recycling operations or is simply the redistribution of sediment from elsewhere along the frontage. Further information on the exact timing and volumes would be required to confirm this.

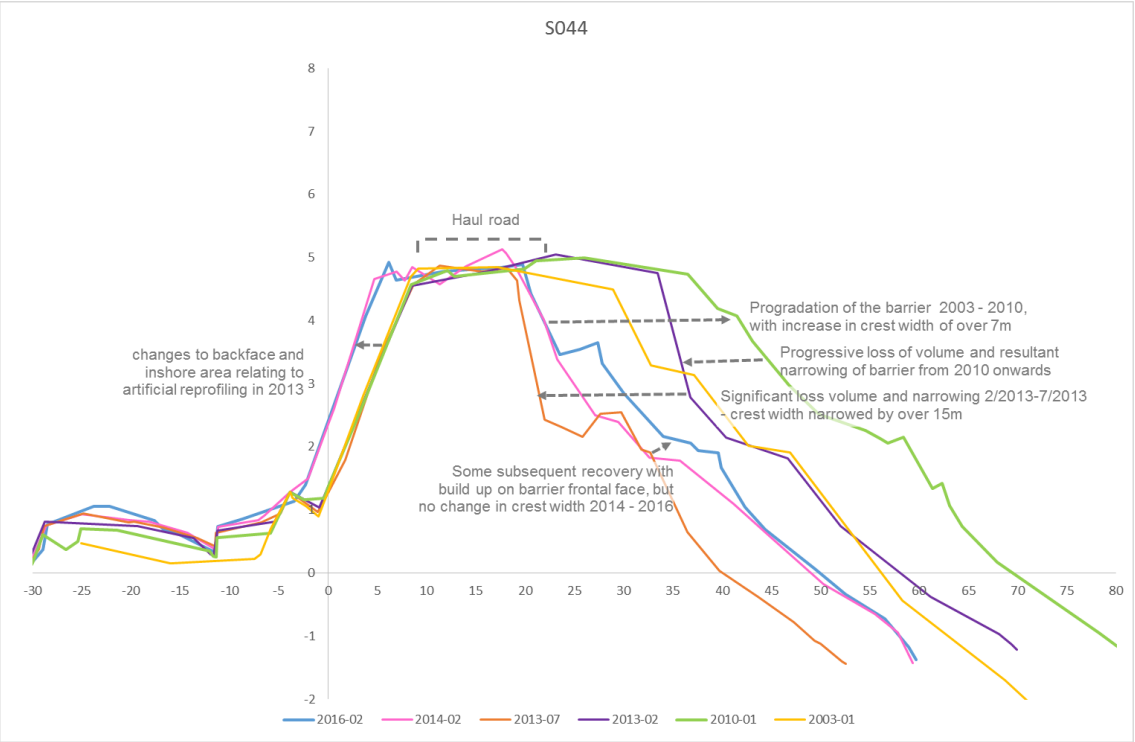


Figure 14 Example beach profile plot for location S044, which illustrates the initial accretion gf beach in this area between 2003 and 2010, followed by a subsequent net year on year erosion. Taken from CH2M, 2016.

Conceptual understanding of shoreline behaviour

As part of the CH2M (2016) study information on physical controls and shoreline response was brought together in a sketch, showing key features observed:

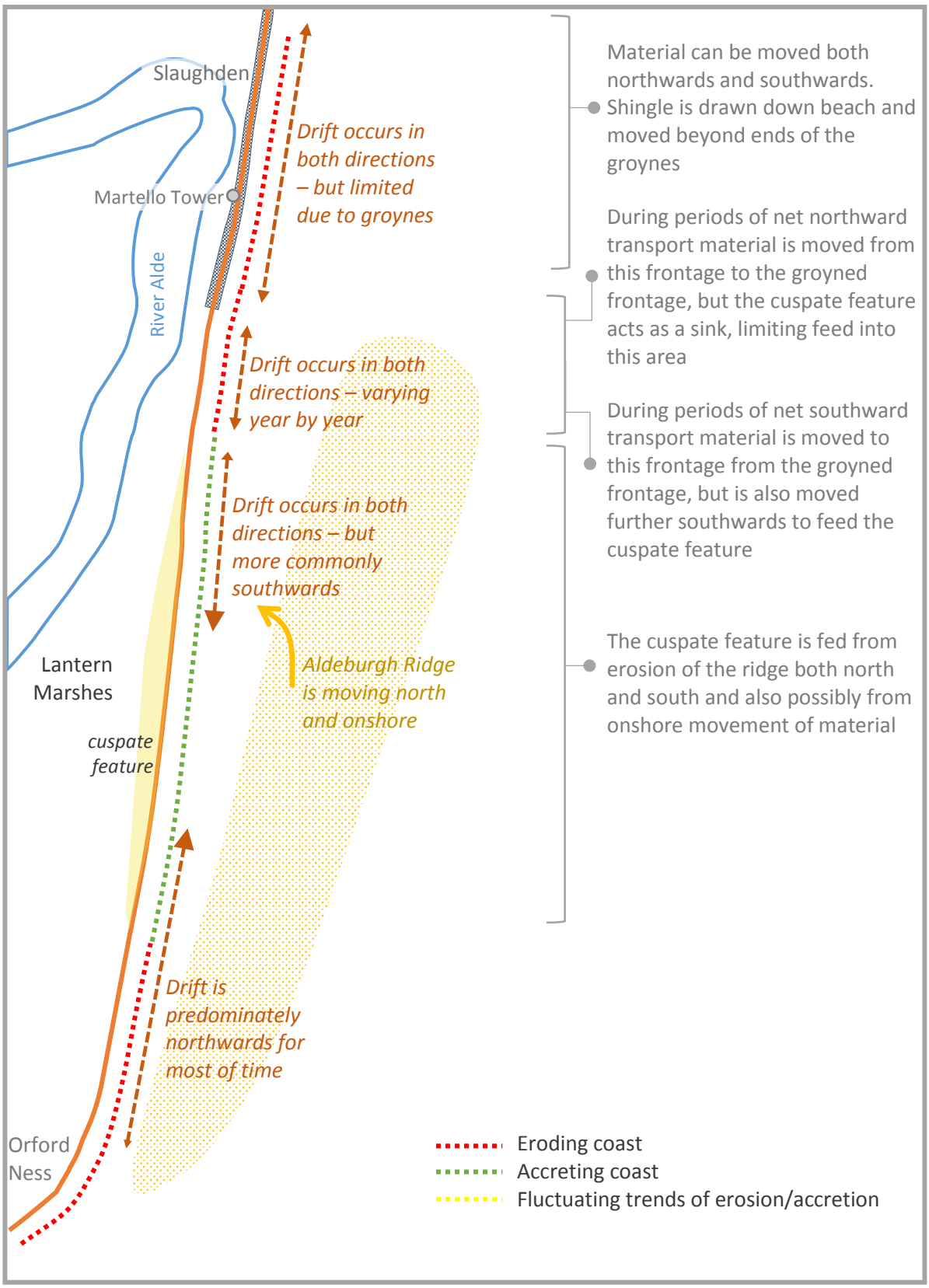


Figure 15 Conceptual sketch of the key features of shoreline behaviour.

Environment, social and economic considerations

Information used

This section draws upon information contained within the SMP and the more recent Alde and Ore Estuary Partnership Estuary Plan 2016, and also takes account of recent advice provided by Natural England in response to environmental risks and opportunities association with the Suffolk Shingle Engine (Natural England letter, 2016).

The environmental, social and economic features (and potential impact on these) can be considered at two levels: (a) local scale, the shingle spit, foreshore and saltmarsh which are bounded by the River Ore within the unit 15.1, and (b) estuary-wide, i.e. the Alde-Ore Estuary complex, which encompasses the remainder of the coastal frontage from Aldeburgh in the north to the end of the Orford spit to the south, and the Alde and Ore estuaries.

Biodiversity, geology and geomorphology

Local

The coastal strip is constrained by the Alde River to the west and the sea to the east. It is designated as part of the wider system, namely Alde-Ore Estuary Ramsar site, Ordfordness-Shingle Street SAC, Alde-Ore SPA and Alde -Ore SSSI. Further details on these designations is provided in the wider scale section. Orford Ness is also an internationally important nature reserve (Orford Ness NNR), with an RSPB site at Havergate.

Four priority habitats are recognised: coastal saltmarsh (lying between the shingle ridge and the bank of the River Alde), coastal vegetated shingle, saline lagoons (at the southern end of the unit) and mudflats (located along the bank of the River Alde).

The SSSI is broken down into a number of units: the SSSI units along the shoreline of policy unit 15.2 (units 13 and 15) are currently defined as being in an “unfavourable condition - no change” on the basis of “inappropriate coastal management” and “public access/disturbance”, respectively. The site inspection for unit 13 (in 2013) concluded that the vegetated shingle habitat is constrained between a track and eroding coast, meaning that the transition zones are quite limited and that there was evidence of trampling by foot and along track by vehicles. Loss of vegetated substrate within the unit was noted as a result of anthropogenic activities, including walkers, fisherman and vehicles. For unit 15, which covers the accreting section of coast fronting Lantern Marshes, the last Natural England inspection in 2013 concluded that historical activities (shingle extraction) have caused long lasting disturbance and that “there is presence of some activities causing disturbance notably EA shingle take and fishermen”. It is noted, however, that the report refers to the shingle ridge “naturally rolling back covering vegetation in places”, which is not indicative of the current accretion experienced along this section.

Estuary-wide

Orford Ness is a geological and geomorphological feature of national and international significance, being one of the three major shingle landforms in the UK and the only one which combines a shingle spit with a cuspate foreland. It is notified as a Special Area of Conservation along with Shingle Street (Orford Ness-Shingle Street SAC) and also forms the Orford Ness-Havergate National Nature Reserve. Qualifying features are:

- Coastal lagoons – these have developed in the shingle bank adjacent to the shore at the mouth of the Ore Estuary. Salinity of the lagoons is maintained by percolation through the shingle, although at high tides sea water can overtop the shingle bank. The fauna of these lagoons includes typical lagoon species, such as the cockle Cerastoderma glaucum, the ostracod Cyprideis torosa and the gastropods Littorina saxatilis tenebrosa and Hydrobia ventrosa. The nationally rare starlet sea anemone Nematostella vectensis is also found at the site (Natural England, 2005).

- Annual vegetation of drift lines – drift-line vegetation occurs on the sheltered, western side of the spit, at the transition from shingle to saltmarsh, as well as on the exposed eastern coast. The drift-line community is widespread and comprises sea beet Beta vulgaris ssp. maritima and orache Atriplex spp. (Natural England, 2005).
- Perennial vegetation of stony banks; coastal shingle vegetation outside the reach of waves - the site supports some of the largest and most natural sequences in the UK of shingle vegetation affected by salt spray (Natural England, 2005). Pioneer communities with sea pea Lathyrus japonicus and false oatgrass Arrhenatherum elatius grassland occur. The northern part of Orfordness has suffered considerable damage from defence-related activities.

Conservation objectives are to maintain or restore:

- the extent and distribution of qualifying natural habitats,
- the structure and function (including typical species) of qualifying natural habitats, and
- the supporting processes on which qualifying natural habitats rely (Natural England, 2014).

The adjacent estuarine and intertidal habitats are designated separately as the Alde, Ore and Butley Estuaries SAC. The Alde/Ore Estuary together with the shingle ness is also designated as a Ramsar site and SPA. The site comprises the estuary complex of the rivers Alde, Butley and Ore, including Havergate Island and Orfordness. There are a variety of habitats, including intertidal mudflats, saltmarsh, vegetated shingle (including the second-largest and best preserved area in Britain at Orfordness), saline lagoons and grazing marsh (JNCC, 2008b). The site supports nationally-scarce plants, British Red Data Book (BRDB) invertebrates, and notable assemblages of breeding and wintering wetland birds. It has been estimated that the area supports 20,000 seabirds feeding, roosting and nesting, including populations of redshanks and lesser blacked-backed gulls.

The site is also part of the Alde Ore and Butley European Marine Site (Natural England, 2014) and was recommended as a Marine Conservation Zone in 2012, but is yet to be designated as such.

In addition to the priority habitats identified at the local scale (see above), the area is noted for: “coastal and floodplain grazing marsh”, “refined coastal and floodplain grazing marsh”, “reedbeds” (small area along Orford Ness) and “no main habitat but additional habitat present” priority habitats.

The Alde-Ore Estuary is a designated Site of Special Scientific Interest (SSSI), first notified in 1949 and extended at the last revision in 1992. The site stretches along the coast from Bawdsey to Aldeburgh and inland to Snape. It includes Orfordness, Shingle Street, Havergate Island, and the Butley, Ore and Alde Rivers. The site contains a number of coastal formations and estuarine features including mud-flats, saltmarsh, vegetated shingle and coastal lagoons which are of special botanical and ornithological value, and the shingle structures of Orfordness and Shingle Street are of great physiographic importance.

Orfordness-Havergate NNR is managed by the National Trust and the RSPB. The site supports large lichen and moss communities. Many plant species that are nationally rare are found here in abundance (Natural England, 2008v). The shingle supports a number of rare and scarce invertebrates - particularly beetles and spiders - and the site is also an important breeding place for many bird species including terns and avocets (Recurvirostra avosetta) (Natural England, 2008v).

National Character Areas (NCAs) are areas that share similar landscape characteristics and NCA Profiles are guidance documents to inform decision-making. This shoreline is covered by NCA Profile 82 Suffolk Coast and Heaths (NE, 2015).

As part of the Profiles, Statements of Environmental Opportunity (SEOs) have been produced: of particular relevance to management of the shoreline is SEO1:

> “*SEO 1: Manage the nationally significant coastal landscapes, ensuring that coastal management decisions take full account of landscape, environmental and visual impacts as part of an integrated approach working with coastal processes. Improve people’s understanding of the process of coastal change.”*

Water and hydromorphology

Local

The frontage lies within the Suffolk waterbody (coastal) (ID GB650503520002), which is defined as "heavily modified", with moderate ecological status and good chemical status. Just to the south of the Martello Tower, the River Alde is a designated as a shellfish protected area by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 as amended. The aim of the designation is to protect and improve water quality to sustain shell fishing.

Estuary-wide

There are two water bodies that cover the estuary: Suffolk coastal waterbody (discussed at the local scale, see above) and Alde & Ore transitional waterbody. The Alde & Ore transitional waterbody is defined as "heavily modified" with moderate ecological status and good chemical status.

Of key importance to the areas are also the groundwater aquifers. Agriculture on the Suffolk coast is dependent on the maintenance of a freshwater supply from groundwater aquifers. Abstraction and storage of freshwater upon the lower marshes also allows use of the higher land around the estuary. The delivery of this supply is threatened by intrusion of salt water into freshwater aquifers and from the loss of boreholes at risk from erosion.

Historic environment and landscape

Local

There are no statutory historical designations within the local area. There are, however, a number of sites that are listed under the HER (Heritage Environment Record), namely post-medieval shellfish pits, post-medieval sea defences and post-medieval oyster beds.

Estuary-wide

The whole coast lies within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB) and Suffolk Heritage Coast (designated in 1973). The landscape character and special qualities of the Area of Outstanding Beauty are set out in the AONB Management Plan 2013- 2018. http://www.suffolkcoastandheaths.org/assets/AONB-Management-Plan-20132018.pdf.

At the northern end of the policy unit is the Martello Tower, a Scheduled Monument, whilst to the south is the former military area of Orford Ness including the Scheduled Monument, the Atomic Weapons Research Establishment and four WW1 and inter-war period buildings which are Listed as Grade II. Another relic of the cold war period is the steel structure which once housed a top-secret Anglo- American radar project, code-named 'Cobra Mist'. Further south is Orfordness lighthouse, Grade II listed, which is situated at the most south-easterly point of Orford Ness and which dates from 1792. There are also several listed buildings at Orford, Aldeburgh and within the parish of Sudbourne, landward of the River Alde, with three main conservation areas in Orford, Snape and Aldeburgh. There are a number of non-designated archaeological areas both along Orford Ness and within Sudbourne Marshes. Many of these relate to historic sea defences or remains associated with military activities.

Community, economy and material assets

Local scale

Other than the first few hundred metres, there is no public right of way as an access route to Orford Ness, although anglers are permitted pedestrian access. Any public access to Orford Ness, where permitted, is via ferry from Orford Quay.

Estuary-wide

The Alde and Ore area is a popular tourist destination, with an estimated 300,000 day and overnight visitors each year (reported in RPA, 2014). A wide range of business rely on the estuary and the activities it supports, such as sailing clubs, boat related businesses, fisheries, leisure facilities and

holiday rentals and Orford Ness itself is a popular sea fishing spot. English Heritage and National Trust are also significant contributors to local interests. The historic town of Orford lies inland on the River Ore and has a harbour and yacht club. Two other yacht clubs are located at Orford Haven and near Slaughden Quay (to the north). The SMP (Haskoning, 2010) recognised that the yachting centre at Slaughden is one of the most important in the area. The beach itself is also used by fishermen for boat launching and this activity is an important feature of the character of the area.

Access from the river to the open coast is through North Weir point, where there are massive continuously shifting shingle banks. Havergate Island lies between Orford beach and the mainland. It is a marshy nature reserve run by the RSPB, with large populations of avocets and terns.

Much of the natural flood plain of the Alde / Ore estuary is reclaimed and lies behind extensive flood defences. This land is an important agricultural area, which relies on freshwater being available for irrigation. Abstraction and storage of freshwater upon the lower marshes also allows use of the higher land around the estuary. A particular threat to farming and abstraction in the Alde-Ore area is seawater ingress. Occasional overtopping of ds defences is not a significant issue, as salt water can be pumped out, but agriculture will suffer is sea defences failed and seawater was able to flow into waterways within the Alde-Ore areas (RPA, 2014).

The majority of properties in Orford and Aldeburgh lie on higher ground and outside flood risk areas, with the main exceptions being those properties along Quay Street in Orford and along the southern frontage of Aldeburgh. There are however a number of isolated farmstead and houses which lie just within the flood risk areas of Town Marshes, Sudbourne Marshes and Aldeburgh Marshes.

The Alde-Ore area supports a number of public utilities such as electricity sub-stations and sewage/ water treatment works. Roads through the area are mainly access roads, including the B1084 into Orford and Quay Street, which is the road to the National Trust Quay.

The Alde and Ore Estuary Plan concluded that any changes in the river shape or flow, such as increased current, loss of navigable channels and increased risk of flooding will have an adverse effect on water-based and leisure activities.

Flood risk

The flood maps for the area (EA website) show little property at risk from flooding. It is also noted from the previous hydrodynamic modelling of the estuary that extreme water levels within the Alde and Ore may actually reduce as a consequence of a breach forming in the Sudbourne Beach/Slaughden area. Although the topography of the flood plains may mean that the extents of potential inundation will remain similar if any of those estuary walls/banks were also breached, the risk of that occurring is perhaps less as a consequence of those lower water levels.

Economic appraisals

Although some indicative costs for options are included in a few past studies, there is very little information contained in existing plans relating to economics for this particular frontage. The sections below summarise the key information contained within the previous appraisals.

Shoreline Management Plan

SMP7 provides an economic summary for the area, presenting the total economic damages of NAI for Management Area 15 totalling just under £0.8 Million. Unfortunately, the baseline information behind this is not included in the published documents, so it is uncertain what these values are based on. Appendix H of the SMP does, however, make reference to estuary damages totalling "*£14.4 Million - including floodzones O1, O2, O3, N1, N2*".

The SMP policy statement notes that over 90% of the economic activity of the Alde estuary hinterland is supported by tourism and agriculture, and that there is "*a concern that a breach in the area of Slaughden may destroy the unique safe sailing for which Aldeburgh is renowned*'. It also points out that south from Aldeburgh there is '*a 300-400m wide 100m deep London clay strip which creates an impermeable barrier to saline incursion from the seabed, and the aquifers within 500m of*

the coast produce large amounts of fresh irrigation water….. So, if seawater gets across the marshes into these sand aquifers, it will go to brackish for miles inland, wrecking all the underground irrigation of the hinterland and destroying the huge agricultural output."

No costs are attributed to this frontage in the SMP, reflecting the stated preferred policy to not intervene, although Appendix H also refers the reader to Management Area 14 which states '*The cost and impact of protecting against a breach at Slaughden is significant. Even so there are important interests that will need to be considered with respect to the broader economic value of the area. For these reasons a policy of HTP has been given for MA 14.4 [Slaughden] but NAI for Management Area 15. The cost for combining these two areas to provide continued protection against a breach is identified in the WPM [With Present Management] cos*ts'. Indeed costs included for Management Area 14 allow for £4 Million to manage a breach south of the Martello Tower, which, based upon statements in the main policy document, will appear to be the assumed cost for providing a terminal structure that will hold shingle to the north and provide a training wall to a breach that the SMP predicts will occur to the south of that structure, based on the preferred policies.

Alde Ore Estuary Plan

The executive summary of this plan states that this plan '*will seek to achieve the protection of the local economy, including agriculture, tourism and leisure pursuits, housing and the unique environment and flora and fauna of the area*.'

Based upon the Alde-Ore Futures work from around 2009, Appendix 11 (Flood Cell Prioritisation Data), identifies 556 houses in the floodplain. Approximately 45% of those are in one flood cell (FC10 – Aldeburgh), with a further 20% approximately in one other flood cell (FC4 – Orford). More details on these are provided in Appendix 12 (Flood Cell Features), which also provides a valuable first reference source for future economic appraisals. The plan does though note however that a local survey picked up omissions from that data, and in total around 1,400 properties in flood cells were identified.

The plan goes on to identify the potential consequences of not maintaining the river walls will also mean 3,878 Ha of land protected will no longer remain pasture or arable land, and many freshwater habitats in that area being lost. In addition, over 3,000 Ha of land outside the flood zone is irrigated for 'nationally valuable vegetation production' from water abstraction points within the flood plans – if those point sources became salinated that will render the water unusable and the farming practices will need to alter accordingly, with a product value of £6- to 8 Million less a year.

Further, the plan identifies the potential effects on tourism, a key local industry, which is calculated to contributing £80 to 90 Million or more to the local economy.

Costs to deliver flood risk management throughout the estuary are also included in the plan.

However, and critically for this appraisal, any economic assessment (damages, benefits or costs) for the Sudbourne Beach frontage is excluded from the Estuary Plan. So, although the plan provides some values that might be used in further economic justification, it is not apparent whether and to what extent a HTL or NAI policy may alter any of the impacts or requirements for the estuary defence lengths or risks to flood zones.

Alde-Ore Economic Study (RPA, 2014)

This 2014 report by RPA assessed the economic benefits of the Alde-Ore estuary and local environment, as it is now, to better understand who benefits from flood protection, based upon a wide-ranging series of surveys. This identifies that "*there are a number of activities which rely on the estuary and the local environment, with residents, visitors and local businesses valuing the landscape characteristics and opportunities they provide*."

RPA identified that 7,585 residential properties and 964 second homes lie within the Alde-Ore local area, having an estimated total spend by home and second homeowners of £16 million and £1.6 million per year respectively. The total visitor spend within the Alde-Ore local area by day and

overnight visitors was estimated to be £59 million and £17 million per year respectively. A further £1.4 million per year was identified as being generated by yachting and sailing, and around £65,000 per year by wildfowling. This gives a total annual spend of £96 million within the Alde-Ore local area by residents, visitors and recreational users.

The value of agricultural output alone to the local economy was estimated at £9 to £12 million per year within the Alde-Ore local area and the report highlighted that businesses in the Alde-Ore local area support a large number of jobs, many of which rely on the revenue generated from tourism and recreation.

The study also notes that "*The economic impacts of changes to the management of flood defences may be significant*", but recognises that the magnitude of changes to the local economy from such changes to flood defences cannot be made based upon this particular piece of work.

Appendix B
Option Development and Assessment

Appendix B Option Development and Assessment

This appendix includes the following:

- Review of previous management option appraisals
- Current management and defence condition
- Technical description of the potential implementation measures
- Summary of costs for potential implementation measures and management approaches

Previous management option appraisals

Suffolk Shoreline Management Plan (SMP7), 2010

The SMP does not consider different implementation options along the Sudbourne Beach frontage, and only considers the approach with present management and with no active intervention up to a point. In the estuaries appendix to the plan (Appendix I), for the Alde & Ore it states the following position taken: "*In the case of Slaughden, the SMP has highlighted the consequence of either maintaining defence at Slaughden or allowing or creating a new entrance to estuary at this location. The SMP makes recommendations solely from the perspective of management of coastal defences and discusses how adjacent sections of the coast might then be managed. These recommendations will then be considered through the Alde/Ore Futures initiative before final management decisions are made.*"

The SMP projects potential baseline erosion rates along this section of shoreline as being between 30m and 120m over the next 100 years. It also notes that, despite some variations in previous estuary strategies and associated modelling, "*in neither report is it suggested that there is a significant possibility of a breach from the estuary through to the sea. The main pressure for a breach is in terms of coastal erosion on the open shoreline*". SMP7 goes on to report "*The breach scenario has been modelled within the estuary and shows that Slaughden will act as the main inlet mouth*". A breach was considered to be likely to occur in either an 'Unconstrained' or 'No Active Intervention' scenario. As well as opening up the estuary, the SMP also describes the impacts on shingle transport and the potential for increased pressure on sea defences at Aldeburgh.

For a 'With Present Management' scenario, the SMP concludes that with the intent of preventing a breach into the estuary, defences will need to be extended southwards and will eventually reach a point estimated as being some 4km south of Aldeburgh. It goes on to note that although initial defence construction over the next 40 years will be sustainable over the period of the SMP, "*in order to stop breaches occurring further south, further modification and management of the frontage is likely to be required beyond the 100 years*". In short, any interventions along this frontage is still effectively delaying rather than preventing a breach somewhere along this stretch of shoreline.

The SMP does also note that should a new estuary mouth open up either at Slaughden or south of Martello Tower, the estuary will not form any significant ebb delta, and therefore sediment could be lost from the beaches to the north if a terminal structure were not built. Such a structure would have a potential benefit to the Slaughden and Aldeburgh frontages in increasing the level of protection afforded to those frontages.

The SMP identifies allowing a breach to occur would be the preferred approach, but also acknowledges that this does not take account of the impact within the estuary, recognising that such impacts could significantly affect many features and values therein.

In conclusion, the SMP sets NAI policies for the medium and long term, but accepts that a future estuary strategy plan may modify those.

AOEP Estuary Strategy Plan, 2016

Although the SMP defers to an estuary strategy plan to conclude on the requirements or otherwise for this section of shoreline, the adopted AOEP Estuary Strategy Plan does not address this; it contains no detail on potential options for the management of the coastal frontage (which is itself not included part of the plan).

Instead the plan defers to others to resolve management of the open coast (the Environment Agency, for example), but appears to be based on the presumption of no breach in the coastal defences with the ultimate aim of maintaining the status quo within the estuary for as long as possible.

One of the supporting documents (the Sustainability Appraisal Report of Jan 2016) refers to an Environment Agency Technical Report for Alde & Ore Futures, 'Managing the Coast' plan of 2011 (Halcrow, 2011). In addition to reviewing the merits of a number of generic options, this 2011 report summarises the results from modelling the impacts upon estuary water levels for a series of strategic scenarios (e.g. retaining or removing estuary defences, with or without a breach at Slaughden), and assesses three plans for managing the coast (A, B and C). The latter are based upon combinations of options with different funding approaches, concluding a preferred plan being that which was most economical and affordable, if sufficient contributions are available. It will represent a reduction in flood risk to people and property, while allowing the estuary to evolve and adapt through time due to the effects of climate change. Under that plan, it was expected that defences will eventually fail at Slaughden (estimated to be after 20 -30 years), and a permanent tidal inlet will have formed in this area.

The report includes no assessment of the risk or impact of a breach forming to the south of the Martello Tower. It is important to note that at the time of this report, the risks along policy unit 15.1 were lower, with the recent issue of erosion here having occurred since 2010.

Current management and defence condition

Current management of the shoreline

The frontage sits within the SMP development zone PDZ05, which stretches from Thorpeness in the north to just south of the apex of Orford Ness to the south (see Figure 1).

Policy Unit 15.1 begins at the termination of the concrete wall that fronts the Martello Tower which lies to the north of this Policy Unit (PU), and extends to a point midway along Lantern Marshes. The total length is approximately 2750m.

Although this PU has a shingle barrier throughout, the characteristics of this shoreline are somewhat different along its length, and might be considered in three sections, sub-units A, B and C, which reflect those differences, and the potential options going forward.

- The seaward face of the most northerly section (sub-unit A), a length of approximately 550m, is currently defended, through a combination of rock armour and mass concrete armour units, with timber groynes. Along the crest of the shingle ridge, a concrete block mattress exists to provide extra stability and a firm surface for plant recycling shingle along the frontage.
- The central section (sub-unit B) starts where that armour terminates, and is a single shingle ridge. There are no built defences along this section although the crest has been reinforced with hoggin beneath the surface to provide a firmer haul route for shingle recycling plant. This sub-unit presently extends over a distance of approximately 1300m.
- To the south of this (sub-unit C), accretion has resulted in the development of multiple shingle ridges rather than just the single ridge. This increases in width over the southernmost 900m. There are no structures along this section but the same underlayer to the haul route exists.

Behind the main shingle bank, the edge of the estuary channel is only approximately 100m back throughout much of sub-unit A, and narrows further to just 50m or less over the southernmost 100m of its length. That very narrow strip continues for another 250m approximately along the northern length of sub-unit B. Thereafter, the distance to the estuary channel increases up to approximately 200m, widening further as sub-unit C is reached.

Recycling

Although prior to the 1980s recharge was carried out along the frontage, planned beach recycling was only introduced in 1987 as part of the Slaughden scheme. Initially this involved around 25,000m^3 per year, but this reduced to recycling involving around 7,000m^3 of shingle per year, placed every two to three years, up to a maximum of 10,000m^3 per year. Material is sourced from Sudbourne Beach, an area immediately south of sub-unit C.

From 2003, the timing of recycling operations was changed from February/March to October/November to allow time for the germination and recovery of annual vegetation. As part of the recharge campaign, no mechanical reprofiling of the shingle is undertaken along Martello Tower frontage, it is simply tipped over the wall. The most recent recycling operation was undertaken in Autumn 2013. Following the storms in December 2013 emergency works were undertaken at the Martello tower, but these used existing stockpiles of shingle stored near the Martello Tower.

The future viability of shingle recycling is threatened by the risk to the haul road directly to the south of the groyne field at the Martello Tower. Here the shingle ridge is already narrow and should the shingle bank be breached it will not be possible to continue operations.

Existing condition

Sub-unit A

Although the shingle along ridge sub-unit A has been armoured with a revetment placed on the front face, this has suffered some damage in the past, with some slumping/slippage having occurred and some rocks/armour units displaced now on the lower beach.

There are areas of the revetment face which appear to be well covered with shingle from time to time, but this is not permanent cover and is a case of shingle filling the voids in the armour rather than forming a beach of any significance seaward of the defence. CH2M (2016) examined the effectiveness of the groynes along this section, concluding them to be relatively ineffective at shingle retention.

The increasing pressure on this length has become even more evident over the past couple of years. Despite the defences there is much more erosion on the seaward edge of the crest and now the concrete block mattress has been exposed and displaced at the southern end.

Without the rock and mass concrete armour unit defences, the shingle ridge would have experienced significantly greater erosion, and potentially even breached. A major reason for this is the unnaturally seaward alignment at which the shoreline is now being held at this location. Present evidence of damage and stress on this length of shoreline also suggests that improvements to the current defence measures are going to be necessary if a breach along this sub-unit is to be prevented.

Sub-unit B

This length of shoreline comprises a single narrow ridge and should be considered as susceptible to breach. This is particularly so at the transition point between the defended section, where the alignment is held, and this length where the natural tendency is for the ridge to move back. (It should be noted that a long-term retreat here is not a new trend – historic maps show this to have been a continual process since at least the first Ordnance Survey maps of the late 1800s). The 350m long section spanning sub-units A and B is a definite pinch point along this frontage.

Although this pinch point has been close to being breached at this point as recently as 2013, for most of the length the seaward face is characterised by a steep slope. Through this there is also a key relationship with sub-unit A – at times this is quite probably a source of shingle material to that frontage, whilst at other times it probably receives shingle material from there.

Historically the shingle barrier has been managed to ensure that a haul route of suitable width has been maintained. This has involved artificial profiling of the barrier into a high and steep sided berm. Evidence of recent changes along this coastline indicates that where there has been increased pressure on the system; the response has been for erosion of the face of the berm resulting in a net narrowing of the berm crest width. There is little evidence of significant overwashing or overtopping processes indicating that the barrier is not currently rolling landwards, which would be the expected response in a more natural situation, but some erosion along the edge of the haul route is noted in several places.

The landward side of the ridge is steep but partially vegetated, again suggesting some stability. There is however no buffer of material should the crest be overwashed – any significant event would likely result in a breach along this sub-unit.

Sub-unit C

At a point further south (which is transitional rather than fixed), there is a change from a single shingle ridge, to a progressively wider beach, featuring several ridges. Towards the southern end of sub-unit C there are possibly a dozen ridges lying seaward of the main shingle ridge. This is indicative of accretion over time (since at least 1992 when monitoring profiles began) and some northerly movement of material from the apex of Orford Ness.

Whether this is a trend that will continue, i.e. the length of the vulnerable sub-unit B will reduce, is not known as there is inadequate information or knowledge on that process to be able to confidently predict that to be the case. One possibly factor contributing to this process is changes in the nearshore bank and channel that lie offshore of here, but such linkages are yet to be established and fully understood.

Within sub-unit C itself, there is virtually no risk of breach, at least not for many decades and only then if the current accretional trend reverses to become one of rapid erosion of the multiple ridges, which is not anticipated.

Technical description of the potential implementation measures

Introduction

There are four SMP-level policy options to consider: Advance the Line, Hold the Line, Managed Realignment, or No Active Intervention. Various implementation options exist within these, and it is those which are the focus of this assessment.

Policy unit (PU) 15.1 begins at the termination of the concrete wall that fronts the Martello Tower which lies to the north of this unit, and extends to a point midway along Lantern Marshes. Although this is a single policy unit and is characterised by a shingle barrier throughout, the characteristic, current status and associated risks differ along its length, and so the coastline might be considered in three sections, sub-units A, B and C. Options for its future management have therefore been considered separately for each of the three sub-units, albeit recognising that in-combination effects must also be determined.

An assumption made for this assessment is that the policy to the north of PU15.1 remains hold the line and does not change, i.e. the defence of the Martello Tower, which forms a promontory along this coastline, remains in place.

Options considered for sub-unit A

Do nothing (A1)

A No Active Intervention policy is implemented through a Do Nothing approach. Under this approach the revetment and haul road will not be maintained. With volatile beach levels, it is probable that the armour units and rock will continue to slump and/or be displaced. In addition, more frequent overtopping of this slope will lead to further erosion of the crest of the shingle ridge and displacement of any protection along that (as evidenced by the damage already seen). With that erosion behind the revetment, the armour blocks and rock forming that will also become further destabilised and the cycle of reduced protection and increased destabilisation will continue.

The eventual outcome of this is probably not a full depth breach, as much of these rocks and blocks will remain, forming some barrier around below mean water. But it is probable that water will flow freely through this on high tides, which in itself may cause higher erosion in around the breach points with in the estuary, along the foreshore, and potentially threaten the stability of the seawall and Martello Tower situated to the north of this PU.

Interventions to Maintain/Develop a Beach (A2)

Attempts to Hold the Line through implementation measures that seek to maintain or develop a beach along this length are unlikely to be effective. The 2016 report for the Environment Agency considering approaches at Slaughden considered the merits of several approaches, including:

- New Timber Groynes (like-for-like replacement)
- Rock Groynes to replace existing timber groynes
- Longer Rock Groynes (with or without more shingle renourishment)
- Offshore Breakwaters

The conclusion however, was that none of these approaches were likely to be either technically suitable, effective, or affordable, either along the Slaughden frontage or sub-unit A to the south of that. Recognising the issues with shingle retention along this frontage, which are described more fully therein, approaches based upon reinstating groynes, building breakwaters, re-nourishing the beach or increasing levels of recycling in an attempt to maintain the present defence line are considered unlikely to be suitable options at this location.

Maintain/Improve the Existing Revetment Structure (A3)

An obvious approach to implementing a Hold the Line policy will be to maintain the existing revetment structure. However, existing damage (that has occurred since the assessments that fed into the 2016 report for Slaughden) already shows that structure alone is clearly not adequate to provide a robust line of defence in the longer term. Therefore, works will be required to bolster and improve this structure, which will require the import of additional rock/armour units to strengthen it. But, that alone will not address the issue of falling foreshore and the potential slumping of that structure, and a more robust toe will be required. If this approach is to be progressed then it may prove better to pick apart the existing structure and rebuild it using the existing and new materials, to a form that is going to be more resilient to increased storm exposure in decades to come. Future works to maintain this line are also going to require work to maintain the crest of the ridge, potentially having to replace the block mattress currently there.

New Seawall (A4)

An alternative approach to maintain the current position will be to replace, or supplement, the existing revetment with a concrete/sheet piled seawall – extending the structure that currently terminates just to the north of here. That is not considered an appropriate option, with the problems experienced at the Martello Tower already evident and due to the issues already of retaining a beach this will simply extend the same issue.

Widen the Defence (A5)

A different approach will be to widen the defence line by adding a buffer of shingle on the rear face of the ridge. This will not in itself prevent the damage occurring to the revetment on the seaward side or prevent some overtopping and scouring of the crest from occurring, but it will reduce risk. Provided this were substantial enough, it will be there to prevent a breach from occurring during single storm events and give time for repair to overtopping erosion damage to then be undertaken. Although works will therefore be required to maintain and sustain the existing protection on the seaward side, this can be carried out on an 'as-required' basis. In time it may be that the seaward protection is no longer sufficient and works similar to that described for the maintain option will be required (see above). However, the cost of those works may be deferred for several years until necessary, and the extent of those can be matched to the actual need, as the risks are lowered.

The quantity of additional shingle required to enable this option would be lower than the current recycling operations from Sudbourne Beach, but would require a higher amount to be removed in a single operation, but less frequently. As it is not certain that would be permissible, particularly in the longer term, it may be necessary to import this shingle from another source, most likely offshore dredging.

New Embankment along estuary channel (A6)

There is limited space available for Managed Realignment along most of this sub-unit due to the proximity of the estuary channel on the landward side of the ridge, which is within 100m. Because the footprint of any new structure will be at least 25-30m, any new alignment (as opposed to widening the current defence) will effectively therefore be a new structure along the marsh side edge of the estuary channel. The technical difficulties in doing this should not be underestimated; constructing over what will be poor soil conditions to achieve the necessary elevation and stability could necessitate substantial works and costs. This will also need to be engineered to resist and potential erosion on the river and tidal flows within the estuary, as well as protected on the seaward side to resist wave attack from the sea, the extent of which will depend upon choices made regarding the existing defence.

One option for protection of any new embankment under this approach will be to reclaim some of the material presently used to armour the existing ridge, and place this on the front face of the new embankment, which will also become the new access route between Slaughden and Orford Ness. That will have some benefits in terms of allowing the beach slope to behave more naturally, and reform itself in front of the new alignment.

Another option will be to leave the rock and concrete armour block on the existing alignment to provide added protection. Although they will become overtopped and slump over time, the remains of the 'sacrificial' structure will in itself still serve as a low breakwater/raised toe berm to reduce wave action on the new embankment. It will also provide some continuity with the existing seawall and thus added protection to the Martello Tower, which is otherwise at risk of becoming outflanked if the end of the wall is not adequately defended.

Terminal structure (A7)

The Shoreline Management Plan presents an approach that will most likely result in a breach at some point to the south of the Martello Tower, but in order to hold the line through the Slaughden frontage and Aldeburgh to the north, a terminal groyne will be constructed. This same option is also outlined in the Alde and Ore Futures – Managing the Coast Technical Appraisal Report.

The principle is that construction of a terminal groyne will enable sediment build up updrift of the groyne, reducing flood and coastal erosion risk at Slaughden, although the rate of erosion is likely to increase downdrift of the structure. This will move the potential breach location to a point further south rather than at Slaughden.

Two locations were proposed; one at the interface with the concrete seawall at the northern end of sub-unit A, the other at the termination of the rock/armour revetment at the southern end of sub-unit A.

Other considerations

Depending upon the approach implemented works may be required to secure the termination point of the seawall directly to the north of sub-unit A, and prevent that from being outflanked.

Likewise, some works may be required at the southern end of sub-unit A to prevent outflanking of this unit as a consequence of whatever approach is implemented in sub-unit B. In that respect, the creation of a hard point spanning sub-units A and B may be appropriate if any realignment were considered to north and south of this point.

In fact, as part of enabling a more naturally functioning coastline to evolve south of Slaughden, Bradbury (2014) suggested the construction of a headland structure at a location between the Martello Tower and the end of the groyne field to form a 'hinge point'. The concept will be to encourage the development of a bay south of the defended frontage, with the aim of enabling a more naturally functioning shoreline to develop, through some reorientation of the beach to the south.

This will follow the same principle but the proposal will be to create that hardpoint where the distance between the sea and estuary is narrowest, i.e. along the 350-400m spanning sub-units A and B. That could also help support a managed realignment approach to the north of this point too, i.e. in sub-unit A, by helping to stabilise any beach material that might accumulate in front of a retired line.

Options considered for sub-unit B

Do Nothing (B1)

Although there will be significant implications from a No Active Intervention approach, the appropriateness and implications of this need to be considered. It is also a baseline against which other approaches can be evaluated.

As evidenced from recent experience, it is probable that future storms will result in a breach through the bank occurring at some point in the future. This could occur anywhere along its length, but is most likely to first occur at the interface between sub-unit A and sub-unit B, simply because the hard defences in sub-unit A will present a discontinuity along the frontage.

Whether a breach will cut to full depth, to become a new entrance channel for the estuary, or some form of barrier beach that may be occasionally overwashed, depends upon a number of factors,

including the hydrodynamic regime within the estuary and the dynamics of the shingle on the shoreface. Determining that will require more extensive study and modelling which is beyond the current remit.

In addition, it is expected that the shingle ridge will also roll landward over time as sea levels rise and exposure increases, which may also result in some changes in the profile of the ridge. That will again result in some continuity issues and potential for breach at the interface between sub-units A and B, assuming the former is still defended.

That roll back also presents another issue over the northernmost section of sub-unit B, as there is limited space before the ridge will encounter the estuary river channel. As it moves into that area the bed levels fall and thus the ridge will no longer be able to sustain its current elevation.

Beach Nourishment (B2)

An approach to strengthening the existing shingle ridge will be to introduce more beach material to the foreshore, regularly re-nourishing the beach.

Profile data indicates that since 2010 this frontage has tended to show a net decline in volume. Prior to this, it is possible that recharge of the groyned frontages to the north provided an input to this frontage and helped to sustain this frontage. Subsequent build-up in some areas following the severe erosion in 2013 indicates that the beaches do have the capacity to retain sediment. However, the dynamic nature of this section of shoreline and the underlying long-term trend of erosion will mean that recharge will probably be needed on a regular basis. There will also need to be re-profiling if the current level of the haul road were to be maintained, as this sits above the natural crest level. Unless substantial volumes of recharge were undertaken this is likely to result in a steeper seaward face of the berm being created than will occur naturally, in order to achieve the required berm height, which in turn will potentially result in a more reflective profile and greater potential for erosion.

An issue with the approach will be the need to keep pace with the rate of shingle movement along this shoreline. It is possible that an initial major campaign might be needed to build up a sufficiently robust barrier width, with regular renourishment to maintain that in areas where the beach becomes depleted due to prevailing conditions. Given the susceptibility to breach in places, such as the interface between sub-units A and B, an emergency response capability may also be required.

This approach will be highly intensive and will require much greater flexibility on timing and volumes than currently permitted with the historic recycling campaigns at Slaughden. The quantities of shingle required to implement this measure would be considerable and, combined with the frequency of operation, mean that it is highly likely that use of material from Sudbourne beach would not be permissible (even though this shingle will remain in the littoral system). Consequently, it is probable that the shingle would have to be imported, i.e. sourced from offshore dredging, both for the initial campaign and subsequent operations.

Interventions to Hold a Beach (B3)

Approaches to hold a beach may include introducing groynes or building breakwaters, in conjunction with initial nourishment and subsequent recycling operations to replenish the beach to the requisite profile when necessary.

This should have the advantage over simply recycling, in reducing the extent of longshore movement and thus reduce the frequency and quantity of those operations.

However, experience in sub-unit A and to the north of that have so far indicated that such structures have become ineffective and difficult to maintain. Although the offshore profile and water depths, combined with some change in alignment of the shoreline further southwards may result in greater success, that will need to be subject to more detailed investigation, and it is considered likely that these will have very limited effectiveness over the more northerly length adjacent to sub-unit A, based upon performance there.

The comments made for B2 regarding sourcing of shingle would also be applicable here for any necessary recharging of the beaches.

Widen the Shingle Ridge (B4)

In order to achieve the required width an alternative measure will be to recharge along the landward edge of the ridge, as has been proposed by others (e.g. Bradbury, 2014 and Orford, 2014). The advantage of this approach is that the fresh material will not be removed by longshore transport and will be an artificially replicating the natural process of barrier rollback – in this way it may be possible to achieve a more dynamically stable position.

This will not in itself prevent some reprofiling and littoral transport occurring on the seaward side or prevent some overtopping and scouring of the crest from occurring, but it will reduce risk. Provided this width were substantial enough, it will be there to prevent a breach from occurring during single storm events and give time for repair to overtopping erosion damage to then be undertaken. Further material will therefore probably need to be stockpiled.

The quantity of shingle required to enable this option would be considerably more than the current recycling operations from Sudbourne Beach, and would also require a higher amount to be removed in a single operation. It is questionable whether this level of removal would be permissible, therefore it is likely that it would be necessary to import this shingle from another source, most likely offshore dredging. That will have higher cost implications, which would reduce substantially if material could be obtained locally.

'Natural' Shingle Ridge Management (B5)

Whereas the beach nourishment approaches will seek to hold the ridge in its present position, an alternative will be to allow some ongoing natural movement of it whilst maintaining its integrity.

With this approach, instead of operations designed to hold the shingle bank in its present position, it will allow some landward roll back of that position, also allowing it to adopt a lower crest elevation as nature determines. This will ultimately require less intensive operations than seeking to hold the same alignment and profile, and be closest to a natural formation, albeit with some assistance.

As argued by Pye (2015) there is no guarantee that a new non-maintained barrier, left to roll back naturally, will maintain constant volume and crest height. Historically this has not been the case along this coastline, and even prior to the construction of defences roll back of the Slaughden ridge appears to have been accompanied by net volume loss resulting in a narrower barrier developing over the period of Ordnance survey mapping, i.e. the last 180 years. There will need to be an acceptance of an increase in risk with this approach, and there is therefore a possibility that a lower wider barrier will actually result in increased overtopping (although there may be limited impacts of this) but ultimately more frequent over-washing.

If implementing this approach, some consideration could however be given to whether temporary breaches will actually be acceptable, if managed through being repaired by the re-instatement of the shingle bank where necessary following storms.

Such an approach will include being prepared with stockpiled material and readily accessible plant to make good if and when this occurs. That will be necessary as occasional breaches and temporary loss of the haul road will be a consequence which will need to be factored into this approach.

In line with the philosophy of this approach, it is anticipated that any shingle required to help maintain and manage the barrier could be sourced locally, i.e. not imported from offshore dredging. The quantities required in any single operation should not exceed the amounts currently permitted to be taken from Sudbourne Beach, and the total quantity required would be substantially less than the current recycling operation. Any shingle recycled to sub-unit B would also remain in the natural littoral system.

What is currently uncertain is how the apparent northerly and landward movement of Aldeburgh Ridge and growth on the north side of the cuspate feature at Sudbourne beach might affect the erosional or accretionary trends in the future. So, this may be an approach worth considering rather than embarking upon more expensive and potentially unsustainable works to maintain the haul route if this area does appear to suffer only occasional problems and the movement of these features could result in naturally improving stability here.

It needs to be acknowledged is that whilst it should be technically feasible where the barrier is backed by marshland, there will be longer term issues associated with this practice where the width is narrow due to the proximity of the estuary channel.

Extend the Revetment Structure along the shoreline (B6)

Pye (2015) suggested that a possible option to reduce the risk of breaching will be to extend the hard defences southwards, i.e. something similar to the revetment structure in sub-unit A. However, based upon damage and erosion observed recently along sub-unit A, this will need to be a more robust structure than its counterpart (deeper toe, larger armour units, thicker revetment and potentially higher elevation).

Whilst recognising that this will move the issue of beach erosion southwards, he argues that the greater width of barrier further south will reduce the level of flood risk and breach. The proposed approach included some realignment of the shingle ridge before placing the revetment, and then seeking to maintain a beach in front through recycling .However, based upon more recent experience seen in sub-unit A, it is thought unlikely that a beach could be retained along the whole of this frontage without considerable renourishment in the future, particularly the northernmost few hundred metres, due to the migration of low water and decreasing lack of space for a beach to be accommodated. It is also unlikely that measures to retain the beach, such as groynes, will assist, given the evidence of their ineffectiveness in sub-unit A.

It is also possible that a phased approach might be adopted here, i.e. initially extend a revetment for some distance only, e.g. 500 to 800m, and manage the unprotected ridge over the remaining length, only extending the revetment further south as and when the need arises. However, it is notable from most recent inspection that erosion to the edge of the haul road hoggin is evident quite a long way south in this unit, suggesting that this too is potentially vulnerable to breach. Although a phased approach might be adopted, i.e. address such issues only when they become more serious, that may not be that cost effective or environmentally acceptable, as the nature of works required each time will require significant materials to be imported and large plant to be mobilised to the area.

New Embankment along estuary channel (B7)

Compared to sub-unit A, there is more space available for Managed Realignment along most of this sub-unit, with the estuary channel being around 100m landward of the ridge. Consequently, even with continued retreat of the shingle ridge, it will not impinge upon any new flood embankment over the course of the coming 100 years.

The exception to this is over the northernmost 250m length, adjacent to sub-unit A, where there is no space available for managed realignment – although an additional flood embankment might be constructed, this is effectively simply a widening of the existing defence line.

Elsewhere, the form of any realigned defence will likely be a new earth embankment along the marsh side edge of the estuary channel. That will therefore also need to be engineered to resist and potential erosion on the river and tidal flows within the estuary. The seaward side may require some light protection but as the natural shingle beach will still exist in some form, and there are also saltmarsh areas between the two defence lines (albeit the characteristics of that saltmarsh may alter), most wave action will be attenuated even when localised breaches in the shingle occur.

New Embankment - alternative alignments (B8)

With the exception of the northern end of sub-unit B, there are alternative alignments due to more distance being available for Managed Realignment, thus avoiding the need to construct directly along the estuary channel.

The minimum extent for any such re-alignment should be a distance greater than the predicted 100m shoreline position, so that the shingle beach can continue to evolve naturally and unimpeded. But there may be other alignments between these two extremes which offer a more favourable route due to topography or ground conditions (which will affect cost) or to minimise impacts on habitats for example.

One further consideration is that a major expense in building such embankments is the cost of providing any surface protection – the less exposed they are the lesser the requirement for any protective covering. Consequently, the further back from the coast that any embankment can be located, the lesser the frequency and severity of wave attack, and therefore the lower the cost.

Other options/considerations

As described for sub-unit A and extending that principle, an approach which fixes the position at the interface between sub-units A and B, to form a hard point may be appropriate, with realignment to north and south which will then also provide a wider area which is more conducive to sediment trapping and a more natural shingle beach forming seaward of the realigned flood embankments. A variation on that might be to that might also be to maintain the revetment line in sub-unit A, extending that southwards for 250 to 300m, and then adopting one of the other approaches for sub-unit B such as realigning to the south of that with a new embankment.

Options considered for sub-unit C

Do Nothing

The FCRM risks within sub-unit C are negligible and the best form of defence here is to allow the natural development of this area. Consequently, the only policy option to be considered here is No Active Intervention (do nothing).

Allowing the beach material to move naturally and unimpeded in this sub-unit is likely to result in little net change in the form of this area, with multiple ridges of shingle between the sea and estuary. The number of these and width of this area may expand or contract, depending upon prevailing coastal processes, but is sufficiently wide to be able to tolerate considerable change without any increased risk of breaching along this frontage.

This approach will also ensure that the potential natural improvement in the standard of protection achieved in sub-unit B is not compromised if present accretional trends continue to result in a northerly direction.

Whole policy unit (sub-units A, B and C)

Shingle Engine

A Shingle Engine will affect all three sub-units, as well as the unit to the north of 15.1, so is addressed here rather than under each sub-unit.

The approach will be to create a large mass of shingle, containing approximately 1.2 Million cubic metres of shingle, centred approximately 200m south of the Martello Tower. This will take the form of a bell curve, extending approximately 125m from the present shoreline and extend over a distance of 1000m to north and south of its centre point.

Due to the extremely large quantities of shingle involved, it is almost certain that it would not be permitted to remove this amount of material from Sudbourne Beach and so will need to be sourced from offshore dredging.

Re-routing the Alde

Re-routing the Alde was considered by Orford (2014) as a possible way that 'accommodation space' could be provided for barrier retreat and involved the artificial breaching of the meander spur to allow realignment of the Alde channel landwards. This will seek to remove pressure north of the Martello Tower where the river meander meets the shoreline. This was promoted as a concept only, with no discussion of costs or impacts. In his review, Pye (2015) dismissed the idea due to the expensive of this option and the detailed studies which will be required to support it.

Pye did also considered the pressure at Slaughden resulting from the estuary on the landward side of the shingle barrier. He considered that the construction of a bypass channel at Sudbourne Marshes may offer a viable means of relieving this pressure and enabling landwards realignment of the shingle barrier by up to 50m. This might be a consideration for any managed realignment option here too.

Comparison of shingle quantity requirements

The quantities presented below are indicative of different requirements and based upon very high-level assumptions regarding beach behaviour and response. They are presented for relative comparison purposes only and should not be used in any other context.

APPROACH	Initial Requirement	Future Commitment	Total quantity (100 years)
Current Recycling Operation	*Typically averages 10,000 m^3 every 3 years*		*330,000 m^3*
(A5) Widen	30,000 m^3	Top up every 10 to 20 years	200,000 m^3
(B4) Widen	60,000 m^3 (+ 20,000 m^3 stockpile for interim repairs)	Repeat every 10 to 20 years	530,000 m^3
(B2) Beach recharge	40,000 m^3	Re-nourish every 3 to 5 years	~ 1 Million m^3
(B6) 'Natural'	10,000 m^3 (provisional) (+ 10,000 m^3 stockpile for interim repairs)	Repeat every 10 to 20 years	130,000 m^3
Shingle Engine	1.2 Million m^3	Repeat after 50 years	~ 2 Million m^3

Summary of costs for potential implementation measures

The following tables shows the cost build-up for each implementation measure and costs per management approach. Costs have been considered over three periods also; initial costs (assumption of implementation during remainder of SMP epoch 1, i.e. by 2025); further costs to the end of epoch 2 and extent of current AOEP, i.e. to 2055); and whole life costs assuming a 100 year economic evaluation period. This is important as some approaches that may have a low initial cost may in fact have a considerable ongoing commitment, so a high whole life costs, whilst the converse can also be true.

Table B1 summarises the potential nature of works and estimated approximate costs for each individual implementation measure. However, any scheme will require a combination of those measures and Table B2 shows the potential costs for a variety of possible approaches discussed in the main body of the report. These are illustrative only and therefore where a range of costs might exist with any particular implementation measure, an 'average' of that range has been used and shown in the table.

Rates used to develop the costs presented in this report have been collated from a range of sources, including a number of previous strategies and schemes, and some published reports. It must be emphasized however that they are only indicative; the implementation measures assessed here have not been developed to outline design level, and considerable variations exist in the characteristics of different schemes that will have a bearing on their cost. Four key material considerations apply and with respect to those it is to be noted that:

- Rates for rock and for earth embankments are primarily based upon typical costs per linear metre from schemes elsewhere
- Rates for using locally sourced shingle costs are based upon the average costs from local experience of recycling to Slaughden
- Rates for imported shingle are based upon the costs regularly experienced on other 'large' dredging and beach nourishment scheme

Taking account of the generic nature of the information and broad level of the options presented here at this initial assessment level, a factor commonly referred to as 'Optimism Bias' (OB) has been applied to the costs in each case. OB is a recognised and accepted contingency that is included to take account of uncertainties and a range of items that fall outside of the primary costs, such as lesser ancillary works (e.g. repairs to the haul road), temporary works required during construction, uncertainties over actual volumes required, additional investigations and surveys, dealing with unsuitable ground conditions, on-costs such as design fees, modelling, other unforeseen or changeable factors such as increases in cost rates, material supply issues etc. Research into this has determined that at SMP level, OB should be set at 60%.

Ultimately, the level of costs estimated at this stage of assessment may be subject to considerable change once further information becomes available and development of options takes place. There have also been no factor increases applied at this stage for future climate change, which may see more intensive activities or higher levels of damage and thus repairs, particularly in epoch 3 where changes in coastal process pressure and other demands on resources (materials and finances), may see greater costs increases that affect the viability of some approaches. The costs presented here are, however, sufficient to provide an order of magnitude expectation for each implementation measure and thus, importantly, enable a relative comparison to be made between those different management approaches, particularly through to 2055.

Table B1 Implementation measures and assumptions

IMPLEMENTATION MEASURE	INITIAL WORKS	INITIAL COST	FUTURE WORKS	FURTHER COST (to 2055)	FURTHER COST (post-2055)
Sub-unit A					
1 Do Nothing	No activity *but requiring hard point at south end of Slaughden wall - see (i)*	**£0**	None	**£0**	**£0**
2 Maintain/Develop a Beach New Timber Groynes, Rock Groynes, Offshore Breakwaters, Above + Renourishment	Considered unsuitable - rejected	***£8,000,000***	n/a	***£1,000,000 to £2,000,000***	***£1,000,000 to £6,000,000***
3 Maintain/Improve Existing Revetment	Additional rock/armour to bolster and improve *(new rock plus pick apart and reuse some existing materials)* Strengthen (add) new rock toe structure Repair crest damage	**£4,000,000**	Maintain and repair crest (potentially replace block mattress) Post-storm damage repairs (reposition rocks)	**Less than £500,000**	**£500,000**
4 New Seawall	Considered unsuitable - rejected	***£17,000,000***	n/a	***Less than £500,000***	***Up to £500,000***
5 Widen the Defence	Large recharge (remotely sourced) to add buffer of shingle to landward side Repair/reinstate crest	**£1,000,000**	Repair crest after storm damage (additional shingle) Maintain revetment (as A3 - future works) Rebuild revetment in longer term (As A3 - initial works)	**£1,000,000 to £2,000,000**	**£6,000,000 to £8,000,000**
	If shingle can be sourced locally from existing borrow areas	***£500,000***	As above with locally sourced shingle	***£500,000 to £1,000,000***	***£5,000,000***

IMPLEMENTATION MEASURE	INITIAL WORKS	INITIAL COST	FUTURE WORKS	FURTHER COST (to 2055)	FURTHER COST (post-2055)
6 New Embankment along Estuary		**£5,000,000**		**Less than £500,000**	**£500,000 to £1,000,000**
a) Re-use existing revetment material to protect	New clay embankment Anti-scour protection on estuary side Protective cover layer on seaward side *(use rock/armour reclaimed from existing revetment)*		Some beach management in future? Maintain new revetment after storms		
b) Leaving existing revetment in place	New clay embankment Anti-scour protection on estuary side Additional material for protective cover layer on seaward side		Minor maintenance to new embankment		
7 Terminal Structure					
a) At southern end	Construct new long rock groyne/training arm Repair crest damage behind revetment	**£2,000,000**	Top up shingle along frontage (if necessary) Improve existing revetment (as A3)	**£500,000**	**£4,000,000**
b) At northern end	Construct new long rock groyne/training arm	***n/a***	-	***n/a***	***n/a***
Other considerations					
i) Secure termination point at end of seawall	Re-use existing rock to provide protection on end of wall	**Less than £500,000**	Minor maintenance	**Negligible**	**Negligible**
ii) Secure interface with sub-unit B	Rock 'headland' structure - northern section (sub-unit A)	**Up to £1,000,000**	Minor maintenance	**Negligible**	**Less than £500,000**
	Rock 'headland' structure - southern section (sub-unit B)	**Up to £2,500,000**			

IMPLEMENTATION MEASURE	INITIAL WORKS	INITIAL COST	FUTURE WORKS	FURTHER COST (to 2055)	FURTHER COST (post-2055)
Sub-unit B					
1 Do Nothing	No activity	**£0**	-	**£0**	**£0**
2 Beach Nourishment	Initial major campaign to place shingle along beach (remotely sourced)	**£2,000,000 to £3,000,000**	Regularly renourish beach with fresh shingle (remotely sourced, although some recycling along beach may be possible) Potential regular reprofiling of shingle bank and reinstate haul road as and when required Emergency response to repair breaches	**£7,000,000 to £12,000,000**	**In excess of £10,000,000 to £20,000,000**
	If shingle can be sourced locally from existing borrow areas	***£1,500,000***	As above with locally sourced shingle	***£4,000,000***	***£7,000,000 to £8,000,000***
3 Interventions to Hold a Beach Timber Groynes, Rock Groynes, Offshore Breakwaters, Above + Renourishment	Considered unsuitable - rejected	**£10,000,000**	n/a	**Up to £4,000,000**	**Up to £12,000,000**
4 Widen the Shingle Ridge	Add buffer of shingle to landward side (remotely sourced)	**£1,000,000 to £2,000,000**	Repair crest after storm damage Add further shingle if required	**£1,500,000 to £2,500,000**	**£5,000,000 to £7,000,000**
	If shingle can be sourced locally from existing borrow areas	***£500,000 to £1,000,000***	As above with locally sourced shingle	***Up to £1,000,000***	***£2,000,000 to £3,000,000***

IMPLEMENTATION MEASURE	INITIAL WORKS	INITIAL COST	FUTURE WORKS	FURTHER COST (to 2055)	FURTHER COST (post-2055)
5 Natural' Shingle Ridge Management	Add buffer of shingle to landward side (assuming locally sourced material due to low volume) Establish stockpile of shingle (assuming locally sourced from existing borrow areas)	**Less than £500,000**	Emergency response to fill in breaches Replenish stockpile	**Up to £500,000**	**Up to £1,500,000**
	If shingle has to be imported (remotely sourced)	***£500,000 to £1,000,000***	As above with imported (remotely sourced) shingle	***£1,000,000 to £1,500,000***	***£2,500,000 to £4,500,000***
6 Extend Revetment **a) Full length**	Import rock/armour to build new structure	**£19,000,000**	Maintain and repair crest *(potentially add block mattress)* Post-storm damage repairs	**Less than £500,000**	**£500,000**
b) Phased approach	Import rock/armour to build new structure *extending only part way along sub-unit B* Establish stockpile of shingle	**£13,000,000**	Maintain and repair crest *(potentially add block mattress)* Post-storm damage repairs to revetment Emergency Response to fill in breaches in shingle ridge Extend revetment (additional rock to build new structure)	**£500,000**	**£7,000,000**
7 New Embankment along Estuary	New clay embankment Anti-scour protection on estuary side Light protective cover layer on seaward side (possibly)	**£6,500,000**	Minor maintenance	**Less than £500,000**	**£500,000**
8 New Embankment - Alternative Alignments	New clay embankment Additional material for protective cover layer on seaward side	**£5,500,000**	Intermittent maintenance	**Less than £500,000**	**£500,000**

IMPLEMENTATION MEASURE	INITIAL WORKS	INITIAL COST	FUTURE WORKS	FURTHER COST (to 2055)	FURTHER COST (post-2055)
Sub-unit C					
1 Do Nothing	No activity		-		
Whole policy unit					
1 Shingle Engine	Major dredge and nourishment operation	**In excess of £15,000,000 to £20,000,000**	Re-distribution of shingle, or repeat initial operation	**Negligible**	**£5,000,000 to £25,000,000**
2 Modify Estuary		***Not costed***		***Not costed***	***Not costed***
a) Re-routing the Alde	Major dredge and cut operation		**-**		
b) Bypass channel at Sudbourne Marsh	Dredge/cut new channel		-		

Table B2 Illustrative example costs by Management Approach (the 'average' has been taken and presented where there is a range of potential costs associated with options)

APPROACH	COMBINATION OF MEASURES					OUTCOME	INITIAL COST	FURTHER COSTS (to 2055)	FURTHER COSTS (post 2055)	*TOTAL*	
	N.End	A	Interface	B	C					*to 2055*	*100 year*
1	*Rock*	**A1**	-	**B1**	C1	**Breach**	**£0**	£0.5 M	*£0*	**£0.5 M**	*£0.5 M*
2	-	**A7**	-	**B1**	C1	**Breach**	**£2.0 M**	£0.5 M	*£4.0 M*	**£2.5 M**	*£6.5 M*
3	-	**A3**	-	**B1**	C1	**Breach**	**£4.0 M**	£0.5 M	*£0.5 M*	**£4.5 M**	*£5.0 M*
	-	**A5**	-	**B1**	C1	**Breach**	**£1.0 M**	£1.5 M	*£7.0 M*	**£2.5 M**	*£9.5 M*
4	-	**A3**	-	**B6**	C1	**No Breach**	**£17.0 M**	£0.5 M	*£7.5 M*	**£17.5 M**	*£25.0 M*
	-	**A5**	-	**B6**	C1	**No Breach**	**£14.0 M**	£2.0 M	*£14.0 M*	**£16.0 M**	*£30.0 M*
5	-	**A3**	Headland (S)	**B7**	C1	**No Breach**	**£13.0 M**	£0.5 M	*£1.0 M*	**£13.5 M**	*£14.5 M*
	-	**A3**	Headland (S)	**B8**	C1	**No Breach**	**£12.0 M**	£0.5 M	*£1.0 M*	**£12.5 M**	*£13.5 M*
	-	**A5**	Headland (S)	**B7**	C1	**No Breach**	**£10.0 M**	£2.0 M	*£8.0 M*	**£12.0 M**	*£20.0 M*
	-	**A5**	Headland (S)	**B8**	C1	**No Breach**	**£9.0 M**	£2.0 M	*£8.0 M*	**£11.0 M**	*£19.0 M*
6	*Rock*	**A6**	Headland	**B7**	C1	**No Breach**	**£15.0 M**	£1.0 M	*£1.5 M*	**£16.0 M**	*£17.5 M*
	Rock	**A6**	Headland	**B8**	C1	**No Breach**	**£14.0 M**	£1.0 M	*£1.5 M*	**£15.0 M**	*£16.5 M*
7	-	**A3**	-	**B2**	C1	**Temp Breach**	**£7.0 M**	£10.0 M	*£15.0 M*	**£17.0 M**	*£32.0 M*
	-	**A5**	-	**B2**	C1	**Temp Breach**	**£4.0 M**	£11.0 M	*£22.0 M*	**£15.0 M**	*£37.0 M*
	-	**A3**	Headland (S)	**B4**	C1	**Temp Breach**	**£8.0 M**	£2.5 M	*£7.0 M*	**£10.5 M**	*£17.5 M*
	-	**A5**	Headland (S)	**B4**	C1	**Temp Breach**	**£5.0 M**	£3.5 M	*£13.0 M*	**£8.5 M**	*£21.5 M*
	-	**A3**	Headland (S)	**B5**	C1	**Temp Breach**	**£6.5 M**	£0.5 M	*£2.0 M*	**£7.0 M**	*£9.0 M*
	-	**A5**	Headland (S)	**B5**	C1	**Temp Breach**	**£3.5 M**	£2.0 M	*£8.5 M*	**£5.5 M**	*£14.0 M*
8	*Rock*	**A6**	Headland (N)	**B2**	C1	**Temp Breach**	**£8.5 M**	£10.0 M	*£16.0 M*	**£18.5 M**	*£34.5 M*
	Rock	**A6**	Headland	**B4**	C1	**Temp Breach**	**£10.0 M**	£3.0 M	*£7.0 M*	**£13.0 M**	*£20.0 M*
	Rock	**A6**	Headland	**B5**	C1	**Temp Breach**	**£8.5 M**	£1.0 M	*£2.5 M*	**£9.5 M**	*£12.0 M*
9	**SHINGLE ENGINE**					**No Breach**	**£20.0 M**	£0	*£20.0 M*	**£20.0 M**	*£40.0 M*

Appendix B. Phase 2 reports

B.1 Preliminary assessment of approaches against the Habitat Regulations

For consultation

SMP7 POLICY REVIEW STUDY AT SLAUGHDEN (PHASE 2)

PRELIMINARY ASSESSMENT OF SMP APPROACHES AGAINST THE HABITAT REGULATIONS

POLICY UNIT 15.1 SUDBOURNE BEACH

Prepared for

Suffolk Coastal District Council

June 2018

JACOBS ch2m

Document History

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Contents

Introduction

1.1 Background

As lead authority for the Suffolk Shoreline Management Plan (SMP), Suffolk Coastal District Council (SCDC) is working with the Environment Agency and other stakeholders to review coastal management policy at Slaughden, to the south of Aldeburgh, where the current policy may need revision. The specific area involved is Policy Unit ORF 15.1, from the Martello Tower southwards through to Sudbourne Beach towards Orford Ness (Figure 1). Note that Phase I of the study sub-divided the Policy Unit into 3 sub-units (A, B &C) to account for the differences in characteristics, current status and associated risks.

Figure 1 Policy unit location (taken from the SMP (Royal Haskoning DHV 2009)

1.2 SMP Policy Review

A three-phase approach to the policy review is being followed:

- Phase 1: high level review and assessments to provide baseline appreciation of aspects that are key to identification of a viable policy, with a focus on implementation measures. Informed by this high-level assessment, the Client Steering Group (CSG) can conclude a preferred way forward, i.e. whether to pursue any policy change and what the nature of that might be.
- Phase 2: further assessments, including more detailed environmental appraisal and identification of constraints, to fully consider the proposed policy change, including formal engagement with any statutory consultees.
- Phase 3: upon completion of necessary studies the proposals would be subject to wider public consultation, to review and agree the policy changes. Following this, and taking those responses into account, the policy change process would be finalised.

The rationale for this phased approach is that the need for, and required extent of, further assessments (e.g. any requirement for a Habitats Regulation Assessment and Appropriate Assessment) will depend upon the preferred approach and can therefore vary considerably. Those requirements cannot be determined until initial direction on the options has been agreed by the CSG.

Phase 1 was completed in November 2017 and resulted in the identification of nine separate approaches, which reflect the three overall outcome options (breach, no breach and temporary breach) and the fact that there are alternative solutions of achieving these across the three defined policy sub-units (A, B and C). Further details are provided in Section 3.5 Approaches.

1.3 Habitats Regulations Legislation

The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations) require a Habitat Regulations Assessment (HRA) incorporating an "appropriate assessment" to be undertaken for any plan or project, alone or in-combination, that could have an adverse effect on the integrity of a European site. The exception is where the plan or project is directly connected with or necessary to the management of the site for the purpose of conserving its features.

European sites (also referred to as Natura 2000 sites) comprise Special Areas of Conservation (SAC) and Special Protection Areas (SPA). It is also Government policy that plans and projects that may affect Ramsar sites (wetlands of international importance) are also subject to a Habitats Regulations Assessment (HRA). All these sites are referred to collectively as European sites in this report. As Policy Unit ORF 15.1 falls within and adjacent to a number of European sites the Habitats Regulations apply to any proposed change in policy and associated implementation works.

The purpose of this document is to provide a high-level overview of the potential effects each of the identified approaches could have on European sites and their associated qualifying features. This report does not present the results of a HRA but aims to highlight the likely compliance of the individual approaches (alone) with the Habitat Regulations, to enable the CSG and Natural England to form a view on the impacts of the various approaches on the European sites.

Assessment Method

The assessment method used for this second phase of the SMP Policy Review is detailed below.

The aim of this report is to provide a high-level overview of each approach to determine if they comply with the Habitats Regulations and to detail if an appropriate assessment is likely to be required for each approach taken forward. This is done by identifying whether there will be any Likely Significant Effect (LSE). If there is any uncertainty as to whether or not there will be a LSE then, based on the precautionary principle, an appropriate assessment will need to be undertaken. It

should be recognised that this is a strategic assessment and as such does not consider scheme level detail.

The method used here is as follows:

1. Identification of relevant European sites within, adjacent to, or within, the likely zone of influence of Policy Unit ORF 15.1 (see Section 3 Baseline Data, Relevant European sites).
2. Screening-out sites for likely significant effects on the European Sites as a result of the alternative assessment approaches. Consideration of whether the policy approach is likely to have a significant effect (individually) on the conservation objectives and qualifying features for which the European sites have been designated (see Section 3.2 Screening).

   If it can be demonstrated there are no likely effects (significant or otherwise) on a particular site or qualifying feature then those sites or features are screened out of further assessment in this report.
3. Collate information on the qualifying features and Conservation Objectives for the designated site(s) (see Section 3.3 Screened-in sites: Conservation objectives & 3.4 Screened-in sites: Site condition and status of qualifying features).
4. Document the proposed Approaches from Phase 1 (see Section 3.5 Approaches)
5. Assess each approach against each qualifying feature, bearing in mind its current status and conservation objectives. Both direct (e.g. destruction of habitat in footprint of new structure) and indirect (e.g. change to qualifying feature resulting from change in coastal processes) impacts (see Section 4 Assessment) will be considered. It should be noted that the coastline is a dynamic area and the baseline as described here is correct as of 2018, and dated literature respectively. The losses/gains described within the assessment relate to the current environment and do not take into account further changes that might occur in the future if no works were undertaken.
6. Discussion of the key issues across the approaches. Use of summary table (Table 9) to indicate which approaches are likely to require an appropriate assessment if they are progressed and identify whether there are any approaches which are likely to be non-compliant with the Habitats Regulations, i.e. those which cause irreparable damage even with mitigation (see Section 5 Discussion).

Until recently it was possible to consider whether any LSE could be avoided or reduced through design changes or the implementation of incorporated mitigation measures. Whilst the former is still applicable, recent case law[1] means that incorporated mitigation (including programming of works) can only be considered when undertaking an appropriate assessment. Therefore, mitigation measures will not be discussed at this stage, rather it will be identified whether an appropriate assessment is required. Potential effects on European sites can be direct or indirect, negative or positive. The key issue is whether the impacts could result in an adverse effect on the integrity of any of the site's qualifying features. Examples of direct and indirect impacts are given below and are considered in the discussion (see Section 5 Discussion):

Direct impacts include:

- Disturbance to birds or other fauna;
- Physical damage to habitats used by birds or other fauna;
- Physical damage to habitats that represent one of the qualifying features;

[1] *People Over Wind and Sweetman v Coillte Teoranta (C-323/17)*

And indirect impacts include:

- Reduction in area and/or change in extent and location of habitats that are either a qualifying feature in their own right and/or support qualifying species;
- Increase in area of habitats that are either a qualifying feature in their own right and/or support qualifying species.

Baseline Data

3.1 Relevant European sites

The first stage of this assessment is to identify which European sites may be affected either directly or indirectly by the alternative approaches. Initially a 10 km buffer from the policy unit was drawn, which resulted in the inclusion of 11 individual sites (Table 1 and Figure 2).

Table 1 European sites within a 10 km buffer of Policy Unit ORF 15.1

European Site	Location of policy unit ORF 15.1 with respect to European sites
Orfordness – Shingle Street SAC	Wholly within
Alde-Ore Estuary SPA	Wholly within
Alde-Ore Estuary Ramsar	Wholly within
Alde-Ore & Butley Estuaries SAC	Adjacent - saltmarsh and River Alde behind the shingle ridge
Outer Thames Estuary SPA	Adjacent – boundary is mean low water mark
Southern North Sea cSAC	1.8 km to the west
Sandlings SPA	3.2 km to the east
Staverton Park & The Thicks SAC	9.5 km to the north east
Minsmere to Walberswick Heaths & Marshes SAC, SPA & Ramsar	10 km to the south

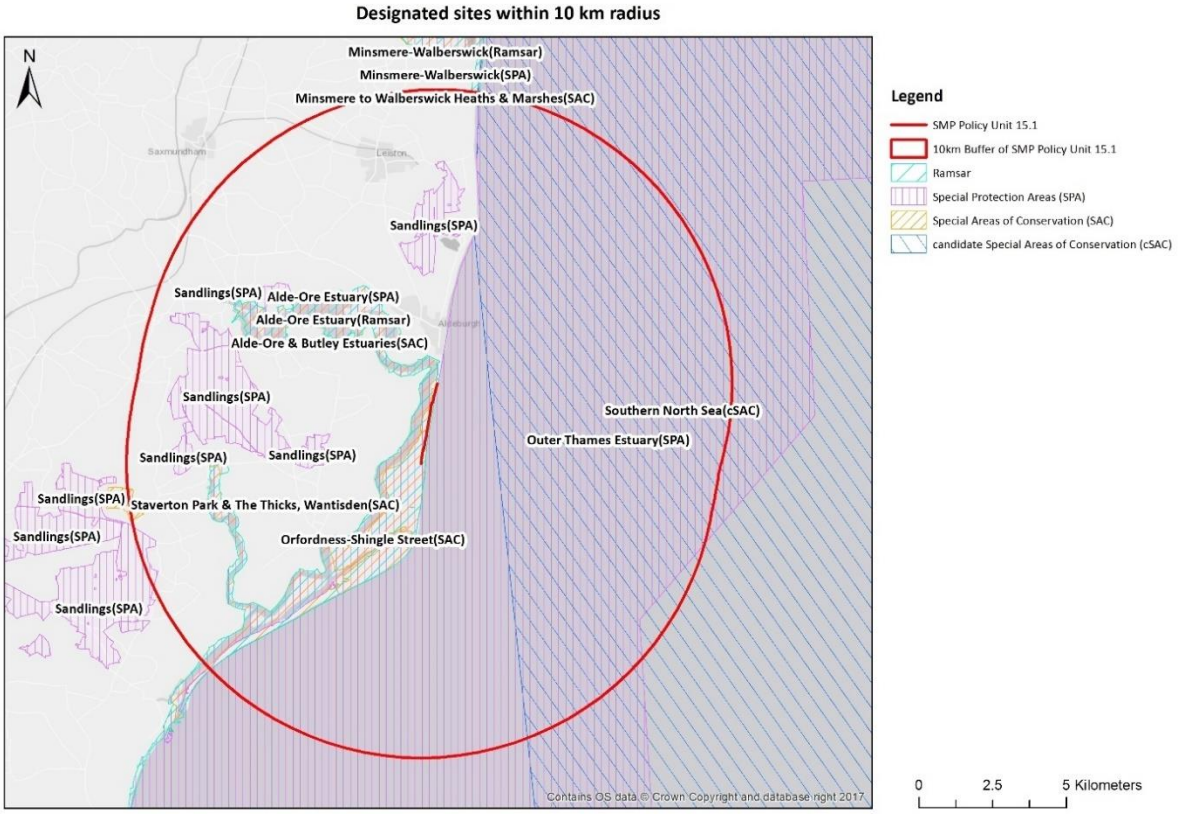

Figure 2 Designated sites within a 10 km buffer of SMP Policy Unit ORF 15.1

3.2 Screening

Screened-out sites

The following European sites have been excluded from further consideration because there are no known pathways or mechanisms for any effects to occur on any of their qualifying features. This includes potential direct effects during any operational works or as a consequence of any related indirect geomorphological or other physical changes.

- **Southern North Sea cSAC** – the only feature is Harbour Porpoise *Phocoena phocoena* and the closest part of the site boundary is 1.8 km away from where any works would be undertaken. There are not considered to be any risks of disturbance to Harbour Porpoise or any indirect changes in habitats that they are dependent upon as a result of any of the approaches.

  Harbour porpoise will be wide-ranging and may come into the waters adjacent to the policy unit. However, activities undertaken on the shingle ridge would not create any significant disturbance as harbour porpoise very rarely come close in shore and the extent of any potential disturbance, such as from plant movement and vibration would be very small given the total area of sea for the animals to use (both nearshore along the coast and further out). Furthermore, for this part of the cSAC the boundary is at least 1.8 km from the shingle ridge (notwithstanding the fact that individuals may still come closer than that). Similarly, any changes in coastal processes as a result of any of the approaches are not expected to alter features in the marine environment to the extent that they would impact the ability of animals to use the area.

- **Sandlings SPA** – the closest part of this site is located 3.2 km inland so there are no pathways for any direct or indirect effects as a consequence of any of the approaches being adopted. The policy unit does not contain any suitable habitat that could be used by any of the SPA bird species so it does not constitute functional (supporting) habitat.

- **Staveton Park & The Thicks SAC** – the closest part of this site is 9.5 km inland and its qualifying feature is oak woodland, which would not be affected by any of the alternative approaches.
- **Minsmere to Walberswick Heaths & Marshes SAC, SPA and Ramsar** – these sites are located approximately 10 km away. Although they include coastal components, as they lie to the north of the area, it is not considered likely that any geomorphological changes along the Slaughden frontage would cause any indirect effects at Minsmere.

  The birds listed for both these sites are largely associated with reedbeds and/or bodies of freshwater (e.g. marsh harrier, teal) and policy unit does not represent functional/supporting habitat for them. There are no significant areas of such habitat within or adjacent to the policy unit. Some species included in these sites are also qualifying features for the Alde-Ore SPA and Ramsar (e.g. breeding little tern) and are covered under the assessment of these sites.
- **Outer Thames Estuary SPA** - although the boundary extends to mean high water, red-throated divers (*Gavia stellate*) rarely come close to the coast. For common and little terns (*Sterna hirundo* & *Sternula albifrons*), recently added as features to the SPA, the citation for the SPA does not specifically include area of the SPA adjacent to the policy unit.

Any works on the shingle ridge would not cause any disturbance to birds given the localised nature of any operations and the enormous area of alternative habitat available to them. Likewise, there is no potential for any offshore geomorphological changes to have any effect and therefore the proposals would not adversely affect offshore feeding areas. Importantly, the SPA covers feeding areas (rather than breeding sites) for the birds and works to the shingle ridge would be done outside the breeding season so there would be no risk of impact.

Screened-in sites

Effects on the qualifying features of the sites listed below (Table 2), and shown in Figure 3, will be considered as part of the high-level assessment.

Table 2 Screened-in sites for assessment under Phase 2: Slaughden SMP Policy Review

Natura Site	Qualifying Feature
Orfordness-Shingle Street SAC	H1150. Coastal lagoons
	H1210. Annual vegetation of drift lines
	H1220. Perennial vegetation of stony banks; Coastal shingle vegetation outside the reach of waves
Alde-Ore and Butley Estuaries SAC	H1130. Estuaries
	H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats
	H1330. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
Alde-Ore Estuary SPA	Eurasian marsh harrier *Circus aeruginosus* (Breeding)
	Pied avocet *Recurvirostra avosetta* (Non-breeding)
	Pied avocet *Recurvirostra avosetta* (Breeding)
	Ruff *Philomachus pugnax* (Non-breeding)
	Common redshank *Tringa totanus* (Non-breeding)
	Lesser black-backed gull *Larus fuscus* (Breeding)
	Sandwich tern *Sterna sandvicensis* (Breeding)
	Little tern *Sterna albifrons* (Breeding)

	Assemblage qualification: A seabird assemblage of international importance: The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 seabirds. During the breeding season, the area regularly supports 59,118 individual seabirds (Count period ongoing) including: Herring Gull *Larus argentatus*, Black-headed Gull *Larus ridibundus*, Lesser Black-backed Gull *Larus fuscus*, Little Tern *Sterna albifrons*, Sandwich Tern *Sterna sandvicensis*. *Assemblage qualification: A wetland of international importance:* The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 24,962 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Black-tailed Godwit *Limosa limosa islandica*, Dunlin *Calidris alpina*, Lapwing *Vanellus vanellus*, Shoveler *Anas clypeata*, Teal *Anas crecca*, Wigeon *Anas penelope*, Shelduck *Tadorna tadorna*, White-fronted Goose *Anser albifrons,* Redshank *Tringa totanus*, Avocet *Recurvirostra avosetta*.
Alde-Ore Estuary Ramsar	*Ramsar criterion 2:* The site supports a number of nationally-scarce plant species and British Red Data Book invertebrates. *Ramsar criterion 3*: The site supports a notable assemblage of breeding and wintering wetland birds. *Ramsar criterion 6 – species/populations of birds occurring at levels of international importance*: Qualifying Species/populations (as identified at designation): Species regularly supported during the breeding season: • Lesser black-backed gull *Larus fuscus graellsii* Species with peak counts in winter: • Pied avocet *Recurvirostra avosetta* • Common redshank *Tringa totanus*

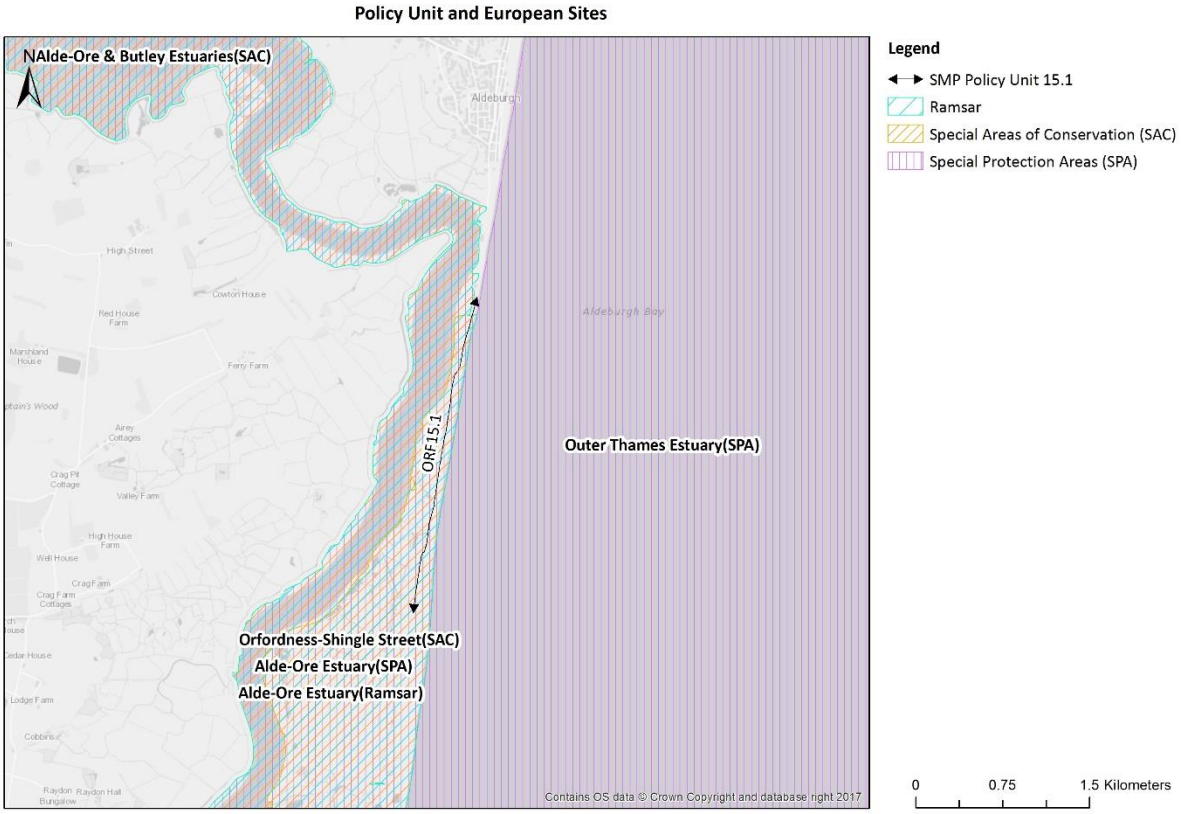

Figure 3 Screened-in European sites

3.3 Screened-in sites: Conservation objectives

This assessment considers the implications of the alternative approaches in view of the site's conservation objectives. The generic conservation objectives for the sites requiring a 'high level' appropriate assessment are summarised below. SAC sites are covered by Table 3 and Figure 4. SPA sites are covered by Table 4 and Figure 5. In addition, supplementary advice is available and referenced for individual sites and features where available. This describes in more detail the range of ecological attributes which are most likely to contribute to a site's overall integrity and the minimum targets each qualifying feature needs to achieve in order to meet the site's objectives.

Ramsar sites do not have conservation objectives but as their features overlap with the SACs and SPAs they are covered by those.

Table 3 Conservation objectives for Orfordness-Shingle Street & Alde-Ore & Butley Estuaries SAC

Orfordness-Shingle Street SAC & Alde-Ore & Butley Estuaries SAC
With regard to the SACs and the natural habitats and/or species for which the site has been designated and subject to natural change; ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring: • The extent and distribution of qualifying habitats • The structure and function (including typical species) of qualifying habitats, and • The supporting processes on which qualifying habitats rely. Supplementary objectives and advice for individual sites: Orfordness-Shingle Street SAC and the Alde-Ore & Butley Estuaries SAC are both components of the Alde-Ore & Butley European Marine Site, with Regulation 33 advice published in 2012: http://publications.naturalengland.org.uk/publication/2908548

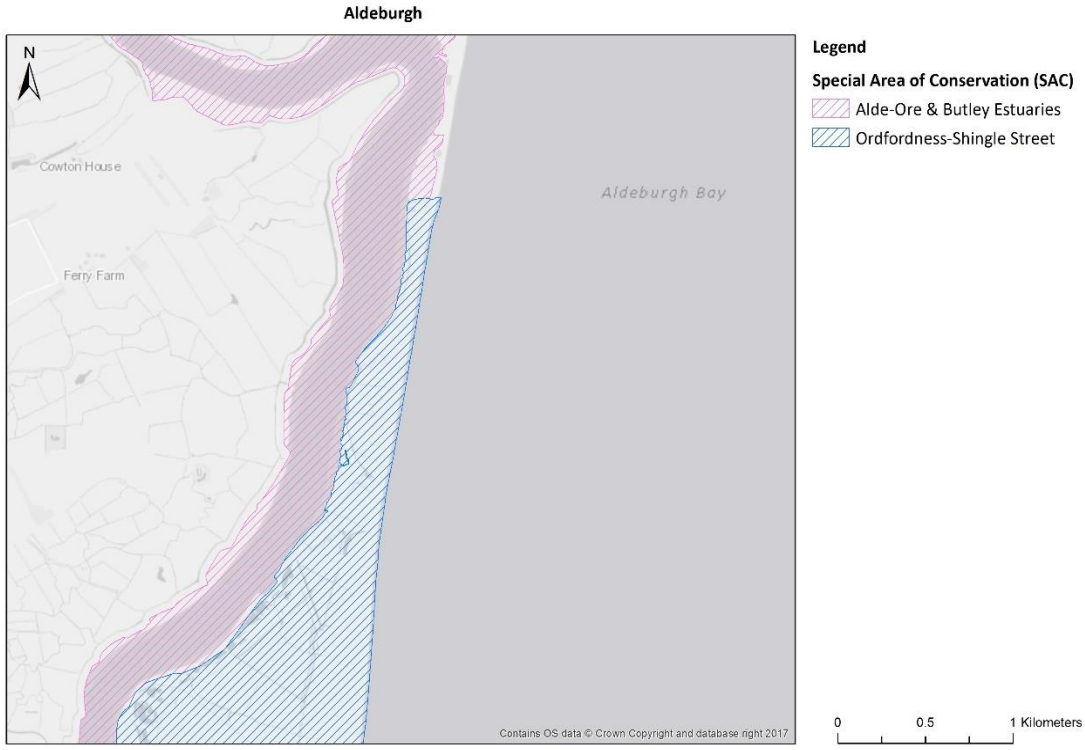

Figure 4 Extent of SACs within the study area

Table 4 Conservation objectives for Alde-Ore Estuary SPA

Alde-Ore Estuary SPA (Version 2, 30/06/14)
With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified and subject to natural change; ensure that the integrity of the site is maintained or restored as appropriate, and to ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring: • The extent and distribution of the habitats of the qualifying features • The structure and function of the habitats of the qualifying features • The supporting processes on which the habitats of the qualifying features rely • The populations of the qualifying features, and • The distribution of the qualifying features within the site. Supplementary objectives and advice: The Alde-Ore Estuary SPA is part of the Alde-Ore & Butley European Marine Site, with Regulation 33 advice published in 2012: http://publications.naturalengland.org.uk/publication/2908548 Supplementary site conservation objectives are also available at https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9009112&SiteName=alde&SiteNameDisplay=Alde-Ore+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Figure 5 Extent of SPAs within the study area

3.4 Screened-in sites: Site condition and status of qualifying features

Condition and other background information on the screened-in sites and their qualifying features are provided within Table 5. Information populating this table has been primarily obtained from Natural England's Designated Sites View webpages[2], namely www.magic.defra.gov.uk (extraction date: May 2018), namely:

- SSSI condition assessments for individual units (Figure 6)
- Conservation Advice for Marine Protected Areas

Other sources include Site Improvement Plans[3] and European Marine Sites Conservation Advice[4].

Units of the Alde-Ore Estuary SSSI considered 'within' the policy unit are those seaward of the River Alde true left bank (Figure 6).

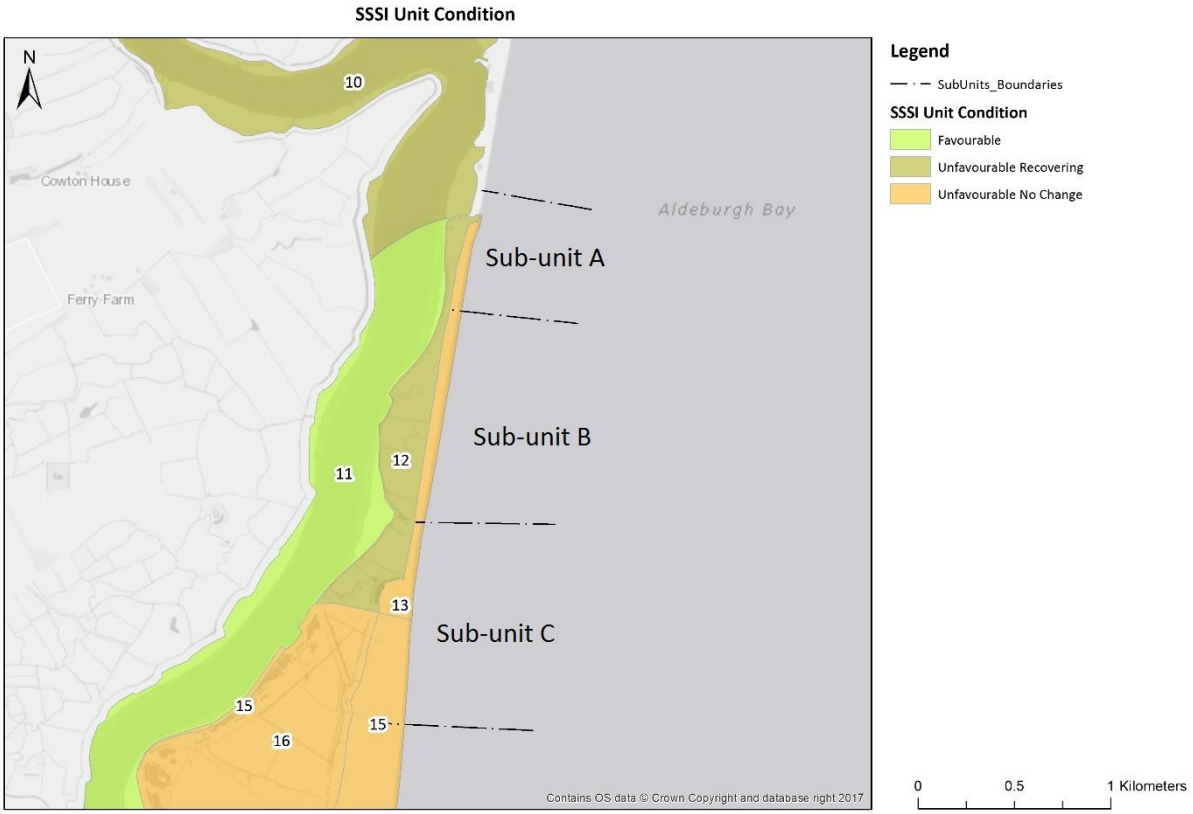

Figure 6 SSSI units and their condition in relation to the sub-units within Policy Unit ORF 15.1

[2] https://designatedsites.naturalengland.org.uk/SiteSearch.aspx

[3] http://publications.naturalengland.org.uk/category/4873023563759616

[4] http://publications.naturalengland.org.uk/category/3229185

Table 5 Screened-in Natura 2000 site features and condition

Qualifying Feature [Habitat/Species] and *description*	**Condition**
Orfordness-Shingle Street SAC	
H1150. Coastal lagoons ***Coastal lagoons are typically areas of shallow, coastal saline water, which vary in size. These are wholly or partially separated from the sea by a barrier which may be sandbanks, shingle, rocks or other hard substrates. Salinity varies, ranging from brackish to hyper-saline.*** ***In 2013, the total area of coastal lagoons was estimated to be 40 ha at Orford Ness (Warrington et al 2014). A field report from the same year estimates the total extent of 9 lagoons at Shingle Street to be 2.8 ha (Fincham and Hay 2013). Due to the tidal surge in the winter of 2013, the extent of coastal lagoons will have changed. The lagoons are fed by a number of saline sources including man-made sluices, natural percolation through the shingle and occasional winter storm overtopping.***	*Within Policy Unit*: Lagoon within unit 12, immediately behind unit 13 is shown as partially destroyed on MAGIC. No mention of a feature here in the condition assessment. *Elsewhere within SSSI*: Lagoons located within Unit 16, 32 and 33 were in favourable condition prior to the 2013 surge.
H1210. Annual vegetation of drift lines ***Annual vegetation of drift lines occurs on shingle beaches at or above mean high-water spring tides. Where there is little human disturbance, annual vegetation can develop where seeds and drift material are deposited by waves. Salt-tolerant annuals are the characteristic colonising plants.***	*Within Policy Unit*: Unit 13 unfavourable recovering due to trampling, shingle management and coastal squeeze. Unit 15 unfavourable recovering due to trampling and shingle take for recharge in unit 13. *Elsewhere within SSSI*: Unit 17 unfavourable recovering due to disturbance by fisherman and lack of management resulting in some rollback of shingle and loss of features (though acknowledged as a natural process). Unit 20 favourable Unit 21 unfavourable recovering due to coastal processes resulting in some rollback of shingle and loss of features. Unit 26 favourable. Unit 27 unfavourable recovering due to physical disturbance by people (being remedied) and loss due to natural coastal processes. Unit 32 unfavourable no change due to species composition and trampling from recreational users. Unit 33 unfavourable no change due to species composition and trampling from recreational users.
H1220. Perennial vegetation of stony banks; Coastal shingle vegetation outside the reach of waves	*Within Policy Unit*: Unit 13 unfavourable recovering due to trampling, shingle management and coastal squeeze.

Qualifying Feature [Habitat/Species] and *description*	Condition
	Unit 15 unfavourable recovering due to trampling and shingle take for recharge in unit 13. *Elsewhere within SSSI*: Unit 17 unfavourable due to disturbance by fisherman and lack of management resulting in some rollback of shingle and loss of perennial vegetation (though acknowledged as a natural process). Unit 20 unfavourable recovering due to poor species composition. Unit 21 unfavourable recovering due to coastal processes resulting in some rollback of shingle and loss of features. Unit 26 unfavourable recovering due to disturbance and lack of characteristic species. Unit 27 unfavourable recovering due to physical disturbance by people (being remedied) and loss due to natural coastal processes. Unit 32 unfavourable no change due to species composition and trampling from recreational users. Unit 33 unfavourable no change due to species composition and trampling from recreational users.
Alde-Ore & Butley Estuaries SAC	
H1130. Estuaries ***The estuary complex holds a range of biologically diverse and important wetland habitats. Two of the key habitats are H1140 and H1330 described below.***	*Within Policy Unit*: Not referred to specifically in the SSSI condition assessments but is represented in all those units where the main habitat is 'littoral sediment' *Elsewhere within SSSI*: Not referred to specifically in the SSSI condition assessments but is represented in all those units where the main habitat is 'littoral sediment'
H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats ***At designation, the area of mudflats and sandflats within the site was 6.25 km^2, which represented 0.2% of the UK's total extent of the feature (JNCC 2013). In 2014, the extent of mudflats and sandflats within the site was approximately 5.55 km^2 (Curtis 2014).***	*Within Policy Unit*: Unit 10 unfavourable recovering Unit 12 unfavourable recovering – location of coastal realignment/saltmarsh creation within this unit *Elsewhere within SSSI*: Units 1 – 4 favourable Unit 5 unfavourable recovering due to coastal squeeze Units 6 and 8-11 unfavourable recovering due to coastal squeeze Unit 7 favourable Units 19 and 23-25 favourable Units 28-29 unfavourable recovering due to coastal squeeze Unit 31 favourable Units 42 and 43 favourable
H1330. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	*Within Policy Unit*: Unit 10 unfavourable recovering

Qualifying Feature [Habitat/Species] and *description*	Condition
Salt meadows occur in a narrow strip above the sandflats and mudflats. Much of their extent is restricted by man-made sea walls, which may lead to coastal squeeze, threatening to reduce highly diverse upper saltmarsh communities. ***There is no definitive baseline for this feature. Total extent of all saltmarsh in July 2011 was 388.5 ha (Environment Agency 2014).***	Unit 12 unfavourable recovering – location of coastal realignment/saltmarsh creation within this unit *Elsewhere within SSSI*: Units 1 – 4 favourable Unit 5 unfavourable recovering due to coastal squeeze Units 6 and 8-11 unfavourable recovering due to coastal squeeze Unit 7 favourable Units 19 and 23-25 favourable Units 28-29 unfavourable recovering due to coastal squeeze Unit 31 favourable Units 42 and 43 favourable
Alde-Ore SPA	
Marsh harrier	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: Unit 44 favourable Unit 5 unfavourable recovering
Avocet	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: Unit 6 unfavourable recovering Unit 38 favourable Unit 42 favourable
Ruff	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: N/A
Redshank	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: Unit 7, 19 and 38 favourable
Lesser black-backed gull	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: Unit 27 unfavourable no change due to failure of colony due to predation, disturbance, habitat change and relocation to rooftops as an alternative. Unit 21 unfavourable recovering – lesser black backed gulls nesting on pagodas.
Sandwich tern	*Within Policy Unit*: No suitable habitat

Qualifying Feature [Habitat/Species] and *description*	Condition
	Elsewhere within SSSI: N/A
Little tern	*Within Policy Unit*: No suitable habitat *Elsewhere within SSSI*: Unit 15 unfavourable no change - Little Tern feature was found to be in unfavourable no change condition due to disturbance and redistribution

3.5 Approaches

Nine separate approaches were presented in the Phase 1 report (Table 6) to reflect three overall outcomes (breach, no breach and temporary breach). There are various combinations of solutions in achieving these outcomes/approaches across the three policy sub-units. A brief assessment of the environmental impacts was undertaken in Phase 1.

Accompanied by a Preliminary Water Framework Directive Assessment, this 'Preliminary Assessment of SMP Approaches Against The Habitat Regulations' provides an appraisal to help identify whether the decision on changing SMP policy may be constrained on environmental grounds.

The assessment for those approaches with an outcome of permanent breach (1 to 3) do not present a change from the current SMP policy for epochs 2 (20 to 50 years) and 3 (50 to 100 years) and therefore do not require a detailed assessment of the wider estuary impacts. That would be extensive, expensive, and likely to be redundant given the very probable outcome of rejecting these approaches. Therefore, the high-level assessments undertaken for Phase 1 for Approaches 1 to 3 are considered to be sufficient. A 'Do nothing' approach has not been undertaken as part of this assessment, as the aim of this study is to assess possible approaches avoiding a permanent breach. As such, the losses/gains described within the assessment relate to the current environment and do not take into account further natural changes that might occur in the future along this highly dynamic coast, even if there were no human interventions.

Similarly, this study does not provide a detailed assessment of the wider potential impacts of Approach 9 (Shingle Engine). However, this assessment does identify potential risks and impacts which that approach would likely need to consider if it is progressed.

Table 6 Management approaches and outcome scenarios across the three sub-units

	Approach 1	**Approach 2**	**Approach 3**	**Approach 4**	**Approach 5**	**Approach 6**	**Approach 7**	**Approach 8**	**Approach 9**
A	A1 – Do nothing	A7 - Terminal structure	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	Shingle Engine
B	B1 – Do nothing	B1 – Do nothing	B1 – Do nothing	B6 - Extend the revetment structure along the shoreline	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	
C	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	
	Breach	**Breach**	**Breach**	**No Breach**	**No Breach**	**No Breach**	**Temporary Breach**	**Temporary Breach**	**No Breach**

Assessment

The table below (Table 7) provides a preliminary assessment of SMP approaches against the habitat regulations.

Table 7 Preliminary assessment of SMP approaches against the habitat regulations: Impacts on Qualifying Features of 'Screened-in' Natura Sites. N.B. Assessment focuses on impacts from proposals within sub-unit A and B as no actions (do-nothing) are proposed within sub-unit C. The colour assigned to each qualifying feature per option represents the least favourable effect identified. This is in-line with the precautionary approach.

KEY: Green - unlikely an adverse effect would be identified through a full Appropriate Assessment
Yellow - potential adverse effects likely to be identified through an Appropriate Assessment but these may be avoided by incorporating mitigation
[It has been assumed that continued coastal squeeze losses will be minimal, in comparison to the overall designated site and with incorporation of appropriate mitigation, will not be deemed an adverse effect - TBC with Natural England]'
Red - potential adverse effect or uncertain effects would be identified through a full Appropriate Assessment. Uncertain whether it could be mitigated without detailed assessment.

European Sites and Qualifying Features	**Approach and High-Level Summary of Strategic Impacts**				
	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
Orfordness-Shingle Street SAC					
H1150. Coastal lagoons *"The lagoons at this site have developed in the shingle bank adjacent to the shore at the mouth of the Ore estuary." (JNCC, U.D.a).* The lagoons are located approximately 15 km south (along the line of the coast) from the southernmost extend of sub-unit B, within Policy Unit ORF 15.1.	A3, A5 and B6 involve maintaining a shore parallel structure which will not lead to a reduction in longshore transport. No change in extent, distribution or function or characteristics (e.g. salinity, depth) of lagoons is anticipated.	A3 and A5 involve maintaining a shore parallel structure which will not lead to a reduction in longshore transport. B7 and B8 involve set back lines of defence allow a naturally functioning frontage which are not anticipated to result in any adverse impacts to the lagoons. No change in extent, distribution or function or characteristics (e.g. salinity, depth) of lagoons is anticipated.	A6, B7 and B8 involve set back lines of defence allow a naturally functioning frontage which will not result in any adverse impacts to the lagoons. No change in extent, distribution or function or characteristics (e.g. salinity, depth) of lagoons is anticipated.	A3 and A5 involve maintaining a shore parallel structure which will not lead to a reduction in longshore transport. B2, B4 and B5 beach management activities allow a naturally functioning frontage which will not result in any adverse impacts to the lagoons. No change in extent, distribution or function or characteristics (e.g. salinity, depth) of lagoons is anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	A6, a setback line of defence, and B2, B4 and B5, beach management activities, allow a naturally functioning frontage which will not result in any adverse impacts to the lagoons. No change in extent, distribution or function or characteristics (e.g. salinity, depth) of lagoons is anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
H1210. Annual vegetation of drift lines *"At this site the drift-line vegetation occurs on both the sheltered, western side of the spit, at the transition from shingle to saltmarsh, as well as on the exposed eastern coast" (JNCC, U.D.a).*	Reduction in extent/distribution of annual vegetation of drift lines in footprint of extended revetment (B6) i.e. direct loss of shingle (as the area would be covered in rock) along the exposed seaward side of the beach where the drift line vegetation colonises. A5 would initially cause loss of this habitat on the sheltered side, between the transition from saltmarsh to vegetated shingle, however the impacts would be short lived (in terms of the implementation of this approach) as the material could revegetate.	Reduction in extent/distribution of annual vegetation of drift lines as B7 and B8 would enclose the saltmarsh area, greatly reducing the input of brackish water into this area. Percolation through the beach would still continue, however the choice to make the breach in the existing embankment in 2009 suggests that this level of saline input is low. A5 would initially cause loss of this habitat on the sheltered side, between the transition from saltmarsh to vegetated shingle, however the impacts would be short lived (in terms of the implementation of this approach) as the	Reduction in extent/distribution of annual vegetation of drift lines as A6, B7 and B8 would enclose the saltmarsh area, greatly reducing the input of brackish water into this area. Percolation through the beach would still continue, however the choice to make the breach in the existing embankment (Lantern Marshes) in 2009 suggests that this level of saline input is low.	A5 and B4 would initially cause loss of this habitat on the sheltered side, between the transition from saltmarsh to vegetated shingle, however the impacts would be short lived (in terms of the implementation of this approach) as the material could be recolonised. Similarly, B2 would lead to losses on the seaward side of the ridge however the ephemeral nature of these plants would allow a quick recovery after the nourishment works. A3 would not cause any direct or indirect change to this habitat.	Reduction in extent/distribution of annual vegetation of drift lines as A6 would enclose the saltmarsh area, greatly reducing the input of brackish water into this area. Percolation through the beach would still continue, however the choice to make the breach in the existing embankment (Lantern Marshes) in 2009 suggests that this level of saline input is low. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.

European Sites and Qualifying Features	Approach and High-Level Summary of Strategic Impacts				
	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
	A3 would not cause any direct/indirect change to this habitat.	material could revegetate and colonising species can tolerate some periodic disturbance. A3 would not cause any direct/indirect change to this habitat.		Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	
H1220. Perennial vegetation of stony banks; Coastal shingle vegetation outside the reach of waves "*The northern part of Orfordness has suffered considerable damage from defence-related activities but a restoration programme for the shingle vegetation is underway." (JNCC, U.D.a).*	A5 has the potential to expand this habitat as widening of the shingle ridge would lead to a new area which could be colonised by the vegetated shingle community (although the works themselves will lead to some localised surface disturbance of the existing shingle ridge). B6 would potentially cause some direct losses if the vegetation was present within this area, however the SSSI condition assessment for Unit 13 suggests that there is little vegetated shingle along the current haul road and therefore the impact would be negligible (Natural England, 2015). However, the beach downdrift of the rock revetment may be expected to re-orientate after construction of the revetment (a normal soft-hard engineering interface response) which may inadvertently lead to the loss of any vegetated shingle within this area. A3 would not cause any direct/indirect change to this habitat.	A5 has the opportunity to expand this habitat as the widening of the shingle ridge would lead to a new area which could be colonised by the vegetated shingle community (although the works themselves will lead to some localised surface disturbance of the existing shingle ridge). B7 and B8 will enable a more naturally functioning coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. There will no longer be a need to rely on shingle recycling to sustain defences, therefore potentially improving the status of Sudbourne Beach. A3 would not cause any direct/indirect negative change to this habitat.	B7 and B8 will enable a more naturally functioning coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. There will no longer be a need to rely on shingle recycling to sustain defences, therefore potentially improving the status of Sudbourne Beach. A6 would not cause any direct or indirect change to this habitat.	A5, B2, B4 and B5 have the opportunity to expand this habitat as the widening of the shingle ridge would lead to a new area which could be colonised by the vegetated shingle community. A3 would not cause any direct/indirect change to this habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	B2, B4 and B5 have the opportunity to expand this habitat as the widening of the shingle ridge would lead to a new area which could be colonised by the vegetated shingle community. A6 would not cause any direct/indirect change to this habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Alde-Ore and Butley Estuaries SAC					
H1130. Estuaries *"[The Alde] is relatively wide and shallow, with extensive intertidal mudflats on both sides of the channel in its upper reaches and saltmarsh accreting along its fringes. The Alde subsequently becomes the south-west flowing River Ore, which is narrower and deeper with stronger currents." (JNCC U.D.b)*	A5 would cause the direct loss of a relatively small areas of saltmarsh/estuary area, within the footprint of the widened shingle ridge. A3 and B6 would not directly/indirectly impact upon the estuary.	B7 and B8 would lead to the enclosure of saltmarsh and estuary edge. This would limit the extent of the estuary and would change the hydrological regime within the enclosed areas, causing a change in habitat. Although this area was enclosed until recent times (i.e. up until when the breach was made in 2009) wider estuary impacts would be uncertain if this area, or a new alignment was to be enclosed again.	A6, B7 and B8 would lead to the enclosure of saltmarsh and estuary edge. This would limit the extent of the estuary and would change the hydrological regime within the enclosed areas, causing a change in habitat. The hydrological regime of the wider estuary would not be significantly affected, as the majority of this area was enclosed until recent times.	A5 and B4 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle. B5 may result in the loss of some intertidal habitat as the shingle ridge rolls back, however this is part of a natural process and would occur in the absence of any approach.	A6 would lead to the enclosure of saltmarsh and estuary edge. This would limit the extent of the estuary and would change the hydrological regime within the enclosed areas, causing a change in habitat. The hydrological regime of the wider estuary would not be significantly affected, as the area enclosed is smaller than an adjacent area which was previously enclosed until recent times.

European Sites and Qualifying Features	Approach and High-Level Summary of Strategic Impacts				
	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
The study area is at the transition between the Alde and the Ore.	With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze[5].	A5 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle. A3 would not directly/indirectly impact upon the estuary. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	A3, B2 and C1 would not directly/indirectly impact upon the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	This new line of defence would also contribute to coastal squeeze. B4 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle. B5 may result in the loss of some intertidal habitat as the shingle ridge rolls back, however this is part of a natural process and would occur in the absence of any approach. B2 and C1 would not directly/indirectly impact upon the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.
H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats	A3, A5, B6 would not directly impact upon the mudflat area of the estuary. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	B7 and B8 would lead to the enclosure of intertidal mudflat, changing the hydrological regime within the enclosed area, potentially leading to the mudflats drying out. There would also be loss of habitat under the foot print of the new embankment (B8) or any alterations to the footprint of the existing embankment (B7). A3 and A5 would not directly impact upon the estuary. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	A6, B7 and B8 would lead to the enclosure of intertidal mudflat, changing the hydrological regime within the enclosed area, potentially leading to the mudflats drying out. There would also be loss of habitat under the foot print of the new embankment (A6, B8) or any alterations to the footprint of the existing embankment (B7). With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	B2, B4 and B5 would not directly/indirectly impact upon the estuary mudflats. A3 and A5 would not directly impact upon the estuary mudflats. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	A6 would lead to the enclosure of intertidal mudflat, changing the hydrological regime within the enclosed area, potentially leading to the mudflats drying out. This new line of defence would also contribute to coastal squeeze. B2, B4 and B5 would not directly impact upon the estuary mudflats. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
H1330. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	A5 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle.	B7 and B8 would lead to the enclosure of saltmarsh. This would limit the extent of the estuary and would change the	A6, B7 and B8 would lead to the enclosure of saltmarsh. This would limit the extent of the estuary and would change the hydrological regime within	A5 and B4 would cause minimal losses of saltmarsh, under the footprint of the shingle.	A6 would lead to the enclosure of saltmarsh and estuary edge. This would limit the extent of the estuary and would change the hydrological regime within the enclosed areas, causing a change in

[5] The definition for coastal squeeze is widely debated (Pontee, 2013). Coastal squeeze is defined here as the loss of habitat due to rising sea levels and a constraining feature preventing the landward migration of that habitat. The constraining feature can be either man-made or natural, however if man-made, compensatory habitat must be made available.

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	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
	A3 and B6 would not directly impact upon the estuary. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	hydrological regime within the enclosed areas, causing a change in habitat. A5 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle. With rising sea levels, by holding the line of defence (A5, B7 and B8) this approach will contribute to coastal squeeze.	the enclosed areas, causing a change in habitat. With rising sea levels, by holding the line of defence (A6, B7 and B8) this approach will contribute to coastal squeeze.	B5 would allow the natural roll-back of the shingle ridge which would lead to some loss of the saltmarsh; this loss would also be expected under do nothing. A3 and B2 would not directly/indirectly impact upon the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	habitat. The response in hydrological regime of the wider estuary is unknown. This new line of defence would also contribute to coastal squeeze. B4 would cause minimal losses of saltmarsh/estuary area, under the footprint of the shingle. B5 would allow the natural roll-back of the shingle ridge which would lead to some loss of the saltmarsh; this loss would also be expected under do nothing. B2 would not directly/indirectly impact upon the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.
Alde-Ore Estuary SPA					
Resident Breeding					
Pied Avocet, *Recurvirostra avosetta* *Nests: colonies within shallow scrape on bare mud or in sparse vegetation. The Alde-Ore Estuary provides roosting and feeding habitats for internationally important populations of avocets* *Feeds within: lagoon or in tidal mud* *(RSPB.org.uk)*	No suitable breeding ground within policy unit or adjacent areas (Table 5). Most birds nest on Havergate Island, at the confluence of the Rivers Ore and Butley. Therefore, no anticipated noise disturbance from construction. Feeding area within the estuary not affected. Losses of small areas of saltmarsh, within the footprint of the widened shingle ridge may impact on feeding and roosting. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and	No suitable breeding ground within policy unit or adjacent areas (Table 5). Most birds nest on Havergate Island, at the confluence of the Rivers Ore and Butley. Therefore, no anticipated noise disturbance from construction. Losses of small areas of saltmarsh, within the footprint of the widened shingle ridge may impact on feeding and roosting. If the enclosure of the area of mudflat/saltmarsh results in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet may be able to continue to feed here. The main feeding area for avocets is the wide expanse of	No suitable breeding ground within policy unit or adjacent areas (Table 5). Most birds nest on Havergate Island, at the confluence of the Rivers Ore and Butley. Therefore, no anticipated noise disturbance from construction. Losses of small areas of saltmarsh, within the footprint of the widened shingle ridge may impact on feeding and roosting. If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet will be able to continue to feed here. The main feeding area for avocets is the wide expanse of	No suitable breeding ground within policy unit or adjacent areas (Table 5). Most birds nest on Havergate Island, at the confluence of the Rivers Ore and Butley. Therefore, no anticipated noise disturbance from construction. Losses of small areas of saltmarsh, within the footprint of the widened shingle ridge may impact on feeding and roosting. Feeding area will not be significantly reduced in size by A5, B2 or B4 as these hold the current position of the defence. B5 may result in the loss of some intertidal habitat from coastal squeeze, however this is part of a natural process	No suitable breeding ground within policy unit or adjacent areas (Table 5). Most birds nest on Havergate Island, at the confluence of the Rivers Ore and Butley. Therefore, no anticipated noise disturbance from construction. Losses of small areas of saltmarsh, within the footprint of the widened shingle ridge may impact on feeding and roosting. If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet will be able to continue to feed here. The main feeding area for avocets is the wide expanse of

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	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
	therefore nesting, feeding and roosting habitat.	mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge (WeBS Low Tide Counts[6]). With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge (WeBS Low Tide Counts). With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	and would occur in the absence of any approach. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge (WeBS Low Tide Counts). With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Little Tern, *Sterna albifrons* *Nests: colonies within isolated beaches. The main nesting areas for the little terns are along the spit of Orfordness on the seaward side in the splash zone.* *Feeds within: seacoasts, rivers, lakes*	Suitable nesting habitat within the policy unit and adjacent areas although current levels of recreational disturbance mean that birds rarely nest here (Table 5). Therefore, noise impacts from construction limited. Losses of small areas of saltmarsh/estuary area, within the footprint of the widened shingle ridge and continued coastal squeeze losses may affect feeding behaviour of little terns. Feeding area within the estuary/sea not affected by any change in geomorphology; there may be steepening of beach profile in front of revetment due to reflective scour, and most likely outflanking of the revetment in the future but this will not affect feeding.	Suitable nesting habitat within the policy unit and adjacent areas although current levels of recreational disturbance mean that birds rarely nest here (Table 5). Therefore, noise impacts from construction limited. If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for little tern. However, if the area is kept wet (and not so hypersaline that no fish can live), i.e. becomes a saline lagoon, then little tern will be able to continue to feed here. Minimal impact on feeding habitat given the overall area available within the wider estuary, lagoons and offshore.	Suitable nesting habitat within the policy unit and adjacent areas although current levels of recreational disturbance mean that birds rarely nest here (Table 5). Therefore, noise impacts from construction limited. If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for little tern. However, if the area is kept wet (and not so hypersaline that no fish can live), i.e. becomes a saline lagoon, then little tern will be able to continue to feed here. Minimal impact on feeding habitat given the overall area available within the wider estuary, lagoons and offshore and reduction would not be significant.	Suitable nesting habitat within the policy unit and adjacent areas although current levels of recreational disturbance mean that birds rarely nest here (Table 5). Therefore, noise impacts from construction limited. No impacts on feeding ground anticipated from any of the activities described above. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	Suitable nesting habitat within the policy unit and adjacent areas although current levels of recreational disturbance mean that birds rarely nest here (Table 5). Therefore, noise impacts from construction limited. If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for little tern. However, if the area is kept wet (and not so hypersaline that no fish can live), i.e. becomes a saline lagoon, then little tern will be able to continue to feed here. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Eurasian marsh harrier, *Circus aeruginosus* *Nests: Reedbed* *Feeds within: reedbed, marshland, & farmland near wetlands*	No suitable breeding area nor key feeding grounds within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue.	No suitable breeding area nor key feeding grounds within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue.	No suitable breeding area nor key feeding grounds within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue.	No suitable breeding area nor key feeding grounds within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue.	No suitable breeding area nor key feeding grounds within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue.

[6] https://app.bto.org/webs-reporting/

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(RSPB.org.uk)				Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Sandwich tern, *Sterna sandvicensis* *Nests: colonies within isolated beaches* *Feeds within: seacoasts*	No recorded colonies within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue. Feeding area within the sea not affected by any change in geomorphology; there may be steepening of beach profile in front of revetment due to reflective scour, and most likely outflanking of the revetment in the future but this will not affect feeding.	No recorded colonies within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue. Feeding area is within sea so no adverse impacts anticipated.	No recorded colonies within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue. Feeding area is within sea so no adverse impacts anticipated.	No recorded colonies within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue. Feeding area is within sea so no adverse impacts anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	No recorded colonies within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Therefore, noise impacts from construction are not likely to be an issue. Feeding area is within sea so no adverse impacts anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Resident Overwintering					
Pied avocet, *Recurvirostra avosetta* *Roosts: shallow scrape on bare mud or in sparse vegetation* *Feeds within: lagoon or in tidal mud* *(RSPB.org.uk*)	Holding the line will prevent any changes to the estuary and therefore no adverse impacts predicted for avocet. Disturbance to avocet from construction works limited, due to timing and duration. In sub-unit B shingle beach will be replaced by rock revetment – Avocet do not typically roost on seaward side of shingle beaches, preferring estuary environments, so no impact anticipated. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet will be able to continue to feed here. There is no shortage of other feeding areas within the estuary for avocet. Disturbance to avocet from construction works limited, due to timing and duration. B8 could provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet will be able to continue to feed here. There is no shortage of other feeding areas within the estuary for avocet. Disturbance to avocet from construction works limited, due to timing and duration. B8 could provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	Feeding area will not be significantly reduced in size by A5, B2 or B4 as these hold the current position of the defence. B5 may result in the loss of some intertidal habitat, however this is part of a natural process. Disturbance to avocet from construction works limited, due to timing and duration. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for avocet. However, if the area is kept wet, i.e. becomes a saline lagoon, then the avocet will be able to continue to feed here. There is no shortage of other feeding areas within the estuary for avocet. Disturbance to avocet from construction works limited, due to timing and duration. B8 will provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.

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Migrant Breeding					
Lesser black-backed gull, *Larus fuscus* *Nests: colonies within cliffs or ground* *Feeds within: coastal environs but also opportunistic* *(RSPB.org.uk)*	No suitable breeding ground within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Feeding area widespread and therefore unlikely to be affected. Roosting area on beach face will be replaced by rock, however there is still alternative space for the birds to roost. No change in sediment supply to Orford ness spit expected, so no change to nesting area (from proposal) anticipated.	No suitable breeding ground within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Feeding area widespread and therefore not affected. No change in sediment supply to Orford ness spit expected, so no change to nesting area (from proposal) anticipated.	No suitable breeding ground within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Feeding area widespread and therefore not affected. No change in sediment supply to Orford ness spit expected, so no change to nesting area (from proposal) anticipated.	No suitable breeding ground within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Feeding area widespread and therefore not affected. No change in sediment supply to Orford ness spit expected, so no change to nesting area (from proposal) anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	No suitable breeding ground within policy unit or adjacent areas, so no adverse effect anticipated (Table 5). Feeding area widespread and therefore not affected. No change in sediment supply to Orford ness spit expected, so no change to nesting area (from proposal) anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Migrant Overwintering					
Common redshank, *Tringa totanus* *Roosts: estuary/lagoon banks/islands* *Feeds within: estuaries and coastal lagoons*	Holding the line will prevent any direct changes to the estuary and therefore limit effects on redshank. Shingle beach will become replaced by rock revetment – redshank do not typically roost on seaward side of shingle beaches, preferring estuary environments, so no impact anticipated. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for redshank. However if the area is kept wet, i.e. becomes a saline lagoon, then the redshank will be able to continue to feed here. The main feeding area for redshanks is the wide expanse of mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge. B8 will provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for redshank. However if the area is kept wet, i.e. becomes a saline lagoon, then the redshank will be able to continue to feed here. The main feeding area for redshanks is the wide expanse of mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge. B8 will provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	Feeding area will not be significantly reduced in size by A5, B2 or B4 as these hold the current position of the defence. B5 may result in the loss of some intertidal habitat, however this is part of a natural process. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for redshank. However, if the area is kept wet, i.e. becomes a saline lagoon, then the redshank will be able to continue to feed here. The main feeding area for redshanks is the wide expanse of mudflats on the Alde, upstream of the policy unit, with relatively few birds using the mudflats behind the shingle ridge. B8 will provide additional roosting area. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Ruff *Philomachus pugnax* *Birds feed on mudflats, around the lagoons plus on grazing marsh*	Holding the line will prevent any changes to the estuary and therefore limit effects on ruff. Shingle beach will become replaced by rock revetment – ruff do not typically roost on seaward side of shingle beaches,	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for ruff. However, if the area is kept wet, i.e. becomes a saline lagoon, then the ruff will be able to	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for ruff. However, if the area is kept wet, i.e. becomes a saline lagoon, then the ruff will be able to	Feeding area will not be significantly reduced in size by A5, B2 or B4 as these hold the current position of the defence.	If the enclosure the area of mudflat/saltmarsh will result in the area drying out, then there will be a reduction in feeding area for ruff. However, if the area is kept wet, i.e. becomes a saline lagoon, then the ruff will be able to

European Sites and Qualifying Features	Approach and High-Level Summary of Strategic Impacts				
	Approach 4 **A3** Maintain / Improve revetment OR **A5** Widen the defence **B6** Extend the revetment **C1** Do nothing	**Approach 5** **A3** Maintain/improve revetment OR **A5** Widen the defence **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 6** **A6** New embankment along estuary channel **B7** New embankment along estuary channel OR **B8** New embankment – alternative alignments **C1** Do Nothing	**Approach 7** **A3** Maintain/improve revetment OR **A5** Widen the defence **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural' shingle ridge management **C1** Do nothing	**Approach 8** **A6** New embankment along estuary **B2** Beach nourishment OR **B4** Widen the shingle ridge OR **B5** 'Natural shingle ridge management **C1** Do nothing
The current mean count of birds for the whole estuary is just 10 (WeBS counts, 2012/13-2016/17).	preferring estuary environments, so no impact anticipated. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	continue to feed here. Given the very small number of birds that this site supports, combined with the large area of suitable habitat (including grazing marsh), any changes are unlikely to result in any significant effects. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	continue to feed here. Given the very small number of birds that this site supports, combined with the large area of suitable habitat (including grazing marsh), any changes are unlikely to result in any significant effects. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	B5 may result in the loss of some intertidal habitat, however this is part of a natural process. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	continue to feed here. Given the very small number of birds that this site supports, combined with the large area of suitable habitat (including grazing marsh), any changes are unlikely to result in any significant effects. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Assemblage qualification: A seabird assemblage of international importance	There are no suitable breeding grounds within policy unit for these wintering birds, so no adverse effects on nesting anticipated (Table 5). No change in sediment supply so no knock-on effects to lesser black backed gull colony at end of Orford ness spit. Feeding area within the estuary/sea not affected by any likely change in geomorphology; there may be steepening of beach profile in front of revetment due to reflective scour, and most likely outflanking of the revetment in the future but this will not affect feeding. Roosting area (front face of beach) will change from shingle to rock.	There are no suitable breeding grounds within policy unit for these wintering birds, so no adverse effects anticipated (Table 5). No change in sediment supply so no knock-on effects to lesser black backed gull colony at end of Orford ness spit. Feeding area within the estuary/sea not significantly affected by any change in defence alignment. Seabirds do not typically search for food within salt marsh areas, so no impact anticipated.	There are no suitable breeding grounds within policy unit for these wintering birds, so no adverse effects anticipated (Table 5). No change in sediment supply so no knock-on effects to lesser black backed gull colony at end of Orford ness spit. Feeding area within the estuary/sea not significantly affected by any change in defence alignment. Seabirds do not typically search for food within salt marsh areas, so no impact anticipated.	There are no suitable breeding grounds within policy unit for these wintering birds, so no adverse effects anticipated (Table 5). No change in sediment supply so no knock-on effects to lesser black backed gull colony at end of Orford ness spit. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	There are no suitable breeding grounds within policy unit for these wintering birds, so no adverse effects anticipated (Table 5). No change in sediment supply so no knock-on effects to lesser black backed gull colony at end of Orford ness spit. Feeding area within the estuary/sea not significantly affected by any change in defence alignment. Seabirds do not typically search for food within salt marsh areas, so no impact anticipated. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Assemblage qualification: A wetland of international importance.	Under hold the line, the estuary will continue to function as it does presently. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.	An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of black-tailed godwit, dunlin, lapwing, ruff and redshank. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and	An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of black-tailed godwit, dunlin, lapwing, ruff and redshank. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and	Under hold the line, the estuary will continue to function as it does presently, which will not contribute to any detrimental impacts on the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	Under hold the line, the estuary will continue to function as it does presently, which will not contribute to any detrimental impacts on the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach. A relatively small area of intertidal saltmarsh/mudflat will become enclosed,

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		therefore nesting, feeding and roosting habitat.	therefore nesting, feeding and roosting habitat.		reducing the feeding areas of black-tailed godwit, dunlin, lapwing, ruff and redshank. With rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore nesting, feeding and roosting habitat.
<u>Alde-Ore Estuary Ramsar</u>					
Ramsar criterion 2: The site supports a number of nationally-scarce plant species (*Althaea officinalis, Frankenia laevis, Lathyrus japonicus, Lepidium latifolium, Medicago minima, Parapholis incurva, Puccinellia fasciculata, Ruppia cirrhosa, Sarcocornia perennis, Sonchus palustris, Trifolium suffocatum, Vicia lutea* and *Zostera angustifolia)* and British Red Data Book invertebrates. The highly specialised invertebrate fauna of the saline lagoons includes *Nematostella vectensis,* and *Gammarus insensibilis*	Under hold the line, the wider estuary will continue to function as it does presently, which will not contribute to any direct detrimental impacts on the estuary flora/fauna. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore potential losses in *Althaea, Frankenia, Parapholis, Puccinellia, Sarcocornia and Lepidium* Some vegetated shingle may be lost under the footprint of the rock revetment, with potential loss of Ramsar flora. No known impact on the qualifying invertebrates within the saline lagoons.	Under hold the line, the wider estuary will continue to function as it does presently, which will not contribute to any direct detrimental impacts on the estuary flora/fauna. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore potential losses in *Althaea, Frankenia, Parapholis, Puccinellia, Sarcocornia and Lepidium* Uncertain impacts due to enclosing Lantern Marshes which may affect Ramsar flora. If the enclosed area of mudflat/saltmarsh dries out, then there may be a potential loss of Ramsar flora. However, if the area becomes a saline lagoon, then there are opportunities for an increase in extent and distribution of Ramsar invertebrates.	Under hold the line, the wider estuary will continue to function as it does presently, which will not contribute to any direct detrimental impacts on the estuary flora/fauna. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore potential losses in *Althaea, Frankenia, Parapholis, Puccinellia, Sarcocornia and Lepidium* Uncertain impacts due to enclosing Lantern Marshes which may affect Ramsar flora. If the enclosed area of mudflat/saltmarsh dries out, then there may be a potential loss of Ramsar flora. However, if the area becomes a saline lagoon, then there are opportunities for an increase in extent and distribution of Ramsar invertebrates.	Under hold the line, the estuary will continue to function as it does presently. Temporary breach will lead to increased salinity within the affected area – the impacts of which are uncertain.	Under hold the line, the wider estuary will continue to function as it does presently, which will not contribute to any direct detrimental impacts on the estuary flora/fauna. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze, leading to loss of intertidal habitats, and therefore potential losses in *Althaea, Frankenia, Parapholis, Puccinellia, Sarcocornia and Lepidium* Uncertain impacts due to enclosing Lantern Marshes which may affect Ramsar flora. If the enclosed area of mudflat/saltmarsh dries out, then there may be a potential loss of Ramsar flora. However, if the area becomes a saline lagoon, then there are opportunities for an increase in extent and distribution of Ramsar invertebrates. Temporary breach will lead to increased salinity within the affected area – the impacts of which are uncertain.
Ramsar criterion 3: The site supports a notable assemblage of breeding and wintering wetland birds.	Small direct loss of saltmarsh as shingle is used to widen the defence. Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence	Small direct loss of saltmarsh as shingle is used to widen the defence. An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds.	An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds. Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by	Under hold the line, the estuary will continue to function as it does presently. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	Under hold the line, the estuary will continue to function as it does presently. A relatively small area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds.

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	this approach will contribute to coastal squeeze. Potential impact from change of roosting area from shingle to rock (which may be preferable/non-preferable to some species).	Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze.	continuing to hold the line of defence this approach will contribute to coastal squeeze.		Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.
Ramsar criterion 6 – species/populations of birds occurring at levels of international importance: Qualifying Species/populations (as identified at designation): Species regularly supported during the breeding season: • Lesser black-backed gull *Larus fuscus graellsii* Species with peak counts in winter: • Pied ruff *Recurvirostra avosetta* • Common redshank *Tringa totanus*	Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. Potential impact from change of roosting area from shingle to rock (which may be preferable/non-preferable to some species).	Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds.	Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. An area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds.	Under hold the line, the estuary will continue to function as is does presently, which will not contribute to any detrimental impacts on the estuary. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.	Under hold the line, the estuary will continue to function as is does presently, which will not contribute to any detrimental impacts on the estuary. Under hold the line, the estuary will continue to function as it does presently. However, with rising sea levels, by continuing to hold the line of defence this approach will contribute to coastal squeeze. A relatively small area of intertidal saltmarsh/mudflat will become enclosed, reducing the feeding areas of breeding and wintering wetland birds. Temporary breach will result in uncertain effects, however impact limited due to limited duration of breach.

Discussion

As stated in the method, impacts can either be direct or indirect and positive or negative. The impacts identified from the individual implementation measures are discussed below. Quantification of losses will be carried out at HRA and AA stage, when specific scheme-level details are available. From this preliminary HRA assessment the following key impacts have been identified:

Direct negative:

A. *Permanent loss of annual drift line vegetation & perennial vegetated shingle habitat; resulting from 'B6 Extend the revetment structure along the shoreline'.*

The rock revetment will cover the crest and face of the beach, thereby replacing shingle with rock. The rock revetment will extend approximately 1 km. A full Habitat Regulations Assessment and Appropriate Assessment would enable the quantifications to be made to find out whether this loss could be mitigated.

At present, the haul route is not vegetated due to disturbance from traffic, however the construction of a rock revetment would remove the need for recycling operations and therefore the haulage route would become undisturbed shingle. This haulage route is two lanes wide and could provide a significant area of new habitat if disturbance was prevented. Due to the extent of the damage, the area would take a long time to recover.

It would not, however, be possible to compensate for the loss of functioning annual drift line vegetation, as this would be difficult to re-create in situ.

It may not be possible to avoid an adverse effect on the designated site.

B. *Temporary/permanent (depending on approach) loss of annual drift line vegetation & perennial vegetated shingle habitat; resulting from placement of shingle under implementation measures: B2 Beach nourishment, A5/B4 Widen the shingle ridge and B5 'Natural' shingle ridge management.*

Implementation measures B2 Beach nourishment and A5/B4 Widen the shingle ridge would attempt to hold the ridge close to its present location and form, whereas B5 would accept a more natural lower and flatter ridge to evolve, which would have more natural resilience but would also be likely to move further landwards.

Implementation measure B2 Beach nourishment would involve adding more material to the foreshore on a regular basis, i.e. less than 5 years between nourishment operations. Reprofiling and redistribution of sediment would be integral to minimising the risk of breach under this implementation measure. Under this measure, the area in which perennial vegetation can colonise will increase at the beginning of each nourishment period, however could decrease in size as the beach erodes. The perennial vegetation will also be subject to disturbance by mechanical plant accessing the foreshore to reprofile the beach would will directly damage this habitat. The area which annual drift line vegetation can colonise would be maintained, however reprofiling will directly damage any vegetation present. The frequency, e.g. annually, biennially, at which the recycling is carried out would affect the potential for the drift line vegetation to re-establish.A full Habitat Regulations Assessment and Appropriate Assessment would enable the quantifications to be made to explore these points in detail.

Implementation measure A5 and B4, Widen the shingle ridge, would mean less frequent interventions. Additional 'topping up' of shingle for A5 and B4 may be required once every 10 years. Initially this measure will cause some disturbance to the perennial vegetated, and possible strand line vegetation, during the works. However, overall this implementation measure will create a wider area of shingle which both perennial and annual vegetation could colonise.

In comparison, B5 'Natural' shingle ridge management, will require less intensive operations than seeking to hold the same alignment and profile, although given the ridge is already very

narrow in places, it is assumed that an initial reworking of the existing shingle might be undertaken to lower and widen the feature. This implementation measure would allow the perennial vegetation to expand onto the haulage route, which is currently too disturbed for the plant life to colonise. Due to the extent of the damage, the area would take a long time to recover.

It may not be possible to avoid an adverse effect on the designated site for large scale shingle management operations. Smaller scale operations would require appropriate assessment, through which it may be possible to avoid an adverse effect on the designated site by incorporating mitigatory measures.

C. *Permanent loss of saltmarsh/mudflat; lost under the foot print new embankment or shingle on the landward side of the defence; resulting from A5/B4 Widen the shingle ridge, B7 New embankment along estuary edge and B8 New embankment – alternative alignment.*

There is potential for the loss of this habitat to be mitigated elsewhere within the estuary. A full Habitats Regulations Assessment would enable the quantifications to be made to find out whether this loss would be significant and whether it could be mitigated through managed realignment.

It may not be possible to compensate for the loss of functioning vegetated shingle habitat.

It may be possible to avoid an adverse effect on the designated site by incorporating mitigatory measures.

D. *Temporary increase in noise from construction works; resulting from all approaches/implementation measures.*

Impacts vary depending on construction. Approach 4, 5 and 6 will have a significant initial period of disruption, however this will be a one-off activity. Whilst approaches 7 & 8 may require more frequent works.

It is likely that impacts during construction could be avoided or mitigated.

Direct positive:
No direct positive impacts have been identified.

Indirect negative:

E. *Permanent loss of mudflat and saltmarsh; resulting from enclosing intertidal areas 'A6 New embankment along estuary', 'B7 New embankment along estuary' and 'B8 New embankment – alternative alignment'*.

Under implementation measures B6 and B7, as the embankments are constructed, the breach which was made in the existing embankment in 2009 will be closed off. Whilst under implementation measure B8, a new embankment will prevent tidal water reaching part of the site. This will stop the twice daily inundation of tidal water within this area which with radically alter the hydrological regime, salinity and water temperature within the enclosed area. This may lead to the enclosed area drying up, which would lead to changes in the types of vegetation present, most likely initially moving towards upper saltmarsh plants but potentially salt pan developing, preventing any vegetation from growing there. It should be possible to offset lost areas of mudflat and saltmarsh by providing compensation sites elsewhere in the estuary.

It may not be possible to avoid an adverse effect on the designated site, but it is likely that habitat could be created to compensate for the loss of saltmarsh and mudflat

F. *Permanent loss of perennial vegetated shingle within zone of reorientation, down-drift of hard structures; resulting in sub-unit C from B6 Extend the revetment structure along the shoreline and within sub-unit B from A3 Maintain/improve the existing revetment structure.*

A typical response to a soft-hard engineering interface, e.g. revetment and beach, is the erosion of beach down-drift of the hard structure. This could lead to a reduction in area of vegetated shingle community at the top of the beach as the shoreline adjusts. This may result in the loss of perennial vegetated shingle as the coastline re-orientates in this area and the crestline retreats; this would be an adverse effect on the site.

There is a risk that an adverse effect on the designated site could not be avoided.

G. *Temporary damage to estuarine habitat; resulting from implementation measures which allow temporary breach, B2 Beach nourishment, B4 Widen the shingle ridge and B5 'Natural' Shingle Ridge Management.*

Under storm events breaches may form within the shingle beach, however these will be repaired immediately (or as soon as practically possible). The intention of the works is that impacts onto the wider estuary habitat will be avoided.

A temporary breach is not likely to result in an adverse effect on the designated site.

H. *Permanent loss of saltmarsh and mudflat habitat from anthropogenic coastal squeeze; resulting from all approaches holding the line.*

Within the study area, coastal squeeze is unavoidable (with or without human intervention), as it is constrained by the sea on one side and the River Alde-Ore on the other. The Alde-Ore Estuary plan addresses coastal squeeze and it may be assumed that any losses are currently offset by the recent creation of new intertidal habitat at Hazelwood Marshes. Monitoring is also in place and should this indicate that net coastal squeeze is likely to occur then mitigatory habitat will be created (AOEP, 2016).

Furthermore, a full Habitats Regulations Assessment would enable the quantifications to be made to find out whether this loss would be significant in comparison to what is being lost naturally. This may be offset by providing a compensation site elsewhere in the estuary.

Coastal Squeeze is likely to be offset during the life of the Alde-Ore Estuary Plan, but monitoring is in place, and should squeeze be indicated, then mitigatory habitat will be created.

Indirect positive:

I. *Reduction in disturbance to flora and fauna at Orford Ness; resulting from all approaches and implementation measures to varying degrees.*

All approaches will result in the reduction in frequency of recycling operations to the Martello tower. Reduction in disturbance to birds on Orford Ness would be highly beneficial, especially if other management issues, e.g. predation by foxes, could be also effectively managed.

The impact varies between approaches preventing breach and those allowing temporary breach. Approaches 4, 5 and 6 (no breach) will reduce the need of recycling to zero. Approaches 7 and 8 which still require beach management activities to be carried out will reduce disturbance to varying degrees (see key impact D).

J. *A more naturally functioning coast; resulting from B7 New embankment along estuary', 'B8 New embankment – alternative alignment' and B5 'Natural' Shingle Ridge Management.*

The beach is currently maintained to an artificially high level, around +5.0 to +6.0 mOD, and is kept in line with the defences further up the coast by frequent recycling. Maintaining the crest at a higher elevation than the natural crest encourages erosion of the seaward face, since dissipative overtopping cannot occur.

By allowing the shingle ridge to lower and develop a natural profile, there will be improvements in the transition of vegetated shingle on both sides of the shingle barrier beach. Regular overtopping will not damage the ridge but instead will encourage a wide diversity of halophytic plants to establish, both on the shingle ridge itself and the hinterland.

Under implementation measures B7 and B8 the reduction in size of the ridge may result in the improved percolation of the shingle ridge: this may provide sufficient saline input for a saline lagoon to form within the enclosed area, but this required further study.

K. *Preventing permanent breach; resulting from all approaches/implementation measures.*

The intention of all approaches discussed here is to maintain the estuary in its present functioning form, which is in-line with the Alde Ore Estuary Plan (2016). This would prevent a permanent breach from forming within the shingle bank which would result in catastrophic change to the estuary and the habitats that it supports.

Other issues for consideration outside of habitat regulations:

L. *Natural resources – importing shingle; potentially required under implementation measures B2 Beach nourishment, A5/B4 Widen the shingle ridge and potentially B5 'Natural' shingle ridge management.*

Measures B2, B4 or A5, are all anticipated to require 2 to 5 times the current amount of shingle extracted at Sudbourne beach. The environmental implications of extraction of shingle on the habitats and geomorphological features at Sudbourne Beach has been disputed in the literature (see Orford, 2015 and Pye, 2015, 2016), but as statutory adviser on nature conservation, Natural England's advice is that this practice is likely to cause damage to vegetated shingle habitats and the geomorphological elements of the feature (Natural England, 2007).

The SSSI site units at Slaughden are currently in an unfavourable recovering condition because of historic shingle recycling activities which were carried out without mitigation measures prior to 2001 (Natural England, 2017). Since 2001, Natural England concluded that the short-term shingle recycling campaigns, which followed strict methods and protocols, had not had an adverse effect on the site.

Given current environmental constraints on volumes allowed for extraction, which means there is a limit of around 50,000 m^3 over a 5 year period, to source sufficient recharge sediment may require importing shingle, e.g. from an offshore dredge site: a potential source area has not been determined as part of this study. There could be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches.

For B2 there may also be a need for mechanical reprofiling of the beach to ensure the standard of protection remains adequate.

Although implementation measure B5 promotes a more naturally functioning coastline along sub-unit B, there may still be a requirement to source some addition shingle from Sudbourne Beach (for breach repairs), which although considerably less than currently. Volumes required will depend upon future prevailing conditions and how areas of accretion and erosion may change in response.

Shingle may potentially be available from the current haulage route (which extends 4 km); this ridge is currently higher than the natural beach crest height. This source of shingle would reduce the need for offshore sourcing, which is expensive and a limited resource in itself and would also mean that the material being placed on the beach/channel side would already be sorted (low fines content) which would be good for water quality. Lowering the crest would also encourage dissipative overtopping, reducing reflection and erosion along the front of the beach.

M. *Future constraints on management options*

It should be noted that certain approaches may constrain future management of the coast, namely those that involve hard engineering (A3 - Maintain/ improve the existing revetment structure, B6 Extend the revetment structure).

N. *Environmental risk - combination of implementation measures.*

The above text considers the implementation measures individually; however, it is important to consider that there are several different combinations of implementation measure that will achieve the same outcome, i.e. breach, temporary breach, but can have varying impacts. Table 8 outlines the environmental risk associated with each combination of implementation measures. It should however be recognised that some conclusions will depend on scheme-level information.

Table 8 Outline of environmental risk associated with each combination of implementation measures within approaches: H = high risk, M = medium, L = low risk

Approach	Combination of possible implementation measure and description		Estimated Environmental Risk
4	(i)	A3 Maintain/improve the existing revetment + B6 Extend the revetment along the shoreline	H
	(ii)	A5 Widen the defence + B6 Extend the revetment along the shoreline	M – H
5	(i)	A3 Maintain/improve the existing revetment + B7 New embankment along estuary edge	M – H
	(ii)	A3 Maintain/improve the existing revetment + B8 New embankment alternative alignment	M – H
	(iii)	A5 Widen the defence + B7 New embankment along estuary edge	M – H
	(iv)	A5 Widen the defence + B8 New embankment alternative alignment	M – H
6	(i)	A6 New embankment along estuary channel + B7 New embankment along estuary edge	M – H
	(ii)	A6 New embankment along estuary channel + B8 New embankment alternative alignment	M – H
7	(i)	A3 Maintain/improve the existing revetment + B2 Beach nourishment	M – H
	(ii)	A3 Maintain/improve the existing revetment + B4 Widen the shingle ridge	M – H
	(iii)	A3 Maintain/improve the existing revetment + B5 'Natural' shingle ridge management	L – M
	(iv)	A5 Widen the defence + B2 Beach nourishment	M – H
	(v)	A5 Widen the defence + B4 Widen the shingle ridge	M – H
	(vi)	A5 Widen the defence + B5 'Natural' shingle ridge management	L – M
8	(i)	A6 New embankment along estuary channel + B2 Beach nourishment	M – H
	(ii)	A6 New embankment along estuary channel + B4 Widen the shingle ridge	M – H
	(iii)	A6 New embankment along estuary channel + B5 'Natural' shingle ridge management	M

Conclusions

All of the proposed approaches have the potential to cause damage to the Natura 2000 sites within the study area and its surroundings, as such all approaches will require Habitat Regulations Assessment and Appropriate Assessment to assess adverse effect on site integrity (see Table 9).

Table 9 Summary Table - Potential for adverse effects on site integrity in the absence of mitigation. The colour assigned to each designated site per option, represents the colour least favourable effects from all qualifying features assessed from Table 7 - which is in-line with the precautionary approach. If there are significantly different outcomes within an approach, resulting from the different combination of implementation measures (Table 6), more than one colour may be shown to reflect those alternate outcomes.

Approach	**Natura 2000 Sites**				**Likely consenting requirements**
	Orfordness Shingle SAC	**Alde-Ore and Butley Estuaries SAC**	**Alde-Ore SPA**	**Alde-Ore Ramsar**	
4					Appropriate assessment required, with consideration of mitigation or compensation for saltmarsh, vegetated shingle and Ramsar flora (if present), which will be lost. It may not be possible to compensate for loss of annual drift line vegetation and for this reason this option represents a very high environmental risk.
5					Appropriate assessment required with consideration of mitigation for vegetated shingle and compensation for saltmarsh, mudflats, and Ramsar flora (if present), which will be lost.
6					Appropriate assessment required with consideration of compensation for saltmarsh, mudflats and Ramsar flora (if present), which will be lost.
7					Appropriate assessment required but impacts on vegetated shingle can likely be mitigated to avoid adverse impacts and avoid requirement for compensatory habitat. Consideration for compensation of saltmarsh habitat required. A3&B5,A5 &B5 may be possible to conclude no adverse effect.
8					Appropriate assessment likely required with consideration of compensation for saltmarsh, mudflats and Ramsar flora (if present), which will be lost.

KEY:

Green - unlikely an adverse effect would be identified through a full Appropriate Assessment

Yellow - potential adverse effects likely to be identified through a full Appropriate Assessment but these may be avoided by incorporating mitigation

Red - potential adverse effect or uncertain effects would be identified through a full Appropriate Assessment. Uncertain whether it could be mitigated without detailed assessment.

It should be recognised that the study area is part of a dynamic coastline and the driving forces that influence the physical processes are continually changing, all of which affect the sedimentary processes along the frontage. In turn, these affect the morphology which has a feedback to the coastal processes and supported habitats and species. Therefore, even without further intervention, changes to habitats and species in the future would be expected.

At this strategic level, it is possible to appraise the level of environmental risk and difficulty associated with the different options. For each approach, there are different combinations of implementation measure that could be adopted and these may result in variations in the impacts between the approaches, as shown in Table 8. The overall environmental risk from the different approaches can be summarised as follows:

Approach 4 (depending on the implementation measures adopted in the approach) represents a **high** environmental risk. It may not be possible to compensate for the loss of designated habitat, to overcome an adverse effect on integrity, and therefore it may not be possible to make a case for formal Secretary of State approval through the Habitat Regulations.

Approaches 5, 6, and 8 represent a **moderate to high** level of environmental risk. They are likely to result in the loss of designated habitat, but this may be mitigatable, and the re-alignment approach works with coastal processes over the longer term. It may therefore be possible to provide compensation for habitat losses, but formal Secretary of State approval through the Habitat Regulations would be required. This would potentially be a complex and onerous process, but it is feasible.

Approach 7 (assuming certain implementation measures) works with natural processes and so has **low to moderate** environmental risk, such that it may be possible to conclude 'no adverse effect' with mitigation. This would potentially be the most simple and least onerous process in terms of the Habitat Regulations, depending on the implementation measures adopted.

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B.2 Preliminary Water Framework Directive Assessment

For consultation

SMP7 POLICY REVIEW STUDY AT SLAUGHDEN (PHASE II)

PRELIMINARY WATER FRAMEWORK DIRECTIVE ASSESSMENT

POLICY UNIT 15.1 SUDBOURNE BEACH

Prepared for

Suffolk Coastal District Council

June 2018

JACOBS ch2m

Document History

This document has been issued and amended as follows:

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1. Introduction

1.1 Purpose and Content of this Report

This Water Framework Directive (WFD) assessment report has been prepared for the Policy Review Study at Slaughden: Policy Unit 15.1 Sudbourne Beach (referred to as the "policy review") and presents the appraisal of the proposed approaches at a strategic level, in compliance with the Directive requirements. It should be read in conjunction with the Phase 2 main report.

The aims of this report are:

- Review information in the SMP2 Water Framework Directive Assessment.
- Check each approach option and alternatives against Environmental Objectives.
- Identify the potential for any policy change to contribute to deterioration of a waterbody.
- Where this is the case provide a Summary Statement including any identified mitigation measures.

The content of this report has been prepared in accordance with the requirements of the Directive and is structured in the following sections:

- **Section 1 Purpose and Content of this Report** (this section) - sets out the context and intention of this WFD assessment.
- **Section 2 Background & Study Area** – defines the study area, WFD legislation and previous work (SMP2 WFD assessment).
- **Section 3 Current Assessment Methodology** – outlines the data used and explains the various steps in the WFD appraisal process.
- **Section 4 Baseline Data** – screening water bodies in/out of the study; the current status / potential of the water bodies scoped in; and the approaches/scenarios being considered as part of the policy review proposals.
- **Section 5 WFD Appraisal** - discusses the appraisal process step by step, including screening, detailed assessment, compliance with WFD objectives and Article 4.7 test.
- **Section 6 Summary and Conclusions** - provides a summary of key findings.

2. Background and Study Area

2.1 Introduction

Suffolk Coastal District Council (SCDC) is working with the Environment Agency (EA) and other stakeholders, notably the Alde and Ore Estuary Partnership (AOEP), to review coastal management policy at Slaughden.

This report discusses SMP Policy Unit (PU) ORF15.1 -Sudbourne Beach, south of the Martello Tower. PU 15.1 begins at the termination of the concrete wall that fronts the Martello Tower which lies to the north of this policy unit, and extends to a point midway along Lantern Marshes North (Figure 1). This unit is located south of Slaughden (PU 14.4 for which the long term SMP policy is hold the line) and forms part of the larger geomorphological feature of Orford Ness, which can be considered as the shoreline between Aldeburgh marshes and the end of Orford spit (Figure 1). Orford Ness encloses the Alde-Ore Estuary but in places the shingle barrier that separates the estuary from the open sea is very narrow, which poses a threat to the future of the estuary system in its current form. Management of this coastline is therefore intrinsically linked to future management plans for the estuary.

A second revision of the Lowestoft Ness to Felixstowe Landguard Point Shoreline Management Plan 7 covering the frontage, was completed by Royal Haskoning in 2010. The overall aim of Policy Area 15 was to maintain the important natural character of Orford Ness. Due to uncertainty with respect to future management, an interim policy for PU 15.1 was defined, "*pending an agreed Management and Investment Plan for the Alde and Ore area*":

Table 1 - SMP Policy for PU 15.1 covering the next three epochs (Royal Haskoning , 2010)

2025	2055	2105
Hold the Line (HTL)	No Active Intervention (NAI)	No Active Intervention (NAI)

Since development of the SMP, there have been further studies undertaken to look at the coastline and more recent change. These have indicated that in places the barrier is *more vulnerable* than it has been previously, due to recent wave conditions. This has therefore led to questions regarding the sustainability of the current approach to management. This more recent data, together with the adoption of the AOEP Estuary Plan (2016), has therefore prompted the need for this current review.

2.2 Policy Unit 15.1

Policy Unit (PU) 15.1 begins at the termination of the concrete wall that fronts the Martello Tower which lies to the north of this policy unit, and extends to a point midway along Lantern Marshes North (see Figure 1). Although this is a single policy unit and is characterised by a shingle barrier throughout, its characteristics, current status and associated risks differ, meaning that approaches to future management also vary along its length. Therefore, for this appraisal, the coastline has been considered in three sections, sub-units A, B and C (Figure 2).

Figure 1: Policy Unit location with unit ORF 15.1 highlighted. Source: SMP7 Royal Haskoning 2010.

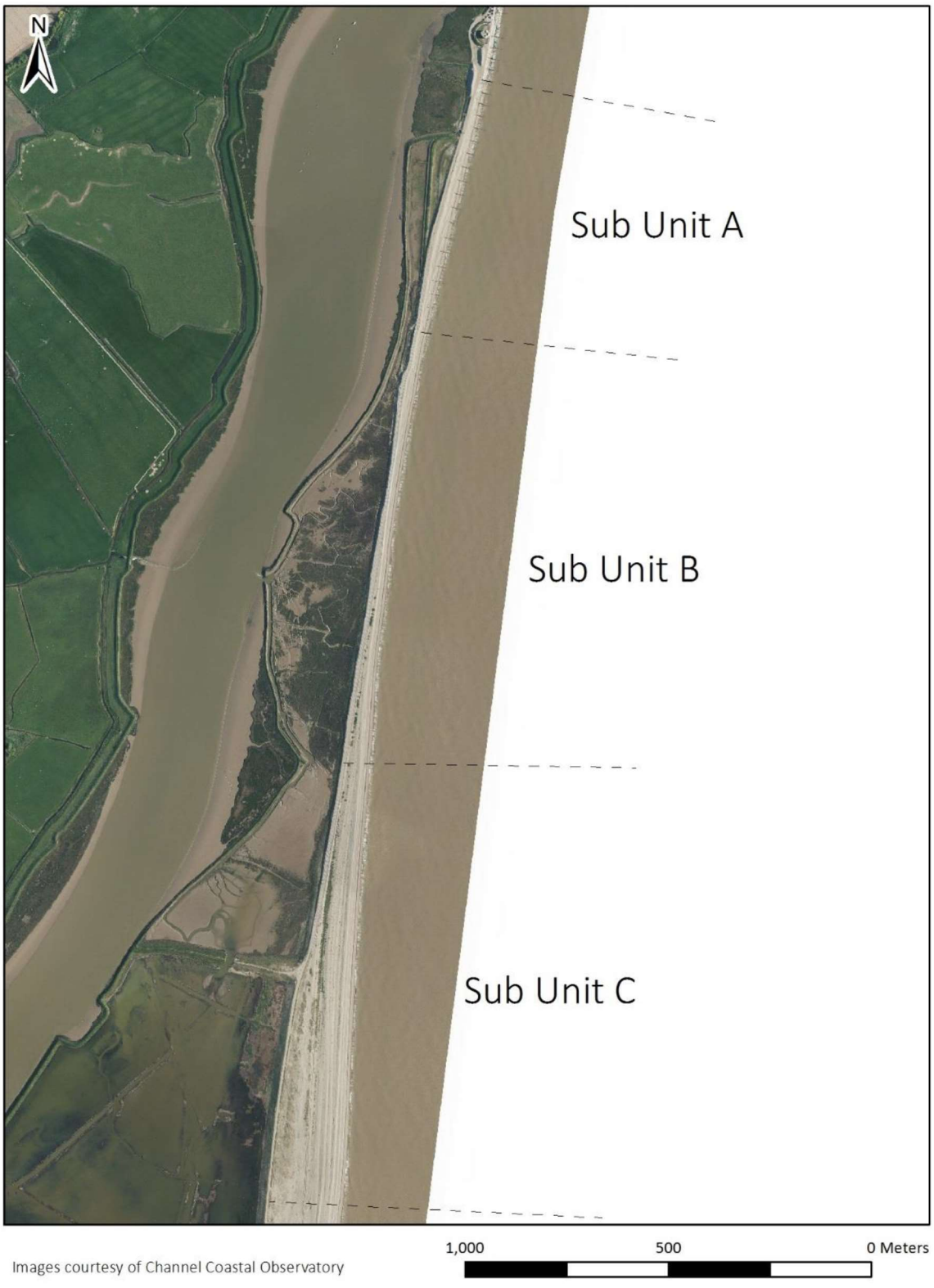

Figure 2: Map of the Policy Unit 15.1 & sub-division of the coast used in this appraisal. Source: Phase 1 report (CH2M, 2017).

2.3 Legislation, policy and guidance

The European Water Framework Directive (WFD)[1] was passed into UK legislation in 2003 and is currently transposed in England as the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 407/2017). Its aim is to protect and improve the water environment.

The WFD requires that Environmental Objectives (Table 2) are set for all surface waters and groundwater. Overall status is a composite measure that looks at both ecological status and chemical status: a water body must be of good or better ecological status, and good (pass) chemical status assessment to be given a good overall status. The WFD specifies the quality elements that are used to assess the ecological and chemical status of a water body. For each River Basin District (RBD), a River Basin Management Plan (RBMP) outlines the actions required to enable natural water bodies to achieve this.

Table 2: WFD Environmental Objectives

WFD Environmental Objectives (taken from Article 4.1 of the Directive)
Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water.
Member States shall protect, enhance and restore all bodies of surface water, subject to the application of subparagraph (iii) for artificial and heavily modified bodies of water, with the aim of achieving good surface water status by 2015.
Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015. Where this is not possible and subject to the criteria set out in the Directive, aim to achieve good status by 2021 or 2027.
Progressively reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.
Prevent deterioration in status and prevent or limit input of pollutants to groundwater.

The WFD recognises that some water bodies, those considered Heavily Modified Water Bodies (HMWB) or Artificial Water Bodies (AWB), may be prevented from reaching good ecological status (GES) by the physical modifications for which they are designated or purpose for which they were constructed (e.g. navigation, flood defence, urbanisation). In these cases, the aim is to achieve good ecological potential (GEP), through implementation of a series of mitigation measures outlined in the applicable RBMP (and in some cases updated since the publication of the RBMP). These measures are to mitigate impacts that have been or are being caused by human activity and to enhance and restore the quality of the existing environment and prevent further deterioration.

There are four key reasons for considering the WFD at a strategic level during the revision of Shoreline Management Plan Policy:

1. To maximise the linkages with the RBMPs and the contribution of flood risk management to delivering their requirements.
2. To include and consider alternatives that would not result in significant adverse impacts on the water environment and avoid narrowing down alternatives to a selection that would compromise any Article 4.7 consideration at project level.
3. To include, wherever possible, mitigation, opportunities or enhancements that could contribute to the achievement of good status or potential.
4. To clarify the reasons for the modification and whether they are of overriding public interest or benefit to the environment, human health, human safety or sustainable development.

[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

2.4 Previous work: SMP2 Water Framework Directive Assessment

As part of the development of the SMP2, a WFD assessment of the SMP2 policies was undertaken (Appendix L of the SMP2). The WFD assessment examined the hydromorphological parameters that could potentially be affected by SMP2 policies and the Biological Quality Elements (BQE) that are dependent upon these. The assessment then considered whether there is a potential for the WFD Environmental Objectives to be compromised at a Policy Unit scale.

The generic Environmental Objectives set out below (based on Article 4.1 of the Directive and as described in Table 2) were used for the assessment of the SMP22 in relation to the Water Framework Directive.

- WFD1: No changes affecting high status sites.
- WFD2: No changes that will cause failure to meet surface water Good Ecological Status or Potential or result in a deterioration of surface water Ecological Status or Potential.
- WFD3: No changes which will permanently prevent or compromise the Environmental Objectives being met in other water bodies.
- WFD4: No changes that will cause failure to meet good groundwater status or result in a deterioration of groundwater status.

Table 3 is the Assessment Table 2 taken from the SMP2 WFD assessment for ORF 15.1.

Assessment Table 3 of the SMP2 WFD assessment expanded on the assessment of the SMP2 policies, indicating whether there is potential for Environmental Objectives to be compromised at a policy unit scale. An extract of this table is provided in Table 4 for the Policy Units relevant to this study.

Table 3: Extract (showing water bodies of interest for this study) from Assessment Table 2 Water Framework Directive Features and Issues for TraC water bodies in the Suffolk SMP2. Source: Appendix L Water Framework Directive Assessment Suffolk SMP2 (November 2010)

Feature		**Issue**	**Water Body classification and Environmental Objectives**
Water body (Policy Development Zones)	**Biological Quality Elements**	**Changes to BQE physical and/or hydromorphological dependencies**	
Suffolk Coast (PU LOW1.1 – DEB18.1)	Macroalgae	Potential changes to macroalgae through changes in abrasion (associated to velocity) as a result of SMP2 policies. For example, changes to control structures may result in changes to wave and current dynamics and subsequent changes in abrasion.	Classification: Moderate Status (cHMWB)* • WFD2: No changes that will cause failure to meet surface water Good Ecological Status or Potential or result in a deterioration of surface water Ecological Status or Potential. • WFD3: No changes which will permanently prevent or compromise the Environmental Objectives being met in other water bodies. • WFD4: No changes that will cause failure to meet good groundwater status or result in a deterioration groundwater status.
	Angiosperms	There is potential for changes in the frequency of tidal inundations, sediment loading, land elevation and abrasion (associated to velocity) which may impact upon angiosperms. In particular, there is potential for impact on shingle and dune flowering plants as this SMP2 has large stretches of shingle and sand dune habitat. The policy options for these sections of coastline have the potential to result in changes to the shingle and dune habitat extent.	
	Benthic/ macroinvertebrates	SMP2 policies have the potential to cause changes in the beach water table and/or the groundwater connectivity upon which invertebrates are dependent.	
	Fish	Potential impacts on fish due to changes in substrate conditions and/or accessibility to nursery areas.	
Alde and Ore (PU ALB 14.4 – HOL 16.3)	Macroalgae	Potential changes to macroalgae through changes in abrasion (associated to velocity) as a result of SMP2 policies. For example, changes to control structures or defences may result in changes in wave and current dynamics and subsequent changes in abrasion patterns.	**Classification:** Not Yet Assessed (cHMWB)* • WFD2: No changes that will cause failure to meet surface water Good Ecological Status or Potential or result in a deterioration of surface water Ecological Status or Potential. • WFD3: No changes which will permanently prevent or compromise the Environmental Objectives being met in other water bodies. • WFD4: No changes that will cause failure to meet good groundwater status or result in a deterioration groundwater status.
	Angiosperms	There is potential for changes in the frequency of tidal inundations, sediment loading, land elevation and abrasion (associated to velocity) which may impact upon angiosperms.	
	Benthic/ macroinvertebrates	SMP2 policies have the potential to cause changes in the beach water table and/or the groundwater connectivity upon which invertebrates are dependent.	
	Fish	Potential impacts on fish due to changes in substrate conditions and/or accessibility to nursery areas.	

*cHMWB is a candidate Heavily Modified Water Body. At the time of the SMP WFD report date (November 2010) these water bodies had not been allocated a hydromorphological designation. They have since been designated as Heavily Modified Water Bodies.

Table 4: Extract (showing Policy Unit of interest for this study) from Assessment Table 3 WFD Assessment of SMP2 Policy for the Suffolk SMP2 (Note: WFD 1 is not included in the Table as there are no High Status water bodies present in the SMP2 Study area. SMP2 Preferred Policies: HTL = Hold The Line; NAI = No Active Intervention; MR = Managed Realignment). Source: Appendix L Water Framework Directive Assessment Suffolk SMP2 (November 2010)

Policy Development Zone		Management Area		Policy Unit		Preferred Policy			WFD Assessment of Deterioration	WFD2	WFD3	WFD4
						2025	2055	2105				
PDZ5	Thorpeness to Orford Ness	ORF 15	Martello Tower to Orford Ness	15.1	Sudbourne Beach (Suffolk Coast water body)	HTL	NAI	NAI	SMP2 policies within this PDZ have the potential to affect Ecological Potential in two water bodies; Suffolk Coast and Alde and Ore Transitional. The Suffolk Coast water body runs along the entire frontage of PDZ5. The complex Alde and Ore water body runs parallel to the coast behind a large shingle ridge (Orfordness) and is potentially affected by Policy Units which front this section of coastline. Defence polices within the estuary itself are subject to a separate strategy. In regard to policies that may affect the Alde & Ore water body the preferred policies seek to work with natural processes and the integrity of the Alde & Ore water body will be maintained. There will be some shingle roll back at Orford (policy unit 15.2) but the main Alde channel will not be change as a result of SMP2 policies along this frontage. The preferred policies in Management Area ORF 15 promote natural development of the coast. It is anticipated that the shingle ridge will roll back landward at a slow rate which may lead to the eventual loss of saline lagoons. As this is a natural process, it does not constitute a failure to meet Environmental Objectives.	√	√	√
				15.2	Orford Ness (Suffolk Coast water body)	NAI	NAI	NAI		√	√	√
				15.1*	Sudbourne Beach (Alde and Ore water body)	HTL	NAI	NAI		√	√	√
				15.2*	Orford Ness (Alde and Ore water body)	NAI	NAI	NAI		√	√	√

* denotes where polices overlap for the same water body

Further to the Policy Unit scale assessment, an assessment of the effect of potential failure to meet the objectives at the water body scale was made in Assessment Table 4 from the SMP2 WFD assessment. Assessment Table 4 concluded that there was potential for Environmental Objectives WFD2 and WFD3 to be compromised for the Suffolk Coastal water body. However, this was not in the ORF 15.1 Policy Unit. The report also concluded that the Environmental Objectives were likely to be supported by the proposed SMP2 policies for the Alde and Ore transitional water body.

3. Assessment Method

The scope of this WFD assessment is to appraise the proposals recommended in the Phase 1 report to ensure that these are compliant with the Environmental Objectives of the WFD as set out within the Directive. Only changes that are likely to have long term effects at the water body level are considered, such that construction and maintenance activities have not been appraised. The assessment has therefore focused on identifying possible long term and permanent effects on the water bodies which would result in deterioration in status/potential or that would prevent the improvement of a failing water body.

This is a preliminary assessment with the expectation that a more detailed appraisal is likely to be required at scheme stage, which would need to follow the latest guidance: Clearing the Waters for All.

For this high-level assessment the following steps have been taken:

1) identify waterbodies within the area;
2) screening of waterbodies;
3) collation of baseline data of screened-in water bodies;
4) definition of current status/potential;
5) preliminary assessment of each proposed approach against the WFD Environmental Objectives 1 -4; and
6) reporting conclusions.

This report is to be read in conjunction with the Preliminary HRA report; which details impacts on the European sites, which is also a requirement under the Water Framework Environmental Objectives. This Preliminary WFD report focuses on the impacts from the schemes on water quality, which comes under the wider Environmental Objectives.

4. Baseline Data

4.1 Waterbodies: Screening

Data has principally been extracted from the Environment Agency's Catchment Data Explorer http://environment.data.gov.uk/catchment-planning/ (cycle 2, 2016 data) to identify water bodies present within the SMP review study area, their ID numbers, designation and classification details [accessed June 2018]. The WFD compliance mapping for groundwater risk and status assessment was also reviewed.

The study area is located within the Anglian River Basin District (RBD) and the relevant water body classifications are reported in the Anglian River Basin Management Plan (RBMP) (Environment Agency, 2015). Within this RBD, the SMP review coastline lies within the wider Anglian TraC (Transitional and Coastal) Management Catchment and within the Suffolk Trac Operational Catchment.

Table 5 lists the water bodies and explains which have been scoped in or out of the assessment and why.

Table 5: WFD water bodies scoped in or out of the study

Water body ID	Name of water body in RBMP	Type and hydro-morphological designation	Scoped in?	Reason (for scoping in/out)
Coastal/TraC water bodies				
GB650503520002	Suffolk	Coastal (heavily modified)	Yes	This is the coastal water body that is directly affected by the policy review. Potential effect on fish, invertebrates and macrophytes, sediment quality and quantity, and sensitive habitats.
GB520503503800	Alde and Ore	Transitional (heavily modified)	Yes	This is the estuary that is directly affected by the policy review. Potential effect on fish, invertebrates and macrophytes, sediment quality and quantity, and sensitive habitats.
Freshwater/Riverine water bodies				
GB105035045950	Alde/Ore (downstream of confluence)	River (not designated artificial or heavily modified)	No	If temporary breaches occur (e.g. if Approaches 7 or 8 are adopted), emergency works will be undertaken to repair the breach therefore wider and longer term impacts on the estuary will be avoided. This freshwater water body is sufficiently far upstream to avoid any impacts of temporary breaches.
Groundwater body				
GB40501G400600	Waveney and East Suffolk Chalk and Crag	Groundwater body	Yes	Potential saline intrusion risk. Potential effect on salinity and chemical status.

4.2 Waterbodies: Current status/potential

Table 6 presents the current status (or potential if heavily modified) of the water bodies scoped into this assessment and identifies key biological quality elements and supporting elements. Those elements shown in bold indicate elements that have been identified by the Environment Agency as preventing waters from reaching good status/potential. This information has been taken from the Catchment Data Explorer cycle 2 (2016) data [accessed June 2018].

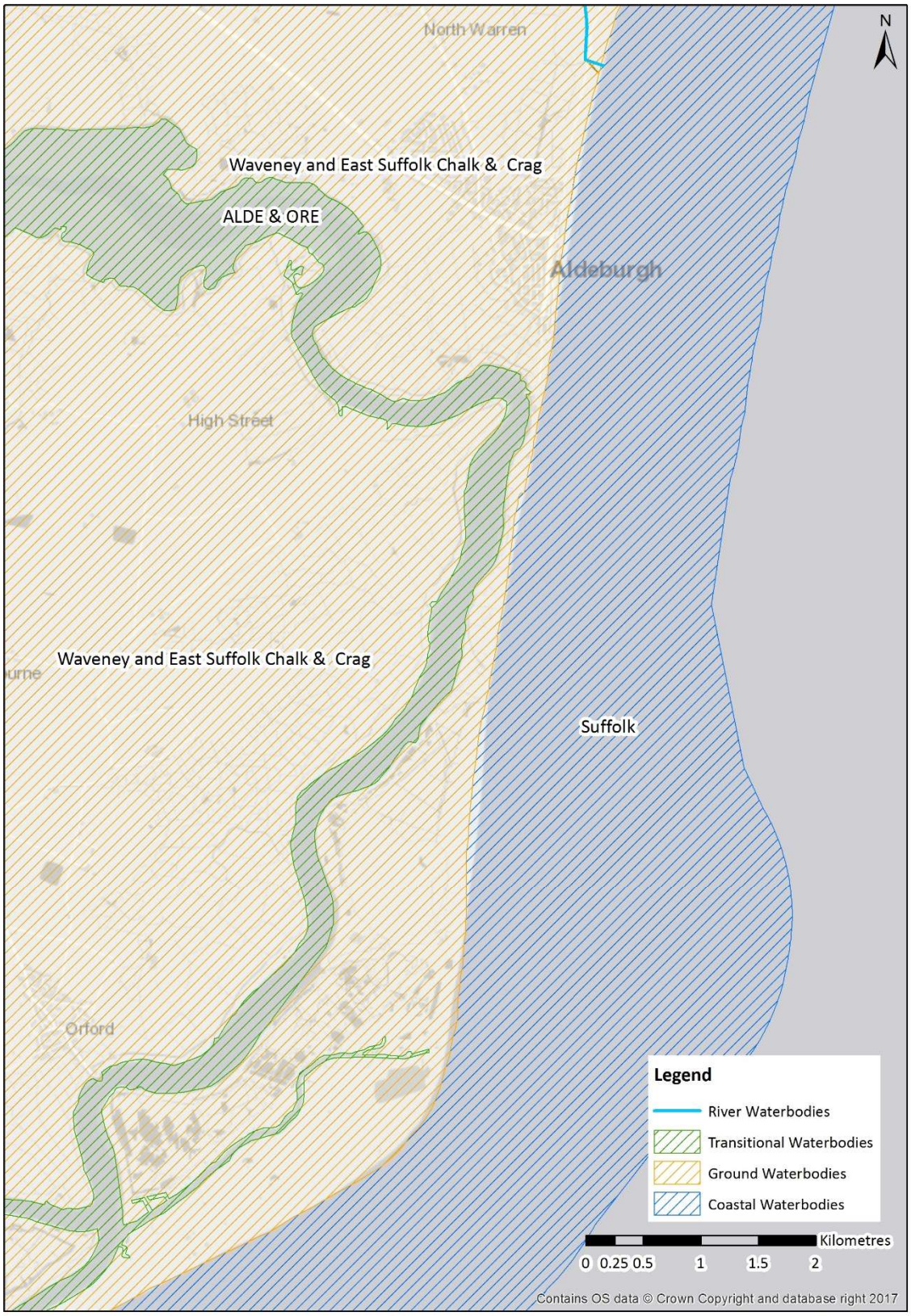

Figure 3: WFD waterbodies within the study area. Source: EA Datashare site (accessed 11/06/2018).

Table 6: Water body classifications for water bodies assessed. Source: Environment Agency Catchment Data Explorer cycle 2 (2016) data

Water body ID/ Name	**Type and designation**	**Status/ potential 2016 (Cycle 2)**	**Target Status/ Potential**	**Biological quality elements**	**Supporting elements (elements limiting status/potential shown in bold)**	**Reasons for not achieving good (Stated as Classification item, Category, Business Sector, Activity)**
GB650503520002 Suffolk	Coastal. Heavily modified (coast protection)	Moderate	Moderate by 2015	Phytoplankton	**Dissolved inorganic nitrogen** Dissolved oxygen	• Dissolved Inorganic Nitrogen; Agriculture and rural land management; Agriculture – Arable; Poor nutrient management. • Dissolved Inorganic Nitrogen; Water Industry; Waste water treatment; Sewage discharge (continuous).
GB520503503800 Alde and Ore	Transitional water. Heavily modified (flood protection)	Moderate	Moderate by 2015	Angiosperms Fish Invertebrates Macroalgae	**Hydrological Regime** **Dissolved inorganic nitrogen** Dissolved oxygen	• Dissolved Inorganic Nitrogen; Sector under investigation. Not applicable; Unknown • Dissolved Inorganic Nitrogen; Water Industry; Waste water treatment; Sewage discharge (continuous) • Dissolved Inorganic Nitrogen; Agriculture and rural land management; Agriculture – Arable; Poor nutrient management • Hydrological regime; Sector under investigation; Not applicable; Unknown
GB40501G400600 Waveney and East Suffolk Chalk and Crag	Groundwater body	Poor	Poor by 2015	-	Quantitative status (and status objective)	• Quantitative Water Balance; Agriculture and rural land management; Agriculture – Arable; Groundwater abstraction • Quantitative Water Balance; Agriculture and rural land management; Agriculture – Arable; Surface water abstraction • Trend Assessment; Agriculture and rural land management; Agriculture – Livestock; Livestock • Chemical Drinking Water Protected Area; Agriculture and rural land management; Agriculture – Livestock; Livestock • General Chemical Test; Agriculture and rural land management; Agriculture – Livestock; Livestock

4.3 Proposed Approaches

Nine separate approaches (Table 7) have been presented in the Phase 1 report to reflect three overall outcomes (breach, no breach and temporary breach). There are alternative combinations of solutions in achieving these outcomes/approaches across the three policy sub-units. A brief assessment of the environmental impacts was undertaken in Phase 1. Accompanied by a the main report for Phase 2, this preliminary WFD assessment provides a detailed appraisal to identify whether the decision on changing SMP policy may be constrained on environmental grounds.

The assessment for those approaches with an outcome of permanent breach (1 to 3) do not present a change from the current SMP policy in epochs 2 and 3 and therefore do not require a detailed assessment of the wider estuary impacts. That would be extensive, expensive, and likely to be redundant given the very probable outcome of rejecting these approaches. Therefore, the high-level assessments undertaken for Phase 1 for Approaches 1 to 3 are considered to be sufficient.

Similarly, this study will not be assessing in detail the wider potential impacts of Approach 9 (Shingle Engine) which could again be much wider ranging and is the responsibility of the promoters of that scheme to undertake. This assessment will though identify potential risks and impacts which that approach would likely need to consider if it is progressed.

Table 7: Management approaches and outcome scenarios for each sub-unit of ORF 15.1. Source: Phase 1 report.

Sub-unit	Approach 1	Approach 2	Approach 3	Approach 4	Approach 5	Approach 6	Approach 7	Approach 8	Approach 9
A	A1 – Do nothing	A7 - Terminal structure	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	A3 - Maintain/ improve the existing revetment structure **or** A5 - Widen the defence	A6 - New embankment along estuary channel	Shingle Engine
B	B1 – Do nothing	B1 – Do nothing	B1 – Do nothing	B6 - Extend the revetment structure along the shoreline	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B7 - New embankment along estuary channel **or** B8 - New embankment - alternative alignments	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	B2 - Beach nourishment **or** B4 - Widen the shingle ridge **or** B5 - 'Natural' shingle ridge management	
C	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	C1 – Do nothing	
	Breach	**Breach**	**Breach**	**No Breach**	**No Breach**	**No Breach**	**Temporary Breach**	**Temporary Breach**	**No Breach**

5. WFD Appraisal

Table 8 to 12 consider the proposed approaches, within the SMP review of PU 15.1, in respect to the Water Framework Directive Environmental Objectives 1 - 4 for the scoped-in water bodies. The focus of this assessment is to demonstrate:

- The proposed approaches will not cause any changes affecting high status sites (WFD objective 1 - WFD1).
- The proposed approaches will not result in a deterioration of current surface water ecological status or potential (WFD objective 2 – WFD2).
- The proposed approaches will not cause failure to meet the surface water Good Ecological Status (GES)/Good Ecological Potential (GEP) by the target timeframe (WFD objective 3 – WFD3).
- The proposed approaches will not permanently prevent or compromise the relevant environmental objectives being met in other water bodies (WFD objective 4 – WFD4).

Note that WFD 1 is not included in the tables as there are no High Status water bodies present. Furthermore, WFD 2 and WFD 3 only apply to surface water bodies whilst WFD 4 only pertains to ground water bodies.

As part of appraising the above, the appraisal should consider whether the proposed approaches will negatively impact the delivery of any of the mitigation measures or whether the proposed approaches can include improvement or mitigation measures required to meet good ecological status / potential for those water bodes that are not currently at good status / potential identified in the tables below. However, all WFD mitigation measures for the Suffolk Coastal and Alde and Ore HMWBs are listed as “not applicable”. In the tables below additional mitigation actions have been identified where appropriate.

The Preliminary HRA report assesses the implications of the approaches on the protected sites, and these are not repeated in detail here.

Table 8: WFD assessment of future management options: Approach 4

Approach 4. Outcome = No breach							
Summary of approach **A3 Maintain / Improve revetment** OR **A5 Widen the defence** **B6 Extend the revetment** **C1 Do nothing**							
Water body ID/ Name	**Assessment of proposals against WFD objectives**	**Target WFD status/ potential**	**Expected contribution to WFD status/potential**	**WFD2**	**WDF3**	**WFD4**	**Proposed mitigation actions**
GB650503520002/ Suffolk	A breach will be prevented by reducing overtopping, either through reinforcement of the existing rock revetment (A3) or by depositing shingle on the landward side of the defence (A5). The existing revetment terminates approximately 700m south of the Martello Tower – to prevent outflanking causing a breach within this area – it is proposed that the existing revetment is extended (B6) along the length of sub-cell B. In the long-term, under measure A3 & B6, maintenance/construction of defences will result in significant disturbance to intertidal and beach habitats and by holding the shoreline in an artificially advanced position, there will be coastal squeeze along the coastal edge, resulting in the steepening of the foreshore in front of the defence. Strengthening the existing revetment (A3) would involve importing more rock, making improvements to the toe and crest of the structure. This may result in a slight change in the footprint of the existing defence. In the area of rock revetment extension (B6) the sea-land interface would change from shingle to rock. Extending the section of rock armour will severely limit the natural response of the shoreline to wave action. There may be an increase in	Moderate by 2015	No change in potential	Y	Y		None required

	reflective scour which, combined with coastal squeeze may lead to the foreshore (immediately in front of the defence) lowering. Approach 4 is unlikely to affect migration of aquatic organisms. Overall this approach will not compromise the environmental objectives 2 - 3.						
GB520503503800/ Alde and Ore	Importing shingle to the rear slope (A5) of the defence may have some implications on the wider channel. The shingle will change the physical habitat structure - in that shingle will replace some areas of salt marsh/back of slope vegetation, however it will also provide opportunity for vegetated shingle to establish. It is not thought that the material will affect river flow, as it will be deposited above the mean water level and set back from the main channel. By constructing a feature which constrains the adjustment of the intertidal habitat, anthropogenic coastal squeeze occurs, causing the steepening of the intertidal area. However, in this case coastal squeeze would already occur naturally as the intertidal area is constrained by the sea on one side and the river on the other. The shingle may need to be sourced from an offshore source and if so may have a higher organic/fines content than well sorted shingle exposed to wave action. The water body lies inland of the coastal frontage and the key impacts will be the continued reduction of flood and erosion risk and as the purpose of the implementation measures is to prevent a breach, large-scale impacts on the wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected. Defined Mitigation Measures are associated with in-channel form, obsolete structures ecology and dredging control, which are listed as “not applicable” and are also outside the scope of this study.	Moderate by 2015	No change in potential	Y	Y		A5 - Consider measures to reduce release of fines during recharge
GB40501G400600/ Waveney and East Suffolk Chalk and Crag	The key impact will be the continued reduction of flood and erosion risk and, associated with this, the continued protection from saline inundation during extreme water level events. Other elements that are causing the water body to have poor status are unlikely to be affected by Approach 4.	Poor by 2015	No change in status			Y	None required

Table 9 WFD assessment of future management options: Approach 5

Approach 5. Outcome = No breach							
Summary of Approach **A3 Maintain/improve revetment** OR **A5 Widen the defence** **B7 New embankment along estuary channel** OR **B8 New embankment – alternative alignments** **C1 Do Nothing**							
Water body ID/ Name	**Assessment of proposals against WFD objectives**	**Target WFD status/ potential**	**Expected contribution to WFD status/potential**	**WFD2**	**WDF3**	**WFD4**	**Proposed mitigation actions**
GB650503520002/ Suffolk	A breach will be prevented by reinforcing the existing rock revetment (A3) or by depositing shingle on the landward side of the defence (A5) within sub cell A. Within sub cell B an earthen embankment will be built, either along the existing embankment (B7) or along a new alignment (B8). For both B7 & B8 it would also be necessary to extend the existing revetment approximately 200 m into sub cell B to provide extra protection in front of the narrowest section between river and coast. In the long-term, under measure A3 and the rock revetment extension (B7 & B8), maintenance/construction of defences will result in disturbance to intertidal and beach habitats and by holding the shoreline in an artificially advanced position, there will be coastal squeeze, resulting in foreshore steepening in front of the revetment. The structure of the intertidal zone will be affected by the maintenance and extension of revetments. Strengthening the existing revetment would involve importing more rock, making improvements to the toe and crest of the structure. This may result in a slight change in the footprint of the defence however the foreshore fronting the defence would not be expected to change significantly. In the area of rock revetment extension (B7 & B8) the sea-land interface would change from shingle to rock. The structure of the intertidal zone will be affected by the maintenance and extension of revetments, widening the defence and by new embankments..	Moderate by 2015	No change in potential	Y	Y		None required

	Approach 5 is unlikely to affect migration of aquatic organisms.						
GB520503503800/ Alde and Ore	Any new embankment along the estuary line or set back into the saltmarsh would directly result in impacts on the structure of the intertidal zone within the estuary, namely the area becoming enclosed, by reducing the input of water and sediment to the saltmarsh. During flood events there is the potential for flood water to overtop and then become trapped behind the embankment rather than draining via the salt marsh. UKTAG recognise that: *"(Saltmarshes) hold an essential function in the exchange of nutrients and sediments within estuarine and coastal ecosystems."* By constructing a feature which constrains the adjustment of the intertidal habitat, anthropogenic coastal squeeze occurs. However, in this area coastal squeeze would occur naturally as a result of the shingle beach is rolling back. The water body lies inland of the coastal frontage and the key impacts will be the continued reduction of flood and erosion risk from the coast and as the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected. Defined Mitigation Measures are associated with in-channel form, obsolete structures ecology and dredging control, which are listed as "not applicable" and are also outside the scope of this study.	Moderate by 2015	No change in potential	**Y***	**Y***		***Only Yes if:** **B7/B8 - Mitigation measures to look at an exchange of saline water into the salt marsh at Lantern Marshes.** A5 - Consider measures to reduce release of fines during recharge
GB40501G400600/ Waveney and East Suffolk Chalk and Crag	The key impact will be the continued reduction of flood and erosion risk and, associated with this, the continued protection from saline inundation during extreme water level events. Other elements that are causing the water body to have poor status are unlikely to be affected by Approach 5.	Poor by 2015	No change in status			Y	None required

Table 10: WFD assessment of future management options: Approach 6

Approach 6. Outcome = No breach							
Summary of Approach **A6 New embankment along estuary channel** **B7 New embankment along estuary channel** OR **B8 New embankment – alternative alignments** **C1 Do Nothing**							
Water body ID/ Name	**Assessment of proposals against WFD objectives**	**Target WFD status/ potential**	**Expected contribution to WFD status/potential**	**WFD2**	**WDF3**	**WFD4**	**Proposed mitigation actions**
GB650503520002/ Suffolk	The approach will involve a new embankment along the estuary channel (A6) and new embankments along the estuary channel (B7) or an alternative alignment (B8). Between sub-units A and B, there will be a shore parallel rock headland to provide additional protection along the meander where the estuary channel is closest to the sea. This will protect the rear embankment both directly and through trapping shingle in its lee, however as the shingle beach rolls-back naturally this defence may encourage down drift erosion/outflanking. The new embankments (A6 & B7/B8) will enable a more naturally functioning coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. There will no longer be a need to rely on shingle recycling to sustain defences, therefore potentially improving the status of Sudbourne Beach. The new line of defence will provide a tracking route for plant, which will allow the vegetated shingle along the beach to recover/expand. Approach 6 is unlikely to affect migration of aquatic organisms.	Moderate by 2015	No change in potential	Y	Y		None required
GB520503503800/ Alde and Ore	The two new embankments (A6 & B7/B8) would directly result in impacts on the structure of the intertidal zone within the estuary, namely the area becoming enclosed, by reducing the input of water and sediment to the saltmarsh. During fluvial flood events there is the potential for flood water to overtop and then become	Moderate by 2015	No change in potential	**Y**	**Y**		***Only Yes if:** **A6 & B7/B8 - Mitigation measures to look at an**

	trapped behind the embankment rather than draining via the salt marsh. UKTAG recognise that: *"(Saltmarshes) hold an essential function in the exchange of nutrients and sediments within estuarine and coastal ecosystems."* The water body lies inland of the coastal frontage and the key impacts will be the continued reduction of flood and erosion risk from the coast and as the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected. By constructing a feature which constrains the adjustment of the intertidal habitat, anthropogenic coastal squeeze occurs. However, in this area coastal squeeze would occur naturally as a result of the shingle beach is rolling back. Defined Mitigation Measures are associated with in-channel form, obsolete structures ecology and dredging control, which are listed as "not applicable" and are also outside the scope of this study.						**exchange of saline water into the salt marsh at Lantern Marshes.**
GB40501G400600/ Waveney and East Suffolk Chalk and Crag	The key impact will be the continued reduction of flood and erosion risk and, associated with this, the continued protection from saline inundation during extreme water level events. Other elements that are causing the water body to have poor status are unlikely to be affected by Approach 6.	Poor by 2015	No change in status			Y	None required

Table 11: WFD assessment of future management options: Approach 7

Approach 7. Outcome = Temporary breach							
Summary of Approach **A3 Maintain/improve revetment** OR **A5 Widen the defence** **B2 Beach nourishment** OR **B4 Widen the shingle ridge** OR **B5 'Natural' shingle ridge management** **C1 Do nothing**							
Water body ID/ Name	**Assessment of proposals against WFD objectives**	**Target WFD status/ potential**	**Expected contribution to WFD status/potential**	**WFD2**	**WDF3**	**WFD4**	**Proposed mitigation actions**
GB650503520002/ Suffolk	Within sub cell A, breach will be prevented by reinforcing the existing rock revetment (A3) or by depositing shingle on the landward side of the defence (A5). Within sub cell B, the beach will be managed either using traditional beach nourishment activities (B2) or through natural shingle ridge management (B5). In the long-term, under measure A3 maintenance of defences will result in disturbance to intertidal and beach habitats and by holding the shoreline in an artificially advanced position, there will be coastal squeeze along coastal edge, resulting in the steepening of the foreshore in front of the defence. Outflanking may occur to the south of the revetment which will need to be managed through the shingle beach management. The structure of the intertidal zone will be affected by the maintenance of revetments. Strengthening the existing revetment would involve importing more rock, making improvements to the toe and crest of the structure. Beach nourishment (B2) is a soft engineering method, allowing natural processes, e.g. longshore drift, to continue whilst providing a form of natural protection by attenuating wave energy. Subtidal habitats and features within the areas covered by this water body have the potential to continue to be directly and/or indirectly affected by the beach nourishment activities. There is the potential for alteration to benthic habitat (e.g. smothering). Beach nourishment could temporarily change the beach sediment profile e.g. more fines at Low Mean Water because of changed beach	Moderate by 2015	No change in potential	Y	Y		B2 & B5 - Consider measures to reduce release of fines during recharge and revetment construction.

	profile. However, along a relatively exposed coastline, such as at Sudbourne, this is unlikely. These are all localised and temporary changes. Natural Shingle Ridge Management (B5) would allow a naturally functioning coast and no long-term negative impacts would be anticipated. Similarly, there would be no negative impacts on the Suffolk water body associated with widening the ridge (B4) however there are negative impacts for the saltmarsh on the back of the shingle ridge (see next section: Alde & Ore). Measures B2, B4 or A5, may require shingle to be imported, e.g. from an offshore dredged source. The source of that nourishment is currently unknown, particularly given the significant volumes required. There may be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches. The alternative would be to engage on more intensive recycling from Sudbourne Beach for any of these measures. For B2 there would also be a need for mechanical reprofiling of the beach to ensure the standard pf protection remains adequate. The environmental implications of this on the habitats and geomorphological features at Sudbourne Beach has been disputed in the literature (see Orford, 2015 and Pye, 2015, 2016), but there is general concern regarding the long-term damage of this practice on vegetated shingle habitats and the geomorphological elements of the feature. The SSSI site units at Slaughden are already currently in an unfavourable condition because of shingle recycling activities. Although measure B5 promotes a more naturally functioning coastline along sub-unit B, there may still be a requirement to source some addition shingle from Sudbourne Beach (for breach repairs), which although considerably less than has historically and currently been extracted, may still result in these impacts. Approach 7 is unlikely to affect migration of aquatic organisms. There is potential for a temporary increase in suspended sediment concentrations due to the outwashing of fines from recharged material, although impacts on light and water will not be more severe than that normally experienced under stormy conditions. There could						

	however be a wider impact on phytoplankton growth, macrophytes and invertebrates and other aquatic flora as sediment is moved offshore and alongshore.						
GB520503503800/ Alde and Ore	It is not thought likely that the addition of shingle to the rear slope (A5 & B4) will affect river flow, as it will be deposited above the mean water level and set back from the main channel. The shingle will most likely be from an offshore source and may therefore have a higher organic/fines content than well sorted shingle exposed to wave action. As the 'Natural' Shingle Ridge Management (B5) will allow the roll-back of the shingle ridge there will be local loss of the backing marsh areas through coastal squeeze. The water body lies inland of the coastal frontage. The measures proposed for the sub cell B may result in a temporary breach however there is a commitment to repairing the breach so large-scale impacts on the wider estuary will be avoided. There is a particular risk of breach where the ridge is already narrow and is constrained by the river channel meander: here works to widen the ridge will be limited and similarly, there is little accommodation space for a wider barrier to naturally form. As the intention is for emergency work to be undertaken to repair a breach, impacts on the wider estuary environment should be limited. However, at the pinch points, where the breach is most likely to occur there may be over-washing of shingle across the fringing marsh. Any recovery of this material may cause damage to the underlying surface and supported habitats. During period of temporary breach there will be more frequent overtopping where the ridge breaches, but this is not likely to have a significant impact on the local waterbody. The exception could be the designated shellfish protected area within the River Alde, but sensitivity of this zone will need further consideration.	Moderate by 2015	No change in potential	Y	Y		A5 & B4 - Consider measures to reduce release of fines during embankment construction.

	Defined Mitigation Measures are associated with in-channel form, obsolete structures ecology and dredging control, which are listed as “not applicable” and are also outside the scope of this study.						
GB40501G400600/ Waveney and East Suffolk Chalk and Crag	The key impact will be the continued reduction of flood and erosion risk and, associated with this, the continued protection from saline inundation during extreme water level events as any temporary breaches will be repaired. Other elements that are causing the water body to have poor status are unlikely to be affected by Approach 7.	Poor by 2015	No change in status			Y	None required

Table 12: WFD assessment of future management options: Approach 8

Approach 8. Outcome = Temporary breach							
Summary of Approach **A6 New embankment along estuary** **B2 Beach nourishment OR B4 Widen the shingle ridge OR B5 'Natural shingle ridge management** **C1 Do nothing**							
Water body ID/ Name	**Assessment of proposals against WFD objectives**	**Target WFD status/ potential**	**Expected contribution to WFD status/potential**	**WFD2**	**WDF3**	**WFD4**	**Proposed mitigation actions**
GB650503520002/ Suffolk	The approach will involve a new embankment along the estuary channel (A6) and beach nourishment (B2), widening of the shingle ridge (B4) or natural shingle ridge management (B5). Between sub-units A and B, there will be a shore parallel rock headland to provide additional protection along the meander where the estuary channel is closest to the sea. This will protect the rear embankment both directly and through trapping shingle in its lee. Furthermore, additional rock will need to be added to the end of the sea wall (close to the Martello Tower), to protect against outflanking. The new embankments (A6 & B7/B8) will enable a more naturally functioning coast to develop along this stretch, as well as to the south. This should lead to an improvement in the status of this stretch of shoreline. There will no longer be a need to rely on shingle recycling to sustain defences, therefore potentially improving the status of Sudbourne Beach. Beach nourishment (B2) is a soft engineering method, allowing natural processes, e.g. longshore drift, to continue whilst providing a form of natural protection by attenuating wave energy. Subtidal habitats and features within the areas covered by this water body have the potential to continue to be directly and/or indirectly affected	Moderate by 2015	No change in potential	Y	Y		B2 & B5 - Consider measures to reduce release of fines during recharge

	by the beach nourishment activities. There is the potential for alteration to benthic habitat (e.g. smothering). Beach nourishment could temporarily change the beach sediment profile e.g. more fines at Low Mean Water because of changed beach profile. However, along a relatively exposed coastline, such as at Sudbourne, this is unlikely. These are all localised and temporary changes. Natural Shingle Ridge Management (B5) would allow a naturally functioning coast and no long-term negative impacts would be anticipated. Similarly, there would be no negative impacts on the Suffolk water body associated with widening the ridge (B4). Measures B2, B4 or A5, may require shingle to be imported, e.g. from an offshore dredged source. The source of that nourishment is uncertain, particularly given the significant volumes required. There may be environmental impacts should the new shingle differ in physical or chemical composition from the existing material on the beaches. The alternative would be to engage on more intensive recycling from Sudbourne Beach for any of these measures. For B2 there would also be a need for mechanical reprofiling of the beach to ensure the standard pf protection remains adequate. The environmental implications of this on the habitats and geomorphological features at Sudbourne Beach has been disputed in the literature (see Orford, 2015 and Pye, 2015, 2016), but there is general concern regarding the long-term damage of this practice due to damage caused to vegetated shingle habitats and the geomorphological elements of the feature. The SSSI site units at Slaughden are already currently in an unfavourable condition as a result of shingle recycling activities. Although measure B5 promotes a more naturally functioning coastline along sub-unit B, there may still be a requirement to source some addition shingle from Sudbourne Beach (for breach repairs), which although considerably less than has historically and currently been extracted, may still result in these impacts. Approach 8 is unlikely to affect migration of aquatic organisms. There is potential for a temporary increase in suspended sediment concentrations due to the out-washing of fines from recharged material, although impacts on light and water will not be more severe than that normally experienced under stormy conditions. There could						

	however be a wider impact on phytoplankton growth, macrophytes and invertebrates and other aquatic flora as sediment is moved offshore and alongshore.						
GB520503503800/ Alde and Ore	It is not thought likely that importing shingle to the rear slope (A5 & B4) will affect river flow, as it will be deposited above the mean water level and set back from the main channel. The shingle will most likely be from an offshore source and may therefore have a higher organic/fines content than well sorted shingle exposed to wave action. The new embankment, (A6) would directly result in impacts on the structure of the intertidal zone within the estuary, namely the area becoming enclosed, by reducing the input of water and sediment to the saltmarsh. During fluvial flood events there is the potential for flood water to overtop and then become trapped behind the embankment rather than draining via the salt marsh. The water body lies inland of the coastal frontage and the key impacts will be the continued reduction of flood and erosion risk from the coast and as the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. The designated shellfish protected area within the River Alde, will also remain protected. The water body lies inland of the coastal frontage and the key impacts will be the continued reduction of flood and erosion risk from the coast and as the purpose of the implementation measures is to prevent a breach, large-scale impacts on wider estuary will be avoided. Defined Mitigation Measures are associated with in-channel form, obsolete structures ecology and dredging control, which are listed as “not applicable” and are also outside the scope of this study.	Moderate by 2015	No change in potential	**Y***	**Y***		***Only Yes if:** **A6 - Mitigation measures to look at an exchange of saline water into the salt marsh at Lantern Marshes.** B4 - Consider measures to reduce release of fines during recharge

GB40501G400600/ Waveney and East Suffolk Chalk and Crag	The key impact will be the continued reduction of flood and erosion risk and, associated with this, the continued protection from saline inundation during extreme water level events as any temporary breaches will be repaired. Other elements that are causing the water body to have poor status are unlikely to be affected by Approach 8.	Poor by 2015	No change in status			Y	None required

6. Conclusions

Suffolk Coastal District Council (SCDC) is working with the Environment Agency (EA) and other stakeholders, notably the Alde and Ore Estuary Partnership (AOEP), to review coastal management policy at Slaughden, where current policy may need revision. This document is a preliminary assessment of a number of policy approaches against the objectives of the WFD, to evaluate the potential for long term changes at the water body level.

It should be noted that the potential impacts upon the protected sites, namely Orfordness Shingle Street SAC, Alde-Ore Estuary SAC and Alde Ore & Butley Estuaries SPA, have been assessed in detail within the main report: Preliminary assessment of SMP approaches against the Habitat Regulations. The safeguarding of these sites against any deterioration has therefore not been discussed in detail within this preliminary WFD assessment.

The assessment indicates that Approaches 4 and 7 comply with the WFD objectives considered. Approaches 5, 6 and 8 do not meet the criteria, as they enclose the saltmarsh which may result in the deterioration of good ecological potential (GEP); however, with appropriate mitigation built into the scheme, i.e. measures to ensure the tidal exchange of saline water into the site, the approaches are considered to be acceptable.

The WFD assessment presented in Section 4 has shown that the policy options being considered will satisfy the relevant criteria for compliance with the WFD, subject to any mitigation measures identified within a scheme level HRA being undertaken. Therefore, the proposed approaches are considered, at this stage, to satisfy the following objectives, at the water body level:

- WFD 2: The proposed works will not result in a deterioration of current surface water ecological status or potential.
- WFD 3: The proposed works will not cause a failure to meet surface water GES /GEP by the target timeframe.
- WFD 4: The proposed works will not permanently prevent or compromise the relevant environmental objectives being met in other water bodies.

In conclusion, all options put forward as part of the SMP Policy Review for PU 15.1 are not predicted to cause deterioration in water body status or prevent the water body from meeting its objectives and therefore **an assessment against the conditions listed in Article 4.7 is not required**. However, it is recommended that a scheme-level WFD assessment is undertaken at design stage of any approach adopted.

7. References

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