Costing Report

Hunstanton Coastal Management Plan

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Borough Council of
King's Lynn & West Norfolk
King's Court
Chapel Street
King's Lynn
Norfolk
PE30 1EX

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Prepared by	Checked by	Approved by
George Batt Engineer	**Daniel Glasson** Associate Director	**Paul Norton** Director

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Prepared for:

Borough Council of King's Lynn & West Norfolk
King’s Court
Chapel Street
King’s Lynn
Norfolk
PE30 1EX

Prepared by:

AECOM Infrastructure & Environment UK Limited
Midpoint
Alençon Link
Basingstoke
Hampshire RG21 7PP
UK

T: +44(0)1256 310200

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1. Introduction

1.1 Project Background

AECOM Infrastructure and Environment UK Limited has been appointed by the Borough Council of King's Lynn and West Norfolk (BCKLWN) to develop a Coastal Management Plan (CMP) to implement the 2010 Shoreline Management Plan's (SMP2) preferred management policy for the Hunstanton frontage.

1.2 Purpose of this Report

This report presents how the capital, maintenance and whole life costs of the short-listed options have been developed, the assumptions taken, and the methodology used. The options in this report have been short-listed from the 'Option Appraisal Report'. The costs developed will be used for option appraisal purposes in order to compare options and determine a preferred option.

2. Approach to costing the Options

2.1 Methodology

Capital works are fixed, one-time projects whilst maintenance works are repeatable tasks with relatively less investment and planning needed. The cost estimations for capital and maintenance works were undertaken using the best available information from a variety of sources.

In the first instance where costing information was available from previous projects, published data or supplier quotations, these costs were used as a basis to cost the options. In the absence of this information, values have been estimated from rates provided in civil engineering price books and Environmental Agency guidance, coupled with experience of costs from similar projects (further details in Section 2.4).

For a number of the options considered the cost is dependent on the dimensions of the existing structures. This information was obtained using a combination of methods: lidar data and existing drawings of the structures.

2.2 General assumptions

The costs have been produced assuming:

- No services will require diverting;
- The land is not contaminated;
- VAT and any other taxes or duties are excluded;
- Statutory authority charges such as planning approval, services etc. are excluded;
- An allowance for unknown site or ground conditions is excluded;
- Where required inflation costs have been based on Bank of England calculations.

2.3 Preliminary costs

To cost for items which are not typically accounted for in build-up of costs by tasks using price books; a preliminary cost of 35% has been applied to costs developed using price books, this is a recommendation set out in various pricing guides. The following items are considered to be included in this cost:

- Establishment and running costs of contractors site offices, toilets, mess facilities act;
- Mobilisation and demobilisation of construction equipment;
- Provision of site vehicles;
- Contractors site management team;
- Provision of stores and warehousing including labour and plant;
- Surveys, permits and insurances;
- Contractors profit;
- Contractual requirements i.e. insurance;
- Detailed design and cost consultant fees;
- Environmental mitigation and potential enhancements.

2.4 Optimism bias

In line with Defra's Flood and Coastal Erosion Risk Management – Appraisal Guidance (FCERM-AG), optimism bias has been applied to the estimated costs of each option. According to the guidance, optimism bias;

"*is the tendency for appraisers to be overly optimistic in early assessment of project costs, time scales and benefits in comparison to the final values. To counter this HM Treasury issues guidance in the form of a percentage to increase the costs depending on the uncertainty surrounding the estimates. An optimism bias of 60% is typically used for projects at an early stage of consideration. At the more detailed project stage, a figure of 30% is more commonly used. This percentage is added to the original estimate and used in the cost-benefit calculations."*[1]

The costs have been developed using a 30% optimism bias for Unit A costs and a 60% optimism bias for Unit B costs. This is because there is more uncertainty about the estimated costs for Unit B due to the presence of the existing structures. Although there has been visual condition assessment and some past intrusive investigation of the existing structures there is still some uncertainty about the internal condition of the structures. Also, the tie-ins and interactions between the proposed new structures and the existing structures have only been considered at a high-level of detail and there could potentially be cost increases following the completion of a more detailed assessment.

2.5 Discounting

Discounting is a technique used to compare costs that occur at different points in time over the appraisal period or over the whole life of an option. Standard discount rates have been used to convert all costs to 'Present Value' (PV). FCERM-AG recommends using HM Treasury Green Book and the following variable discount rates (expressed as a %) have been used within the whole life costing; 3.5% for years 0 to 30, 3% for years 31-75 and 2.5% for years 76-99. Using these discount rates over the 100-year appraisal period, a total PV cost for each option was determined. The discount rates applied are the same as those applied to the economic damages and benefits and therefore the PV costs of options and benefits are directly comparable. Cash costs are costs which have not been discounted. Both PV and Cash costs of the options are presented in the 'Coastal Management Plan' report.

Example of discounting

A construction project has an initial cost of £1000k (year 0). It also requires maintenance in years 50 and 75 which will cost £50k each time.

Calculation of Cash whole life cost = £1000k + £50k + £50k = £1100k

(no discounting is applied to whole life cash costs)

Calculation of Present Value whole life cost = £1000k x 1.0 + £50k x 0.197 + £50k x 0.094 = £1015k

(discount factor in year 0 is 1.0, in year 50 is 0.197 and year 75 is 0.094)

2.6 Capital costs

The cost estimates for capital works (design and construction) were undertaken using the best available information from a variety of sources. In the first instance costs were developed from published data and civil engineering price books (e.g. SPONS 2018). The published material used in the development of the capital costs included:

- *Environment Agency (2015) Delivering benefits through evidence, cost estimation for coastal protection – summary of evidence. Report SC080039/R7*
- *Environment Agency (2015) Delivering benefits through evidence, cost estimation for fluvial protection – summary of evidence. Report SC080039/R2*
- *Spon's Civil Engineering and Highway Works Price Book (2018)*

Unit rates for specific materials in the various option designs were obtained from contractors or material suppliers. For example, timber costs were obtained from Gilmore and Aitken Timber Merchants. For options where the cost was likely to be heavily influenced by scale and efficiencies an average unit rate based on published costs from similar scale schemes around the country was utilised (for example beach nourishment in Unit A). Otherwise previous defence costs from the site or from nearby / comparable locations were used as a benchmark to check cost estimates.

In Unit B, where many of the options involve using and modifying the existing defences, the existing dimensions were used to identify quantities of materials and labour required. The defence dimensions were obtained from defence cross sections generated by Mott MacDonald as part of their condition assessment and ground

[1] Flood and Coastal Erosion Risk Management appraisal guidance, Environment Agency, 2010

investigation carried out in 1996. One cross section per defence section was provided and therefore this was assumed to be representative of the full defence section.

In Unit A, where the options involve construction of new defences, indicative defence cross sections were prepared, using lidar and available survey data, and were used to estimate the quantities of materials and labour required. Please note these cross sections were developed for costing purposes only and should not be used for construction.

The following assumptions were made when developing the capital cost estimates:

- In Unit A and B, a 35% allowance for preliminaries has been included;
- In Unit A, a 30% optimism bias allowance has been included;
- In Unit B, a 60% optimism bias allowance has been included;
- Assumed that there are no services or utilities to be diverted by the option or during construction;
- Assumed that the land beneath or adjacent to the options is not contaminated;
- Legal and financing costs are excluded;
- VAT and any other taxes are excluded;
- Costs associated with wayleaves and other third-party issues are excluded;
- No allowance for unknown site or ground conditions have been included;
- All price estimates obtained from guidance or published material prior to 2018 has been uplifted in accordance with Bank of England guidance.

2.7 Maintenance costs

In addition to capital costs, maintenance costs also contribute to the whole life costs that were estimated for each of the options. Maintenance costs refer to the periodic or annual maintenance works that are required to maintain the structural integrity of the defences.

Maintenance costs for different types of defences were estimated based on the published values provided in:

- *Environment Agency (2015) Delivering benefits through evidence, cost estimation for coastal protection – summary of evidence. Report SC080039/R7*
- *Environment Agency (2015) Delivering benefits through evidence, cost estimation for fluvial protection – summary of evidence. Report SC080039/R2*

2.7.1 Seawalls / linear defences at back of beach (Unit B)

In the published Environment Agency guidance, estimated maintenance costs are provided for three target condition grades. The costs have been derived from experience, contract rates and estimated rates for a range of activities. They represent indicative costs and provide a broad range of annual costs per defence length depending on the type of maintenance works required.

The approach requires a weighting factor to be determined based on the level of access to the defence, the susceptibility to vandalism, the nature of the environment (i.e. sheltered or exposed) and the defence height. For the potential defences in this study a weighting factor of 10/12 was applied to reflect the potential difficulties accessing the defences, the aggressive exposed coastal environment and an allowance for defences potentially higher than 1m. The defences were not considered to be particularly susceptible to vandalism (hence not scoring a full 12/12). This weighting factor was applied to produce an estimated annual maintenance cost of £820 per km of defence (uplifted to 2018 prices).

2.7.2 Groynes (Unit B)

In the published Environment Agency summary of evidence for coastal protection (2015), a range of example maintenance costs for groynes are provided. The average annual cost per groyne was identified from examples around the country, including from; Bournemouth Borough Council, Canterbury Borough Council, Suffolk Coastal District Council, Great Yarmouth and Waveney District Council. Uplifted to 2018 prices, the average annual maintenance cost for one groyne was estimated to be £1,050.

2.7.3 New defences in unit A

The published Environment Agency summary of evidence guidance (2015) does not specify maintenance costs for beach nourishment or for rock, timber or Geotube revetments in a coastal environment. Therefore, it has been necessary to make a number of assumptions when estimating the maintenance requirements of these new defences in Unit A. The assumptions have been informed by the team's engineering experience and knowledge from other projects / sites around the UK. In addition, whilst the EA guidance does not specify costs, it does provide an indication of the general level of maintenance that would typically be required for the various structures as displayed in Table 2-1.

Table 2-1: Level of maintenance costs required as specified in the published EA summary of evidence (2015)

Measure	Maintenance costs
Rock revetment	Low
Timber revetment	Medium
Geotube revetment	Not specified
Beach nourishment	Medium

The following assumptions have been made for the maintenance of new defences in Unit A:

- Rock revetment: maintenance costs assumed to be 10% of capital costs every 10-years.
- Timber revetment: maintenance costs assumed to be 20% of capital costs every 10-years.
- Geotube revetment: maintenance costs assumed to be 10% of capital costs every 10-years.
- Beach nourishment: maintenance costs assumed to be 5% of capital costs every 2-years (starting 5-years post recharge).

2.8 Whole life costs

2.8.1 Service life assumptions

In order to develop the whole life costs of the various options over the next 100-years it was necessary to make assumptions regarding the service life of the proposed defences. These assumptions determined how often defences would need to be replaced which formed an important aspect of the overall cost of the options. The assumptions made are as follows:

Unit A

- Assumed that the service life of a rock revetment will be 100-years (duration of appraisal period). This is based on frequent maintenance being carried out every 10-years.
- Assumed that the service life of a timber revetment will be 50-years. This is based on frequent maintenance being carried out every 10-years.
- Assumed that the service life of a Geotube revetment will be 20-years, after which the full structure will need replacing.
- For beach nourishment it has been assumed that 50% of the initial nourishment material will be required every 20-years for the option to be effective over the full appraisal period. This is in addition to the maintenance costs associated with recycling the material every 2-years.

Unit B

- Assumed that a capital resurfacing of the existing defences (i.e. encasement) would extend the service life of the defences by approximately 30-years.
- Assumed that a capital refurbishment of the existing groynes (i.e. timber replacement) would extend the service life of the groynes by approximately 30-years.
- Assumed that new defences (i.e. a new seawall, completely replacing the existing defences) would provide approximately a 65-year service life before a significant refurbishment is required.

- Assumed that maintenance will not be required on wall structures for the first 10-years after refurbishment / replacement works have been completed.
- Assumed that the existing service life of the defences are as specified in the defence condition assessment.
- For sections of the existing defences at the back of the beach with a relatively low residual life where the initial capital intervention is required from year 15, for efficiency reasons it has been assumed that the initial groyne refurbishments will also be undertaken in year 15 (so the works will coincide).
- For sections of the existing defences at the back of the beach with a longer residual life and where the initial capital resurfacing intervention is required from year 35, it has been assumed that the initial groyne refurbishments will be undertaken earlier from year 5. This is because it is considered too long to wait until year 35 for the initial groyne works.

3. Cost Calculations

This section presents how the costs of the different potential management options have been developed. The methods have been briefly described and the results presented; full outline design sketches of the options that have been used for this costing purposes can be found in Appendix F of the 'Coastal Management Plan'.

3.1 Unit A

3.1.1 Rock revetment/sill (Improve 1)

Development of capital costs

The rate was calculated through build-up of tasks using price books. The tasks included excavating the ground to level, installation of a geotextile and installation of armour stone rock of up to 3 tonnes. The cost of importing rock armour to the site was sense checked against recent quotations from a rock supplier to confirm it was reasonable. An increase for preliminaries and optimism bias was then applied.

Capital cost (£/m)

£2.05k per metre length

(£1.57k per metre length before 30% optimism bias applied)

Ongoing costs (for whole life costs)

Expected design life (with maintenance) – 100-years

It has been assumed that every 10-years after construction a small amount of maintenance will take place to reposition any displaced rock to maximise the effectiveness of the defence over the 100-year appraisal period. To estimate the cost of this work 10% of the capital cost of the works has been applied every 10-years from the time the defence is completed.

Table 3-1: Summary of rock revetment rates

Type of Cost	Description
Initial Capital Cost	£2.05k per metre length
Future Capital Costs	None
Future Maintenance Costs	Every 10-years after construction 10% of capital cost applied to account for maintenance works

3.1.2 Timber revetment (Improve 2)

Development of capital costs

The rate was calculated through build-up of tasks using price books and supplier quotations. The tasks included supply and installation of the different timber elements and included an allowance for piling the timber supports. A supplier quotation for hardwood timber was used for the material cost. An increase for preliminaries and optimism bias was then applied.

Capital cost (£/m)

£2.01k per metre length

(£1.56k per metre length before 30% optimism bias applied)

Ongoing costs (for whole life costs)

This option is assumed to have a design life, even with continued maintenance, of 50-years. For the purposes of whole life costing over the 100-year appraisal period, 50-years after the initial construction the capital cost has been reapplied to capture the cost of replacing the structure.

It has been assumed that every 10-years after construction (and replacement) a small amount of maintenance will take place to refurbish the structure, replacing any timber elements as required. To estimate the cost of this work 20% of the capital cost of the works has been applied every 10-years after the defence is completed. This maintenance cost is higher than that used for the rock armour option as wood is a less durable material and replacing elements is a more labour-intensive process than repositioning rock.

Table 3-2: Summary of timber revetment rates

Type of Cost	Description
Initial Capital Cost	£2.01k per metre length
Future Capital Costs	Replacement after 50-years (same as initial cost)
Future Maintenance Costs	Every 10-years after each construction (including replacement) 20% of initial capital cost applied to account for maintenance works

3.1.3 Geotubes/sandbags (Improve 3)

Development of capital costs

The rate was calculated through build-up of tasks using price books and supplier quotations. The tasks included excavating to level, installation of geotextile scour apron and installation and filling of the geotubes. A supplier quotation for the geotubes was used for the material cost. An increase for preliminaries and optimism bias was then applied.

Capital costs (£/m)

£2.07k per metre length

(£1.59k per metre length before 30% optimism bias applied)

Ongoing costs (for whole life costs)

The geotubes only have an expected design life of 20-years. Therefore, for the purposes of whole life costing over the 100-year appraisal period, 20-years after initial construction the capital cost has been reapplied to capture the cost of replacing the structure and this has been repeated until 100-years is reached. 10-years after each construction (including replacement) 10% of the capital cost of the works has been applied for small maintenance works such as isolated repairs/patching and filling of the geotubes.

Table 3-3: Summary of geotube/sandbag rates

Type of Cost	Description
Initial Capital Cost	£2.07k per metre length
Future Capital Costs	Replacement every 20-years (same as initial cost)
Future Maintenance Costs	Every 10-years after each construction (including replacements) 10% of initial capital cost applied to account for maintenance works

3.1.4 Beach nourishment (Improve 4)

Development of capital costs

The rate was calculated by using cost information about previous beach nourishment projects on the UK coastline to produce an estimate. No additional increase for the cost of preliminaries was added on as this would already be included in the base costs, however optimism bias has been applied.

Capital cost (£/m)

£6.60k per metre length

(£5.07k per metre length before 30% optimism bias applied)

On-going costs (for whole life costs)

Expected design life (with maintenance through 'top-ups' of material and recycling) is assumed to be 100-years.

The beach nourishment option will require periodic 'top-ups' (also known as recharges) in order to counter the removal of beach material over time and to maintain beach levels. It has been assumed that every 20-years a major recharge will be required to replace lost material (classified as capital works), and this would cost 50% of the initial capital cost. In addition, it has also been assumed that 5-years after the completion of the initial re-nourishment, or after a major recharge, maintenance works (minor recharge and recycling of beach material) would occur of 5% of the initial capital cost and this would be repeated every 2-years until the next major recharge.

Table 3-4: Summary of beach nourishment rates

Type of Cost	Description
Initial Capital Cost	£6.60k per metre length
Future Capital Costs	Every 20-years after initial construction 50% of initial capital cost applied to account for future capital works (major recharges)
Future Maintenance Costs	Every 10-years after each construction (including major recharges) 10% of initial capital cost applied to account for maintenance works (minor recharges)

3.1.5 Relocation of key assets (Improve 5)

Development of cost

A cost has been estimated for relocating the assets at risk in Unit A based a previous example relocation of a lighthouse. As this form of managing assets is seldom used and each individual project will have different constraints, i.e. whether land is available, type of structure, distance of relocation, there is significant uncertainty over the costs at this high level of assessment. To address this uncertainty a higher amount of optimism bias of 60% has been applied.

Cost

Total capital cost: £3,680k.

(£2,300k before 60% optimism bias applied)

Table 3-5: Summary of asset relocation costs

Type of Cost	Description
Initial Capital Cost	£3,680k
Future Capital Costs	n/a
Future Maintenance Costs	n/a

3.2 Unit B

3.2.1 Do Minimum - Patch and repair maintenance of seawall, promenade and floodwall

Development of cost

The rate was calculated by using cost guidance published by the Environment Agency (Report – SC080039/R7), costs have been uplifted to the present day. The report gives examples of annual costs for both groynes and seawall maintenance and an average cost of this information has been used for the cost estimate. No additional increase

for the cost of preliminaries was added as this is already be included in the quoted rate, however optimism bias was applied.

Cost

Do Minimum maintenance: £21.5k per year (over 100-year appraisal period)

Made up of costs for a Do Minimum maintenance regime for groynes and for seawall:

Groynes: £1,050 per year per groyne and Seawall: £820 per year per kilometre.

Table 3-6: Do Minimum cost summary

Description	Cash Cost	PV Cost
Capital costs	-	-
Annual Maintenance costs	£21.5k	(varies)
Whole life costs	£2,150k	£641k

3.2.2 Re-facing of the seawall, promenade and floodwall (Maintain)

Development of capital costs

The cost was calculated through the build-up of tasks using price books and supplier quotations for materials. The tasks included major refurbishment of the existing groynes and concrete encasement of the seawall, promenade and floodwall. An increase for preliminaries and optimism bias was then applied.

Capital cost

Total capital cost of Maintain: £28,851k

(£18,032k before 60% optimism bias applied)

Ongoing costs (for whole life costs)

Expected design life (with maintenance) is assumed to be 30-years (protection through this type of defence can be extended to 100-years through repeat refurbishments)

The initial refurbishments of the existing defences will only be carried out towards the end of the residual service life of the existing defence structures. After the initial refurbishment repeat refurbishments (capital interventions) have been assumed to be required every 30-years. Reactive maintenance has been assumed to be the same level and cost as in the Do Minimum approach throughout the 100-year appraisal period.

Table 3-7: Maintain option cost summary

Description	Cash Cost	PV Cost
Capital costs	£28,851k	£7,212k
Maintenance costs	£2,150k	£641k
Whole life costs	£31,001k	£7,853k

3.2.3 Re-face and raise existing defences (Sustain)

Development of capital costs

The cost was calculated through build-up of tasks using price books and supplier quotations for materials. The tasks included the same major refurbishment tasks as the Maintain option (starting towards the end of the residual service life of the existing defences), however in addition, the raising of the rear floodwall is also included. It was assumed that the raising of the rear floodwall will occur at three intervals throughout the appraisal period to deal

with increasing sea levels. These intervals will be timed to coincide with the scheduled major refurbishments. An increase for preliminaries and optimism bias has also been applied.

Capital cost

Total capital cost of Sustain: £34,507k

(£21,567k before 60% optimism bias applied)

Ongoing costs (for whole life costs)

Expected design life (with maintenance) is assumed to be 30-years (protection through this type of defence can be extended to 100-years through repeat refurbishments)

The initial refurbishments of the existing defences and crest raising will only be carried out towards the end of the residual service life of the existing defence structures. After the initial refurbishment repeat capital interventions have been assumed to be required every 30-years. Reactive maintenance has been assumed to be the same level and cost as in the Do Minimum approach throughout the 100-year appraisal period.

Table 3-8: Sustain option cost summary

Description	Cash Cost	PV Cost
Capital costs	£34,507k	£8,567k
Maintenance costs	£2,150k	£641k
Whole life costs	£36,656k	£9,208k

3.2.4 Replacement seawall, promenade, floodwall and groynes (Improve)

Development of capital costs

The option includes new seawall and groynes at the end of the existing structures residual life. The cost for the various groyne options was calculated through build-up of tasks using price books and supplier quotations for materials. The cost for the new seawall has been based on Environment Agency's costing guidance examples and an average taken (Report – SC080039/R7). (Please note, because there are many uncertainties about what the design of a new seawall at this early stage this method of estimating was preferred over using price books to build-up a cost.) No additional increase in costs have been included for preliminaries as this is already included in quoted rate, however optimism bias has been applied.

Capital costs

The total capital costs for each of the Improve options are displayed in Table 3-10 below:

Table 3-9: Improve options capital cost summary

Improve Option	Description	Cash Cost
Improve 1	- Construction of new seawall - Construction of new timber groynes (all sections)	£48,627k
Improve 1A	- Construction of new seawall - Construction of new timber groynes (sections A-E) - Extended concrete groynes (section G)	£47,931k
Improve 2	- Construction of new seawall - Construction of new rock groynes (all sections)	£42,133k
Improve 2A	- Construction of new seawall - Construction of new rock groynes (sections A-E) - Extended concrete groynes (section G)	£43,482k

Ongoing Costs (for whole life costs)

Expected design life of the new seawall (with maintenance) is assumed to be 100-years. It has also been assumed that with an adequate maintenance, refurbishment and (where appropriate) replacement regime in place (detailed in the 'Coastal Management Plan'), each of the potential groyne options will achieve a design life of 100-years.

In addition, reactive maintenance has been assumed to be the same level and rate as the Do Minimum approach throughout the 100-year appraisal period.

Table 3-10: Improve options cost summary

Option	Description	Cash Cost	PV Cost
Improve 1	Capital costs	£48,627k	£20,373k
	Maintenance costs	£2,150k	£641k
	Whole life costs	£50,777k	£21,014k
Improve 1A	Capital costs	£47,931k	£19,636k
	Maintenance costs	£2,150k	£641k
	Whole life costs	£50,081k	£20,277k
Improve 2	Capital costs	£42,133k	£18,351k
	Maintenance costs	£2,150k	£641k
	Whole life costs	£44,283k	£18,992k
Improve 2A	Capital costs	£43,482k	£18,590k
	Maintenance costs	£2,150k	£641k
	Whole life costs	£45,632k	£19,231k

AECOM
Midpoint
Alencon Link
Basingstoke
RG21 7PP