REPORT

Bacton to Walcott Coastal Management

RMA Outline Business Case (Final 2.0 for LPRG)

Client: North Norfolk District Council

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BUSINESS CASE APPROVAL SHEET

1 Review & Technical Approval			
Project title	Bacton to Walcott Coastal Management (Sandscaping) Scheme		
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Lead authority	North Norfolk District Council	Date of submission	18.04.18
Consultant	RHDHV	Document stage (SOC/OBC/FBC)	OBC
Previous document	NA	Previous doc ref	
Job title	Name	Signature	Date
'I confirm that this project meets our quality assurance requirements, environmental obligations and Defra investment appraisal conditions and that all internal approvals, including member approval, have been completed and recommend we apply to the Environment Agency for capital grant and local levy in the sum of £ 3,435,000			
Authority Project Executive	Steve Blatch	See separate PDF	18.04.18
'I have reviewed this document and confirm that it meets the current business case guidelines for local authority and Internal Drainage Board applications.'			
Business case reviewer	Rob Goodliffe	See separate PDF	18.04.18
'I confirm that the project is ready for assurance and that I have consulted with the Director of Business Finance'			
Area Flood & Coastal Risk Manager	Mark Johnson	See separate PDF	18.04.18
NPAS Assurance (Tick the appropriate box) ☐ Projects £100k - £10m		Large project review group (LPRG) ☒ Projects >£10m	
Recommended for approval			Date
~~NPAS or~~ LPRG Chair	Richard Nunn	Deputy Director Investment and Delivery Assurance	
Project total as approved £	18,263,000	Version number	2.0
Project total made up of :	Capital Grant (£k)	3,435	
	Levy + NFM funding (£k)	500 + 120	
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2 Project Financial approval				
Financial scheme of approval	Project total	Name	Signature	Date
Director of Business Finance	All >£100k			
Director of Operations	£1m - £10m			
Executive Director of Operations	>£10m			
Chief Executive	>£20m			

3 Defra approval			
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Comments	

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1 Executive Summary

1.1 Introduction

This Outline Business Case (OBC) seeks approval and funding contributions (Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA), Natural Flood Management (NFM) and Local Levy) for the Bacton to Walcott Coastal Management Scheme. The Scheme concerns the placement of a large volume of sand on the beach at Bacton and Walcott in North Norfolk, aiming to protect the Bacton Gas Terminal ('the Terminal') and its associated infrastructure (including pipelines) from cliff erosion and to reduce the risk of flooding and erosion for the villages of Bacton and Walcott ('the Villages'). The project is a private-public partnership: the requested funding contributions only reflect the benefits arising from flood and erosion risk reduction to the Villages and are approximately 20% of the total project costs.

1.2 Strategic case

1.2.1 Strategic context

The Bacton to Walcott scheme is developed by a private – public partnership of the Bacton Terminal Companies (BTC) and North Norfolk District Council (NNDC), referred to as the Client Group.

The Kelling to Lowestoft Ness Shoreline Management Plan (SMP) (August 2012) states that coastal protection at the Terminal and its infrastructure can be protected from coastal erosion, but only if any negative impact on coastal processes is mitigated. For the Villages, the SMP states that the sea defences should be maintained as long as economically viable, but this is only expected to be possible in the short term. Before the sea defences fail, measures will be required to manage the risk and mitigate the displacement of people and loss of property and facilities in the medium term.

The Bacton Gas Terminal is operated by a number of private companies, referred to as the BTC. Their business strategy is to continue to operate the Terminal and its infrastructure until the 'end of field life', which is currently estimated to be at least 20 years into the future. Any coastal protection works required for this purpose are not eligible for Government funding.

NNDC is the Risk Management Authority (RMA) for coastal erosion in the area. NNDC published coastal studies in 2013 and 2014 which confirmed the SMP's intent of management for the area and identified the potential for a combined scheme between the Terminal and the Villages. NNDC has been at the forefront of developing approaches for coastal adaptation. In line with the SMP it aims to enable adaptation of people, property and facilities before they are lost to erosion, but due to the lack of a national approach for funding of coastal adaptation, this is not yet possible.

1.2.2 The case for change

The north-east Norfolk coast has been eroding for the last 5,000 years. The shoreline has been held in its current position by structures from around the 1960s. Since then beach levels have been lowering, which is threatening the structures' stability. The Terminal needs to be protected from erosion, and the BTC intend to carry out and fund the required works, including measures required to mitigate impacts on neighbouring areas. Their preferred solution is to use a mega nourishment; studies show that this is the most cost-effective way to protect the Terminal for around 20 years while mitigating negative impacts.

As outlined in section1.2.1, the SMP indicates that it will not be possible to hold the current shoreline position for the Villages beyond the short term. Adaptation will be needed, but this is not yet possible in

the absence of a national approach and funding stream. There is a unique opportunity to turn this 'Terminal only' project into a combined project that generates wider benefits by improving the beach in front of the Villages; this will delay the loss of the coastal defences and buy the time needed to enable coastal adaptation, while also reducing flood risk and providing socio-economic benefits. A stand-alone scheme for the Villages would not be viable; the combination with the Terminal project can make it viable and affordable.

1.2.3 Objectives

The overarching intent of management for the joint approach to coastal management between Bacton and Walcott is to enable the Terminal to continue to function, whilst extending the life of the Villages' defences to support a process of adaptation to coastal change for the communities in the medium term. This involves sustaining the viability of communities, businesses, infrastructure and individuals, but within the context of change over time. An additional aim is to minimise social, economic and environmental impacts and maximise social, economic and environmental opportunities.

This overall intent is supported by specific objectives for the Terminal and for the Villages.

1.3 Economic case

1.3.1 Options considered

Stand-alone options for the Terminal and for the Villages were considered in earlier stages, but rejected as part of the combined Bacton to Walcott project, because only a combined approach would meet the project's double objective. There are viable stand-alone options that do meet the Terminal objectives and mitigate negative impacts (and create some risk reduction benefits for the Villages); in that context the BTC selected a sediment-based solution for their own reasons (outside of this OBC); this OBC treats the sediment-based Terminal-only solution as the Do Minimum option. Stand-alone options for the Villages have been shown to be unviable.

The Bacton to Walcott study used these earlier findings as a starting point for option development. Its longlist therefore consisted of various sediment-based frontage-wide solutions. The longlist options varied in the expected functional life (from traditional beach nourishment to a 'sandscaping'-style mega nourishment that is designed to work with natural processes to transport sediment). They also included hybrid options which contained hard structures at key problem locations in combination with nourishment. The longlist appraisal concluded that the combined scheme will need to be a fully sediment-based solution, because this is the only approach that can generate the efficiency benefits required to make the investment in the Villages part of the scheme viable and affordable.

The team then used an iterative approach, combining analysis (including extensive modelling), contractor engagement and socio-economic and environmental input to develop the shortlist. The starting point was the minimum protection profile needed for the Terminal (optimised separately on the basis of the BTC's considerations). Option development focused on the following variables:

- Reliance on natural transport of sand from the Terminal to reduce risk at the Villages: analysis showed that the objective of supporting the whole Villages frontage required some direct placement along the whole area, so this is included in all shortlisted Do Something options. Natural processes will improve the beach throughout the frontage over time, but for the sections further away from the Terminal, the improvement would not arrive until after the predicted end of life of the seawall.

- Grain size: the starting point is to use the same grading as currently on the beach. Finer sediment could generate cost savings but these would not balance out the performance risks. Coarser sediment would be more expensive per cubic metre placed, but the additional costs may be balanced out by the increased stability of the nourishment. The procurement process will provide flexibility for use of coarser sediment if more cost-effective. This same principle is applied in all shortlisted Do Something options
- Size and shape of the nourishment: the buffer in front of the minimum Terminal protection profile and the transition toward the Villages frontage, down to Bacton Green, was optimised (and forms the Do Minimum as introduced above). This left the size and shape of the Villages nourishment at Walcott as the only spatial variable in the shortlist.

The resulting shortlisted Do Something options for detailed appraisal therefore only differ in the volume of sediment placed along the Bacton to Walcott village frontage. Option 1 has a total nourishment volume of 1.5m m^3, of which 0.3m m^3 is placed at the Bacton to Walcott villages. This volume is increased in steps of 0.1m m^3 each for Options 2, 3 and 4. Consequently Option 4 has a total volume of 1.8 m m^3, of which 0.6 m m^3 is placed at the Bacton to Walcott villages.

1.3.2 Key findings

The Do Something options generate GiA eligible benefits for reducing four types of risk, each quantified on the basis of the standard methods from the Multi-Coloured Handbook:

- **Properties protected from erosion**. Improved beaches improve stability and reduce exposure of the defence structures, delaying their failure and therefore the onset of erosion, and ultimately the time that each property at risk is predicted to be lost. The benefits are generated by this delay of the loss of the properties, which reduces Present Value Damages.
- **Properties protected from flooding**. Bacton and particularly Walcott are vulnerable to flooding from wave overtopping. Increasing beach volume will reduce overtopping. The benefits were calculated through an (appropriately pragmatic) analysis of the results of the Environment Agency's recently completed coastal overtopping study.
- **Highways protected**. The delayed failure of the seawall at Walcott delays the need to reconstruct the B1159 Coastal Road. The benefits are generated by the reduced Present Value Damages (PVD).
- **Loss of recreational value prevented**. Improved beaches reduce the loss of visitor spend that would result from further loss of the beaches at the Villages.

The scheme may have further risk-related benefits elsewhere, because it is likely to improve beaches further downdrift, but this is not included in this OBC. The scheme is also expected to create other benefits concerning the enhancement of the communities' capacity to adapt and the improvement of tourism beyond current levels. These are relevant for other sources of funding, but not discussed further in this OBC.

The performance of the options is characterised in terms of delay of defence structure failure and flood risk reduction, and these were calculated through modelling and analysis. The resulting performance, and the associated economic benefits, improve in a logical order from Option 1 to Option 4.

The decision process from the Appraisal Guidance leads to a conclusion that Option 4 is the leading option from an economic perspective: the higher costs for the additional sediment placed at Walcott are more than outweighed by the higher benefits generated by the higher beach. This conclusion does not change when considering contributions (very relevant for this project), uncertainty, and the achievement of

wider objectives. The variation in the incremental Benefit Cost Ratio (iBCR) suggests that Option 4 is close to the optimum from an economic perspective.

1.3.3 Preferred way forward

The non-financial benefits do not change the ranking based on the economic analysis, so Option 4 is confirmed as the preferred option.

However, for reasons of affordability, Option 1 is proposed at this stage for presentation in the OBC. Based on current availability of other funding sources (both private and public) and current cost estimates (based on extensive engagement with multiple dredging contractors) it is confirmed that Option 1 achieves an Adjusted Partnership Funding exceeding 100%, and is affordable. When the construction costs are confirmed through the procurement process, and when the full availability of other funding sources is clear, the Client Group will re-assess the sediment volume at Bacton and Walcott (as part of the overall option) that is affordable. It is recognised that the amount of GiA funding depends on the scheme that is implemented, and its calculated Outcome Measures, and this will form part of the post-procurement reassessment of the selected option, up to the maximum defined by Option 4 in this OBC.

This OBC is therefore requesting approval from the Large Projects Review Group (LPRG) for Option 1, with the understanding that in reality the final decision on the option to be implemented will depend on the actual construction costs and on the funding sources that are available at the time, and the implemented option will determine the appropriate amount of GiA, up to the amount of £5.0m calculated for Option 4.

1.4 Commercial case

1.4.1 Procurement strategy

As the project's lead delivery and contracting body, NNDC will procure:

- Contractor for the construction of the Sandscaping works.
- Project Manager and Supervisor functions as defined typically in the NEC3 form of contract.
- Principal Designer for the construction phase of the project as defined by the Construction (Design and Management) Regulations 2015.
- Continuing design support.

Based on comparison of various procurement options, the Steering Committee's preferred procurement procedure is to use the WEM Framework for both the works and professional services contracts. For the Principal Designer and continuing design support, NNDC has resolved to appoint Royal HaskoningDHV to continue its involvement from the design stage.

1.4.2 Key contractual terms and risk allocation

All services and works to be provided will be based on the terms of the relevant NEC3 contract, in accordance with the requirements set out in the WEM framework agreement: the NEC3 Professional Services Contract (PSC) for the Project Manager/Supervisor and the NEC3 Engineering and Construction Contract (ECC) for the works.

The allocation of risk will be managed using the terms of the WEM ECC supplementary clauses ("z" clauses) in line with the Environment Agency's practice, with particular attention to the risks associated with fuel price, currency exchange rate, weather and sea state, loss of sediment after placement and loss of sediment on completion.

1.4.3 Efficiencies and commercial arrangements

There has been an extensive design process which has sought to optimise the scheme, including engagement with the contracting consortia that are part of the WEM Lot 4.

There may be an opportunity for this project and the next phase of the Environment Agency's Lincshore nourishment contract to benefit mutually from the local positioning of major plant and equipment.

The combined scheme by its nature facilitates a unique opportunity to extend the life of their defences.

The extension or replacement of the three surface water outfalls at the Terminal, required because of the nourishment, is likely to be included in the works contract for the nourishment. As the WEM Lot 4 contractors have the required experience for both the nourishment and the outfall works, this has cost, programme time and efficiency benefits.

The Crown Estate (TCE) has indicated that there is an opportunity for the royalties payable to TCE to be re-negotiated. The works information for the ECC contract will require the contractors to negotiate the royalty fee with TCE and to evidence the agreed fee in their tenders.

1.5 Financial case

1.5.1 Summary of financial appraisal

	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs up to OBC	N/A – sunk costs		
OBC to construction			
Existing staff costs	12	12	12
Site investigation and survey	20	20	20
Subtotal	32	32	32
Construction			
Construction costs (nourishment)	14,687	14,687	14,687
Environmental enhancement	60	60	60
Environmental mitigation	5	5	5
Existing staff costs	10	10	10
Consultants' fees	62	62	62
Site supervision and construction management	221	221	221
Land purchase and compensation	10	10	10
Subtotal	15,055	15,055	15,055
Risk contingency			
Optimism bias (20%)	3,011	3,011	3,011
Risk allowance (see Table 3.6)	165	165	165
Future costs (estimate)	450	600	

	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Subtotal	3,626	3,776	3,176
Project total costs	**18,713**	**18,863**	**18,263**

1.5.2 Funding sources

The funding for the Bacton to Walcott Coastal Management Scheme will come from a number of private and public sources. The FCERM GiA, NFM and Local Levy are critical elements of the project to enable the joint Terminal and Villages scheme to proceed, but they do not form the primary funding source. The private funding is being led by Shell UK and Perenco UK who are overseeing an umbrella of other infrastructure provider contributions. Other public funding sources that are intended to be made available concern contributions from NNDC, the Norfolk Business Rates Pool and the New Anglia Local Enterprise Partnership (LEP) Growth Funds, plus contributions from the local community through the JustGiving account set up by NNDC.

As discussed in section 1.3.3, approval is being sought for implementing Option 1, but it is possible that a larger scheme will be implemented if it becomes affordable, with GiA based on the benefits of the option selected for implementation. Table 1-1 is based on Option 1 and shows an adjusted partnership funding score that exceeds 100%.

Table 1-1 Summary of funding sources

	%	Description	Total £k
Raw partnership funding score	19%		
Funding:			
Contributions (list)		LEP, Business Rates Pool, Local Community, Bacton Terminal Companies	14,357
Other: (list)		NFM	120
Local Levy			500
Non GiA contributions			14,977
Adjusted Partnership funding score	105%		
Grant in Aid			3,435
Project total costs (approval)			18,263

1.5.3 Overall affordability

The affordability of the Bacton to Walcott Scheme is intrinsically embedded in the delivery of the privately funded protection of the Terminal. The private contributions, which cover Terminal protection, mitigation of negative impacts, but also (if needed) an element of the costs for the Villages, are confirmed in the Development Agreement signed between Shell UK, Perenco UK and NNDC. All other contributions required for implementation of Option 1 have been agreed and confirmed, subject to the scheme being implemented. FCERM GiA funding is required to construct the scheme, and has been included in the Environment Agency's FCERM Investment Programme. Table 1-2 is based on Option 1.

Ongoing costs are expected to be low as the scheme will naturally decommission over time. Monitoring costs are to be shared and it is expected that a significant proportion of the costs can be captured in the

Environment Agency's Anglian Coastal Monitoring programme. Further research will be supported and encouraged but this is outside the core project and remit of the OBC.

Table 1-2 Overall Scheme affordability

Annualised spend profile (£k)	Yr 0 2019	Yr 1 2020	Yr 2 2021	Yr 3 2022	Yr 4+	Total
Construction & other costs	15,115	30	30	30	510	15,695
Optimism bias & risk	3,076	50	50			3,176
Project total costs	18,191	80	80	30	510	18,871
Less: Contributions	14,781	30	0	0	480	15,271
Capital Grant	3,410	50	80	30	30	3,600

1.6 Management case

1.6.1 Project management

NNDC is the lead delivery and contracting body on behalf of the partners involved in the project. NNDC will manage the scheme through Coastal Partnership East (CPE), which is the coastal management service for the Council. It will apply NNDC's PRINCE2-based project management processes.

The collaboration of the partners is defined in the project's Development Agreement and reflects the high-level support for the project in all parties:

- The Project Steering Committee (PSC) is in charge and is well-established from the earlier project stages. It is chaired by NNDC's Corporate Director and contains representatives from all parties. The PSC has change authority above a value of £10,000.
- The PSC is supported by a Technical Group that also includes consultant support.
- The Project Executive is responsible for delivery and consists of NNDC staff with support as required. It reports to the PSC.
- Project assurance is provided by each party's representation in the PSC. For NNDC this is supplemented by regular reporting to the Council's Large Project Board.

Key milestones are confirmation of consent; contract award; mobilisation; and completion of the works.

1.6.2 Benefits realisation

The improved protection of properties and the highway against erosion will be realised after the year when these receptors are currently predicted to be lost to erosion; this ranges from the very short term to 50 years. The reduction of flood risk and the prevention of the loss of tourism spend will start directly when the scheme has been constructed, and the level of these benefits will develop over time as the sediment moves into and away from the frontage.

The Operations, Maintenance and Monitoring (OMM) Plan will detail the activities that will need to be completed to assess the scheme's performance as well as the (NFM) aspects of the project. This will address functional performance for the Terminal and for the Villages, and the environmental and socio-

economic impacts and benefits (such as cliff geology, coastal zone benthos and juvenile fish as identified in the Environmental Impact Assessment).

It is the intention to couple the Scheme's monitoring programme with a wider-reaching research programme seeking to develop knowledge from the proposed scheme. The results of the monitoring programme and wider-reaching research programme will be shared with the risk management authorities.

1.6.3 Risk management

Risk will be identified and managed through the use of a Risk Register, managed by the Project Team and PSC as appropriate. The current risk register is structured by Financial / Legal, Procurement, Delivery and Communications Risks. The highest risks currently identified concern programme, including its dependence on consenting, and these are mitigated by regular programme review and finetuning.

1.6.4 Assurance, approval and post project evaluation

The design of the scheme is not based on a single modelling tool, but on a conceptual model that combines the best available tools and expert judgement, validated against monitored beach profiles. It was reviewed throughout by the project team and the Client Group, including sensibility checks by the Dutch NatureCoast Zandmotor research programme. The economic assessment methodology was reviewed by LPRG economists and appraisal experts in the early stages and throughout. Ongoing assurance is built into the governance arrangements described in section 1.6.1.

Project Evaluation Review (PER) is integrated into the contracts for implementation and will be undertaken after construction. A Project Implementation Review (PIR) will be integrated into the OMM Plan.

1.7 Recommendation

The OBC recommends LPRG's approval in principle of the preferred Option 1, and the associated funding contribution from FCERM GiA, NFM and Local Levy. Depending on affordability, the Client Group will update and confirm the actual option to be implemented, and will review and confirm the associated GiA contribution sought, which will not exceed Option 4.

2 The Strategic case

2.1 Introduction

2.1.1 Overview of the problem

The north east Norfolk coast is subject to long-term coastal change. It is likely that the cliffs have been eroding at around the present rate for the last 5,000 years when sea level rose to within about two metres of its present position. The cliffs are made of soft deposits, mainly sand and soft clays, which are very vulnerable to erosion. This problem of coastal erosion extends from Weybourne, west of Sheringham, to Happisburgh. This long-term coastal change puts pressure on communities, infrastructure and business in the coastal zone.

The Bacton Gas Terminal is situated on the North Norfolk coast with infrastructure near the cliff edge, within the cliff and under the beach. It is a piece of nationally important critical infrastructure, supplying up to one third of the UK's gas demand. It is one of the three main gas terminals in the UK and receives gas from the North Sea extraction fields and from the continent. The Terminal is owned by Shell, Perenco and other oil and gas businesses. The Gas Terminal needs to be protected from cliff erosion and beach lowering for as long as the terminal is needed to avoid national impacts in the event of the gas supply being interrupted.

The terminal is currently defended by a series of timber groynes, which seek to manage beach levels and a timber revetment, which seeks to reduce cliff erosion. These structures are now more exposed due to beach lowering and suffer damage during storm events.

Despite these defences, cliff erosion at the terminal has progressed rapidly over recent years, notably during storm surges in November 2007 and December 2013. Following the December 2013 storm it became clear that erosion was starting to threaten the infrastructure at the terminal. This included the cliff top infrastructure itself, as well as vertical pipeline shafts within the cliffs and pipelines buried within the cliffs and beach. There is, therefore an urgent need to provide protection against further erosion. In January 2017, due to the immediate risk, Shell constructed a temporary coast protection solution along critical lengths of their section of the terminal frontage. This temporary solution consists of rock-filled gabion baskets placed at the toe of the cliffs on a gabion mattress and backfilled with sand. The temporary solution was designed to provide intermediate protection, assuming construction of a full permanent scheme in the near future. The vulnerability of the Gas Terminal infrastructure to erosion was highlighted again in the storm surge event of January 2017, which caused significant lowering of the beach and damage to the existing timber revetment and the temporary coast protection solution which was in the process of being constructed.

Downdrift of the Bacton Gas Terminal, continued protection of the villages of Bacton and Walcott (referred to as "the Villages" within this document) is only likely to be economically viable in the short term. The Villages form an integral element of the community and socio-economic structure of north-east Norfolk, providing residential areas supporting the population and overall housing stock of the area. They provide aspects of the important tourism potential to the area and sustain small businesses that also form part of the support structure to the wider rural hinterland. The Villages are protected from erosion and flooding by the presence of a concrete seawall along most of their length, flanked by timber revetment. These defences are supported by a timber groyne field which, due to falling beach levels preventing access, is in varying states of repair. The defences all rely on the beach as the first line of defence to reduce water depth and therefore the height of the waves that can reach the defences as well as protecting the lower part of the seawall from direct exposure to waves and providing structural support. The beach has eroded

significantly since the construction of the seawall in the 1950s and 60s, to a point where the seawall is predicted to have a residual life of between 5 and 15 years only. The erosion of the beach also contributes to flood risk: the storms of 2007, 2013 and 2017 caused significant flooding of the coastal road and properties due to wave overtopping at Walcott, and also at Bacton in 2013.

2.1.2 Previous studies and investigations

There is a clear link between the coastal frontages of the Gas Terminal and of the Villages downdrift due to the sediment movement along this coast. The Kelling to Lowestoft Ness Shoreline Management Plan (SMP) was adopted in August 2012 and developed policies for managing the long-term coastal retreat on the North Norfolk coast. It states that coastal protection at the Bacton Gas Terminal needs to be sustained for as long as it is needed to protect the terminal buildings and sub-surface pipelines, but includes an explicit requirement to mitigate any negative impact that this protection could have on sediment supply along the coast. For the Villages, the SMP states that the sea defences should be maintained as long as economically viable. This is only expected to be possible in the short term, but before the sea defences fail, measures will be required to manage the risk and mitigate the displacement of people and loss of property and facilities in the medium term.

The Cromer to Winterton Ness Coastal Management Study was published in July 2013 and aimed to validate and potentially refine the SMP management policies. This 'Coastal Study' confirmed that a scheme to Hold the Line at the Bacton Gas Terminal over the long term is economically justified. For the coast downdrift of the Gas Terminal, the Study confirmed that none of the unit-focused scenarios showed an economically justified scheme. In 2014, the Bacton, Walcott and Ostend Coastal Management Study was published to provide more detailed investigation into the economic case for coastal protection schemes specifically at Bacton and Walcott. This confirmed the potential for economically justifiable schemes for parts of the frontage, however significant contributions would be required and this could cause wider environmental impacts. It also highlighted that a combined scheme between the Gas Terminal and the Villages should be considered in more detail.

A full list of previous studies and investigations is provided in **Appendix A**.

2.1.3 The Bacton to Walcott Coastal Management scheme

The Bacton to Walcott Coastal Management project grasps the opportunity offered by combining the need for protection at the Gas Terminal and medium-term management of change for the Villages as set out by the SMP and confirmed by the Coastal Study. The project has developed a joint approach to management that provides the necessary protection for the Bacton Gas Terminal as well as reducing flood and erosion risk for the Villages. The rationale for the combined project is that it is cost-effective to invest in risk reduction at the Villages if done in combination with the Terminal protection scheme that is going ahead anyway and will be funded by the private Terminal Operators, while risk reduction for the Villages on a stand-alone basis would not be viable. This is the case because of the nature of the proposed coastal management solutions, for two reasons:

- The significant cost of dredger mobilisation would be needed for a stand-alone Terminal Protection scheme, so the incremental costs of adding material for the Villages are limited.
- Much of the nourishment material placed in front of the Terminal will naturally move downdrift toward the Villages, helping to sustain the beaches after they would have been improved directly by nourishment in the initial investment.

Improvement of future beach levels for the Villages has the following effects:

- It will delay the failure of the coastal structure (mainly seawall): it will take longer for the beach to erode below the minimum level required for structural support, and the higher beach will reduce the structure's ongoing exposure to wave loading and salt water.
- For the low-lying areas behind the coastal structure the higher beach will reduce the risk of flooding due to wave overtopping, to the coast road and the nearby properties.
- In addition to these direct impacts, it is expected that the higher beach will slow down the ongoing trend of reducing beach levels, especially cross-shore losses made worse by exposure of the lower vertical face of the seawall.

The economic benefits at the Villages are therefore mainly related to delaying the loss of properties, infrastructure, tourism and households in the communities of Bacton and Walcott, in addition to reduction of flood risk in the low-lying areas, and prevention of loss of recreational value.

2.2 Business strategies

The Bacton Gas Terminal is operated by Shell, Perenco, ENI, National Grid and Interconnector, and there are a number of associated and linked services and companies. Shell UK and Perenco UK have led the terminal strategy to stop erosion to the cliff in front of the terminal until its "end of field life". This is not known precisely because it depends on the global oil and gas market, but it could be 50 years or longer. As well as ensuring that the terminal infrastructure itself is protected, the operators want to ensure a minimum sediment cover of 1.2 metres over the pipelines until the terminal's "end of field life". Options that consist of adaptation of the infrastructure, or re-locating the infrastructure further landward, are not feasible due to the interconnected nature of the cliff top, cliff and sub-beach level assets and the significant costs and disruption involved. The operators accept that there is a significant chance that the outfalls will need to be extended to ensure that there is no disruption to their operation.

As discussed in section 2.1, the Kelling to Lowestoft Ness SMP matches the strategy of the terminal operators by stating that coastal protection at the Bacton Gas Terminal needs to be sustained for as long as it is needed to protect the terminal infrastructure (including sub-surface pipelines), however it includes an explicit requirement to mitigate any negative impact that this protection could have on sediment supply along the coast. For the Villages, the SMP states that the sea defences should be maintained as long as economically viable and environmentally sustainable. Before the sea defences fail, measures will be required to manage the risk and mitigate the displacement of people and loss of property and facilities in the medium term.

The project also aligns with North Norfolk District Council (NNDC)'s strategic approach: the Council's efforts to support coastal adaptation, the Shoreline Management Plan and the Council's subsequent strategic studies. NNDC has been at the forefront of developing coastal adaptation and has successfully worked with communities on the coast utilising the one-off Defra Pathfinder funding. Such approaches have been found to be effective, however currently there is no national approach to funding for coastal adaptation and therefore at present it is not possible to bring forward such an approach for the Villages. The SMP allows for continued protection as long as this is viable; the scheme described within this document seeks to make it viable for longer to sustain the defences at the Villages in the short and medium term, to provide time to enable such an adaptive approach to be developed nationally and locally.

As stated in section 2.1 the Cromer to Winterton Coastal Management Study, which fulfils the role of a Coastal Strategy, identified the opportunity to combine a coastal management scheme at the Villages with the required coastal management at the Bacton Gas Terminal.

Further to the strategic coastal studies, an additional assessment was made of the frontage following the 2013 storm surge to assess flood risk from the sea. This study identified potential actions to mitigate flood

impacts during storm events. It highlighted that if it was economically viable, a beach management solution would be preferred.

2.3 Environmental and other considerations

This section provides a summary of the relevant environmental issues, regulatory requirements, legal or other obligations affecting the project, as agreed with regulators and stakeholders involved in the process of developing the scheme. The full Environmental Scoping Report is available on request, with the Scoping Opinion included as **Appendix B**.

The Marine Management Organisation (MMO) and NNDC, as Local Planning Authority, determined that a statutory Environmental Impact Assessment (EIA) under the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) and the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 was required for the proposed scheme.

This determination followed consultation on the "EIA Scoping – Bacton Gas Terminal Coast Defence Scheme – Coast Protection Works" written and published by Royal HaskoningDHV in 2016 on behalf of Shell UK, Perenco UK and NNDC. The NNDC Planning Department and MMO consulted a number of departments/organisations on this report, as shown in Table 2-1, and the majority of these provided their advice on the environmental issues relevant to this project.

Table 2-1 Departments/organisations consulted

Consulted by the MMO	Consulted by NNDC
• Centre for Environment, Fisheries and Aquaculture Science (Cefas) • Maritime and Coastguard Agency • Trinity House • Royal Yachting Association • Crown Estates • Environment Agency • Marine Management Organisation • Historic England • Eastern Inshore Fisheries and Conservation Authority (Eastern IFCA) • Natural England	• Norfolk County Highways • RSPB • Norfolk Wildlife Trust • Norfolk Coast Partnership • NNDC Coastal Management • NNDC Landscape • Great Yarmouth Borough Council • Health and Safety Executive

There are a number of designated sites within the study area which the proposed works have the potential to affect. This includes the conservation interest features of Winterton-Horsey Dunes SAC and SSSI, Cromer Shoal Chalk Beds MCZ, Mundesley Cliffs SSSI, Great Yarmouth North Denes SPA, Happisburgh Cliffs SSSI and the Norfolk Coast AONB. These sites have all been included within the Environmental Statement now produced for the proposed scheme. In addition, a habitats regulations assessment has been completed for the European designated sites.

The EIA phase assessed the potential impacts associated with the proposed development and the preferred option. Table 2-2 shows a summary of the potential impacts considered in the EIA phase. Where impacts are considered to have adverse impacts on receptors, mitigation measures are proposed to reduce these impacts as in section 2.3.1. Full details of the impacts are provided in the Environmental Statement.

Table 2-2 Impacts considered during EIA

Section of EIA	Potential impact considered	Impact significance	Reason
Coastal processes and geomorphology	Elevated suspended sediment concentrations at the coast may be generated by placement of the sand and water mix from the discharge pipe	**No impact** upon identified receptors	The receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column.
	The increases in suspended sediment concentrations associated with the placement of the sand engine have the potential to result in changes in sea bed levels as the suspended sediment deposits. Changes in substrate at the Cromer Shoal Chalk Beds MCZ during construction could potentially occur if sediment was deposited on top of the chalk outcrops	**No impact** identified upon Cromer Shoal Chalk Beds MCZ.	Based on the plume modelling simulations, deposition from the plume generated by sand engine placement indicates that the changes in sea bed elevation at the MCZ are zero.
	Buffering of wave energy leading to a reduction in coastal erosion and overtopping for: - Bacton Gas Terminal; and - The Villages.	**BGT: Major beneficial** **Villages: Moderate beneficial**	BGT has a high sensitivity to coastal erosion and overtopping and a high magnitude of effect. The villages have a high sensitivity but a medium magnitude of effect.
	Potential loss of exposure of geological interest within a section of the Mundesley Cliffs Site of Special Scientific Interest (SSSI) and Bacton Cliff Candidate County Geological Site (CCGS) due to a reduction in erosion of the cliff along the northern edge of the terminal frontage. The site is designated for its continuing exposure of geological information	**Moderate adverse impact reduced to Minor adverse impact following mitigation (monitoring of cliff exposures and reduction of vegetation if necessary)**	Given the scale of the sand engine feature the beach could remain stable for the lifetime of the sand engine which would cover cliff exposures for similar lengths of time. Mundesley Cliffs SSSI and Bacton Cliffs CCSG have a medium magnitude of effect and medium sensitivity to being obscured by sediment.
	The operation of the sand engine would constitute a new source for wind-blown sand and, given the increased height of the berm, increase its potential to transport landward and over the top of the cliff, where it could affect the functioning of Terminal infrastructure	**No impact** on geological or coastal processes	N/A
	Change in provenance of the beach through importation of foreign sediment	**Minor adverse**	There is a medium magnitude of effect of mixing sediments of different provenances and a low sensitivity of the system to these potential changes.
	Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine would potentially lead to changes in wave climate.	**No impact** beyond the immediate nearshore zone.	The particle size envelope of the sand engine is similar to the existing beaches. The effect incurred by an initially steeper beach is likely to be temporary, and will be re-distributed to produce a beach slope

Section of EIA	Potential impact considered	Impact significance	Reason
			which is similar to the pre-sand engine beach.
	Changes in the nearshore bathymetry and beach topography caused by placement of the sand engine could potentially lead to changes in tidal currents	**No impact** beyond shallow nearshore zone.	The protuberance into the North Sea created by the sand engine is extremely small compared to the regional drivers of tidal currents.
	Interruption of sediment transport by outfall pipes	**No impact** beyond shallow nearshore zone.	The extended pipeline(s) will only provide a minor obstruction to bedload sediment transport and that pipelines are already present in the nearshore zone, together with the fact that the majority of moving sediment will be able to bypass them, the effect of the extended outfall pipes on coastal processes is considered to be very small.
Flood Risk	Effect on flood protection during construction phase	**No Impact**	
	Effect on the flooding potential for the Villages of Bacton and Walcott and the coastal road during operation	**Moderate Beneficial**	Reduction of flood risk through overtopping due to the presence of the higher beach levels.
Water and sediment quality	Elevated suspended sediment concentrations generated by placement of the sand using suction dredgers.	**Moderate to Minor adverse impact**	The magnitude of the impact will be high in a localised area but for a temporary duration. The waters in and around Bacton terminal and the immediate area are considered to be of low sensitivity.
	Increases in suspended sediment concentrations associated with the construction of the sand engine have the potential to result in changes in sediment characteristics as the material deposits.	**Negligible**	Plume modelling simulations suggest that sand-sized sediment would settle out of suspension immediately upon discharge from the pipe. The predicted sediment deposition is limited to the nearshore environment.
	Potential impacts associated with extension of outfalls on water quality.	**Not expected to be of significance**	To be assessed once outfall extension methodology is confirmed.
Benthic and coastal ecology	Direct smothering in nourishment zone (coastal habitats)	**Minor adverse**	The proposed scheme nourishment zone has low species richness and has the

Section of EIA	Potential impact considered	Impact significance	Reason
			potential to be easily recovered/ replaced following construction, however there will be a potentially high magnitude of loss and the high probability of loss occurring.
	Direct impact to broad-scale marine habitats in the proposed nourishment zone.	**Minor adverse**	The broad scale habitats present are considered to have low sensitivity to the direct impact of dredging. There will be a low magnitude of effect and low receptor sensitivity but a high probability that loss will occur.
	Increase in suspended sediment concentrations	**Minor adverse**	The species present are deemed to have a low sensitivity to the suspended sediment increases. There is a potential low magnitude of change to baseline suspended sediment condition and a low sensitivity of the species affected.
	Changes in sea bed level and substrate type due to deposition from suspension during placement	**No impact** on the Cromer Shoal Chalk Beds MCZ	The changes in sea bed levels due to deposition of suspended sediment during sand engine placement are likely to have low to negligible magnitudes of effect. The plume modelling also suggests that changes in sea bed elevation of the Cromer Shoal Chalk Beds MCZ is zero.
	Smothering of features by sand placement and subsequent transport during operation (including wind-blown sand)	**Negligible**	The species present are deemed to have a low sensitivity to the suspended sediment increases. There will be a low magnitude of change to baseline suspended sediment conditions and a low sensitivity of species affected.
	Wind-blown sand affecting terrestrial ecology features	**Negligible**	The species present are deemed to have a low sensitivity to the suspended sediment increases. There will be a low magnitude of change to baseline suspended sediment conditions and a low sensitivity of species affected.

Section of EIA	Potential impact considered	Impact significance	Reason
Terrestrial ecology	Impact of construction and operation of sand engine on habitats within the proposed scheme	**Negligible**	The habitats within the proposed scheme are of low ecological value.
	Impact of construction and operation of sand engine on legally protected species	**Negligible**	The proposed scheme is assessed as having low suitability for nesting birds and common reptile species. The loss of potential nesting habitat will result in negligible effect as alternative habitats are present in the wider area.
Marine mammals	Disturbance from underwater noise during construction from: - Vessels; and - Vessel collisions	**Negligible to Minor adverse** **Negligible to Minor adverse**	Marine mammals are considered to have a low sensitivity to the risk of vessel collision as well as a low magnitude of impact due to the temporary nature.
	Disturbance at and around seal haul-out sites	**Negligible**	Seals along this coast line would be habituated to the noise, movements and presence of vessels.
Ornithology	Increase in suspended sediment concentrations impacting on bird foraging	**Negligible**	There is a high availability of other foraging sites, relatively low numbers of breeding pairs using the sites closest to the proposed scheme and the increased sediment concentrations would be short term and temporary.
	Smothering of nests due to sand placement, specifically on sand martin nests in the proposed nourishment zone	**Moderate Adverse depending on time of year of works. Reduced to Minor or negligible with mitigation**	Sand Martins nest in cliff face along the frontage and could be disturbed if present during the placement works.
	Direct disturbance from vessel transits to and from aggregate extraction site to proposed scheme location, specifically on breeding terns	**Negligible**	Due to the high existing vessel movements between North Norfolk, Great Yarmouth and the Lincolnshire coast, it is unlikely that the small number of movements required for the proposed scheme would impact on the foraging behaviour of species utilising these areas.
	Smothering of features by sand placement and subsequent transport	**No Impact**	No impact from smothering as not affecting known specific nesting habitat.

Section of EIA	Potential impact considered	Impact significance	Reason
Commercial and recreational navigation	The construction phase dredging vessels will increase the risk of vessel to vessel collisions	**Minor adverse to negligible with good practice measures**	The increased vessel movements are significantly lower than the baseline, and the activity will be short term. The sensitivity of the vessels will be high in adverse weather conditions however overall receptors will likely be able to tolerate and adapt to increased vessel movements.
	There is a potential risk associated with accidental pollution from ships such as oil, waste or sewage	**Minor adverse to negligible with good practice measures**	Although the sensitivity of the receptors would be high if a pollution event were to occur, the likelihood is low assuming all navigation activities will be undertaken in accordance with applicable navigation regulations and guidance.
Commercial and recreational fisheries	Potential disruption to fishing activities due to vessel movements between the extraction site and the nourishment area	**Negligible**	The potential for disruption will be limited in time (i.e. minutes, for each interaction), in duration (i.e. during the construction activity), and space (i.e. within the transit route which covers some, but not all, of the available fishing grounds and fishery resources, that are subject to generally low intensity of fishing effort).
	Potential disruption to inshore fisheries due to construction activity at the beach fronting Bacton Gas Terminal, Bacton and Walcott	**Moderate local temporary impact, but minor adverse overall**	The local fishing activity has a low sensitivity to being displaced from the proposed scheme footprint, there is a low magnitude of the loss/ restricted access, given the limited time of displacement and the availability and accessibility of fishery areas adjacent to the proposed scheme footprint.
	Potential changes to access to the beach for recreational fisheries as during construction period, sections of the beach would be closed to public access 24 hours a day, 7 days a week	**Minor adverse**	There is a large amount of available area for each type of fishing in the area, and therefore local fishing activity has a low sensitivity to being displaced. There will be a limited time of displacement and accessibility to adjacent fishery areas.
	Vessel displacement to other fishing grounds could indirectly influence other local fisheries	**Minor adverse**	There is a large amount of available area for each type of fishing in the area, it is anticipated that local fishing activity has a

Section of EIA	Potential impact considered	Impact significance	Reason
			low sensitivity to being displaced from the proposed scheme footprint. The magnitude of the loss is considered low given the limited time of displacement.
	Potential for access to the beach to change following the works	**Minor beneficial**	The width of the beach will be increased between Bacton and Walcott which could provide a minor beneficial impact through an increased area for access at all states of the tide.
Archaeology and historic environment	Direct impacts to potential heritage assets (above ground remains) due to the placement of pipes or anchor placement	**Minor adverse**	There are two heritage assets recorded within the proposed development footprint, these are concrete blocks/ cubes and are considered unlikely to sustain damage.
	Indirect impacts on the setting of heritage assets related to the presence of a dredging vessel, pipes and land-based plant, including visual impact, noise, smell and dust	**Negligible**	Short-term, temporary construction programme.
	Indirect impact on above ground archaeological remains during operation	**No impact**	No known sites to be affected.
	Indirect impact on the setting of heritage assets due to the presence of increased levels of sand	**Minor adverse**	There will be an altered setting due to sandscaping. Measures have been historically put in place to protect the receding cliff, therefore this is fundamental to the historic land use and landscape character.
Local community and tourism	During construction, there will be temporary impacts associated with increased noise levels and access disruption	**Minor adverse**	These impacts will be short term, however are highly likely to affect the local people and tourists. The proposed scheme will require the England Coast Path to be temporarily diverted.
	Impact at the caravan park during construction	**Moderate adverse to visitors but reduced to Minor or negligible with management from park owners.**	Impact of noise, lighting and access restriction could impact on visitors during construction phase. However, this could be managed by the park owners. **Impact during construction balanced with major beneficial impact during operation.**

Section of EIA	Potential impact considered	Impact significance	Reason
	Protection of the coastline at the Bacton Gas Terminal	**Major beneficial**	Protecting the facility in the area, Bacton Gas Terminal and associated pipelines, and providing coastal protection and flood defence to the Villages.
	Improved access to the coastal footpath during operation	**Minor to Moderate beneficial**	The scheme will provide a greater tidal access window for improved access.
	Potential for the gain of beach material further south-east of works to improve protection for downdrift properties	**Major beneficial**	Protection of properties downdrift, although only temporary will allow more time for planning for the future.
Services and other users of the sea	Impact on infrastructure during placement	**No impact with mitigation**	During placement restrictions will be in place for the movement of plant in areas where pipelines occur.
	Bacton Gas Facility	**Major Beneficial**	Protection of the national asset of the Terminal provide benefits to the nation and the local community.
Traffic	Impact of construction traffic on total daily traffic	**Negligible to Minor adverse**	The peak change in total daily traffic for all links is less than a 30% change in total traffic
	Impacts on pedestrian amenity	**Negligible to Minor adverse**	GEART suggests that significant effects on pedestrian amenity are only likely to occur on links where total traffic flow (or HGV component) is halved or doubled. All areas fall under this threshold.
	Impacts on driver delay	**Negligible**	There could be up to 20 employee vehicles and five HGV arrivals and departures per day. This is less than the peak increase of 25 vehicle movements per hour which is considered indiscernible from day to day fluctuations in background traffic.
Air quality	Background pollutant concentrations are well below relevant objectives within the study area.	**No impact**	The works are small scale and of short duration, the profiling activities have a wide spatial distribution and are unlikely to impact

Section of EIA	Potential impact considered	Impact significance	Reason
			human or ecological receptors in the study area.
Noise and Vibration	Potential for noise levels to cause disturbance during placement of sand and movement of sand on the beach to both local residents and tourists	**Minor Adverse**	Best practice measures to be applied to reduce any potential impacts.

2.3.1 Mitigation measures

Geology

In order to mitigate the potential moderate adverse impact on the Mundesley Cliffs SSSI, the following measures are considered appropriate:

- Pre-construction monitoring by an appropriate geology specialist (Quaternary scientist) of the Mundesley and Bacton cliffs and shore platforms to record the geological interest at the sites which would become covered, inaccessible or impacted by a change in erosion rate during the operational phase of the sand engine;
- Harmful impacts during the construction phase and any ensuing replenishment phases to be avoided where possible and appropriate mechanisms put in place to protect the geology and ensure that contractors are briefed on its importance and need for conservation;
- A mitigation strategy encompassed in a Scheme for Geological Recording, Monitoring and Management should be completed. This should be produced by the developer with input from Natural England and the Norfolk Geodiversity Partnership and include monitoring and management after placement so that impacts can be measured. This would also include an agreement on access to the cliff sites behind the sand engine; and
- Annual monitoring (which may be reduced in frequency after a few years depending on the outcomes) of geology, vegetation growth and mass movement activity in the area of the cliff affected, and if agreed thresholds are crossed, then appropriate vegetation control would be put in place, with flexibility to adapt to any unexpected impacts on the geology. The monitoring boundary would change with the natural development of the sand engine.

Ornithology

In order to mitigate the potential for impacts on sand martins nesting on the cliff face in the proposed nourishment zone, from early March onwards, measures would need to be taken to make the site uninviting to the sand martins before they arrive. Surveys should be carried out prior to work taking place if the construction works are likely to take place between March and September. If nests are found, it should be noted that all wild birds, their nests and eggs are afforded legal protection under the Wildlife and Countryside Act 1981 (as amended), and therefore works in the vicinity of the nest may have to be delayed until any chicks have fledged.

Local Community

Wind-blown sand in village locations and on the coastal road will be removed if necessary.

Effective signposting at appropriate locations will be implemented prior to the commencement of on-site works.

Good level of liaison to ensure adequate warning is given to all interested parties of proposed working periods. Minimal (only essential) working of land based equipment during night time hours.

Commercial and recreational navigation and fisheries

In order to mitigate potential navigational impacts of the proposed transport and placement activities, navigation activities should be undertaken in accordance with:

- Applicable navigation regulations;

- Guidance (such as Guide to Good Practice for Ensuring Navigation Safety during Dredging Operations);
- Notice to Mariners (NtMs);
- Ensuring vessels exhibit signals as per the requirements of COLREGS;
- Use of the Traffic Separation Scheme (TSS);
- Use of designated approaches to the scheme area; and
- Liaison with local fishermen for potential exclusion zones.

2.4 Investment objectives

The overarching intent of management for the joint approach to coastal management between Bacton and Walcott is to enable the Bacton Gas Terminal to continue to function, whilst extending the life of the Villages' defences, needed to support a process of adaptation to coastal change for the communities in the medium term. This involves sustaining the viability of communities, businesses, infrastructure and individuals, but within the context of change over time. The intent of management also aims to minimise social, economic and environmental impacts and maximise social, economic and environmental opportunities.

With specific reference to the terminal, the objectives are to:

- Implement coast protection works as soon as possible;
- Stop erosion to the cliff in front of the Bacton Gas Terminal until its "end of field life". This is not known precisely because it depends on the global oil and gas market, but it could be 50 years or longer;
- Prevent an increase in erosion to the cliffs adjacent to the terminal;
- Ensure a minimum cover of material of 1.2 metres over the pipelines until its "end of field life" (see definition in second bullet point above); and
- Have no significant adverse impact as a result of the works.

For the villages, the objectives are to:

- Extend the life of the coastal defences;
- Provide time for adaptation of affected households, business and other key features and values;
- Create and enhance features of the coast that support community viability over the period of transition and beyond, providing a secure place to live, reducing deprivation and decline, and supporting sustainable growth and regeneration;
- Ensure change is managed. Where it is not possible to protect a feature or value, ensure change is managed; and
- Provide long term opportunity for sustainable use of the area.

2.5 Current arrangements

The current coast protection arrangements are provided below and are shown in **Appendix C**.

2.5.1 Terminal frontage

Assets

The terminal frontage is protected by a line of timber revetment, located typically between 10 and 30 metres from the toe of the cliffs. This line of revetment runs from Mundesley in the north to the beginning of the Bacton to Walcott seawall immediately to the south of the terminal frontage. The timber revetment

consists of a timber planked revetment with a slope of approximately 1 in 1, with a vertical sheet piled toe on the seaward side. The timber revetment is estimated to provide protection up to and during a 1 in 10 per year storm event. Seaward of the revetment are timber groynes which are approximately 90 metres in length and are spaced at intervals of approximately 180 metres. The timber groynes are constructed perpendicular to the revetment and are permeable, allowing sediment to transport across the frontage.

There have been a number of targeted attempts by the terminal operators to protect critical sections of the cliff and buried pipes, the access ramp and surface water outfalls. These have included creation and replenishment of an artificial sand berm at the toe of the cliff (which was abandoned after the December 2013 storm), placement of geotextile bags as an emergency measure (which have now been replaced), and more recently the temporary gabion basket solution to protect the Shell frontage.

Current condition

The Coastal Defence Condition Survey Update was carried out by Mott MacDonald in 2012 and was published as part of the Cromer to Winterton Ness Coastal Management Study. There has been no formal update to this survey. This study indicated that the groynes were in good to fair condition with a residual life of between 8 and 15 years. It also established that the timber revetment was in good condition with a residual life of between 15 and 20 years. However, recent storms such as in January 2017 caused significant local damage and repairs are ongoing. Temporary terminal protection structures are in good condition.

Asset management and maintenance

NNDC owns the timber revetment and groynes which protect the terminal, however, due to limited and reducing maintenance budgets, and the need to prioritise maintenance for coastal communities, the operators of the terminal have carried out maintenance of these defences in recent years. New defences constructed at the terminal such as the artificial sand berm, geotextile bag placement and temporary gabion basket solution are the responsibility of and owned by the terminal operators.

2.5.2 Villages frontage

Assets

Immediately south of the terminal frontage, the coastline is protected by a private secondary defence behind a revetment consisting of a length of steel sheet piles together with rock armour. There is also a length of steel sheet piles backfilled with rubble.

Outside the private defences and the terminal frontage, NNDC are the Risk Management Authority responsible for the maintenance of defences.

Further to the south, from the terminal boundary up to and including the Villages, the timber revetment continues for approximately 0.5 kilometres before returning to the cliff line just after the start of the concrete sea wall. This concrete sea wall extends southward approximately 2.9 kilometres throughout Bacton and Walcott. Beyond the end of the seawall, in front of Ostend (easterly part of Walcott), a timber revetment similar to the one at Bacton provides some protection. Timber groynes are present for the whole frontage.

Current condition

Table 2-3 provides a summary of the condition and residual life of the defences across the Villages frontage as taken from the Mott MacDonald Coastal Defence Condition Survey Update (2012) and further reviewed and updated based on local expert asset manager knowledge.

Table 2-3 Condition assessment for the Villages frontage

SCAPE section no.	Location	Defence type	Defence residual life (years)
42	Directly to the south east of Bacton Gas Terminal	Timber revetment Timber groynes	0
41, 40 and 39	Castaways Holiday Park, Bacton and Keswick	Concrete defence structure Timber groynes	5
38	Between Keswick and Walcott	Concrete defence structure Timber groynes	15
37 and 36	Walcott	Concrete defence structure Timber groynes	5
35	Easterly part of Walcott (Ostend)	Timber revetment Timber groynes	0

The beach is also an important flood and coastal erosion risk management asset. The Environment Agency has been surveying beach profiles along the North Norfolk coast since 1991. Analysis of beach profile data shows significant variation, suggesting that there are gluts of sediment that appear to move through the system. More recently (after 2004) there has been a far more substantial loss of sediment generally across each profile. The overall trend for the frontage has been a decrease in volumes, coupled with a lowering of the beach.

Asset management and maintenance

Between 2006 and 2017 NNDC has invested over £1.5M in coastal protection maintenance on the Bacton to Walcott frontage. This has included the completion of the refurbishment of the sea wall apron (a three kilometre length), reactive maintenance, upkeep and replacement of storm gates, maintenance of beach access and storm damage repairs. A summary of this investment is provided in Table 2-4.

Table 2-4 Maintenance spend at Bacton and Walcott between 2006 and 2017

Year	Activity	Value
2006/7	General Maintenance	41,700
	Apron Refurbishment	99,000
2007/8	General Maintenance	24,800
	Apron Refurbishment	107,000
2008/9	General Maintenance	30,600
	Apron Refurbishment	112,000
2009/10	General Maintenance	40,500
2010/11	General Maintenance	16,200
	Apron Refurbishment	61,600
2011/12	General Maintenance	15,000
	Apron Refurbishment	62,700
2012/13	General Maintenance	29,100
	Apron Refurbishment	63,800
2013/14	General Maintenance	28,000
	Apron Refurbishment	75,000

Year	Activity	Value
	Surge recovery	184,460
2014/15	General Maintenance	61,270
	Apron Refurbishment	104,000
	Ostend Rock Placement	75,000
2015/16	General Maintenance	29,910
	Apron Refurbishment	73,000
	Rudrams Ramp refurbishment	30,000
2016/17	Apron Refurbishment	100,800
	General Maintenance	1,500
2017/18	Apron Refurbishment	51,500
Total		**1,518,440**

NNDC's annual coastal protection budget for maintenance activities across the North Norfolk coastline is approximately £310,000. This is re-calculated each year and is supplemented through external funding and internal capital investments.

The current asset management protocol, in line with the SMP policy, is to maintain and repair the Bacton and Walcott villages coast protection assets. Asset condition and health and safety inspections for all assets are completed by NNDC staff twice a year. Defects are identified, prioritised and rectified accordingly. In addition, following any storm event, a 'post storm survey' is undertaken to inspect the assets. This records any damages or changes to the defences' condition and remedies any noted defects.

2.6 Main benefits

The project's joint approach to coastal management for the Bacton to Walcott frontage would fulfil the need to protect the Gas Terminal as a piece of critical infrastructure, thus avoiding potentially significant national damages relating to disruption of the gas supply, whilst making it possible to sustain coastal defence over a longer period of time at the Villages. The combined approach is essential for both objectives:

- It would be unacceptable and non-compliant with the SMP to implement a stand-alone Terminal protection scheme that risks increasing erosion at the Villages; and
- There is no viable stand-alone approach identified for delaying cliff erosion at the Villages.

There will be direct benefits to the Villages in terms of the number of households at reduced risk of flooding (Outcome Measure 2) and erosion (Outcome Measure 3). The delayed loss of properties, highways and amenity value will provide more time for adaptation to inevitable coastal change.

The innovative approach proposed has the potential wider benefits of sharing learning across other parts of the country, where such an approach might be applicable or required.

The joint approach to coastal management for the Bacton to Walcott frontage also aligns with the key objectives and priorities of the leading organisations. The Environment Agency's objectives for 2016 to

2020 are set out in their "Creating a better place; our ambition to 2020" document (Environment Agency, 2016). The relevant objectives are:

- A nation better protected against natural threats and hazards, with strong response and recovery capabilities; and
- Higher visibility, stronger partnerships and local choices.

One of the five objectives outlined in Defra's single departmental plan published on 14th December 2017. is to create a nation better protected from floods and other hazards, with strong response and capabilities by:

- Better protecting 300,000 homes from flooding by 2022;
- Build, maintain and operate high quality flood and coastal erosion risk management assets; and
- Publish guidance to local authorities and other flood risk management authorities on coastal adaptation.

NNDC's Corporate Plan 2015 to 2019 includes a Priority relating to creating a district where the beautiful natural environment is managed and protected for future generations. To achieve this, NNDC are working jointly with neighbouring authorities and key partners to attract funding to manage the coast for future generations,

2.7 Main risks

The type of coastal construction work involved in delivering the scheme is well understood and the scheme will be delivered by an appropriately skilled specialist dredging contractor. There is strong commitment from the Bacton Terminal Companies and North Norfolk District Council to deliver the joint Scheme, which will deliver significant Flood and Coastal Erosion Risk Management (FCERM) Outcome Measures: just under £20 million for OM1 (ratio of whole life benefits to costs), around £560k for OM2 (households at reduced risk of flooding), and just over £12.5 million for OM3 (households at reduced risk of erosion).

Early consultation with the public has been undertaken successfully which has identified positive public support for the scheme. The need for the scheme has been reinforced by recent storm events which have caused significant cliff erosion, beach lowering and flooding.

There are a number of interested stakeholders which have been, and will continue to be, engaged. These links are captured in an approved communications plan.

A full risk register has been produced for the project and is periodically updated as the project moves through its stages (see section 6.5). The key strategic risks provided in Table 2-5 have been identified as the main risks to the delivery of the Scheme.

Table 2-5 Summary of strategic risk

Strategic risk	Key mitigation
Failure to secure funding for the full Scheme e.g: • Promised partnership funding sources do not come to fruition or there are specific spending constraints from particular funders, leading to larger funding gap between Terminal only protection and FCERM GiA funding; and/or	Full partnership approach with Terminal Companies from start of project, leading to legal agreement including confirmation that the Terminal Companies will bear Terminal Protection costs (final approval to be taken following selection of preferred contractor). Under the agreement NNDC became the lead in delivery with support from the other partners where appropriate. The Bacton

Strategic risk	Key mitigation
• Failure to secure investment required to meet funding gap between Terminal only protection and FCERM GiA funding. • Construction costs are higher than expected following procurement. • Impacts of changes to exchange rates.	Terminal Companies recognise the potential for shortfalls in funding for the Villages element of the scheme and are willing to consider meeting that gap should that situation arise. Continued engagement with partnership funding bodies to secure funding contributions. Early commitment from stakeholders to provide necessary investment. Accurate identification of value of funding gap through informal early contractor involvement during development of the scheme's detailed design. Inclusion of exchange rate risks as part of tender and construction contract.
Major storm event or critical failure of defence before Scheme is completed	Shell have implemented a temporary gabion basket solution to protect their frontage (the most critical section of the Gas Terminal frontage). The Perenco and ENI frontage is inspected regularly and following storm events. There are ongoing inspections and maintenance of the Villages defences. A contingency plan for managing risk during the construction of the Scheme will be developed by the Contractor before construction.
Failure to secure required volume of sediment to deliver the preferred scheme	Discussions with Contractors took place throughout the detailed design phase and sediment availability was not flagged by them as a key risk. These has been ongoing consultation with The Crown Estate from the very early stages of the project, and this will continue through procurement of the main works contractor.
Conditions from Planning and other statutory stakeholders cause a delay in construction commencement and increase the cost of construction	Continue liaison with strategic, development and conservation planners. Identify elements of the frontage that require more detailed consultation.
Third party stakeholders such as landowners, or the Bacton Terminal Companies outside of the legal agreement, do not engage or impose non-deliverable conditions.	Discussions with third party stakeholders are already underway and will continue through to project delivery.
Loss of continuity in management leading to loss of critical knowledge	Robust project management and clear document control systems. Legal agreement in place between partners.
Change in legislation or regulations that affect the delivery of the scheme	Review and monitor all future changes in legislation or regulations that may affect the Scheme. Undertake early assessment of the possible effect on the scheme.
Negative public reaction to the scheme	Continued engagement and involvement with key stakeholders as set out in the communications plan.
Design frequencies are exceeded e.g. an extreme storm causes seawall failure despite the scheme	A sandy solution is more robust – there will be additional sediment in the system which will be increasing beach levels and providing some additional protection to the sea defences, even if a storm event exceeds the design frequency.
Environmental and social risks identified in the EIA, including the potential impact on fisheries and the potential for wind-blown sand risk post construction.	Monitoring as is being developed through the Environmental Management Plan and the Operations, Monitoring and Maintenance Plan.

2.8 Constraints

There is a need for implementation of the Scheme within the coming few years: both for the Terminal and the Villages, delays in the implementation increase the risk that a storm will cause irreversible damage. As discussed in section 2.2, the design of the temporary coast protection solution implemented by Shell assumes construction of a full permanent scheme to be completed during the summer of 2019. For the Villages, the residual life of most of the structures is between 5 and 15 years, but for some sections it is even less, and a severe storm could cause structural failure at any point in time.

The preferred solution is a beach nourishment with marine-sourced sediment, therefore there is a preference that the works are carried out in the spring/summer season (between April and October) to avoid increased downtime, costs and construction risk during the winter season. Further socio-environmental constraints are being considered in the EIA. They include the fisheries seasons, the summer tourism season and other constraints around the MCZ and adjacent SSSI (see section 2.3).

If sufficient funding is not secured for the Village-related part of the combined scheme (including FCERM Grant in Aid), the Bacton Terminal Companies could proceed with the implementation of a solution which will fulfil the objectives of the terminal only. This solution would be designed to have no adverse impact on the Villages, but there would be a missed opportunity for the Villages, as stand-alone works here are not economically justifiable.

2.9 Dependencies

The obvious dependency for this project is the decision by the terminal companies to proceed with protecting the terminal until its “end of field life”, with the option to provide protection for 50 years or longer. If this priority changes, this project would become impossible as focused works at the Villages are not economically justifiable. This dependency has been secured through the legal agreement between the parties signed in September 2017.

Implementation of the scheme is also clearly dependent upon the necessary consents, licences and permissions being secured. These are being developed in parallel to the design of the scheme such that the scheme’s design has been adapted where necessary to avoid significant adverse impacts and maximise opportunities for enhancement.

3 The Economic Case

3.1 Introduction

The aim of the Bacton to Walcott coastal management project is to develop a combined and deliverable coastal management approach. The term 'deliverable' covers a range of aspects, in particular technical feasibility, likelihood of achieving environmental consents, acceptability for the community and affordability.

The technical feasibility, likelihood of achieving environmental consents and acceptability for the community are aspects that are discussed as part of the longlisting and shortlisting process, see sections 3.3 and 3.4.

The affordability aspect relates to the likelihood that there will be sufficient financial contributions to cover the costs. There is a range of potential sources of funding, including FCERM Grant in Aid (GiA) and external sources of funding. Defra has stated that businesses and infrastructure owners or providers are ultimately responsible for their own resilience, while Government funding is intended to provide additional benefits and should not replace private investment. The following sources of funding have been confirmed in principle (others are currently still being explored):

- The Bacton Terminal Companies' **contribution** to cover the cost of the terminal only protection;
- **NNDC's** contribution;
- **Local Levy** contribution from the Anglian Eastern Regional Flood and Coastal Committee (RFCC);
- Environment Agency's **Natural Flood Management** (NFM) funding stream;
- Norfolk Business Rates Pool contribution;
- Local Enterprise Partnership funding contribution;
- Local community contribution; and
- The Bacton Terminal Companies' willingness in principle to cover the **funding gap**, as defined in the Partnership Agreement.

This Outline Business Case (OBC) aims to justify the best value for money option for the envisaged GiA, Local Levy and Natural Flood Management contributions only. This assessment is complicated by the fact that a large proportion of the scheme's cost and funding relates to the protection of the Terminal: the justification of that investment is up to the Terminal Operators, and outside the scope of this document, but those decisions do influence the case for the Villages part of the scheme. This principle is the same for any project with third-party funding contributions, but the balance is different than most other projects.

Following early discussion with Richard Nunn from the Large Project Review Group (LPRG) that have taken place since 2015, this OBC treats the scheme as one integrated project, treating all funding contributions (including those directly intended for Terminal protection) as Partnership Funding contributions. In principle, the identification of the 'preferred option' for determining potential FCRM GiA will follow the stepped approach prescribed in the FCERM Appraisal Guidance, starting by determining the option that has the highest Benefit Cost Ratio (BCR), and then exploring whether there are other options with higher benefits for which the Incremental Benefit Cost Ratio (iBCR) exceeds particular threshold values.

Note that this approach is slightly different than discussed with the Environment Agency and Defra in 2015, when the emerging initial economic assessment was fully based on the notional cost and benefits of the Villages part of the scheme. This approach is not taken in this OBC, as it would require an artificial quantitative split between the Terminal and Villages parts of the project that does not reflect the reality that

both parts are intricately entwined and enhance each other's performance. This was discussed and confirmed with Richard Nunn and other LPRG members in December 2017.

Given the level and influence of the Partnership Funding element of the scheme, there is a significant chance that the preferred option from the perspective of national GiA funding is different from the ultimate choice of preferred option by the Client Group (the Bacton Terminal Companies and NNDC). It is recognised that GiA availability in that case is defined as follows:

- If a scheme with lower eligible benefits is selected, the GiA available will be limited to the benefits of the selected scheme (not the higher value for the economically preferred option determined in the OBC); and
- If a scheme with higher eligible benefits is selected, GiA available will be limited to the economically preferred option determined in this OBC.

3.2 Critical success factors

The critical success factors for the scheme are summarised in Table 3-1.

Table 3-1 Critical success factors

No	Critical Success Factor	Measurement Criteria
1	Policy	Is the option in line with the SMP, Strategy and Local/Business Plans?
2	Affordability	Is level of Partnership Funding required in addition to GiA to cover the option costs acceptable and fundable?
3	Technical	Is the option technically sound i.e. able to provide the required FCERM function. For the terminal protection, is there certainty of design standard (cliffs and pipelines), is the behaviour under excess loading acceptable and what is the surplus protection level over time? Can the option be implemented without unacceptably high technical risks? Is the option adaptable? What is the certainty around the 50 year design life? What are the costs and impacts if the option needs to be adapted in case of faster than expected sea level rise, unexpected changes in terminal life etc.? For the Villages, does the option provide an acceptable reduction of economic risk to households, the economy and infrastructure?
4	Environment	Is the option likely to be acceptable from an environmental standpoint? Does the option provide additional benefits in terms of ecology and the local community (beyond risk reduction) such as tourism and amenity?
5	Health & Safety	Is the option safe to construct, through its design life and in future and does the option provide an acceptably low level of risk for users (the public, operation & maintenance staff etc.)?
6	Other opportunities	Does the option provide for present and known future amenity use? Can the option deliver or link with wider objectives such as amenity, working in partnership?

3.3 Longlist options

Table 3-2 provides the longlist of options considered for delivery of the project objectives. Reflecting the history of the project's development, the longlist starts with stand-alone solutions for either the Terminal or the Villages:

- For the Terminal;
    - the stand-alone Do Nothing or adaptation options that are usually considered within an appraisal were rejected early in the process. This decision is also outside of the OBC process.
    - there are viable stand-alone solutions which can be designed to mitigate negative impacts elsewhere, but they do not meet the objective of reducing flood and erosion risk to the whole of the Villages frontage. For this OBC, they could therefore be seen as Do Minimum options.
- For the Villages, stand-alone solutions are not considered viable, and have therefore been rejected.

The conclusion from the longlist assessment of combined options was that the scheme will need to be a sediment-based solution. This is the only type of solution which can achieve the project objectives of delivering a combined scheme that provides the required protection in front of the Gas Terminal as well as sustainably and affordably reducing flood and erosion risk across the Villages frontage. It should be noted that the Bacton Terminal Companies (BTC) selected a sediment-based solution as their preferred solution for their own reasons, as outlined below, both for a stand-alone and a combined scheme. This is outside the remit of this OBC, but presented in Table 3-2 for completeness.

Table 3-2 Longlist of options

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
Terminal only solutions			
1	Beach nourishment	Acceptable with low risk of objections Fully adaptable in case of unexpected future changes (faster sea level rise or beach lowering) Tourism benefit associated with creation of a wider beach Natural solution will require managed-adaptive approach Scale and shape to be optimised	**Shortlisted** as Do Minimum– assuming it is designed to mitigate downdrift impacts and provide additional benefits at the Villages
2	A range of various hard and hybrid solutions	Risk of downdrift impacts, likely requiring high cost mitigation with additional sediment. Risk of objections from local stakeholders Mostly expensive to adapt in case of unexpected future changes (faster sea level rise or beach lowering), except for any softer nourishment elements Some tourism benefit associated with creation of a wider beach Potential impacts on the amenity value of the beach including the coastal footpath	**Rejected** – risk of downdrift impact and associated costs and risks make this unacceptable

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
Villages only solutions			
3	Do nothing	No benefits – defences left to fail with no clear adaptation plan for communities	**Rejected –** does not comply with strategic policy due to the lack of community adaptation plans in place This could become the fall-back position without implementation of a combined scheme but also once the benefits of the initial placement from the combined scheme are no longer realised at the Villages
4	Do minimum (patch and repair)	Extends defence life to allow some time for adaptation planning, but this is uncertain and could be reduced significantly if there are unexpected future changes (faster sea level rise or beach lowering) Impact on amenity value of the beach Lack of funding available	**Rejected –** would not be economically justifiable or affordable. This could become the fall-back position without implementation of a combined scheme but also once the benefits of the initial placement from the combined scheme are no longer realised at the Villages
5	Fixed hard onshore structures (e.g. rock revetment)	Expensive to adapt in case of unexpected future changes (faster sea level rise or beach lowering) Impact on amenity value of the beach including the coastal footpath Potential downdrift impacts	**Rejected** – does not comply with strategic policy and would not be economically viable or affordable
6	Fixed hard offshore structures (e.g. offshore breakwater)	High risk of objections from local stakeholders Expensive to adapt in case of unexpected future changes (faster sea level rise or beach lowering) Potential downdrift impacts	**Rejected** – does not comply with strategic policy and would not be economically viable or affordable
Frontage-wide solutions			
7	Beach nourishment (designed for less than 10 years' performance, frontage-wide)	Acceptable with low risk of objections Fully adaptable in case of unexpected future changes (faster sea level rise or beach lowering) Tourism benefit associated with creation of a wider beach Increased frequency of disturbance	**Shortlisted** – frontage-wide nourishment would provide the additional benefits immediately post construction
8	Sandscaping solution (large-scale nourishment designed for more than 10 years' performance, supported by natural sediment supply from Terminal to Villages)	Compared to beach nourishment, lower whole life costs, but higher initial costs Acceptable with low risk of objections Fully adaptable in case of unexpected future changes (faster sea level rise or beach lowering) Potential for higher impact on chalk beds and navigation (dependant on design) Significant tourism benefit associated with creation of a wider beach	**Shortlisted** – frontage-wide sandscaping would be designed to provide the additional benefits immediately post construction

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
9	Hybrid solution: fixed localised hard onshore structures at key problem locations on Village frontage, combined with sandscaping or nourishment at the Terminal	Some risk of objections from local stakeholders, but also increased acceptance from residents at problem locations Soft element is fully adaptable in case of unexpected future changes (faster sea level rise or beach lowering). Expensive to adapt hard elements Impact on amenity value of the beach including the coastal footpath	**Rejected** – hard onshore structure would not be affordable (additional costs of rock structure would outweigh additional benefits) or be acceptable

3.4 Shortlist options

3.4.1 Overview

Developing the options

Starting point for the shortlist

The longlist concluded that the scheme will need to be a sediment-based solution to achieve the project objectives of delivering a combined scheme that provides the required protection in front of the Gas Terminal (measured as nourishment life/interval) as well as sustainably while also affordably reducing flood and erosion risk across the Villages frontage (measured as economic benefits of risk reduction). The assessment against these objectives is discussed further in section 3.4.2. The sediment-based solution allows sand to be moved by natural processes to benefit areas away from the original placement. This sits neatly within the overall umbrella term Natural Flood Management (NFM) where nature/natural processes can help reduce impacts of flooding. For clarity, in the context of this project, the term might be more accurately termed Natural Flood and Erosion Risk Management (NFERM). This OBC therefore seeks approval for funds from FCERM GiA, which includes NFM as well as Local Levy.

All shortlisted options must include the minimum protection profile for the Terminal, as required by the Bacton Terminal Companies. This minimum protection profile has been calculated using modelling and provides the 1 in 10,000 per year protection for the Terminal. The minimum protection profile is a 20-metre-wide berm with a crest level of +7.0mAOD and a 1 in 15 front face slope. The design process for the shortlist options therefore starts with this minimum protection profile at its core. The two main variables for option development are the extent to which sediment supply to the Villages relies on natural processes, and the physical design (size, shape, grain size) of the nourishment.

Reliance on natural processes

The first variable to explore was to what extent the design would rely on natural transport of sand from the Terminal toward the Villages for the reduction of erosion and flood risk there. Engagement with dredging contractors indicated that concentrating the nourishment within a short frontage would be more cost-effective. The modelling indicated that a gradual transition toward the Villages and some overlap was needed to prevent (initial and localised) erosion; this determines the minimum Village frontage extent where direct sediment placement is needed. For the resulting options, the modelling showed that the natural sediment transport from nourishment at the Terminal had a positive impact on beach development along the whole Villages frontage, but for the sections further away from the Terminal, it showed that the improvement would not arrive until after the predicted end of life of the seawall. The design process then explored options in which a certain volume of sediment is placed directly on the beaches in front of the whole Villages frontage, which is then supported and enhanced over time as sediment arrives from the Terminal frontage. These options were modelled to assess the expected increase in benefits (see section 3.4.2), and contractor engagement was used to estimate the additional costs.

Size, shape and grain size

The design process for the Villages element explored a range of options for:

- Size: buffer in front of the Terminal minimum protection profile; width of nourishment in front of the Villages;
- Shape of the coastline created in front of the Terminal (ranging from a pronounced 'bulge' to a shoreline-parallel placement), length and angle of transition between Terminal and Villages, cross-sectional profile;
- Grain size: the starting point is to use the same grading as currently on the beach. Finer sediment was explored; this could generate cost savings but these did not balance out the performance risks. Coarser sediment was also explored; contractor engagement indicates that this would be more expensive per cubic metre placed, but the additional costs may be balanced out by the increased stability of the nourishment. A preferred sediment grading envelope has been defined and there will be some flexibility given to the contractors during the procurement process to allow them to propose coarser sediment (although with a similar sized envelope), based on their individual sediment licence agreements.

Resulting shortlist options

The shortlist options identified for further appraisal are defined based on these variables as follows.

Do Nothing

In the Do Nothing scenario, the current defences are left to fail and no further capital or maintenance works are undertaken. This is the baseline scenario for the economic assessment to calculate the benefits of implementing coastal defence schemes. The expected cliff erosion rates are taken from the 2013 Cromer to Winterton Coastal Study (Mott MacDonald 2013).

Do Minimum

The Do Minimum option is a beach nourishment that provides adequately robust protection to the Bacton Gas Terminal and its pipelines, while providing a sediment supply to the Villages frontage to mitigate any downdrift impacts. As indicated in Table 3-2, this is the 'Terminal only' beach nourishment option. Note that this mitigation can only be secured by direct nourishment on the updrift end of the Villages frontage, and this will generate some risk reduction benefits to the Villages locally and further downdrift.

In the early stages of the design process the Bacton Terminal Companies decided on a preferred overall shape and volume of nourishment at the Terminal, which was informed by results of modelling, contractor information and environmental considerations. This shape and volume provides the optimum balance between nourishment life, initial investment, and risk reduction at the Villages. This optimum Terminal nourishment has a total of 0.9 million cubic metres of sediment spread across the core 1.8 kilometre length in front of the Terminal, and a further 0.3 million cubic metres of sediment placed in the areas immediately downdrift, in front of Bacton Green and Bacton Village (which mitigates risk of erosion, and in the process also generates some risk reduction benefits).

Do Something

The shortlisted Do Something options represent combinations of the two variables introduced earlier: reliance on natural processes and shape / size / grain size of the nourishment. All Do Something options also include the minimum protection profile at the Terminal and are acceptable from an environmental and community viewpoint.

Development of the optimum Terminal nourishment (Do Minimum) showed that benefits to the Villages were limited to the updrift sections only. Further development indicated that direct placement of material

downdrift, in addition to the optimum Terminal nourishment, could realise higher benefits, and that this could still be cost-effective. The decision process set out within this OBC is therefore focused on the volume of the direct placement at the Villages (from the Terminal all the way to the easterly part of Walcott) to reach the optimum balance between costs and benefits. Four Do Something options were developed for appraisal, as summarised in Table 3-3.

Table 3-3 Do Something options

Option number	Volume of sediment (millions of cubic metres)		
	Optimum terminal nourishment (core 1.8km length, Bacton Green and Bacton Village)	Bacton/Walcott (additional benefits for the Villages)	Totals
Do Minimum	1.2	0.0	1.2
1	1.2	0.3	1.5
2	1.2	0.4	1.6
3	1.2	0.5	1.7
4	1.2	0.6	1.8

Through the development of the Do Something options, the grain size of the nourishment sediment was also considered. The starting point for specifying the grain size and grading of the nourishment material was to match the existing beach material, which has a d50 of 0.35mm. The functional performance of the options was also assessed assuming a finer and coarser nourishment sediment.

For finer sediment, the functional performance of the options was tested assuming a nourishment material with a d50 of 0.25mm. The results showed that using fine sediment within the nourishment generated more downdrift sediment supply, but that wasn't translated into significantly higher benefit and Grant in Aid funding: the sediment was predicted to create beach improvements for the Bacton and Walcott frontage, but this was arriving largely after the predicted end of life of the coastal structures, and therefore not generating benefits. A significant technical risk was also identified in terms of non-performance and lack of robustness. There is a lack of knowledge and of successful previous examples of nourishments with material that is finer than that existing on the beach. In summary, there is a risk that finer sediment would move more quickly than modelled, be lost offshore, or create an overall shallower slope, leading to increased frequency of nourishment (therefore higher costs), reduction in realised benefits and reduction in protection at the Villages. Finer sediment may also increase the risks associated with wind-blown sand.

The potential use of coarser sediment (d50 of greater than 0.35mm) was also investigated with the aim of increasing nourishment lives and maximising benefits. Contractor feedback indicated that cost and risk gradually increase, up to a d50 of 1.2mm, at which point they are significantly higher. This means there is a trade-off between higher unit costs and the benefits of improved nourishment performance. The potential impact of using coarser sediment was tested with modelling, which showed that the coarser sediment provided only very minor quantifiable benefit in terms of design life and downdrift benefits. In addition, there is a benefit (unquantified) related to resilience to very extreme events. The benefits are not, however, large enough to cancel out the expected increase of cost and risk. It was, however, agreed that the use of coarser sediment did not need to be ruled out completely and that the contractor should be given the opportunity to use coarser sediment if it is cost-neutral or only slightly more expensive.

To summarise, the assessment of the shortlist Do Something options listed within this OBC assumes that the nourishment material is specified to match, as closely as possible, the sediment size and grading of

the current beach, with a significant coarser 'tail' to the grading curve to provide armouring and therefore some mitigation against wind-blown sand.

3.4.2 Technical assessment

Technical performance indicators and assessment

The indicators for assessing the technical performance of the shortlist options are related to the scheme's two main objectives: nourishment life in front of the Terminal; and reduction of erosion and flood risk for the Villages. The assessment against both objectives for the shortlisted options is provided below.

To assess the technical performance of the shortlist options, a conceptual model was used that combined the strengths of a one-dimensional (Litline) and a two-dimensional area model (coupled wave, TOMAWAC, flow, TELEMAC-2D and sediment transport, SISYPHE, models within the TELEMAC-MASCARET modelling system) with appropriate use of expert knowledge and judgement. The resulting conceptual model was agile enough for optioneering, while fully representing the beach processes. The conceptual model uses the one dimensional Litline model as the central engine, and uses the other tools to add cross sectional processes which cannot be captured by the one-dimensional model on its own. This relates specifically to the loss of sediment toward deep water) and the development of the cross-sectional shape of the beach (i.e. the long-term balance between offshore losses and onshore recovery).

As discussed in section 3.4.1, the overall shape and volume of nourishment at the Terminal was technically assessed and optimised using results of modelling, contractor information and environmental considerations. The Terminal element meets the minimum requirement of providing protection against cliff erosion in storms up to a 1 in 10,000 per year event. The technical performance at the Terminal is not distinctive for the OBC's appraisal and is therefore not discussed further here.

Technical performance at the Villages

Reduction of flood and erosion risk to the Villages

For the Villages, the scheme aims to reduce flood and erosion risk. The direct placement of sediment on the beaches, plus the downdrift supply of sediment from in front of the Terminal, will increase beach levels, and this in turn improves defence life. A higher beach absorbs incoming wave energy, reduces the height of waves which can reach the defence and provides protection and support to the defence toe. This delays the failure of the sea defences and reduces wave overtopping, compared to the baseline of Do Nothing. This reduces the number of households at risk of erosion and flooding compared to Do Nothing, delays the loss of the road and provides additional amenity benefits. These elements can then be translated to economic benefits and Outcome Measures, which attract GiA funding. For the purpose of this section, the scheme's Technical performance is assessed by the extension of the functional life of the seawall in front of the Villages, as shown in Table 3-4.

Table 3-4 Impact of options on functional life of defences

Option	Defence life per zone with option (years)							
	42 Terminal	41 Bacton Green	40 Bacton Village	39 Keswick	38 Rudram's Gap	37 Walcott	36 Walcott	35 Ostend
Do Nothing	0	5	5	5	15	5	5	0
Option 1	50	50	50	35	50	24	18	7
Option 2	50	50	50	50	50	36	24	9
Option 3	50	50	50	50	50	50	30	12
Option 4	50	50	50	50	50	50	36	15

The scheme's flood risk performance concerns the reduction of wave overtopping during storms, from implementation throughout the scheme's functional life, as the beach in each location develops over time.

Note that the loss of the road is only relevant for Zone 37 (Walcott).

Technical risk, opportunity and innovation

Scheme performance

Beach nourishments are a proven technology, but the large scale and (partial) reliance on natural processes to generate benefits downdrift are innovative elements of the scheme. Application of this approach, inspired by the Dutch Zandmotor project (but translated to the context of England and the Norfolk coast), creates a significant opportunity for building experience and lessons learned that can be applied on other similar schemes in the UK. The project's monitoring programme is being developed with input from research institutes, aiming to maximise this opportunity.

Beach nourishment projects generally contain technical risks due to uncertainty around weather and coastal processes, and to an extent this is further increased by the project's innovative nature. As described in section 2.7, there are a number of technical risks relating to this scheme:

- Major storm event or critical failure of defence before scheme is implemented; and
- Design frequencies are exceeded e.g. an extreme storm causes seawall failure despite the scheme.

In a general sense, the project will mitigate these risks by instigating a managed-adaptive approach: there will be regular reviews (at least yearly and after storms), based on a dedicated monitoring programme, to re-assess performance at both the Terminal and the Villages. In addition, the options include different levels of mitigation of this risk:

- For the Terminal frontage, the technical risk of a storm causing cliff erosion is significantly mitigated by the fact that for most of its life, the nourishment will have a significant surplus of material (see robustness discussed above). In addition, the calculated year of expected renourishment includes a certain buffer. So, if there was a significant erosion event toward the end of the expected functional life, the level of protection would remain at the required level until renourishment was undertaken as planned.
- For the Villages, there is a risk that the downdrift movement of sediment from the core placement zone will be less than predicted. If the project relied fully on natural processes for generating benefits at Walcott, there would be a risk of defences failing before the sediment has arrived. This

risk is strongly mitigated by the decision of direct placement in front of the Villages for all options. The higher volume nourishment options provide more robustness at the Villages.

Wind-blown sand

A particular potential risk of (large scale) beach nourishment concerns wind-blown sand and its potential impact on both the Terminal and the communities and infrastructure. A separate study was undertaken to assess the risk of wind-blown sand across the whole scheme frontage. This study used calculation methods and assumptions developed around the Dutch Sand Engine scheme. The methods are known to be conservative, and the calculations used a relatively wide grain size distribution with a much higher fine fraction than is likely to be proposed (which makes the results even more conservative). The results show that if various conservative assumptions are realised, then the cumulative volume of wind-blown sand reaching land could be up to 4 m^3 per metre of coastline for the Terminal, and up to 2 m^3 per metre of coastline for the Villages. Most of this transport will occur in the first six months, especially during storms. There would be some ongoing transport up to 18 months after construction. The risk to the Gas Terminal is partly mitigated with filters, but their maintenance is expensive and disruptive.

Given the uncertainty of the risk, it was concluded that there was no need for expensive design changes (e.g. using coarser sediment). Instead the potential risk would be managed using low cost dune creation, with added potential for wider (environmental, socio-economic) benefits, in combination with monitoring. The dune creation will focus on the Terminal frontage and possibly extend through to the transition with the Villages frontage. This measure is included in all Do Something options and consists of:

- Initial profiling on the nourishment crest created by the contractor: undulations of humps and slacks, say +/- 1 metre from the crest; and
- A combination of sand catching fences, thatching (degradable mats) and planting.

These elements would be left completely naturally, without significant management (apart from a minor allowance for public safety related maintenance).

The above mitigation measure relates to the Terminal frontage only. There is, therefore, a risk that there will be wind-blown sand impacts, and associated required mitigation measures or compensation claims, across the Villages frontage. There remains some uncertainty regarding the potential impacts and following discussion with Ian Hodge (Environment Agency Deputy Director for Project Assurance), it is proposed to keep the capital project ‘open’ for two years post construction in case mitigation measures are required during this period. This approach is consistent with the approach agreed by LPRG for the Rossal scheme, where there were similar uncertainties surrounding the behaviour of the placed sand. An allowance will be made within the risk contingency for funds to undertake mitigation measures related to wind-blown sand impacts (see section 3.5.2).

Operational and recreational risks

There are potential recreational risks associated with how the scheme would change the character of the beach. The scheme may, for example, cause changes to local current patterns, which could impact on the safety of water-based recreational activity, such as swimming. This may require an assessment by the Royal National Lifeboat Institution (RNLI) and provision of appropriate signage.

Access to the beach may also change and require some management (such as appropriate signage), as beach levels will change quite significantly compared to the current situation and there is the potential for localised cliffing following storm events.

3.4.3 Environmental assessment

The environmental assessments (Environmental Scoping Report and draft Environmental Impact Assessment) have not identified any show stoppers. There are potential concerns with regard to disturbance of cliff erosion at Mundesley Cliffs Site of Special Scientific Interest (SSSI) and Bacton Cliff Candidate County Geological Site (CCGS) and the potential for smothering of offshore habitats and fisheries. There is also the potential for positive impacts realised by the supply of additional sediment and the EIA recognises the primary benefits of the scheme: buffering wave energy leading to a reduction in coastal erosion and overtopping to benefit Bacton Gas Terminal and the Villages. A full summary of the impacts considered in the EIA is found in section 2.3.

The EIA covered impacts for the sediment volume in the largest Do Something option considered (option 4, 1.8 million cubic metres of sediment in total). Therefore, any impacts associated with other options would be equal to or slightly reduced compared to those stated in the EIA. For all options the same method of sediment distribution would be used and the grain size of the sediment would be specified to match, as closely as possible, the sediment size and grading of the current beach.

3.5 Economic appraisal

3.5.1 Benefits

In line with the approach introduced in section 3.1, this OBC aims to justify the best value for money option for the envisaged GiA contribution only. This principle is the same for any project with third-party funding contributions, but in this case the GiA contribution will not be the primary share of the total funding. This section also gives a summary of additional benefits to the Villages relating to other funding sources.

With regards to the benefits to the Villages eligible for FCERM GiA, methods were discussed extensively with Defra and Environment Agency members of LPRG. The following have been considered:

- Properties protected from erosion, by applying the standard methods from the Multi-Coloured Handbook (MCH). Essentially, the benefits are generated by the delay of the loss to erosion of properties in Bacton and Walcott, using appropriate property values to calculate the damage. The year of loss of individual properties and their respective access roads was estimated for each option, based on the estimated year of seawall failure followed by erosion at an appropriate rate, and this was combined into a Present Value Damage (PVD) amount for each option. Note that this leads to a ‘duration of benefits’ that varies along the frontage, which has been incorporated in the calculation of GiA,
- Properties protected from flooding. Bacton and particularly Walcott are vulnerable to flooding from wave overtopping over the coastal structure. Reflecting the relatively low importance compared to erosion, the team has taken a pragmatic approach to calculating the benefits. First, the economic flooding damages for Walcott Gap calculated in previous studies, updated to the current date, were used to estimate how the scheme options would generate benefits. In addition, the number of households for which the scheme options reduce the probability of flooding, was estimated on the basis of data from the Environment Agency’s currently ongoing coastal modelling study. These two results were combined to determine the scheme options’ economic benefits and their contribution to Outcome Measure 2.
- Highways protected. The benefits concern the delayed need to reconstruct the B1159 at Walcott on a more inland alignment. In practice, it is more likely that the road would not be repaired, and calculations confirmed that the economic impact of the resulting delays would

be higher. However, in line with Treasury rules the lowest damage scenario is used in this business case.

- Loss of recreational value. This was calculated as the loss of visitor spend, based on available economic data. Alternative analysis based on reduced value of enjoyment produced higher impacts, but was considered less reliable. Therefore, the lower value is used in this business case.

There may also be additional benefits further downdrift from the Villages frontage. Options that provide additional sediment will over time also generate benefits downdrift from Walcott: first at Happisburgh and then also at Eccles and Sea Palling. Due to the significant uncertainty regarding these possible benefits, and the fact that its inclusion is outside of current policy guidance, these additional benefits have not been included in this business case.

The scheme is expected to create other benefits which are not eligible for GiA because they do not relate to reduction of flood and erosion risk. This concerns the enhancement of the communities' capacity to adapt to coastal change (likely to improve economic productivity and reduce the burden on the UK's health care system) and the improvement of tourism facility (in addition to prevention of losses, which is potentially eligible for in GiA). These benefits are relevant for other sources of funding, but they are not discussed further in this OBC.

The results of the benefits assessment as contributions to outcome measures are summarised in Table 3-5 below. For OM1, in addition to the standard BCR based on total scheme whole life costs, the table also includes the 'Benefit versus GiA ratio' with costs taken as the calculated GiA contribution.

Table 3-5 Contributions to outcome measures

Contributions to outcome measures	Option 1	Option 2	Option 3	Option 4
Outcome Measure 1 − Ratio of whole-life benefits to costs				
Present value benefits (£k)	21,199	25,896	30,466	32,220
Present value costs (£k)	18,713	20,152	21,314	22,473
GiA (£k)	3,435	4,159	4,781	5,015
Benefit: cost ratio	1.13	1.29	1.43	1.43
Benefit: GiA ratio	6.17	6.23	6.37	6.42
Outcome Measure 2 − Households at reduced risk of flooding				
2a – Households moved to a lower risk category (number – nr)	68	64	103	101
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	37	37	37	37
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	0	0	0	0

Contributions to outcome measures	Option 1	Option 2	Option 3	Option 4
Outcome Measure 3 – Households with reduced risk of erosion				
3a – Households with reduced risk of erosion (nr)	298	298	298	298
3b – Proportion of those in 3 protected from loss within 20 years (nr)	90	90	90	90
3c – Proportion of households in 3b that are in the 20% most deprived areas (nr)	0	0	0	0
Outcome Measure 4 – Statutory environmental obligations met – NOT APPLICABLE				

3.5.2 Costs

Overview

In line with the approach introduced in section 3.1, the costs presented in this OBC are the costs for the whole scheme, consisting of the core Terminal element and the additional sediment outside of this core in front of the Villages. The costs used for this OBC are for a functional life of 50 years. This means that it also includes the future large-scale renourishments that would be required when the initial nourishment will have eroded to the point where it no longer meet the Terminal's requirements, up to a 50-year life. However, no future nourishments are foreseen for the Villages.

The costs of dredging projects are usually split into fixed costs and variable costs. The fixed costs for the Bacton scheme include the following:

- Mobilisation and demobilisation;
- Maintenance and monitoring over the scheme life (assumed to be 50 years for all options for the purposes of the economic assessment); this does not include the future renourishments.
- Construction project management which is a function of the construction programme, but is assumed to be the same for all options.

Variable costs are the unit costs per cubic metre of sediment, taking into account that there can also be variation in those unit costs as a function of the scale (total quantity of sand in the scheme).

The development of the costs has been informed by engagement with a group of five Contractors who were invited because they are part of the Environment Agency's Water and Environmental Management (WEM) framework (Lot 4). In addition to discussing the designs (with focus on construction methods, costs and health and safety), the Contractors were also asked to provide cost estimates for emerging options and indications of the sensitivity of costs to particular design variables. Despite this Contractor engagement, there is still a risk that the outcome of the main works contractor tender process produces significantly higher construction costs.

Risk contingency

Sections 3.4.2 and 3.4.3 and the Overview section above introduce the main technical, environmental and cost-related risks for the short-listed options, as summarised in Table 3-6 below. These risks are all related to the Villages element of the short-listed options only – any risks identified for the core Terminal element of the scheme are assumed to be addressed by the BTC outside of this business case and hence

any risk contingency allowance for the Terminal element is excluded from the risk contingency presented in Table 3-6.

Table 3-6 does not include an allowance for underperformance of the scheme: it is felt that it would not be justifiable to claim Grant in Aid to cover this risk, because the mitigation required in that scenario (patch and repair of structures; work to enable mitigation of the affected community and infrastructure) is expected to be needed in the short term if the Bacton to Walcott scheme is not implemented, and this would not be eligible for Grant in Aid under current arrangements.

Table 3-6 Risk contingency allowances

Risk	Mitigation	Risk contingency allowance
Final initial construction costs are higher than expected	A 20% optimism bias is included within the cost estimates (see below) which is considered appropriate given the contractor engagement undertaken. If initial construction cost estimates exceed the 20% allowance, there would be a requirement for NNDC and BTC to go back to the funders to try to seek to fill the additional gap.	£0 Included within optimism bias (see below)
Wind-blown sand	Potential need for mitigation measures such as sand clearance for a 2 year period post construction. For the nearby Jaywick/West Clacton scheme, spend on sand clearance can be up to £50k per year. This provides the basis for the risk allowance quoted here.	£100k (£50k per year for 2 years)
Operational and recreational risks	NNDC may be required to undertake mitigation measures such as an RNLI assessment and provision of appropriate signage relating to swimmer/water safety and beach access	£5k
Compensation claims are received by the fishing community/businesses	NNDC may be required to pay compensation to fishermen/businesses for loss of earnings during or post scheme construction.	£60k
	Total risk contingency allowance	**£165k**

The total risk contingency allowance presented in Table 3-6 is included in full in each short-listed option. There is no difference in risk contingency allowance between the short-listed options because it is considered that the mitigation measures do not vary significantly between options.

Optimism bias

The optimism bias is set at 20% to reflect the level of confidence gained through previous stages of design fine-tuning and contractor engagement, and the further contractor engagement undertaken during the latest stage of this project. This optimism bias is included in the best estimate of the costs by direct addition, rather than as an uncertainty band.

3.5.3 Present values

For the purpose of this OBC, all costs and benefits have been discounted in accordance with the recommendations of the HM Treasury 'Green Book' (HM Treasury, 2003) to provide the present value costs and damages with discount rates starting at 3.5% and reducing to 3.0% in year 30 and 2.5% in year 75.

Table 3-7 Present values (£k)

	Option 1	Option 2	Option 3	Option 4
First nourishment cost (excluding construction management)	14,687	15,886	16,854	17,820
Existing staff costs – OBC to construction	12	12	12	12
Existing staff costs – construction	10	10	10	10
Consultants' fees (construction management)	62	62	62	62
Site investigation and survey	20	20	20	20
Environmental mitigation	5	5	5	5
Environmental enhancement	60	60	60	60
Site supervision	221	221	221	221
Land & compensation	10	10	10	10
Optimism bias (20% on construction costs only)	**3,011**	**3,251**	**3,444**	**3,638**
Risk contingency	165	165	165	165
Subtotal	**18,263**	**19,702**	**20,864**	**22,023**
Future costs (construction, maintenance and monitoring)	450	450	450	450
Project total (present-value) costs	**18,713**	**20,152**	**21,314**	**22,473**

3.5.4 Option ranking and economic appraisal conclusion

The economically preferred option is selected by following the decision process presented in the Appraisal Guidance, based on the (incremental) benefit cost ratios ((i)BCRs) of the options.

Stage 1 of the process asks whether the BCR of at least one option is greater than one. When considering full scheme costs and Grant in Aid eligible benefits only, this is the case for all options, see Table 3-8.

Stage 2 involves organising the options either by reducing probability of erosion or flooding, or by BCR. Ranking the options by BCR gives **option 4 as the leading option**, followed by option 3, option 2 and then option 1 (i.e. BCR reduces with the volume of sediment placed at Walcott). Table 3-8 also presents the iBCR. The iBCR needs to be greater than one to reflect that the additional costs of moving to a bigger option (in terms of volume) are outweighed by the additional benefits that the bigger option attracts. As the highest BCR option is also the biggest option in this case, this is not relevant for this project.

Stage 3 looks at whether the inclusion of contributions changes the choice of the leading option. It looks at whether the incremental costs with contributions reduces to such an extent that a different option

becomes the leading option, either by the iBCR threshold being exceeded, the BCR increasing or the rank order of options changing. Table 3-9 shows that inclusion of contributions means that all four shortlisted options have a BCR between 6 and 7. **Option 4 remains as the leading option** when contributions are included; the BCR ranking behind option 4 remains as option 3, option 2 and then option 1.

Table 3-8 Option ranking and economic appraisal (based on total costs)

Option	Present Value costs (£'000)	Total Present Value benefits (£'000)	Benefit: cost ratio (BCR)	Incremental benefit: cost ratio (IBCR)	Option for incremental calculation
Do Nothing	-	-	-	-	-
Option 1	18,713	21,199	1.13	1.13	Do Nothing
Option 2	20,152	25,896	1.29	3.26	Option 1
Option 3	21,314	30,466	1.43	3.93	Option 2
Option 4	22,473	32,220	1.43	1.51	Option 3

Table 3-9 Option ranking and economic appraisal (based on costs minus contributions i.e. GiA only)

Option	Present Value costs (£'000)	Total Present Value benefits (£'000)	Benefit: cost ratio (BCR)	Incremental benefit: cost ratio (IBCR)	Option for incremental calculation
Do Nothing	-	-	-	-	-
Option 1	3,435	21,199	6.17	6.17	Do Nothing
Option 2	4,159	25,896	6.23	6.49	Option 1
Option 3	4,781	30,466	6.37	7.35	Option 2
Option 4	5,015	32,220	6.42	7.50	Option 3

Stage 4 addresses uncertainty and whether this would affect the choice of the leading option. The only difference between the four options is the volume of sediment placed in front of Walcott. There is no difference in how the options might function or develop in the future, and therefore no real difference in uncertainty between the options. To conclude, Stage 4 does not change the choice of preferred option and the **leading option remains as Option 4**.

Stage 5 asks whether the choice of leading option is affected by the extent to which wider objectives are achieved. Again, the options are all sediment-based solutions which achieve the project's objectives. Option 4 maximises the benefits to the Villages, providing further justification for it being chosen as the leading option.

To summarise, the decision process in the Appraisal Guidance concludes there is a case for government funding, and that **Option 4 is the leading option in terms of the economic appraisal**.

As shown in the table, the iBCR reduces strongly between Option 3 and Option 4, which indicates that Option 4 is close to the optimum from an economic perspective (i.e. adding more sediment will not attract the additional benefits that are needed to outweigh the cost of the additional sediment).

3.6 Non-financial benefits appraisal

3.6.1 Methodology

This section appraises the qualitative non-financial benefits associated with each of the shortlisted options, and uses this, combined with the result of the economic appraisal in section 0, to confirm the choice of preferred option for the scheme.

3.6.2 Qualitative benefits

Benefits to the Villages related to other funding sources

Improvement of tourism economy

The loss of existing recreational value described in section 3.5.1 is eligible for FCERM GiA. In contrast, the improvement of tourism economy concerns the positive impact on the local tourism economy of the options, for example by improving the beach.

Improving adaptive capacity of the communities

The current understanding that a large number of households are expected to be lost in the coming 20 years has far-reaching impacts on people. One key aspect is the loss of mobility (i.e. the reduction in house prices restricting ability to move elsewhere and therefore find work).

Additional burden of health and social care

The above-mentioned impact on people due to the understanding that households will be lost in the coming years has the potential to put an additional burden on health and social care.

All of the above are not reported quantitatively here, but are considered within the choice of the preferred option. Given that all options are sediment-based solutions which are effectively buying time for the Villages communities, the above benefits will be similar for each option. The options which include a larger placement of sediment on the Villages frontage will provide higher benefits relating to all three benefit categories (improvement of tourism income improving adaptive capacity, burden on health and social care) as they will provide higher and wider beaches and delay failure of the defences, reducing uncertainty and providing more time for adaptation.

Benefits further downdrift

In principle, there may also be benefits further downdrift from the Villages frontage. All of the options provide additional sediment which will, over time, also generate benefits downdrift from Walcott: first at Happisburgh and then also at Eccles and Sea Palling. It would be possible to estimate these benefits directly or to estimate how the additional sediment supply from the scheme would reduce, for example, the requirements for beach nourishment as part of the existing scheme at Sea Palling. This would have to include an allowance for material loss, reduced erosion downdrift and uncertainty and it would have to account for the fact that the sediment would only reach the site a number of years in the future. The resulting estimate of the Present Value cost reduction for the Sea Palling scheme could then be interpreted as a cost reduction for the Bacton to Walcott scheme.

There is significant uncertainty regarding these possible benefits, and its estimation is outside of current policy guidance. The ranking of options for this aspect will be the same as for the direct economic and wider benefits, so it confirms the choice of preferred option.

Reputational considerations

There are reputational considerations that are applicable to all four options. In particular, this relates to the risk of delays – there is considerable expectation within both the private sector and UK Government that a project will be delivered in a timely manner. This benefit does not differentiate the shortlisted options.

The qualitative benefits discussed above have not been scored or weighted as it was felt that there is not a significant difference between the four options and therefore qualitative benefits would not lead to a change in the choice of preferred option.

3.7 Preferred option

Taking account of the non-financial benefits, there is no change to the ranking based on the economics. This confirms that Option 4 is the **preferred option**, based purely on the method set out within the Appraisal Guidance.

However, for reasons of affordability, the Client Group have selected a smaller option (in terms of sediment volume at the Villages), Option 1. The intention is that the larger placements at the Villages (up to option 4) could be implemented if additional funding sources are identified or become available, or if the main works contractor procurement process provides lower than expected construction costs.

The Client Group recognises that the amount of GiA funding depends on the scheme that is implemented, and its calculated Outcome Measures. As such, the higher GiA linked to option 4 will only be released if option 4 is implemented.

Figure 3-1 provide the relationship between initial placement volume or initial capital cost (horizontal axis) with the amount of GiA funding available (vertical axis). If additional funding sources are identified or become available, or if the main works contractor procurement process provides lower than expected construction costs, the Client Group will use these relationships to determine the scheme's sediment volume and the associated GiA funding, up to the maximum defined by Option 4.

Figure 3-1 Relationship between initial placement volume and GiA funding

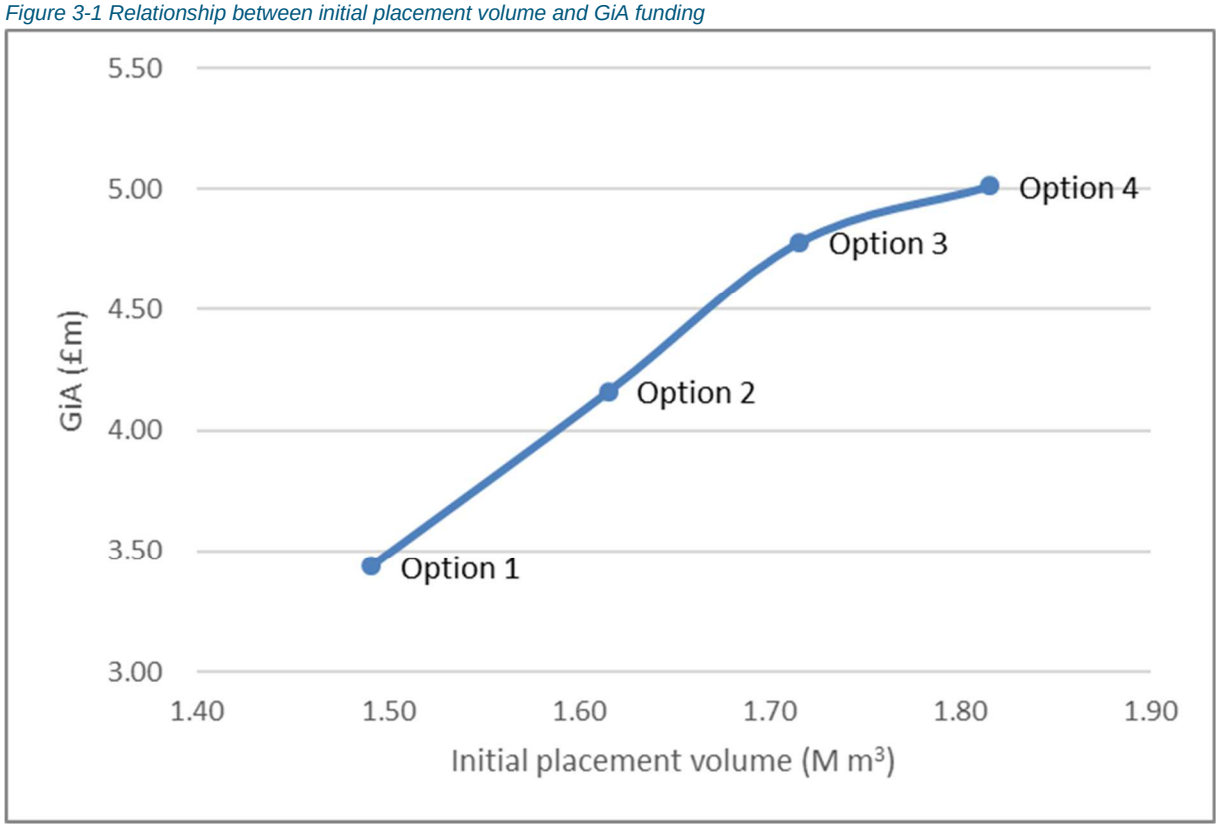
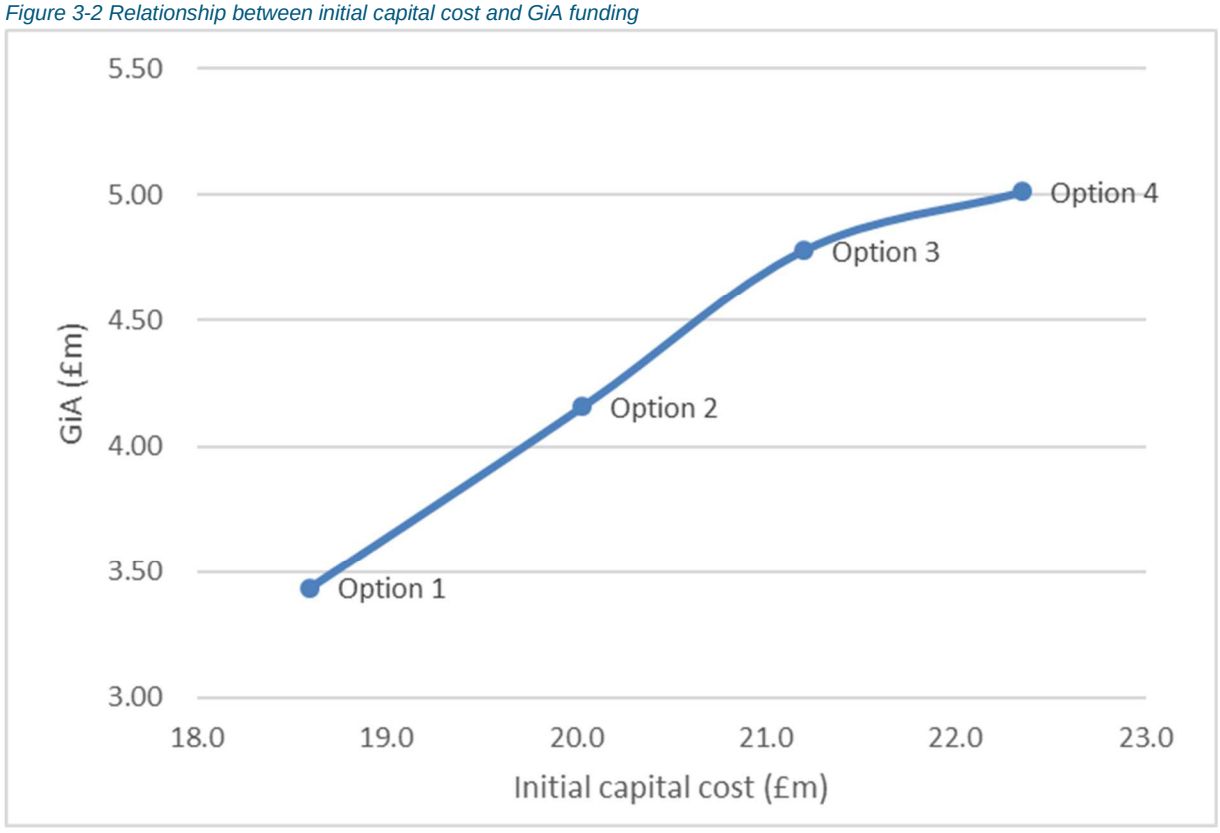


Figure 3-2 Relationship between initial capital cost and GiA funding



This OBC is therefore requesting approval from LPRG for implementation of Option 1 , with the understanding that in reality the final decision on the option to be implemented will depend on the funding sources that are available at the time, and the implemented option will determine the appropriate amount of GiA.

The above discussion is presented in Table 3-10 where both the minimum and maximum options are presented.

Table 3-10 Preferred option

	Preferred Client Group option due to affordability– Option 1	Preferred option from economic assessment – Option 4
Outcome Measure 1 – Ratio of whole-life benefits		
Present Value costs (£'000)	18,713	22,473
Present Value benefits (£'000)	21,199	32,220
Benefit : Cost Ratio (BCR)	1.13	1.43
BCR on GiA only	6.17	6.42
GiA (£'000)	3,435	5,015
Outcome Measure 2 – Households at reduced risk		
2a – Households moved to a lower risk category (number – nr)	68	101
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	37	37
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	0	0
Outcome Measure 3 – Households with reduced risk of erosion		
3a – Households with reduced risk of erosion (nr)	298	298
3b – Proportion of those in 3 protected from loss within 20 years (nr)	90	90

3.8 Sensitivity analysis

A number of additional model runs were carried out based on option 1 to test the sensitivity of the cost and benefit calculations to assumptions made within the model set up. The following assumptions were tested:

- Model boundary conditions – waves:
  - The input wave climate was shifted by +10 degrees.
  - The input wave climate was shifted by -10 degrees.
  - The input wave height (Hs) was increased by 5%.
  - The input wave period (Tp) was increased by 5%.
- Model boundary conditions – offshore losses:
  - Offshore losses from in front of the terminal and Villages assumed to be overestimated, so value halved.
  - Offshore losses from in front of the terminal and Villages assumed to be underestimated, so value doubled.

The results of the sensitivity tests are expressed in terms of impact of options on the scheme's key performance indicators (functional life of defences and the estimated life of the nourishment in front of the terminal), see Table 3-11. The final results for option 1 are also provided as a comparison. The results of the sensitivity testing show that performance at both the Terminal and the Villages is not significantly sensitive to changes within the model boundary condition assumptions. This confirms the choice of preferred option.

Table 3-11 Impact of options on functional life of defences

Option	Nourishment life	Defence life per zone with option (years)							
		42 Terminal	41 Bacton Green	40 Bacton Village	39 Keswick	38 Rudram's Gap	37 Walcott	36 Walcott	35 Ostend
Option 1	21	50	50	50	35	50	24	18	7
Sensitivity 1 (wave climate +10%)	21	50	50	50	35	50	24	18	7
Sensitivity 1 (wave climate -10%)	17	38	50	38	27	50	24	19	8
Sensitivity 1 (wave height +5%)	21	50	50	50	40	50	24	18	7
Sensitivity 1 (wave height -5%)	21	50	50	50	37	50	24	18	7
Sensitivity 5 (sediment sinks halved)	22	50	50	50	39	50	25	18	7
Sensitivity 6 (sediment sinks doubled)	18	41	50	50	29	50	22	17	7

4 The Commercial case

4.1 Introduction and procurement strategy

A full description of the project's management structure and governance is given in Section 6: The Management Case. As the lead delivery and contracting body for the partners involved, North Norfolk District Council is responsible for the procurement of the Works (Contractor), Project Manager, Supervisor and Principal Designer (Consultant(s)). In particular, the following will be procured by North Norfolk District Council:

- Contractor for the construction of the Sandscaping works.
- Project Manager and Supervisor functions as defined typically in the NEC3 form of contract.
- Principal Designer for the construction phase of the project as defined by the Construction (Design and Management) Regulations 2015.
- Continuing design support.

Royal HaskoningDHV is the designer of the project under contract to Shell with the agreement of the partners. However, its contract ends on the completion of the design and the issuing of all of the consents necessary for the implementation of the works. North Norfolk District Council has resolved, subject to negotiation, to appoint Royal HaskoningDHV to continue in its role of Principal Designer until the completion of the works and to provide ongoing design support throughout the construction period.

The procurement process must comply with the requirements of European Union Public Sector Directive 2104/24/EU. This Directive is implemented in England, Wales and Northern Ireland through regulations in the form of a statutory instrument – The Public Contracts Regulations 2015 (SI 2015/102). The Project's Steering Committee has examined three procurement options that satisfy the Directive/Regulation as follows;

1. Full compliance with the mandatory procedures prescribed in the Directives/Regulations following the publication of the tender opportunities in the Supplement to the Official Journal of the European Union (OJEU): (Using either the open or restricted procedures).

Advantages	Disadvantages
• Competitive pricing • Potential to reach the widest range of suppliers with relevant experience • Can utilise a variety of contract forms	• Time and cost associated to complying with the requirements of the Directive/Regulations. • Possibility of having to invite tenders from wholly unsuitable suppliers. • Substantial element of risk rests with North Norfolk District Council to push down the cost of the scheme.

2. The Environment Agency's Water Management Framework (WEM). This framework is OJEU compliant having been procured using the Directives/Regulations' procedures. This is available for use by North Norfolk District Council as a Risk Management Authority.

Advantages	Disadvantages
• Competitive pricing is central to the framework • Experienced contractors and consultants are party to the framework. • Integrated delivery teams • There is not a fee for the use of the framework	• Substantial element of risk rests with North Norfolk District Council to push down the cost of the scheme.

3. The SCAPE Framework. This framework is OJEU compliant having been procured using the Directives/Regulations' procedures. This is a local authority consortium led framework intended for the procurement of a wide range of local authority works and services.

Advantages	Disadvantages
• Competitive rates are embedded in the framework • Pre-construction cost certainty and risk reduction set prior to target cost setting • Integrated delivery teams • A body of standard performance indicators	• There is a fee payable for the use of the framework (0.25%) • There is only one supplier on the framework • The supply chain selection and management is the responsibility of the single supplier

As both the WEM and SCAPE frameworks are OJEU compliant, their use allows for a time and cost saving procurement process with suppliers that have the relevant expertise. The WEM framework suppliers are all pre-approved and are required to work using the framework's terms and conditions. This ameliorates project risk stemming from the procurement process. Similarly, by virtue of pre-construction risk reduction and cost certainty, project risks stemming from the procurement process are reduced using SCAPE. Unlike WEM, the SCAPE framework requires a fee to be paid for its use. By using well established contract documentation and drawing on the wealth of experience available, particularly in the Environment Agency, there is little doubt that robust contracts can be placed if tenders are sought using the OJEU procedures. However, doubt remains about the quality of suppliers expressing an interest and there continues to be the risk of having to seek tenders from all applicants some of whom may not have the relevant experience. There is also the issue of the time and cost needed to comply with the OJEU's contract notice procedures.

The Steering Committee's preferred procurement procedure is to use the WEM Framework for both the works and professional services contracts. This decision is reinforced by early contractor involvement that demonstrated the WEM Framework includes contracting consortia that have in-depth experience of works of this nature.

4.2 Key contractual terms and risk allocation

All services and works to be provided will be based on the terms of the relevant NEC3 contract, in accordance with the requirements set out in the WEM framework agreement. The proposed contract choice for any services to be procured will be the NEC3 Professional Services Contract (PSC) for the Project Manager/Supervisor and for the works it will be the NEC3 Engineering and Construction Contract (ECC).

North Norfolk District Council is drawing on the considerable experience of the Environment Agency in the procurement and management of schemes such as Lincshore, a substantial beach nourishment scheme.

A comprehensive risk assessment has been prepared examining general and project risks as shown in the client risk register. The allocation of risk will be managed using the terms of the WEM ECC supplementary clauses ("z" clauses) in line with the Environment Agency's practice. However, particular attention is paid to the risks associated with:

- Fuel price: Expert advice from the commercial partners to this scheme has been sought on the mitigation of this risk.
- Currency exchange rate: Expert advice from the commercial partners to this scheme has been sought on the mitigation of this risk.
- Weather and sea state: The contract will include a mechanism for risk sharing.
- Loss of sediment after placement: Using before and after surveys, the contractor will be paid for agreed volumes of sediment placed in discrete pre-defined sections. During placement, the loss of sediment will be the contractor's risk. After the sediment has been placed and the design profile achieved and accepted, the loss of material from each discrete section will be the Employer's risk.
- Loss of sediment on completion: On completion of the whole of the works, the loss of sediment will be the Employer's risk entirely.

4.3 Procurement route and timescales

As stated above, the Project Manager and Supervisor and Works contractor will be procured using the WEM Framework. This concerns lots 3 and 4 respectively.

The planned procurement milestones are shown in Table 4-1.

Table 4-1 Planned procurement milestones

Milestone	Start date	End date
Lot 4 Works Contract		
Expression of interest (EOI): Lot 4	23 April 2018	7 May 2018
Tender period	29 May 2018	24 July 2018
Tender assessment period	25 July 2018	28 August 2018
Steering Committee and NNDC approvals	29 August 2018	9 October 2018
Notification of preferred contractor	9 October 2018	
Standstill period	9 October 2018	23 October 2018
Award Lot 4 Works contract	4 December 2018	
Lot 3 Project Manager and Supervisor		
Expression of interest (EOI): Lot 3	14 May 2018	25 May 2018
Tender period	12 June 2018	7 August 2018
Tender assessment period	8 August 2018	21 August 2018
Steering Committee and NNDC approvals	22 August 2018	9 October 2018
Notification of preferred contractor	9 October 2018	
Standstill period	9 October 2018	23 October 2018
Award Lot 3 Project Manager/Supervisor contract	4 December 2018	
Construction		

Milestone	Start date	End date
Construction Period	14 March 2019	15 August 2019

North Norfolk District Council will use Delta eSourcing as the platform for the issue and receipt of tenders. Delta eSourcing is an end-to-end, EU compliant and fully web-based service which gives North Norfolk District Council the ability to manage its tenders, suppliers and contracts in a single solution. The Council's Procurement Officer will manage that part of the process.

The appraisal of works tenders will be done by a panel consisting of:

- North Norfolk District Council Project Manager;
- Expert Client for Engineering and Procurement;
- Environment Agency Project Team Manager;
- Shell Senior Engineer; and
- Perenco Contracts Team Leader.

Royal HaskoningDHV will provide detailed advice to the panel on the technical content of the works contractors' tenders. As Royal HaskoningDHV are part of one of the WEM Framework's consortia, it will not be involved in the appraisal process.

The panel described above will also be responsible for the appraisal of the Project Manager/Supervisor tenders but this time without any input form Royal HaskoningDHV.

North Norfolk District Council is also seeking to use the services of the Local Government Association (LGA) to act in the role of Moderator for the appraisal of the Works tender.

The recommendations of the appraisal panel will be reviewed by the Steering Committee prior to the announcement of a preferred bidder and/or tender award by the Council.

The WEM Framework tender evaluation model will be used for the appraisal of both Lot 3 and Lot 4 tenders. The weighting of the evaluation criteria will be 60% quality : 40% price.

4.4 Efficiencies and commercial issues

There has been an extensive design process which has examined, in detail, matters such as sediment source, levels of protection, beach plan shape and sediment loss over the design life of the scheme drawing on the Dutch Zandmotor project as well as the Environment Agency' own experience of beach nourishment along the east coast of England. The contracting consortia that are part of the WEM Lot 4 have also been consulted as to practice and costs. The next phase of the Environment Agency's Lincshore nourishment contract is programmed to start, on-site, at about the same time in 2019. It is not possible to merge the two contracts for both contractual and physical reasons but, by inspection, it can be seen that by avoiding a programming conflict, there may be an opportunity for this project to benefit from the local positioning of major plant and equipment.

The combined scheme to protect both the Terminal and the Villages provides economies of scale and enables costs and resources to be shared, thereby facilitating a unique opportunity to extend the life of their defences. Previous studies of this frontage have shown that there are no separate and economically viable schemes for the protection of the Villages.

There are three surface water outfalls serving each of the three terminals respectively. These outfalls, which are essential for the operation of the terminals, must be extended or replaced as the new beach will

cover them, preventing their use. The outfalls must discharge below the level of the lowest astronomical tide. Hence, contractors with the experience and equipment to work in an inshore marine environment will be required. Use of a separate advance contract or contracts has been considered for the necessary works. A major disadvantage of this approach is the increased risk that it will delay the implementation of the beach works. As the WEM Lot 4 contractors have the required experience for both the nourishment and the outfall works, there are cost, programme time and efficiency benefits available by including the outfall extensions or replacements in the Works contract.

The Crown Estate (TCE) has evinced that there is an opportunity for the royalties payable to TCE to be reduced. The works information for the ECC contract will require the contractors to negotiate the royalty fee with TCE and to evidence the agreed fee in their tenders.

5 The Financial case

5.1 Financial summary

Table 5-1 Financial summary (£k)

	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs up to OBC	N/A – sunk costs		
OBC to construction			
Existing staff costs	12	12	12
Site investigation and survey	20	20	20
Subtotal	32	32	32
Construction			
Construction costs (nourishment)	14,687	14,687	14,687
Environmental enhancement	60	60	60
Environmental mitigation	5	5	5
Existing staff costs	10	10	10
Consultants' fees	62	62	62
Site supervision and construction management	221	221	221
Land purchase and compensation	10	10	10
Subtotal	15,055	15,055	15,055
Risk contingency			
Optimism bias (20%)	3,011	3,011	3,011
Risk allowance (see Table 3.6)	165	165	165
Future costs (estimate)	450	600	
Subtotal	3,626	3,776	3,176
Project total costs	**18,713**	**18,863**	**18,263**

5.2 Funding sources

The funding for the Bacton to Walcott Coastal Management Scheme is from a number of private and public sources. The FCERM GiA is a critical element of the project to enable the joint terminal and villages scheme to proceed but does not form the primary funding source. The private funding is being led by Shell UK and Perenco UK who are overseeing an umbrella of other infrastructure provider contributions.

Opportunities for external funding have been comprehensively explored with the BTC and UK Government.

The following funds are intended to be made available to the project, subject to Grant in Aid funding being made available. The amounts associated with these funds are provided in Table 5-2.

- The **BTC's contribution** to the cost of the terminal only protection, as confirmed in the signed Development Agreement.
- **NNDC** contribution, as agreed by Cabinet and Full Council;
- **Local Levy** agreed allocation from the Anglian Eastern Regional Flood and Coastal Committee (RFCC);
- Environment Agency's agreed allocation from the **Natural Flood Management** (NFM) funding stream;
- Norfolk Business Rates Pool contribution from Norfolk Local Government sources;
- New Anglia Local Enterprise Partnership Growth Funds contribution;
- Contributions from the local community and other beneficiaries collected through the JustGiving account set up by NNDC; and
- The BTC's agreement to consider funding a remaining funding gap, subject to conditions set out in the signed Development Agreement.

As discussed in section 3.7, currently there are funds available to implement Option 1. Depending on the availability of other potential funding contributions (which are currently still being explored) and the final scheme cost estimate, a larger scheme may be implemented, up to Option 4.

With regards to the NFM funding stream, as part of the original application for funding, the importance of post construction monitoring was covered. As such, and in order to maximise the learning from this project, there is an expectation that a proportion of the NFM allocation will be attributed to such monitoring. Post-construction monitoring in beach nourishment projects is covered by FCERM GiA monies elsewhere (for example the Eccles to Winterton scheme).

Funding arrangements for the post-scheme monitoring costs are currently being developed and are therefore not included in this table.

Letters of support or agreement to funding are provided in **Appendix D**.

Table 5-2 Summary of funding sources (cash) in £k

Annualised funding needs (£k)	Yr 0 2019	Yr 1 2020	Yr 2 2021	Yr 3 2022	Yr 4+	Total
Grant in aid	3,345	0	30	30	30	3,435
Contributions						
New Anglia LEP	1,080					1,080
North Norfolk District Council	500					500
Anglian RFCC (Local Levy)	500					500
Norfolk Business Rates Pool	500					500
Environment Agency NFM	60	60				120
Local community	1					1

BTC (terminal only protection, outfalls, plus expected Option 1 contribution)	12,277					12,277
Long term monitoring (funding source to be confirmed)					450	450
Project total costs	**18,263**	**60**	**30**	**30**	**480**	18,863

5.3 Impact on revenue and balance sheet

The capital funding requirement for the Bacton to Walcott scheme is included in the Environment Agency's flood and coastal risk management investment programme (2015-2021), BTC investment programmes and NNDC capital investment programme. The revenue for future maintenance is limited and will be shared as identified in the Development Agreement.

5.4 Overall affordability

FCERM GiA funding is required to construct the Bacton to Walcott scheme. The GiA capital funding requirement for the scheme has therefore been included in the Environment Agency's Flood and Coastal Erosion Risk Management Investment Programme. The level of the funding requirement will be updated as the project progresses although this OBC details the maximum GiA requirement.

The affordability of the Bacton to Walcott scheme, is intrinsically embedded in the delivery of the privately funded protection of Bacton Gas Terminal. The private contributions are confirmed in the Development Agreement signed between Shell UK, Perenco UK and NNDC.

The private contributions are from a number of sources which highlight the widespread support for the delivery of the scheme.

Ongoing costs with regards to maintenance are expected to be low as the scheme will naturally decommission over time. Monitoring costs are to be shared and it is expected that a significant proportion of the costs can be captured in the Environment Agency's Anglian Coastal Monitoring programme. Further research will be supported and encouraged but this is outside the core project.

The combined sources of funding (including GiA) identify a partnership funding score of over 100% for Option 1 (the minimum option for which funding is currently expected to be available). The partnership funding score for the larger options, up to Option 4, will depend upon the additional funding.

The partnership funding calculator spreadsheets are provided in **Appendix E**.

Table 5-3 Overall affordability (cash costs)

Annualised spend profile (£k)	Yr 0 2019	Yr 1 2020	Yr 2 2021	Yr 3 2022	Yr 4+	Total
Authority costs	24					24
Consultant fees and ECI	74					74
Construction costs (incl. construction management)	17,902					17,902
Surveys, monitoring and investigation	20	30	30	30	510	620
Environmental mitigation or enhancement	72					72
Project total costs (excluding contingency)	18,092	30	30	30	490	18,672
Less: contributions	14,918	60				14,978
Total capital grant claim (excluding contingency)	3,345		30	30	30	3,435
Risk contingency	65	50	50			165
Total capital grant (including contingency)	3,410	50	80	30	30	3,600

6 The Management case

6.1 Project management

The Bacton to Walcott Coastal Management Scheme will be managed in accordance with North Norfolk District Council's project management processes. These are based on the principles of PRINCE2 and are in line with the Council's established systems and procedures for effective management of schemes.

The scheme will be managed by North Norfolk District Council through Coastal Partnership East (CPE) in their capacity as the coastal management service for the Council. CPE is a shared Coastal Management service between North Norfolk District Council, Great Yarmouth Borough Council, Waveney District Council and Suffolk Coastal District Council. The Partnership has demonstrated that it is an effective and efficient delivery model.

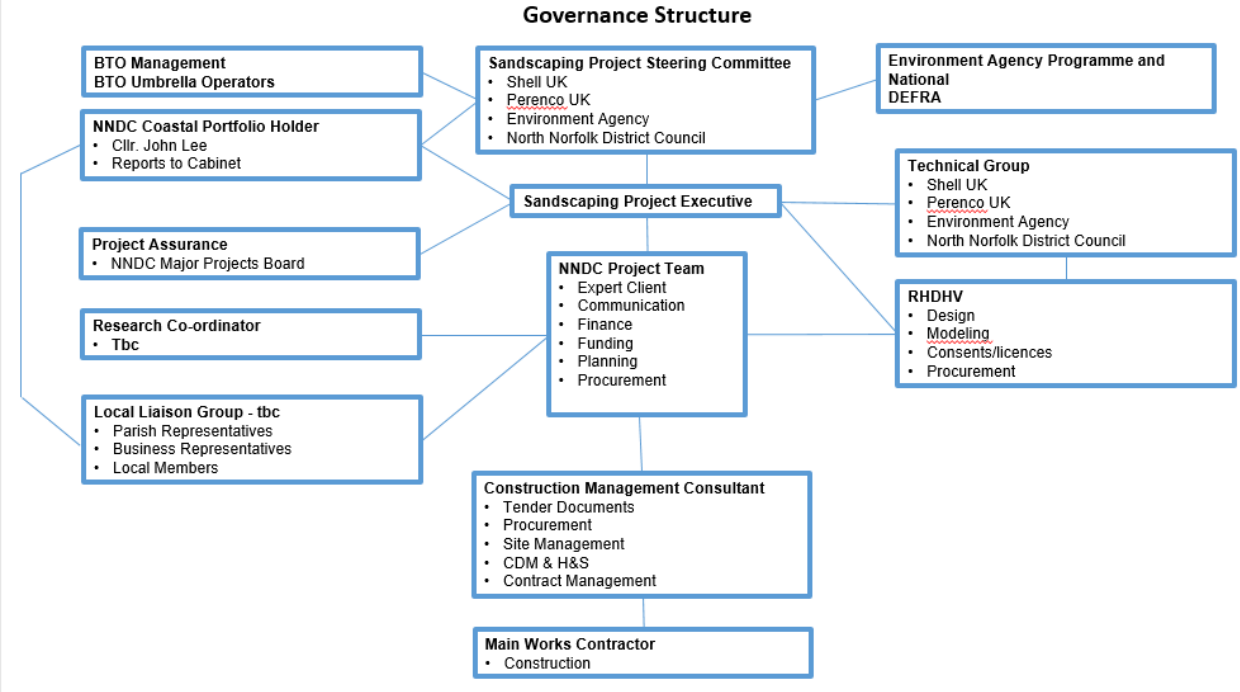
North Norfolk District Council is the lead delivery and contracting body on behalf of the partners involved in the project. Project decisions will be made through a Project Steering Committee as approved and set out in the Development Agreement between the parties. The committee includes voting members from Perenco UK, Shell UK and the Council. The Environment Agency also sits on the committee as an advisor in a non-voting capacity.

6.1.1 Project structure and governance

Robust governance and appropriate project management is at the forefront of the Bacton to Walcott Coastal Management Scheme. The scheme is supported from all parties to a high level including the Shell UK Chair, Perenco UK General Manager, Environment Agency Chair and North Norfolk District Council Leader. The Project Steering Committee is well established and draws on key representatives from earlier stages in the project which have been effective, have established project relationships and are keen to drive the project forward.

The governance and assurance arrangements in place for the project are shown in Figure 6-1 below.

Figure 6-1 Governance and assurance arrangements



The Project Steering Committee is chaired by the NNDC Corporate Director and Head of Paid Service and includes representatives from North Norfolk District Council, Shell UK, Perenco UK and the Environment Agency. There is scope to incorporate further resources as required. The Committee meets as required by the project but is scheduled monthly.

The Committee is supported by a Technical Group for day to day consideration of project development and issues. This includes representation of the organisations that are part of the Committee, supplemented by consultants Royal HaskoningDHV. As the project progresses the Technical Group can include additional representation as required. The Technical Group meets (face to face or via telecom) fortnightly or as required by work stream development.

Project assurance is provided by key representatives integrated into the project delivery team. These include North Norfolk District Council's Legal, Finance, Procurement and Communications departments. This is supplemented by regular reporting to the Council's Large Project Board. Bacton Terminal Companies' assurance is built into their representation on the Committee and Technical Group.

Change Authority is a function which, as per the Development Agreement, is retained by the Project Steering Committee (above a value of £10,000). As part of the procurement process it will be necessary to agree with the Committee tolerances of change which will be delegated to enable timely and effective delivery of construction.

The Project Executive is responsible for the delivery of the project in accordance with the requirements of the Project Steering Committee. The Project Executive Reports to the Project Steering Committee. This role will be supported by an integrated delivery team resourced from specialist departments within North Norfolk District Council and external resources as required. External resources include an Expert Engineering Client, Royal HaskoningDHV and consultant support to assist with delivery as required.

6.1.2 Project roles and responsibilities

The project roles and responsibilities are summarised in Table 6-1.

Table 6-1 Project roles and responsibilities

Function	Project Role	Team Member	Job Title	Project Responsibilities
Governance	Chair [Project Steering Committee]	Steve Blatch	North Norfolk District Council Corporate Director and Head of Paid Services	Project Sponsor Reporting - Corporate Leadership Team, Cabinet, Corporate Coordination
	Voting Member [Project Steering Committee]	Cheree Fletcher	Business Services TL Shell UK	Shell interests Stage 2.2 Agreement delivery Private funding
	Voting Member [Project Steering Committee]	Adrian Fletcher	Senior Commercial Advisor Perenco UK	Perenco UK interests Private funding
	Non-voting Member [Project Steering Committee]]	Mark Johnson	Environment Agency: Area Coastal Manager	Coastal and FCERM Advisor EA Liaison and reporting
	Technical Advisor [Project Steering Committee]	Gerard Spann	Senior Civil / Structural Engineer Shell	Shell Technical Advisor Local gas infrastructure advice Assurance
	Technical Advisor [Project Steering Committee]	Peter Ratcliff	Terminal Manager Perenco UK	PUK Technical Advisor Local gas infrastructure advice Assurance
	Technical Advisor [Project Steering Committee]	Bill Parker	Head of Coastal Partnership East	Internal Resources
	Project Executive	Rob Goodliffe	North Norfolk District Council/Coastal Partnership East Coastal Manager	Co-ordination, Project Overview
Assurance/delivery	Project Accountant/Insurance Professional	Lucy Hume	North Norfolk District Council Chief Technical Accountant	Finance advice, support and assurance. Insurance advice and support
	Project Communications	Ed Foss	North Norfolk District Council Communication and PR Manager	Communication advice, support and assurance. Local Liaison Group Website and media communications
	Project Procurement	Debbie Beckles	North Norfolk District Council Procurement Officer	Procurement advice, support and assurance.

Function	Project Role	Team Member	Job Title	Project Responsibilities
	Project Team Legal	Alexa Baker	North Norfolk District Council Solicitor	Legal advice, support and assurance.
	Expert Client Engineering/Procurement	Peter Lawton	St La Haye Limited Director	Engineering, Procurement and project management support, advice and resource.
	Design & Modelling	Jaap Flikweert	Royal Haskoning DHV Technical Director	Technical advice Procurement documentation (input)
	Project Management (to point of delivery)	Victoria Clipsham	Royal Haskoning DHV Senior Consultant	Project management CDM / H&S
	Consent/Licencing and Environmental	Chris Adnitt	Royal Haskoning DHV Technical Director	Environmental advice EIA Consents and Licencing
Delivery	ECC/PM Consultant	To be appointed		Project delivery management Contract management CDM / H&S
	Main works Contractor	To be appointed		Construction

6.1.3 Project plan

The key stages and timings from the project plan are provided in Table 6-2 and the full project programme is provided in **Appendix F**.

Table 6-2 Project plan

Activity	Date (DD/MM/YYYY)	Comment
Onshore consent received	14/09/2018	This will be followed by a 6 week decision challenge period
Mobilisation and site set up	28/02/2019	TBC Based on ECI input
Work to be started on site	14/03/2019	TBC Based on ECI input
Work substantially completed by	15/08/2019	Based on ECI input, assuming maximum duration of 22 weeks

6.2 Communications and stakeholder engagement

This Business Case indicates that a combined scheme is the only option for reducing erosion and flood risk to the Villages. It is therefore not appropriate to seek to gather alternative suggestions from the communities. The objective of stakeholder engagement (public, not statutory) is therefore to highlight the benefits of the joint scheme and seek to gather support for the wider project, while identifying any additions or amendments which could enhance the scheme.

Table 6-3 summarises the constraints and scope of what can be influenced through public consultation for this project.

Table 6-3 Constraints and scope for stakeholder consultation

In scope	Out of scope
• Amendments or additions to enhance the proposed scheme • Identifying additional environmental issues • Finding additional funding sources • Understanding the process for planning permission and other permissions • Local knowledge to inform design process	• Selection of combined sediment-based solution • FCERM GiA – formula is fixed • Government FCERM - guidance is fixed • Bacton Terminal operators' choice of defence type is decided • NNDC Shoreline Management Plan policy is adopted • Timing of scheme • Planning permission/licencing procedures

The following stakeholder groups have been identified:

- **Key engaged / key players** – MP for North Norfolk, local Fisheries Associations (North Norfolk Fishermen's Society), CEFAS, National Federation of Fishermen's Organisation, the Association of Inshore Fisheries and Conservation Authorities, Marine Management Organisation, Natural England, The Crown Estate, North Norfolk District Council, Bacton terminal and pipeline operators, the Environment Agency, Defra, Department for Communities and Local Government, District Councillors, Ward members, New Anglia Local Enterprise Partnership.
- **Keep satisfied** – Maritime and Coast Guard Agency, RNLI, volunteer lifeboat operators, Trinity House, RSPB, Historic England, Coastal Concern Action Group, Norfolk Wildlife Trust, Joint Nature Conservation Committee, North Norfolk News, Eastern Daily Press.
- **Keep informed** – residents in Bacton, Paston and Walcott, Parish Councillors, members of the public, recreation and tourism groups, local businesses, University of East Anglia, Marine Knowledge Exchange Network, Norfolk and Suffolk Coastal Hub, the ICE, Zandmotor research groups, Bacton Terminal workers and companies.
- **Monitor** – NNDC Employees, general public.

The majority of the key players identified above have all been involved in the EIA consultation process. The EIA process has identified issues which have been assessed and resolved or mitigated. The 'keep satisfied' group have also been consulted during the EIA process to seek to ensure any concerns are identified and understood in order to minimise the likelihood of objections during the consenting process.

In summary, four approaches for communications and stakeholder engagement are required:

- Engagement with key funders.
- Consultation with key interest bodies.
- Develop awareness and understanding in the community.
- Provides updates and information for research potential.

The following stakeholder engagement events were undertaken:

- Initial awareness raising using a range of communications to engage the communities regarding the project – this has been ongoing since project inception in the autumn of 2014;
- Consultation with statutory consultees regarding the Environmental Impact Assessment – undertaken in July 2017 and subsequently through the development of the Environmental Statement;
- Engagement of key councillors and MP through briefings and meetings has been ongoing since project inception. North Norfolk District Council's cabinet have made key decisions in relation to the project, throughout 2016 and 2017.

- Use of appropriate media, social media and external communication activities to continue to raise awareness and keep key media figures (including the trade press) and the public up to date with the project.

The Action Plan as included within the project's Communications Plan is provided in **Appendix G**.

6.3 Change management

6.3.1 Managing change within the project

The Project Steering Committee will be ultimately responsible for managing change within the project. There will be a number of key decision points before construction commences, which provide the opportunity to review and adjust the preferred option to account for new or revised information, such as more accurate cost information, post-consenting requirements and availability of additional funding streams. These decision points are likely to be post-consenting and following procurement of the main works contractor.

Change management in relation to the main works contract will be managed in accordance with the identified NEC3 contract.

Change management regarding FCERM GiA will be completed as required through the Environment Agency FCERM guidance in collaboration with the Environment Agency's Area Coastal Manager and its 6 Year Programme reporting.

Contract change will be managed in accordance with the NEC3 suite of contracts and administered by the project manager.

6.3.2 Managing change caused by the project

In terms of managing the change from the current situation to the new 'with scheme' scenario, there are several considerations:

- The Council's arrangements in relation to beach access – the scheme will actively improve the beach access for the public and fishing fraternity, therefore it is anticipated that there will not be a need for a significant change in management of beach access. There may, however, need to be management of the beach through appropriate signage if cliffing occurs following storm events.
- How the scheme influences NNDC's practical management of the frontage (inspections and maintenance of wall and groynes etc.) – the scheme will extend the life of the defences and potentially enable maintenance of some of the structures to re-commence as beach access is improved.
- Potential increase of wind-blown sand into the communities – the capital project will remain 'open' for two years post construction in case mitigation measures are required during this period. An allowance has been made within the risk contingency for funds to undertake mitigation measures related to wind-blown sand impacts.
- Community adaptation and a more integrated coastal management approach to create access to other funding sources, for example related to reducing community deprivation and improving amenity and tourism – this links with the 'Deep History Coast' project that is seeking to improve tourism on the east North Norfolk coast. The scheme delivers the adopted Shoreline Management Plan and enables additional time to develop 'social mitigation measures' to enable future coastal evolution when required.

- Wider monitoring and review programme to confirm scheme life and need for re-nourishments – this consideration will be owned by both the Bacton Terminal Companies as well as the Council. There are links into the national trial of innovative approach and opportunity for potential change in FCERM activities elsewhere in the country and internationally.

6.4 Benefits realisation

The number of properties better protected will be realised after the scheme has been constructed. The Operations, Maintenance and Monitoring (OMM) Plan will detail the activities that will need to be completed to assess the scheme's performance as well as the Natural Flood Management aspects of the project. The key themes that will be addressed by the OMM Plan are as follows:

- Functional performance for the Terminal: how does the beach develop over time and how does this influence the level and duration of the protection against erosion, informing potential future decisions to renourish.
- Functional performance for the Villages: how does the beach develop over time and how does this influence coastal defence life and flood risk, informing decisions on how to manage coastal change.
- Environmental and socio-economic aspects: monitoring of cliff geology, coastal zone benthos and juvenile fish as identified in the EIA. In addition, monitoring of environmental and socio-economic opportunities.

It is the intention to couple the monitoring programme with a wider-reaching research programme seeking to develop knowledge from the proposed scheme; this is expected to include coastal processes and scheme performance, but also environmental and socio-economic issues and governance. Opportunities may occur whereby social, recreational, environmental, health and other topic areas are better understood, in addition to coastal processes and risk management, producing a deeper and better integrated understanding of large scale nourishment projects and wider influences and benefits.

The results of the monitoring programme and wider-reaching research programme will be shared with the risk management authorities.

With regards to Environment Agency Outcome Measures, Table 6-4 details the expected benefits to be delivered by the scheme. These will be claimed upon completion of the capital element of the scheme.

Table 6-4 Benefits realisation

Outcome Measure (OM)	Yr 1 2019	Yr 2 2020	Yr 3 2021	Yr 4 2022	Yr 5+ 2023	Total
OM2a Households moved to a lower risk category (number- nr)	67					101
OM2b Households moved from very significant or significant risk to moderate or low (nr)	36					37
OM2c Proportion of households in 2b that are in the 20% most deprived areas (nr)	0					0
OM3a Households with reduced risk of erosion (nr)	298					298
OM3b Proportion of those in 3 protected from loss within 20 years (nr)	90					90

Outcome Measure (OM)	Yr 1 2019	Yr 2 2020	Yr 3 2021	Yr 4 2022	Yr 5+ 2023	Total
OM3c Proportion of households in 3b that are in the 20% most deprived areas (nr)	0					0
OM4a Hectares of water-dependent habitat created or improved (ha)	Not applicable					
OM4b Hectares of intertidal habitat created (ha)	Not applicable					
OM4c Kilometres of river protected (km)	Not applicable					

6.5 Risk management

Risk will be identified and managed through the use of a Risk Register. Day to day management of risk will be undertaken by the Project Team while strategic risk management will be undertaken by the Steering Committee. The Committee will receive risk reports from the Project Team and will be required to review and input into identification and management of risk.

The key risks identified are summarised in Table 6-5.

Table 6-5 Risk management

	Risk/Implication	Mitigation	Residual Risk	Actions
FL	Financial and Legal			
FL3	Changes in exchange rate increase scheme costs	Consideration required in tender process and contracts as to how changes in exchange rate can be managed Consider if any other mechanisms are possible to internally manage exchange rate risk e.g. fuel hedge fund	Medium	Consideration as to how risk is managed in tender and contract documentation. Seek guidance as how managed in other schemes such as Lincshore (contract runs over a number of years).
FL4	Following/during implementation there are unintended consequences (e.g. issues with wind-blown sand, erosion hot spot, impacts to other users such as fisheries, environmental impacts) requiring rectification/response leading to reputation and financial risks	Management of unintended consequences included in the Development Agreement with a shared liability. As far as possible to include unintended consequences risk in Outline Business Case for Environment Agency approval and inclusion of contribution of future costs borne by public bodies. Government for assistance investigated and directed to management through OBC approval. Investigate potential for insurance of risk Ensure reliable baseline information to enable comparisons before and after scheme. To include Fisheries data and monitoring, geological assessment, chalk bed assessment. To be included in Operation and Maintenance Plan and monitoring arrangements/agreement.	Medium – there remains a financial risk until Environment Agency Approval of the Outline Business Case and agreement that the EA programme can bear the costs of unintended consequences, or, an alternative underwriting option identified.	Include in OBC Consider potential for insurance of third party risk Question: Does existing insurance for NNDC and BTO cover this risk? Ensure necessary baseline data is collected and appropriate post scheme monitoring is completed.

	Risk/Implication	Mitigation	Residual Risk	Actions
FL5	Costs associated with ongoing coastal monitoring relating to consent/licencing requirements.	Bacton Terminal operators and NNDC (through EA) already complete coastal monitoring. Additional monitoring requirements will be required, some of these may be completed through interested academic institutions or may require additional funds. Operation and Maintenance Plan and Monitoring Plan to be developed as part of the EIA consenting process, delivery to be discussed and agreed with Terminal Operators. Monitoring Agreement to be prepared and agreed by NNDC and BTO prior to appointment of contracts.	Med - Monitoring requirements will become clear following consenting/licencing. Potential to seek to include additional monitoring and funding in EA Anglian Monitoring programme or as part of Outline Business Case.	Operational and Maintenance Plan and monitoring arrangement need to be agreed prior to appointment of main works and supervision contracts.
P	Procurement			
P2	Monitoring Agreement not completed or agreed preventing appointment of main works contractor	None	Med	Progression of Monitoring Agreement required as soon as possible
D	Delivery			
D2	Scheme not constructed impacting on the Gas Terminal (National damages and reputational risk) and local communities (continued increasing risk of short term sea defence failure)	Development Agreement signed and SPSC set up to oversee project progress.	Medium	
D3	The scheme development and delivery programme is extremely tight for a realistic 2018 delivery window.	Continued assessment of the programme and progression of key tasks.	High	Review 2018 target
D4	Consents and licencing for any aspect of the scheme are not forthcoming or have unrealistic conditions, creating delays/project stalling	Continued liaison with consenting bodies and advisory authorities. A need to submit consents etc. as soon as possible. Continued engagement with communities.	Medium	Submission of consents and licences
D5	Consents/licences are challenged, creating delays/project stalling	Processes are followed.	Medium	Delivery of public communications to engender support
D8	Delays in consenting/programme creating delays in delivery and claims from contractor	Main Construction Contractor not to be appointed until after consents/licences are provided and any additional conditions have been negotiated where they may have an impact on cost/delivery. Wide ranging EIA process completed to identify issues to assist with any mitigation required and reduce delays in consenting process. Liaison with consenting bodies.	Med– Contractor claims Medium/High - consenting	Consider how delays could be incorporated in tendering process

	Risk/Implication	Mitigation	Residual Risk	Actions
D9	Impacts to local tourism during construction (27/7 tidal working)	Included in EIA process. The project will potentially be a spectacle attracting visitors to the coast, however, there may be concerns close to the onshore construction site relating to noise and light. This will need to be considered further. Communication plan to include Construction Phase Plan.	Medium	Update to Communication Plan to include construction phase.
C	Communications			
C2	Limited acceptance from local communities regarding Sandscaping concept impacting on reputation and wider buy in.	Ongoing public engagement to explain the project and seek understanding and support. There is no identified scope for an alternative large scale schemes for Bacton or Walcott. Communications Plan has been agreed by all parties and is delivered and kept up to date. Local Liaison Group to assist with local communication	Medium	Set up Local Liaison Group Review communication activities
C3	Not progressing creating reputational impacts	All partners have and continue to input into the project programme to ensure deliverability, this will be kept under review. NNDC continues to lobby government for assistance in delivery and post-delivery risk management. Partners have positive working relationship seeking an outcome for all.	Medium – the programme is constrained and any delays will have consequences.	Regular Technical and Steering Group meetings to track progress.
C4	Scheme does not perform or provide the benefits intended	The scheme has been extensively modelled There are uncertainties, however, these have been reduced to a minimum. Modelling and specialist engineering judgement has assisted with refining the design to maximise on the desired scheme performance. The scheme has drawn on expertise from those who have implemented and monitored the similar Dutch approach.	Medium – there is a risk the scheme performs in an unexpected way; this could be positive or negative. The Dutch example has to date over performed.	Update communication message to include expected variation sin beach levels over time and erosion over time.
H	Human			
H1	Error	Quality management standards are followed	Medium	Ensure QM is at the heart of the contract
H2	Tiredness	Ensure working hours limits are complied with	Medium	Ongoing monitoring of all personnel working times
H3	working in hostile environment	Properly trained and experienced suppliers' staff. Plant and equipment to be assessed. Suppliers' management systems to be complied with	Medium	Monitoring and collaborative working
PC	Planning / consents			
PC1	Permissions and approvals delay or rejection	Ensure all consents in place before award of contracts Allow programme float for delays to consents	Medium	Delivery of pre-construction activities strictly in accordance with the agreed programme.

	Risk/Implication	Mitigation	Residual Risk	Actions
PC2	Coast Protection Act 1949 objections	Allow programme float for delays due to objections	Medium	Application as early as possible.
PR	Project			
PR1	Cost of resolving disputes	Full compliance with contract requirements.	Medium	Funding contingency
PR2	Definition (inaccurate or misleading information)	Ensure design and works information is as full and accurate as possible	Medium	Thorough scrutiny of the works information by all parties to the development agreement
PR3	Planning and quality control	Fully developed and agreed works order of procedure	Medium	All parties involved in construction agree and understand programmes and procedures Steering committee to develop and agree scheme of delegation to project management
S	Safety			
S1	Regulations (e.g. CDM, Marine standards etc.)	Full compliance with all relevant UK H&S legislation and relevant international standards	Medium	All parties to ensure proper application of regulations
T	Technical			
T1	Reliability of plant/works	Maintenance of all plant and vessels to be evidenced	Medium	Suppliers to maintain full records

6.6 Contract management

NNDC will continue to be the Employer for the purposes of the WEM Framework's NEC3 ECC and PSC contracts. NNDC will appoint an ECC Project Manager and an ECC Supervisor utilising the PSC. Royal HaskoningDHV will be the Principal Designer as defined by the Construction (Design and Management) Regulations 2015. Royal HaskoningDHV will also be employed to provide ongoing design support during the construction phase.

NNDC will nominate a senior officer of the Council, or other suitably qualified person, to be the Council's Project Representative and who will report to the Project Executive which will continue to be responsible for the delivery of the project. The ECC Project Manager will report to the Council's Project Representative.

The Development Agreement includes a provision for the management of change. As stated in Section 6.1.1 it will be necessary to agree with the Steering Committee tolerances of change which will be

delegated to enable timely and effective delivery of construction. This will be embedded into the ECC Project Manager's terms of reference.

6.7 Assurance

The detailed design of scheme, including all of the preceding feasibility and outline design work, has undergone scrutiny from a number of sources at key decision points. This included:

- Internal technical and quality reviews within Royal HaskoningDHV;
- Internal modelling reviews and validation by HR Wallingford;
- Technical review / sensibility checks by Arjen Luijendijk of NatureCoast Zandmotor research programme (engaged through TU Delft / Deltares)
- Economic assessment methodology review by David Cotterell and Martin Smalls (Environment Agency) and by Harry Walton(Defra), all representing the Large Projects Review Group
- Technical reviews throughout the design process by Shell UK and Perenco UK engineers;
- Reviews by North Norfolk District Council (Rob Goodliffe) and Coastal Partnership East (Bill Parker);
- Review of the business case by the Large Projects Review Group (LPRG).

The design does not rely on a single modelling tool or exercise, but is based on a conceptual model that combines the best aspects of 2d Area, 1d coastline and 2d cross-shore models in combination with expert judgement and local knowledge. The model's baseline was validated against monitored beach profiles and previous estimates of longshore sediment transport.
As detailed in section 6.1, project assurance is built into the governance of the project delivery structure. Each party provides direct project assurance through membership and input into the Steering Committee and Technical Group. This is third party assessed by each individual management structure. In the case of North Norfolk District Council this is through the Corporate Large Project Board.

6.8 Post project evaluation

Project Evaluation Review (PER) is undertaken and integrated into the Project Management Consultants and Main Works Contract tender and contracts. Following completion of the construction phase a review will be undertaken to evaluate how well the project was managed and delivered compared with expectations. This will include identification of 'quick wins' that may benefit others and will also capture lessons learnt to assist with informing future projects for the contractors and clients.

As construction is expected to take only up to 5 months following deployment, a full evaluation will not be possible after completion of each section of the scheme. However, learning from each section will inform the delivery of latter sections to optimise efficiency in delivery. All learning will ultimately be captured in the PER.

The Project Implementation Review (PIR) will be integrated into the OMM Plan, however it should be noted that this will focus on the statutory requirements for monitoring and review. The OMM Plan will set out the ongoing statutory monitoring requirements and will provide a structure as to what will be assessed, reported and evaluated and by whom. Table 6-6 outlines the key draft activities, timescales and monitoring objectives although these are still to be refined and agreed.

Table 6-6 Key activities, timescales and monitoring objectives

Variables	Method of monitoring	Frequency of measurement	Lead party responsible
Functional – linked to monitoring the protection of the Terminal and Villages that the scheme should deliver, as well as optimising the ongoing maintenance activities			
Topography	Aerial photography	Annual	To be confirmed
	Beach profiles collected by GPS total station	Annual	To be confirmed
	LIDAR survey	Annual	To be confirmed
	Drone survey	2 per year – 1 in autumn (before storm season), 1 in spring (after storm season)	To be confirmed
	E/O topographic survey, collected using quad bike with on board GPS equipment	Monthly, unless additional survey (post storm) is required	To be confirmed
	Laser scan surveys	Annual	To be confirmed
Offshore bathymetry	Bathymetry surveys	Annual	To be confirmed
Nearshore bathymetry	Jetski with GPS/echosounder	2 per year – 1 in autumn (before storm season), 1 in spring (after storm season). This should be undertaken in the same period as land-based surveying.	To be confirmed
Water levels	Full tide bubbler system at Cromer	15 minutes	To be confirmed
Offshore wave data	Met Office hindcast model data	Annual	To be confirmed
Beach sediment composition	Sediment sampling	Annual	To be confirmed
Environmental – linked to the EIA and the requirements from the consenting process			
Coastal processes and geology (Mundesley and Bacton cliffs and shore platforms)	Pre-construction monitoring by an appropriate geology specialist (Quaternary scientist) to record the geological interest at the sites	1 no.	To be confirmed
	Recording geology, vegetation growth and mass movement activity in the area of the cliff affected	Annual	To be confirmed
Benthos, coastal zone	Nearshore scientific dive survey along the coastline to record epi-benthic species present	Estimated 6 dive surveys throughout the dive season – frequency TBC for us to 2 year duration	To be confirmed
Juvenile, fish and epi-benthos	Eastern Inshore Fisheries and Conservation Authority taking ad-hoc randomised whelk samples from fishermen. Measuring and	Monthly - ongoing throughout whelk fishing season (October-March)	EIFCA (Rebecca Treacy) and Richard Clarke (FV Two Boys)

Variables	Method of monitoring	Frequency of measurement	Lead party responsible
	assessing maturity with an aim of providing more scientific basis for setting MLS. Samples received on a monthly basis, first ones taken in January 2018.		
Science – linked to learning from the development of the scheme and relates to the functional and environmental objectives, as well as to topics such as coastal processes, innovative monitoring techniques, socio-economic benefits, governance etc.			
TBC, subject to further discussions			

It is intended that the OMM Plan will be supplemented by a wider reaching research programme operated and managed by a third party. This research programme will seek to co-ordinate wide reaching topics to assist with developing a broad understanding and awareness of the proposed Sandscaping approach. Ultimately this will seek to provide a sound evidence base for which other coastal practitioners in the UK and further afield can draw to shape the future use of this approach. It is likely that the research programme will be far reaching and develop and deliver over the life of the scheme. Ultimately the research programme will be dependent on funding from third parties and suitable funding streams.

6.9 Contingency plans

A key element of this scheme is that it does not rely on continued delivery post construction. Once it has been constructed, natural processes will work to transport the sediment and realise the required benefits.

Immediately pre-construction, there is a risk that beach levels are significantly lower than anticipated and therefore additional volume is required to provide the minimum protection profile at the Terminal frontage. At this point, there would need to be a review of total sediment volumes required and how this translates to cost, and then a review of the volume of sediment being placed at the Villages (i.e. is this still affordable). In the very unlikely event that the Villages element is no longer affordable, the BTC would continue to deliver a standalone scheme to provide the required level of protection to the Terminal, and the GiA and NFM funds would not be claimed. This need for flexibility will be written into the construction contract tender documents.

There is a possibility that part of the project fails, for example the level of protection afforded at the Terminal is not sufficient or does not last as long as expected before renourishment is required, or that beach levels in front of the Villages rapidly decrease following initial placement so that the benefits are lower than expected. The OMM Plan will be critical in identifying these issues at the earliest stage. The scheme is also flexible enough to be adapted. For the Terminal frontage, this might mean undertaking more frequent nourishments or adjusting the minimum protection profile. For the Villages frontage, North Norfolk District Council might need to continue maintenance or patch and repair, or accelerate plans for community adaptation.

There is also a possibility that the scheme has unexpected consequences which lead to third party claims. An appropriate risk allowance has been included within this OBC to account for this risk.

Appendix

A – List of reports produced

Appendix

B – EIA Scoping opinion

Appendix

C – Current defence arrangements

Appendix

D – Letters of support for funding

Appendix

E – Partnership funding calculator

Appendix

F – Project plan

Appendix

G – Communications action plan