Gunton and Corton Coastal Options Appraisal

Appendix C - Coastal Management Options

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Coastal Partnership East

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Contents

1. Introduction

1.1 Background

On behalf of East Suffolk Council, Coastal Partnership East (CPE) have commissioned Jacobs to undertake an updated review of potential options for delivering the Gorleston to Lowestoft Coastal Strategy Plan (2016) – 'the Strategy' – along the frontages extending across Gunton, Corton, and North Corton Cliffs.

In summary, the Strategy is as follows:

- Gunton– to allow this area to remain as natural as possible (acknowledging that future risks to assets may require later action). Also, accepting works may be required to encourage higher beach levels at the southern end to reduce exposure of the east-west section of the seawall alongside Links Road car park.
- Corton – to maximise protection to cliff top assets by defending the present line. There are strategic reasons to hold this position to support the evolution and stability of beaches directly north and south of Corton. A further aspiration is to retain, and preferably improve, public access along this frontage.
- North Corton Cliffs – to control (rather than completely halt) erosion, allowing sediment to be released into the system whilst creating an improved and safer beach for the community and local holidaymakers. This is integral to the objectives across the wider frontages here, in particular at Corton, where a balance of management approaches is desired to support the local tourist economy.

Since adoption of the Strategy, there have been changes in circumstances, namely:

- Changes to the coastal environment (such as rates of cliff erosion/beach-levels), potentially affecting timing of risks to assets,
- Changes to the political/economic landscape (such as Brexit, Covid-19), currently impacting upon investment/funding decisions.

Whilst the overall principles of the Strategy remain robust, this review is seen as an opportunity for 're-setting the scene' - using latest knowledge to re-assess and update the delivery approaches and inform conversations on how to proceed in the short and medium term.

1.2 Assessment

Based upon the above updated review of shoreline behaviour and associated risks, the proposed implementation measures presented in the Strategy have been re-appraised to determine whether these still remain valid management approaches. Although the Strategy also assessed a range of other options, these have not been considered further by this study, unless the change in circumstances suggests these may become more viable.

At Gunton, due to the recent increase in erosion rates and therefore increasing risk to assets, this study has looked at feasible strategic-level approaches for managing this frontage.

Along the Corton frontage, and the cliffs to the north of Corton, this study has focussed on (1) reappraising the feasibility of approaches proposed by the Strategy, given recent changes to the coast, and (2) exploring the potential for lower cost (do-minimum) approaches and the implications of these for longer term management.

High level costs estimates have been derived for the likely preferred approaches. Advice is also provided on whether the preferred approaches will require the existing SMP policy to be revisited.

2. Existing coastal defences

The following briefly describes the existing coastal defence structures along these frontages. More extensive details and assessment of all of these are provided by an appendix to the Strategy document, so not repeated here.

2.1 Gunton Warren

Between North Beach Car Park at Links Road, Lowestoft, and a point just south of 'Tramps Alley' (the beach access point opposite the small car park on the southern side of Pleasurewood Hills), the Gunton Warren shoreline is undefended (other than some timber groynes which are in a state of disrepair and can be considered to have 'failed') and characterised by a vegetated relict cliff slope and backshore dune area.

The southern boundary also forms the limit of the Lowestoft North Denes seawall. Although outside of the study area, the influence of that structure, and future plans for it, are important considerations with respect to the Gunton frontage as the east-west section of the seawall alongside Links Road car park could be undermined by falling beach levels here.

2.2 Corton Woods

The concrete and steel sheet piled wall to the south of Corton Lane was built in 1967/8 in response to accelerated cliff erosion which followed construction of the Corton village defences. Nonetheless, this now forms an important extension (approx 500 m) of that same wall should there be any potential for outflanking of the Corton defences. At the southern end of this wall, a concrete pavement runs behind a small upstand wall, allowing pedestrian access to the beach from the road at the top of the cliff via 'Tramps Alley'. This continues for a distance of approximately 150 m beyond the access point. Any remaining groynes now appear to be derelict.

Residual life is entirely dependent on the presence or otherwise of the beach. Whilst this remains as present, the wall is not at obvious risk of failure. However, should beach levels lower as seen at Corton, the wall would be vulnerable to wave attack and similar potential for failure.

2.3 Corton Village

Defences are present along the full length between Corton Long Lane and Bakers Score (approx 1000 m), consisting of a narrow concrete walkway and sloping upper concrete slab revetment, fronted by a sheet piled toe constructed during the 1960's, and a rock toe placed in 2003/4. The rock toe was intended to delay the failure of the wall for an estimated period of 20 years and has proved effective in reducing further foreshore lowering and preventing rotational failure or bucking of the sheet piled wall. The upper concrete revetment on the cliff face is in very poor condition and in some areas further rock has been placed on the upper cliff slope where sections of the concrete revetment have been displaced. In addition to continued wave attack at high water causing some erosion to the cliff face, there are also issues with the upper cliff face being eroded due to ground water/geotechnical instability. Groynes previously existed along this frontage, but only the skeleton of timbers from those remain.

The long-standing challenge to manage erosion here is evident from the defence history. Predating the current structures, the Colman Wall (the remains of which can be seen at the southern end of Corton) was destroyed by a storm in 1907/08.

Narrow beaches have been an issue for some time and even in the mid-late 1990's it was noted that public access to and along the frontage was becoming difficult and hazardous. High Water was already at the structure toe in places and thus the beach was inaccessible for most of the tidal cycle. The majority of the frontage was deemed unsafe for bathing due to the previous defence ruins. This continues to be a hazard today. Although the walkway is gated at both ends and closed off during the winter, it can be exceptionally slippery when accessible on falling tide so presents a hazardous area for public use.

2.4 North Corton Cliffs

2.4.1 Rock revetment

Immediately adjacent to Corton, the rock continues for approx 150 m along the cliff face beyond the end of the concrete seawall, forming a higher revetment along the cliff face that then connects to the southern end of the timber revetment. This forms an important extension to guard against any potential for outflanking of the Corton defences.

2.4.2 Timber Revetment

Most (approx 950 m) of the North Corton Cliffs frontage is fronted by extensive remains of a failed timber revetment with steel sheet piled toe built around 1973/4. The remnants of failed timber and steel groynes are also present. The revetment is in a state of disrepair and has effectively failed along its entire length, albeit structural elements remain. In particular, most sections of the steel sheet piling still appear to remain intact, albeit deteriorated, as all of the original 4 m long revetment toe piling were replaced with 7 m long piles during the mid to late 1980's. It is due to the deeper embedment of these longer piles that this structure remains standing and has not already failed as has occurred at Hopton.

As the defence structures have failed there has been subsequent erosion of the cliff. There is no beach/foreshore in front of the structure even at lowest tide, although sand remains between the structure and the cliff. This frontage is not accessible due to the nature/condition of the defence structures to north and south, and erosion has washed away the only other access from the cliff top, behind Broadland Sands Holiday Park. However, it would be unsafe to access the beach whilst the aforementioned structural remains exist, and the whole of this length is therefore closed off from the public for safety reasons. Hazards include razor sharp sheet piling, and the potential for individuals to climb upon and over the timber planking, where deep water exists, if attempting to bathe which would be extremely dangerous. The sea also washes through the structure due to its condition, and there are no routes to safety.

2.4.3 Seawall

Over a short length (approx 150 m) between the north end of the timber revetment and the boundary with the Hopton Radar Station site are the extensive remains of a concrete seawall, built around 1972/3. Much of this is outside the limit of this study (which extends to the southern boundary of the land housing the former RAF Radar Station), but a short length of this same wall extends down into the area being considered in this report. In many places the seawall has failed or close to failure, leaving debris at the cliff base, some blocks of old wall still suspended on the vertical rail piling, and where the toe piles have been corroded or abraded completely. Cliff erosion has recommenced, meaning that the cliff top is also now inaccessible in places. There is no beach/foreshore along this frontage.

3. Existing strategic policy and management intent

The Shoreline Management Plan (SMP) (AECOM) was adopted in 2012, although details therein are mostly circa 2004-06), and sets out the long-term plan for the management of flood and coastal erosion at the shoreline, and policies to apply in the short, medium and longer term towards achieving that plan. It takes account of wider thematic and geographic factors, with the intent of having a holistic sustainable approach to management across the greater area.

Within the SMP, the shoreline is considered under three main Policy Units:

- 6.23: Corton to Lowestoft (the undefended length of shoreline extending between Links Road in North Lowestoft and the start of the seawall south of Tramps Alley) – *note that this unit is referred to as 'Gunton' in the subsequent Strategy Plan and extended further north to include Corton Woods (see below).*
- 6.22: Corton (primarily the village frontage, extending up to the end of the seawall and boundary of the caravan site just north of Bakers Score, Corton) – *note in the subsequent Strategy Plan the boundary with the Gunton unit was re-located such that the defended length between approximately Corton Lane and the end of the wall south of Tramps Alley was included as part of the 'Gunton' unit. This helped better delineate between the 'hard' frontage and a 'beach' frontage.*
- 6.21: Hopton to Corton (extending north to the borough and county boundary, which is coincident with the northern boundary of the former RAF radar station site) – *note that the subsequent Strategy Plan worked to a revised boundary at the southern end of the RAF radar station site. This was to better reflect the intent of management to the north to extend 'hard' defence along that frontage, and the ambition for a 'softer' frontage along the majority of this unit.*

The Gorleston to Lowestoft Strategy Plan ('the Strategy') was produced between 2014 and 2016. This builds upon the SMP, evaluating and sets out the most appropriate approaches to deliver the management intent of the SMP.

The SMP Refresh (2020) was a high-level assessment of progress made since the SMP, establishing any potential challenges to deliver of the SMP that have arisen since its production, and identifying recommended next steps for actions to maintain its currency.

Together, these documents provide the strategic context for flood and coastal erosion risk management in the area.

3.1 Gunton

3.1.1 Shoreline Management Plan (2006-12)

The long-term plan set out in the SMP is for a 'naturally functioning' coast between Lowestoft North Denes and Corton, this being one of the very few lengths of shoreline locally where there are no substantial defences works. As such, it is also one of the few frontages in the area that supports a variety of natural shoreline habitats.

The present day policy is to allow retreat through managed realignment, i.e. no longer maintain existing defences (those being the now largely defunct timber groynes) but allow for their management from a health and safety perspective and eventual removal, whilst investigating the potential risks to the oil dump sites and the existing Anglian Water (AW) pipelines. On the basis that those features could be 'made safe', for example through removal or relocation, the SMP policy would then transition to 'no active intervention', i.e. no works to build or maintain defences.

However, noting the potential for erosion of the oil dump sites with the associated pollution risk, and exposure of future sewage and wastewater return pipes, the SMP does acknowledge that some measures to slow the erosion may be appropriate in the long-term if those become threatened. Since the SMP was produced the rate of beach recession has increased and some of those risks could materialise sooner than originally expected, so there may

be justification to consider those measures now rather than later. But, to remain compliant with the intent of the SMP, it is likely that those would need to be approaches that manage the natural movement of beach material and shoreline position rather than approaches that would effectively halt it altogether.

3.1.2 Strategy Plan (2014-16)

Presented in the context of the whole unit between Links Road and Corton Lane, the vision set out in the Strategy is to allow this area to remain as natural as possible whilst minimising the risk of outflanking to the north (at the boundary with Corton). Actions identified in the Strategy were primarily for the regular analysis of monitoring data to identify any key areas for concern and to determine any appropriate response accordingly.

The Strategy also identifies that actions may be required for the adjacent Lowestoft North Denes unit, to encourage higher beach levels at the southern end of Gunton Warren and thus reduce exposure of the east-west section of the seawall alongside Links Road car park. It recommends a terminal groyne to encourage sand/gravel accumulation and locally control beach behaviour.

3.1.3 SMP Refresh (2020)

The SMP Refresh recommends review of the Strategy in light of more recent erosion events at the southern end of Gunton Warren, which this present study is now undertaking, and potentially revisiting the SMP policy for this unit to consider the latest information and address potential uncertainty over future management along this stretch of shoreline.

3.2 Corton

3.2.1 Shoreline Management Plan (2006-12)

At the time of development, the SMP noted that the promontory created by defending the present line at Corton would make it increasingly difficult to sustain, could impact upon the movement of beach sediments from north to south, and there was insufficient economic justification for providing defence. On that basis, the intent was to 'sweat the asset' through routine and reactive maintenance of the existing defences, but when that approach became no longer possible, the long-term plan for Corton was to then allow the cliffs to retreat and allow a more natural shoreline position to be attained through a managed realignment policy. The intent behind the policy was to allow natural straightening of the coast at both Hopton and Corton, thereby improving sediment linkages and moving towards more sustainable long-term management across the wider sub-cell from Gorleston to Lowestoft.

However, since the Shoreline Management Plan was produced, privately funded works have been constructed at Hopton, and there has been a change in the sediment processes. These both conflict with the basis for setting the SMP policy at Corton; i.e. the benefits of allowing Corton to retreat are no longer so evident. Coupled with that, it was recognised that there may be benefit to the adjacent units in maintaining Corton as a headland. In addition, the greater emphasis on partnership funding and ambition of several local businesses to continue operations along the cliff top here have altered the previous perspective on funding. Consequently, in 2017 the SMP policy was amended through the formal policy review process, to hold the line through all three epochs.

3.2.2 Strategy Plan (2014-16)

The objective stated in the Strategy is to maximise protection to cliff top assets, which involves defending the present line. There are strategic reasons to hold this position to support the evolution and stability of beaches directly north and south of Corton.

The preferred approach is to build a more substantial structure over and above the existing wall, capable of providing more robust, longer term protection. This could take the form of a new seawall or rock revetment.

A further aspiration is to retain, and preferably improve, public access along this frontage.

3.2.3 SMP Refresh (2020)

The SMP Refresh acknowledges the change now made to the SMP policy at Corton, albeit identifies the need to continue monitoring the local shoreline behaviour to ensure any impacts of this are understood and inform future decisions here and across the wider shoreline.

3.3 North Corton

3.3.1 Shoreline Management Plan (2006-12)

The management intent of the SMP was to allow sediment to be sourced from cliff erosion and to pass freely along this frontage, noting that "*the sediment from here is vital to feed beaches and enhance protection to areas north and south, where defence is a priority along this length of coast*". Therefore, the long-term Plan for this section of coast was to allow cliff retreat, enabling a naturally functioning coast with minimal human interference.

Towards achieving this, a 'managed realignment' policy was set in the SMP with the intention for derelict structures to be removed, not to maintain or replace them, or seek to limit erosion in other ways. This was to then revert to 'no active intervention' once those defences were removed.

However, since the SMP was developed, there has been a change in the underlying coastal processes and, significantly, works directly to the north with an accompanying change in SMP policy (Hopton), together with a corresponding change in SMP policy directly to the south (Corton). Consequently, the basis for the SMP policy no longer remains valid as both these policy changes will affect the 'free flowing' sediment transport mechanism that previously was a key driver for policy here.

3.3.2 Strategy Plan (2014-16)

Recognising the change in circumstances since adoption of the SMP, the Strategy identifies a modified approach to management of this section, noting "*the vision for Hopton to Corton stretch is to ultimately allow some erosion of the cliffs and release of sediment to promote beach development and improve access along the frontage*". This is integral to the objectives across the wider frontages here, in particular at Corton, where a balance of management approaches is desired to support the local tourist economy, including the provision of good accessible beaches here and at Gunton Warren.

The favoured option in the strategy is to adapt and allow some controlled realignment along this section of shoreline. The strategy refers to developing a managed realignment scheme which would control (rather than completely halt) erosion, thus allowing sediment to be released into the system whilst creating an improved and safer beach for the community and local holidaymakers.

3.3.3 SMP Refresh (2020)

The SMP Refresh acknowledges the Strategy recommendations but notes to release funding potential there may be a need for a policy change from NAI to MR in epoch 3.

4. Strategy Implementation Actions

The following extracts from the Strategy Plan document outline the intended next steps for each section of the frontage, which this study forms part of the implementation.

4.1 Gunton

Implementation (2016-2025)

Immediate Activities

The immediate activity is to monitor the beach in conjunction with the frontages elsewhere along the Strategy shoreline to understand any longer term trends and linkages.

- Use Coastal Monitoring Plan and defined triggers and monitor shoreline position and foreshore level trends against these triggers.
- Visual inspections of the cliff face to assess issues related to drainage and cliff slumping, including access along the 'prom' path.
- Extract and/or make safe steel sheet piling remaining within the existing redundant groynes.

Further Actions

In addition to the above activities, there are two potential courses of action that may be required, depending upon beach behaviour, although it is highly unlikely that the low beach scenario will occur within the 10 years covered by this implementation action plan.

Scenario 1: High beach (most likely)

If beach levels remain high, then:

- Carry out occasional visual inspections of visible areas of seawall for signs of wear and tear to the sloping concrete walls.
- Patch and repair low sea wall as required.

Although outside of the remit of the Strategy, occasional visual inspections to assess slumping due to groundwater/slope instability are recommended and to retain access to the 'Prom' path.

Scenario 2: Low beach

If monitoring indicates further deterioration in beach levels to defined action levels, then:

- Carry out regular visual inspection of structure for defects and any potential remedial works.
- Identify key areas for concern, based on annual inspections (see Appendix B: Assessment of Existing Defences).
- Actions will depend upon findings.

4.2 Corton

Implementation (2016-2025)

Immediate Activities

The key activity is to plan for new works to achieve the objectives for this frontage, whilst also monitoring risks and the requirement to accelerate the implementation of those works.

- Use Coastal Monitoring Plan and defined triggers to indicate any acceleration in the implementation of works.
- Monitor shoreline position and foreshore level trends against these triggers for action.
- Regular visual inspection of the structure to determine any further deterioration or total failure along each section.

- Engage with local Leisure Parks and other land owners on plans for defending this frontage, taking into account the requirements set out, to agree nature of preferred scheme.
- Engage with local Leisure Parks and other land owners on plans for frontages to north and south, to establish optimum approaches to frontage boundaries, and continue ongoing dialogue on developments.
- Instigate formal changes to Shoreline Management Plan Boundary and Policy to reflect this Strategy, once a funding plan has been developed.

- Explore funding sources and establish funding plan.
- Identify scope for any Flood Defence Grant in Aid contribution (which will likely require the production of a business case).

Further Actions

Further action will be required along this frontage at some point with timing informed by the monitoring.

Scenario 1: High beach

If monitoring indicates improvement in beach levels, then:

- Regular visual inspections of concrete wall sections and rock armour for signs of wear and tear.
- Patch and repair concrete as necessary, including:
  - repair and reseal cracks and joints along walkway and upper slabs
  - remove failed slabs on cliff face and replace (if economic to do so) with alternative short term protection, e.g. rock gabions
- Regularly appraise safe public access along seawall, restricting access as necessary.

Scenario 2: Low beach (most likely)

If monitoring indicates further deterioration in beach levels to defined action levels, then:

If Partnership Funding is available:

- Undertake design of scheme, obtain necessary permissions and construct.
- Instigate formal changes to Shoreline Management Plan Boundary and Policy.

If Partnership Funding is not available:

- Identify key areas for concern, based on annual inspections (also see Appendix B: Assessment of Existing Defences).
- Identify what can be achieved with available funds.
- Actions will be determined by findings but are likely to include:
  - Remove timber steps over the rock revetment and close access to wall from cliffs and beach.
  - Patch and repair structures.
  - Remove failed upper revetment sections before they become a safety hazard.
  - Plan for safe removal (and re-use if possible) of structures once they can no longer be maintained.
- Engage with local community on potential impacts and ways forward.
- Monitor and regularly assess erosion risks.
- Continue to review public access.
- Make further applications for funding, if valid.

4.3 North Corton Cliffs

Implementation (2016-2025)

Immediate Activities

The immediate activity is to plan the actions to implement the proposed works.

- Use Coastal Monitoring Plan and defined triggers to indicate the need for advance planning of works.
- Monitor shoreline position and foreshore level trends against these triggers for action.
- Regular visual inspection of the structure to determine any further deterioration/total failure along each section.

- Produce plans for removal of structures:
- include an ECI-developed detailed estimate of costs for removal operations;
- identify the optimum time for removal of structures.
- Consult with local Leisure Park and other land owners on potential impacts, ways forward, and timing to best accommodate their needs, and continue ongoing dialogue on developments.

- Explore funding sources and establish funding plan for construction of hard points.

If this is not achievable:

- Establish funding plan for removal of defences alone.

Further Actions

The nature of further actions is dependent upon availability of private funding. If funds are unavailable the Strategy will revert to a 'do nothing' option.

If Partnership Funding is available:

- Secure the funding to enable works to proceed.
- Undertake design of scheme, including design of rock bunds, defining lengths of defence to be removed and planning safe access routes to the beach.
- Obtain necessary permissions.
- Construct rock bunds and remove all remaining lengths of existing timber and steel defence structures.
- Provide new safe access routes from cliff to beach.

If Partnership Funding is not available:

- Continue to restrict public access along the foreshore/foot of the cliffs.
- Recover failed structural elements from foreshore and nearshore (as funds and access permit).
- Investigate any sources of funds to remove remaining concrete, steel and timber sections and implement if and when obtained.

5. Review and assessment of management approaches

5.1 Gunton Warren

5.1.1 Strategic context

Since the Strategy was developed, the rate of shoreline recession has been more rapid than anticipated, with this study also identifying some re-orientation of the shoreline. As there were no intervention options identified in the Strategy for the immediate future, new approaches have been considered here, primarily for addressing the increased risk to the Anglian Water (AW) pipeline as the risks to houses and the highway are still several decades away.

Options considered as part of this appraisal, primarily to address risks to the existing and future AW pipeline are outlined and discussed in more detail in a technical note to AW (Appendix D), but in summary, those options are:

1) Relocation - select a different route altogether for the future pipelines, away from the shoreline.
2) Linear defence (seawall or revetment) - in front of the future pipelines, to prevent further erosion.
3) Beach management - to control the movement of beach sand and ensure sufficient beach width maintained in the area required to prevent future exposure of the new pipelines.

Since production of the technical note, AW have decided to reroute the northern end of the future pipelines, with the relocation works planned to be carried out and completed through 2022. However, consideration still needs to be given to future risks to this pipeline. However, at the time of reporting no information on future plans by AW is available.

Consideration also has to be given to other risks here, such as the buried oil deposits and options need to consider those. However, at the time of reporting no information on this is available.

5.1.2 Options

Do Nothing

Although the Strategy identified that doing nothing along the southern end of Gunton Warren (other than health and safety activities to make the former groynes safe by removal of hazardous elements) would be acceptable for the time being, changes in erosion trends and resultant increase in risks to the AW pipeline have now made this inappropriate.

Do nothing was also identified by the Strategy as unacceptable for the adjacent Lowestoft North Beach frontage; the wall along Links Road now being even more vulnerable if no actions are taken to prevent exposure via the Gunton Warrant frontage.

Linear defence

A full (permanent) seawall or revetment along the present line would be contrary to the objectives and management intent of the SMP and Strategy Plan. A linear defence built behind the current beach could prevent further dune erosion but will not encourage beach retention and would in fact most likely exacerbate beach losses by creating higher wave reflection and scour in front. That may in turn require further works to ensure the stability of the defence at a later date, so incur further costs to what could initially be an expensive option. Those impact might be less if building a rock revetment instead of a seawall, but this would still sever the sediment process link between the foreshore and backing dunes, with the likely eventual loss of any beach here and to the detriment of existing natural habitats given the advanced (seaward) location that would be required for that structure.

Beach management

Approaches to manage beach movement, thus providing natural protection, are possible here, in particular if introduced before further losses are incurred. There are various methods by which this may be achieved, but the appropriate choice needs to be informed by the appreciation of the ongoing coastal processes and causes of change.

Approaches that might be considered include:

- Beach nourishment
- Replacement timber (or rock) groynes
- Shore parallel breakwaters
- Headland control structures

The coastal processes review conducted as part of this study (Appendix A) would suggest that the latter might be most effective, and for initial planning purposes some good indications of appropriate methods can be obtained from the observed beach behaviour at the macro-scale, i.e. between the 'headlands' created by Corton and Lowestoft North Denes. Being subjected to the same driving conditions, consideration should be given to mimicking this at a local level through the construction of two or three mini-headlands at closer spacing and key points along the frontage. Through design, sand would still be able to move along the frontage, but the landward recession would be limited by these headlands locally holding the beach line. Headlands would almost certainly be designed as rock armour structures. The size, shape and precise location of those would need to be determined based upon likely beach response, and numerical modelling should be considered to determine the most effective approach and configuration, but these are all aspects that would be developed if this option was taken forward for further examination and costing.

This would also be consistent with the approach proposed in the Strategy for Lowestoft North Denes seawall, to build a terminal headland structure (e.g. a T-head or fishtail groyne) at the end of Links Road, to assist in retaining sand to protect the Links Road length of that seawall.

Do Minimum

Should funding to undertake works now not be available, managing the risks may require works in the interim. Given the proximity of the current shoreline to the existing pipeline and oil deposits, options would likely require some form of rapidly installation linear protection. However, if required any such works would need to be minimal, temporary, and removed once the new pipe is operational/the oil deposits are removed. Consideration should also be given to use of materials that might also be reclaimed and reused in any subsequent permanent works.

Along Links Road, the do-minimum alternative to the terminal structure would most likely be to place a rock armour toe along that length, extending landwards, which may reduce wave reflections and scour, but have limited effect on build retention and little benefit to the assets along the Gunton frontage.

5.1.3 Summary

If a scheme was introduced to manage rather than halt beach movement, through mimicking natural processes, this would be more consistent with the intent of management identified by the SMP and Strategy Plan. There are different methods by which this may be achieved, and the appropriate choice needs to be informed by the appreciation of the ongoing coastal processes and causes of change. For example, beach nourishment alone or the introduction of timber groynes may be ineffective, but the headland concept would appear to have most merit and would be the likely preferred approach.

Any permanent interventions would require a formal revision to SMP Policy. This is more likely to be acceptable as a 'Managed Realignment' through the implementation of measures to control beach movements, rather than

'Hold the Line' by providing a linear defence. Although the beach management works might be carried out at the same time as the new pipeline was installed, so fall within the current SMP epoch, the intent would still be to maintain and, if necessary, adapt any structures to ensure the new pipeline remains protected if there were future variations in beach behaviour, for example due to climate change. Consequently, the present 'No Active Intervention' policy would have to be altered before any works would be approved.

Given the current estimate of erosion rates, and the risk to the new pipelines being estimated as over 20 years away, AW may not consider it essential to intervene yet, and indeed future switches in beach behaviour may ultimately render any intervention unnecessary. There is however a risk that through delaying intervention, further beach and dune loss could occur meaning that the only option available at that point is linear defences, which will not be acceptable. To ensure maximum effectiveness for protecting the AW pipelines, there are benefits of undertaking works as soon as possible.

There are however also other considerations at this location in addition to these, including risks to the car park area and infrastructure located at Links Road. At Links Road to the south, it is assumed (as per the Strategy and SMP) that the management intent remains to maintain the seawall which extends from there down to Lowestoft Ness. This is an important assumption as the Strategy identifies proposed actions associated with this wall at Links Road, which would also have beneficial consequences for the southern end of Gunton Warren. The Strategy proposes an L-shaped terminal groyne structure at the seaward end of Links Road, tied to holding beach material along the edge of the wall and ensuring protection there. This can be designed to create one of the aforementioned headland structures. Noting that present assessment identifies further erosion at that location and evidenced by considerable beach draw-down along edge of wall last winter, this should also be a consideration now rather than in the future.

If it is not possible to fund works at this time, the option would be to continue to monitor and reassess on a regular basis until a stronger economic case can be made, or the beach recovers and the risk reduces. However, as noted above, the opportunity to implement the proposed scheme may have passed, and linear defences may not be approved.

5.2 Corton Woods

5.2.1 Strategic context

The concrete wall/revetment fronting Corton realigns south of Corton Lane and extends southward by approximately 650 m, to south of Tramps Alley.

Although no major works were envisaged as being necessary in the near future by the Strategy, it does note that, should this become vulnerable to erosion, then works may need to be extended to prevent outflanking at Corton, which will need to provide the necessary technical and economic case for any works.

5.2.2 Options

Do nothing

At the present time, the healthy beach means that doing nothing would have no immediate detrimental consequence along this frontage. However, history shows that a beach here is not a permanent feature, therefore damage to, and failure of, the wall would ultimately occur when this became exposed once more if it was not maintained.

Linear defence structure

Options here include extending the structures built along the Corton frontage, i.e. a revetment or seawall/hybrid (see section 5.3 below for details). This would be consistent with the Strategy, albeit the requirement is not immediate.

Beach management

Although the beaches are currently healthy and there is no immediate risk to the wall here, future switches in trends, similar to those that have been observed in the past, need to be considered.

An alternative to extending the Corton defence structures is to seek to minimise any future loss of sand in front of this section, providing the necessary protection to the existing wall. This could be achieved by building another terminal structure at the end of main Corton defences, similar to that proposed at Links Road, and potentially one further headland control structure again similar to those proposed at Gunton Warren. These would be designed to hold sand here, rather than this moving onto Corton itself, where it is not providing any significant advantage to either shoreline protection or amenity benefit and has more potential to be moved offshore through tidal currents. Such an approach would be consistent with a wider objective to hold beaches along the entire Gunton unit.

Do minimum

The do minimum approach would be simply patch and repair the concrete revetment on the cliff face until (and if) more substantial intervention is needed, i.e. if the natural processes switch again to an erosive trend and increased re-exposure of the seawall is leading to its deterioration. This would be feasible for now, and consistent with the Strategy, but there would probably still be a need to do something more substantial in the future to prevent both the cliff top holiday park and the road becoming at risk, together with potential to outflank southern end of new Corton defences.

Upper cliff stability measures

In addition to the coastal defence options above, consideration also needs to be given to the erosion of the upper cliff face caused by groundwater and/or geotechnical instability, which is the more immediate threat to cliff top assets north of Tramps Alley. This is discussed in section 5.3, so not repeated here.

5.2.3 Summary

With the present accumulation of sand here, there is little apparent need to do anything here at the moment (other than possible works to address upper cliff face/cliff top instability) and a do minimum approach may suffice. However, if works along this frontage are not undertaken at the same time as the Corton scheme, which will form the economic basis for intervention here, economies of scale are lost so become more expensive, and there is also a risk that the finances to undertake subsequent construction at a later date is no longer available.

Options include undertaking the same type of works as proposed along the Corton frontage, but those will be costly and perhaps unnecessary along that whole length so perhaps limited to just the 500 m north of Tramps Alley. The alternative is to undertake works to maintain higher beaches locally through implementing a similar approach to that being advocated for Gunton Warren, i.e. headland control structures. In addition, attention has to be given to work to address the upper cliff face erosion. In all cases, intervention will potentially affect the condition of Corton Cliffs SSSI, and this will need to be a further consideration (see Appendix E).

5.3 Corton

5.3.1 Strategic context

Along this central section of the study area, the Strategy is to continue to hold the present line through provision of some form of defence. Holding this line also has a strategic benefit in creating a headland control to support a softer shoreline formation to north and south, though assisting in the retention of beaches on either flank, which can also help offset the loss of amenity beaches along this frontage.

There are no notable changes in the coastal processes from the time of the Strategy development, so assessments made at that time remain valid.

5.3.2 Options

Do nothing

To do nothing would result in the gradual long-term deterioration and failure of the existing defences, leading to erosion recommencing at the base of the cliffs and the subsequent loss of cliff top assets. However, this was rejected by the Strategy so has not been considered further, noting also that management actions at Corton are not solely related to protection of cliff top assets here, but also towards delivering the management objectives to the shorelines north and south.

Beach creation

The Strategy concluded that it is highly unlikely that a significant beach could be re-created in front of Corton, as is being attempted at Hopton, without considerable works and costs – essentially large structures to retain a recharged beach - and the more recent evidence indicate that the findings and recommendations of the Strategy do not require changing. Although since the introduction of rock here almost two decades ago the foreshore level has stabilised, and even improved slightly, most this still only accessible at the lowest tides and not consistently all the way along. But despite these very recent accretional trends in front of the seawall, the beach remains low (relatively speaking for 'a beach') and there is ample historic evidence to indicate that such trends can be episodic and, even if sustained for several years, have every chance of reversing to become again erosional. There is also evidence from bathymetric data that the nearshore channel is migrating closer to the shoreline, making the likelihood of sustaining a beach here even more difficult. Bathymetry has indicated a continued shoreward migration of the subtidal channel (-5 m contour); this currently lies around 100 – 150 mm offshore but could migrate to within 20-50 m within 50 years if trends observed over the past 20 years persist.

Linear defences

To hold the line requires improvement to the defences at the toe of the cliff. This could be achieved through building a more substantial structure over and above the existing wall, capable of providing more robust, longer term protection. This could take the form of a larger rock revetment, a seawall, or a hybrid of the two.

A rock revetment would be a much more substantial structure than currently exists, sitting over the existing wall and rock toe, and extending further up the cliff face to protect the base. This can be designed to be able to deal with foreshore lowering and reduce wave impacts on the cliff. It is a much less complicated construction than a seawall but would prevent public access along this frontage (unless some of the cliff top holiday park land can be given over to that).

A new seawall would be considerable structure but could incorporate public access, and potentially provide a holistic solution to address cliff face instability issues too. This would be a more difficult construction and expensive approach compared to other options but would provide protection and also enable access to be maintained along the frontage through provision of a paved walkway at higher elevation than the present wall. This would need to be able to accommodate any predicted future foreshore lowering, so would most likely be a hybrid of concrete structure fronted by a lower rock revetment.

Do minimum

If, due to funding constraints, it is necessary to consider other lower cost approaches to simply try and delay the time to failure of the existing defences, do minimum options may have to be considered. Do minimum options would involve simply repairing elements of the defence, in particular cliff face protection, as and when required. This would help to delay erosion for some years but not indefinitely, as damage to the lower (main) wall will continue with eventual failure of this section. It is difficult to predict the exact timing of defence failure, as this will depend upon the degree of investment and work undertaken. Activities could include:

- Maintain the rock at the toe (which currently appears to be in reasonable condition): and,
- Patch and repair the upper concrete slab revetment on the cliff face: or,

- Re-place that concrete slab revetment with a more durable alternative, for example extending some of the existing armour rock protection,

None of these approaches will however address the upper cliff face recession problems, and in due course coastal access would be lost.

Upper cliff stability measures

A separate technical note has been produced, considering in detail the causes of cliff top erosion and potential approaches to address the erosion (Appendix B). Any engineered interventions described therein should be considered in conjunction with options being considered for the coastal defence works to protect the toe of the cliff; erosion of the lower cliff face by waves will continue as long as the beach is narrow and storm waves are able to overtop the defences. Sea-level rise will mean that overtopping events will occur more frequently in the future. Construction of a new larger sea wall for example could significantly reduce wave overtopping and erosion of the lower cliff face; or drainage works might be incorporated into any scheme. Conversely, if works are not being undertaken at the base of the cliffs, any interventions dealing with the upper cliff instability ought to be proportional, considering the residual risk of those being damaged or failing as a consequence.

5.3.3 Summary

The approaches outlined in the Strategy remain valid – as are the reasons for discounting other options.

The approach identified by the Strategy is to build a more substantial structure over and above the existing wall, capable of providing more robust, longer term protection. Options are for a new seawall or rock revetment, or a hybrid of the two: these all remain relevant.

As discussed elsewhere, the works at Corton need to consider the extended lengths of defence north and south of the main development, to address any potential for outflanking of the defences here, and so need to be considered in both technical and economic terms as part of any Corton scheme.

Although intervention will be required to address the long-term underlying recession trends here, the recent build-up of sand might, however, buy a little more time for the works to the base of the cliffs rather than these being required immediately, if finances are not currently available. However, there would remain issues with cliff face erosion due to groundwater and drainage issues, and low-key actions at the base could also mean works higher up on the cliff face are at a high risk of failure as the cliff would remain susceptible to wave overtopping and some destabilisation on lower parts.

5.4 Corton to North Corton transition

5.4.1 Strategic Context

Beyond the end of the concrete and steel sheet piled structure fronting Corton, a more substantial rock revetment extends northward along the cliff face to the start of the timber revetment fronting North Corton Cliffs.

Should erosion of the North Corton Cliffs occur, this structure prevents outflanking of the defences to Corton village (and thus costs and their justification also coming from Corton benefits).

5.4.2 Options

Do Nothing

If no works are carried out, the distal end of this revetment will be outflanked and collapse as erosion of the North Corton Cliffs continues, reducing its structural integrity. Its function as a structure to prevent outflanking of Corton will not be compromised, but its effectiveness to perform as part of the North Corton Cliffs scheme would be reduced.

Do Minimum

Maintaining, and simply reconfiguring the northern end of this structure into a bund (as the area to the north erodes) with modest enhancement, should be sufficient to both prevent outflanking and to ensure this location remains an effective control on erosion between this and the next shore-parallel breakwater created to the north (assuming the preferred approach in the Strategy is adopted for that frontage).

5.4.3 Summary

Modest modifications to the existing rock work will mean that this structure will not only reduce the risk of outflanking of the Corton village defences but will also act as the southern control point to the embayment approach being advocated for the North Corton Cliffs frontage.

5.5 North Corton Cliffs

5.5.1 Strategic context

This study has shown that since the Strategy erosion has continued, with varying rates which may also be influenced by different degrees of deterioration of the defences, but trends are consistent with the Strategy and the assumptions and options for management outlined in there remain valid.

One potential issue would have been if considerable seabed lowering had occurred on the seaward side of the defences. However, examination of the most recently analysed monitoring profiles indicates that, although levels are lower to seaward, at around Lowest Astronomical Tide (LAT), there has not yet been a considerable drop and that the Strategy approach should still remain viable in the immediate term.

5.5.2 Options

Do nothing

Doing nothing would simply allow the defences to further deteriorate. Whilst elements of these structures have already been destroyed, other elements remain and show no immediate signs of being removed altogether, leaving a hazardous length of shoreline that cannot be used safely by anyone. Erosion of the cliffs behind would occur, but a useable beach and frontage is unlikely to exist; as even once further failure occurs, there will be a foreshore littered with dangerous remnants of structures which would create a 'no-go' area for bathers, walkers, and boat users.

Remove existing defences only

Completely removing the existing structures would address the safety hazard issues and provide an opportunity for re-opening this frontage to public access. Ultimately this should form a semi-stable bay between the defended points at Corton and Hopton with better beaches in front of the retired cliff line. This has considerable benefits to local people who want to be able to access the full length of coastline between Gorleston and Lowestoft, and also providing healthier and useable beaches for amenity and tourism benefits. The holiday parks in particular will have beaches that their patrons can use, with the provision of suitable access points.

However, unconstrained erosion between the two extremities will see more rapid rates of cliff recession initially as this accelerates to 'catch up' to a more natural position before returning to pre-defence rates, and without any other form of management most likely see considerable erosion of parts of the Broadland Sands holiday park.

Defending along the cliff line

The Strategy rejected options to Hold the Line, noting this would require substantial works along the line of the timber revetment, or at the foot of the cliffs. A large seawall or revetment back at the cliff line, similar to that being considered for the Corton frontage, would not be appropriate as it would not be conducive to beach retention and

could exacerbate beach lowering, so would prevent any future access along this section of coast other that along the cliff top. This would not achieve the strategic vision of improving the beaches and so would be contrary to one of the main objectives for this location and the wider area. Consequently building, reinforcing or replacing the current defences in this way, is not considered an appropriate way forward.

Other approaches involving beach control structures, such as groynes, would cost more than the preferred approach in the Strategy (see below), and potentially be less effective in creating the semi-stable embayment's and controls on erosion management that shore-parallel breakwaters are designed to provide.

Defending along the existing revetment line

Rock placed all along the line of the revetment, over and above the hazardous elements, would be an alternative to doing something at the base of the cliffs. However, holding this whole length may be more detrimental than advantageous. A long continuous barrier could set up fast flowing currents on the shoreward side which could be both detrimental to holding sand locally and also hazardous to beach users. This structure could also become a significant navigation hazard if and when submerged, or a danger to vessels from loose structural elements in the water.

Controlled retreat through shore-parallel breakwaters

The approach would be to undertake only partial removal of the existing failing defence structures. The remaining sections would be encasing in rock to both make them safe (by ensuring the hazardous steel sheet piles are both covered and cannot break loose) and providing some intermediate control points to reduce and manage the erosion. This mimics the headland-bay coastal formations that naturally form elsewhere.

The assumptions in the Strategy for preliminary costing and assessment was that approximately 50% of the piling would remain and be covered, forming four or five shore-parallel breakwaters. The effect of these will be to modify the waves approaching the shoreline, reducing erosion in the lee of these and helping to hold up more of the eroded sand on the beaches, and thus further reducing exposure of the cliff to direct wave action.

Do minimum

Alternative lower cost options to address erosion could include placing rock at the toe of the cliffs. This might slow the cliff erosion at the base, but as observed at Corton geotechnical instability in the upper cliff will still continue. Furthermore, this approach will not affect recession of the beach itself and could eventually end up with little/narrow beach. However, for this frontage to be safely accessible and useable there still remains the need to remove the offshore hazard in addition to these options, so this itself would not address one of the main objectives for the area.

5.5.3 Summary

The approaches outlined in the Strategy remain valid – as are the reasons for discounting other options. The Strategy approach was for partial removal and modification of the hazardous structures, removing some sections of the sheet piles and encasing the remainder in rock armour, forming a series of offshore breakwaters. Removal of the intermediate lengths will be a difficult and potentially expensive operation, but essential for this section of the coast to become accessible once again. This removal of the structures would have been easier, cheaper and safer several years ago whilst still accessible by land-based plant; now, however, it will be considerably more costly marine based operations would be necessary.

Encasing the remaining sections in rock will be even more expensive than the removal operation. But by reducing and controlling (rather than completely halting) the rate of cliff erosion, reducing land loss along the cliff top and allowing safe and accessible beaches to develop, wider strategic benefits may be delivered that support the wider economy, in particular tourism at Corton, and potentially Hopton.

Any permanent interventions here over and above removal of the existing structures will require an SMP policy change as the current management intent was to revert to No Active Intervention once the existing derelict structures are removed, whereas the proposed approach here would in fact be a continuation of Managed Realignment. Significantly however, the basis for that original SMP policy has altered, through both a change in the underlying coastal processes and works directly to the north with an accompanying change in SMP policy (Hopton), together with a corresponding change in SMP policy directly to the south (Corton). Consequently, the basis for the SMP policy no longer remains valid as both these policy changes will affect the 'free flowing' sediment transport mechanism that previously was a key driver for SMP policy here.

Although outside of the area covered by this present assessment, it is also important to note the current change in management practices to the north. Along the Hopton frontage, recent works to improve and extend the life of the existing defences have been carried out, and it is assumed that those will continue to be maintained. It is also assumed that similar works will in due course also extend further south to prevent erosion of the former radar station and underground bunker. This assumption is important for any consideration of how the preferred approach will be designed and implemented.

6. Costs

Costs for providing different management approaches were developed during the Strategy from information obtained from a variety of sources, including details on works or rates for materials, elements or structures from other recent coastal schemes around the country. Option costs have not been recalculated from first principles for this study but have been reviewed to determine whether any adjustments might be required to reflect changes in rates identified since the Strategy was prepared. In additional costs have been estimated for any new works identified as part of this study.

This is common practice for assessment at this stage, but because of the high-level nature of this assessment and the exact nature of requirements at this location to deal with the dynamic and changing conditions, they must be treated as indicative only. Therefore, a contingency of 60% has been applied to the costs of all potential approaches to account for a range of variable factors and uncertainties that may be encountered. This is referred to as 'Optimism Bias' or 'OB'. Those include items that fall outside of the primary costs, such as lesser ancillary works (e.g. access roads), 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. Again, this is standard practice for early-stage economic assessment and a requirement when planning funding needs, with this standard percentage value based upon analysis of a range of previous estimates and actual outturn costs from a large number of schemes.

6.1 Gunton Warren

6.1.1 Previous estimates (Strategy)

The costs previously calculated for Gunton Warren only cover making safe (removing) the old derelict groyne structures, estimated at approximately **£0.23 million**.

In addition, costs for the construction of a terminal rock groyne as part of the Lowestoft North Denes were estimated in the Strategy at £1.8 million, including future maintenance, with a capital construction cost of **£1.4 million**. Costs for just placing rock along the Links Road end of the seawall (do minimum) were **£0.26 million**. These estimates both include 60% Optimism Bias.

6.1.2 Updated estimates

Cost estimates provided for more recent schemes indicate that the rate for supply and placement of rock armour could be up to 20% higher than originally estimated in the Strategy.

It could be argued that the 60% OB allows for such increases in rates, but it would be prudent for budgeting purposes to now update the cost estimate for the terminal rock groyne using the more recent information on rates. The capital construction cost is therefore re-calculated to be **£1.7 million**, plus future maintenance.

The do minimum rock revetment along the Links Road frontage, would now be estimated at **£0.87 million** (plus maintenance), as additional length also required due to the more recent erosion and longer length now potentially required.

The estimated costs for making safe the relict groynes would remain the same, **£0.23 million**.

6.1.3 Additional cost estimates

The proposed option for beach management at the southern end of Gunton Warren would involve the addition two additional Y-shaped headland groynes. The estimated cost of constructing these, and including 60% OB, could be as much as **£5.5 million**. Detailed scheme design may be able to reduce the size or even number of these, but it might be prudent to assume this requirement for initial

budgeting purposes. Note that this will be in addition to the terminal structure already proposed for Links Road.

6.2 Corton Woods

6.2.1 Previous estimates (Strategy)

The costs included for in the Strategy were simply for repairs and maintenance of the existing wall behind the beach, estimated at **£0.19 million** over the lifetime of the strategy, and includes 60% Optimism Bias.

6.2.2 Updated estimates

The Strategy estimate was made for 400 m of the seawall down to Tramps Alley, not the entire 650 m length of the structure. Allowing for that additional length would increase this cost to **£0.31 million**. Note however this is not an upfront investment but the aggregated costs of annual/regular commitment to ongoing maintenance.

6.2.3 Additional cost estimates

Corton scheme extension

Based upon the assessment presented in section 6.3.2, if the scheme proposals at Corton were to be extended down as far as Tramps Alley (a distance of approximately 500 m), the estimated construction costs could be in the region of £6-7 million (based upon revetment option only).

Beach management structures

The proposed option for beach management at the northern end of Gunton Warren rather than linear defence would involve another terminal groyne structure similar to that proposed for Links Road (see section 6.1.2) and one Y-shaped headland groyne (see section 6.1.3). The estimated cost of constructing these, including 60% OB, is approximately £4.4 million.

Upper cliff stability works

The basis for potential costs associated with any engineering works to address the upper cliff instability (i.e. if required over and above land drainage management) are described in section 6.3.3. Should those be required here along the frontage north of Tramps Alley (approximately 500 m), the pro-rata costs could be of the order of **£5 million**.

6.3 Corton

6.3.1 Previous estimates (Strategy)

The construction costs included for Corton in the Strategy were calculated for a length of 1300 m, as that included for 300m along the Corton Woods frontage, and ranged from approximately **£13.8 million** for a large revetment structure to **£29.3 million** for a seawall (noting the full scheme costs for economic appraisal also included future additional maintenance costs).

Do minimum options priced in the Strategy allowed for works to replace sections of the concrete sloping revetment as it fell into disrepair, plus works to maintain the rock at the toe of the existing wall. These were estimated to be in the range of **£3.1-3.4 million**.

The above costs all include 60% Optimism Bias.

6.3.2 Updated estimates

The Strategy calculated costs over a 1300 m length of frontage. However, in this study the length under consideration is 1000 m, with the Corton Woods frontage being costed separately. So, an adjustment should be made for this shorter length.

Cost estimates for more recent schemes indicate that the rate for supply and placement of rock armour could be up to 20% higher than allowed for in the Strategy. It could be argued that the 60% OB allows for such increases in rates, but it would be prudent for budgeting purposes to update the cost estimates using the more recent information on rates.

Taking both of these points into consideration, the construction costs are therefore re-calculated to be approximately **£13 million** for the revetment, and seawall would be an estimated **£23 million**.

Applying similar adjustments to the do-minimum options would revise those estimates to **£3.3-3.7 million**.

Note that none of these included for works to address the upper cliff face instability issues.

6.3.3 Additional cost estimates

Re-estimate

Further high-level costing was undertaken by a contractor in 2019 (subsequently adjusted as originally covered Corton and North Corton together, OB added and length adjusted for 1000 m). Although some manipulations of the cost estimates were required to extract the elements for this frontage, this indicates construction cost for a revetment of just over **£16 million** and just under **£19 million** for a seawall.

Again, none of these included for works to address the upper cliff face instability issues.

Upper cliff stability works

A number of possible engineered approaches have been identified to addressing the upper cliff instability if required over and above any drainage management measures (see Appendix B). Much more detailed assessment would be required to develop costs for those, but to give some context, costs on other schemes have been investigated. Most comparable are recent works involving cliff nails and mesh for a scheme in south-west England with similar characteristics. Based upon that, pro-rata costs calculated for the Corton frontage could be approximately **£10 million**.

Note that this would need to be added to the above coastal defence costs.

6.4 Corton to North Corton transition

6.4.1 Previous estimates (Strategy)

The costs included for in the Strategy were reconfiguring the existing rock bund, estimated at approximately **£0.37 million**, assuming only 50 m of the total 150 length would require any reconfiguration. This included 60% Optimism Bias.

6.4.2 Updated estimates

Cost estimates for more recent schemes indicate that the rate for supply and placement of rock armour could be up to 20% higher than allowed for in the Strategy.

It could be argued that the 60% OB allows for such increases in rates, but it would be prudent for budgeting purposes to update the cost estimate using the more recent information on rates. This is therefore re-calculated to be **£0.44 million**, plus maintenance.

6.4.3 Additional cost estimates

Not required.

6.5 North Corton Cliffs

6.5.1 Previous estimates (Strategy)

The costs included for in the Strategy for removal of half the existing defences and encasing the remaining half in rock to form shore parallel breakwaters was estimated at approximately **£5.4 million**.

The do minimum option of placing a line of rock along the toe of the revetment was estimated at **£1.9 million**.

Removal alone of the old structures was expected to cost over **£2.5 million**.

These both included 60% Optimism Bias.

6.5.2 Updated estimates

Cost estimates for more recent schemes indicate that the rate for supply and placement of rock armour could be up to 20% higher than allowed for in the Strategy.

It could be argued that the 60% OB allows for such increases in rates, but it would be prudent for budgeting purposes to update the cost estimate for the proposed scheme using the more recent information on rates. Construction cost is therefore re-calculated to be **£6.1 million**.

The estimated cost for the do minimum option would also increase, to **£2.3 million**.

No information is available to indicate any changes to be made to the estimated removal only cost for the old structures, so **£2.5 million** remains the assumption.

6.5.3 Additional cost estimates

Re-estimate

Further high-level costing was undertaken by a contractor in 2019 (subsequently adjusted as originally covered Corton and North Corton together, and OB added). Although some manipulations of the cost estimates were required to extract the elements for this frontage, this indicates a similar order of magnitude cost for the preferred approach as the Strategy, of approximately **£5.0 million**.

However, some assumptions made in there regarding the extraction of steel sheet piles (land-based working, no marine plant, shorter embedded pile lengths), would suggest that this estimate could be on the light side. Consequently, it is recommended that these are not used for preliminary budgeting, but the updated estimates quoted in 6.5.2 above are adopted instead.

Rock to base of cliffs

One further option was considered as another do-minimum, placing rock at the cliff base. This alone would be expected to cost in the region of **£4.8 million**, which does not include for the costs of removal of any of the old structures, which when added would result in an overall cost in excess of the preferred option in the Strategy.