Great Yarmouth Third River Crossing

OUTLINE BUSINESS CASE

MARCH 2017

Appendix H – Note on Scheme Costs and Discounting

Norfolk County Council

Great Yarmouth Borough Council

New Anglia Local Enterprise Partnership for Norfolk and Suffolk

Scheme Costs for Economic Appraisal

Project:	Great Yarmouth Third River Crossing	**Date:**	28.03.17
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Subject:	Scheme Costs for Economic Appraisal		
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1.1 Introduction

Total scheme costs for construction, land, preparation and supervision during construction have been estimated.

In addition, an allowance for risk has been calculated from a Quantitative Risk Assessment (QRA).

All costs are presented in 2016 Quarter 3 prices.

Preparation costs that have already been incurred are considered to be sunk costs and therefore do not form part of the appraisal.

Land costs from years 2010 to 2016 are considered to be recoverable and therefore have been included in the economic appraisal allowing for potential Part 1 claims.

The economic appraisal requires that these costs are adjusted to:

- Account for inflation; and
- Reflect Optimism Bias.

The estimation of costs for the scheme has been carried out following the principles set out in WebTAG Unit A1.2. The costs have been estimated under the headings of investment, operating and maintenance costs. The base cost represents the basic costs of the scheme made up of investment, maintenance and operating costs, for a given price base. This includes estimates for construction, land, preparation and supervision. It incorporates a realistic assumption of changes in real costs over time (e.g. cost increases or reductions relative to the rate of general inflation);

1.2 Construction Cost

All costs have been estimated using a 2016 q3 price base and are detailed in Table 1. The total cost exclusive of risk and inflation amounts to **£85,937,088**.

Table 1 - Scheme Cost Estimate

Cost Area	Costs
Construction	
West Section	*£11,464,865*
Bascule Bridge	*£40,012,609*
East Section	*£5,909,159*
Sub-total Construction Cost (Incl. Ancillary Works/Prelims)	**£57,386,633**
Work by Statutory undertakers and others	£3,040,454
Survey/Investigate/Design/Procure/Supervise/Manage & Liaise	£11,400,000
Sub-total including Stats/Others & Design (excl. Land/Risk)	**£71,827,088**
Land	£14,110,000
Total work cost (exclusive of risk)	**£85,937,088**

1.3 Scheme Cost Profile

The revised scheme cost profile based on the current scheme programme is set out in Table 2 and is inclusive of risk.

Table 2 - Scheme Cost Profile

Type	Year							Total
	Prior to 2017/18	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	
Construction	0	0	10.048	1.773	18.226	22.783	4.557	**57.387**
	0%	0%	17.5%	3.1%	31.8%	39.7%	7.9%	
Utilities	0	0	0.456	1.368	1.216	0	0	**3.041**
	0%	0%	15.0%	45.0%	40.0%	0%	0%	
Land	2.700	0.282	0.423	4.233	4.939	0.988	0.545	**14.110**
	18.9%	2.0%	3.0%	30.0%	35.0%	7.0%	3.9%	
Fees	0	1.112	2.223	2.594	3.078	1.995	0.399	**11.400**
	0%	9.8%	19.5%	22.8%	27%	17.5%	3.5%	
Total	**2.700**	**1.394**	**13.150**	**9.968**	**27.459**	**25.766**	**5.501**	**£85.937**

1.4 Adjustment for Inflation

The Cost of planning, building and maintaining the Third River Crossing has been developed through a process of estimation at 2016q3 prices, inflated over the construction period to 2023 and then beyond to 2083, with all costs discounted to 2010 at 2010 prices.

For the Outline Business Case, inflation for the operation and maintenance of the proposed scheme has not been included.

If the 2016 prices are inflated through the construction period based on the Bank of England CPI latest forecasts of general inflation then the following would apply.

Table 3 – Bank of England Inflation Rates

2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
2.40%	2.70%	2.50%	2.40%	2.40%	2.40%

However, construction inflation has previously been assessed and agreed by the Highway Authority, based on an assessment of local contractors' rates, and set at 2% per annum for the years 2013 to 2018.

The Building Cost Information Service (BCIS) and other construction inflation indices show forecast construction inflation to be at a lower level than forecast background inflation from RPI over the short term and therefore the Bank of England inflation rates are considered both realistic and reliable in the context of setting out robust scheme costs for an Outline Business Case. Therefore, the rates as shown in Table 3 have been used to account for inflation in the preparation of the Outturn Scheme Cost as detailed within the Financial Case.

Notwithstanding this position, the cost of the scheme has been modelled in the Economic Case to determine the effect of forecast construction inflation relative to general inflation to take account of the following inflation rates and factors.

Table 4 – General Inflation Factors – Financial Year

Index	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
GDP deflator	1.9%	2.0%	1.9%	2.0%	2.1%	2.2%
General Inflation Rate	2.2%	2.1%	2.1%	2.1%	2.4%	2.4%
Construction Inflation Rate	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%

Table 5 – Proposed Inflation Rates

Index	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Construction Inflation Factor	1.021	1.027	1.034	1.040	1.045	1.048
General Inflation	1.012	1.013	1.015	1.016	1.018	1.020
Other Costs	1.012	1.013	1.015	1.016	1.018	1.020

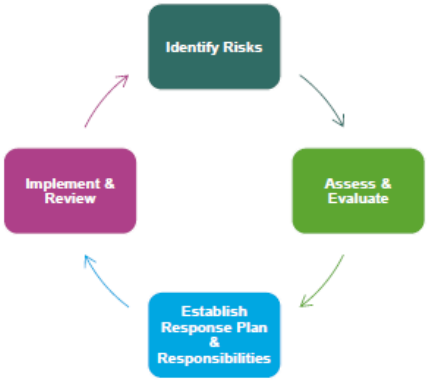
1.5 Adjustment for Risk

The Treasury Green Book states that "effective risk management helps the achievement of wider aims, such as effective change management, the efficient use of resources, better project management, minimising waste and fraud, and supporting innovation".

The process of managing and reviewing a wide range of project risks, and ensuring an appropriate transfer of risk to the contractor, is described more fully in the Management Case.

A four stage risk management process has been followed, as follows:

Figure 1 - The Four Stage Risk Management Process



Risks have been identified by specialists from all relevant disciplines, including highways and structural engineering, geotechnics, marine engineering, navigation and harbour operation, mechanical and electrical, transport planning, quantity surveying and the environmental disciplines.

A Risk Management Workshop was held on 30th January 2017 to consider risks associated with the preferred scheme and to provide up-to-date input to the above process.

Assumptions were tested for stability and sensitivity, and where they were deemed to be unstable, a corresponding risk was assigned and assessed.

Taking a ‘bottom up’ and ‘top down’ approach, the workshop also considered:

- A range of specific risks previously identified by the project team; and
- Risks prompted by consideration of a range of risk categories.

The workshop completed Project and Design Assumption testing using a mind mapping tool.

Risks are catalogued in a Risk and Opportunities Register and were categorised as:

- Strategic and programme;
- Statutory process and planning;
- Design;
- Ecology and archaeology;
- Organisational and human factors;

- Financial and commercial;
- Land;
- Construction;
- Statutory undertakers and third parties; and
- Operational (both highways and port/harbour) and maintenance.

TAG Unit A1.2 requires that all project related risks that may impact on the scheme costs should be identified and quantified in a Quantified Risk Assessment (QRA), in order to produce a risk-adjusted cost estimate.

The range of possible costs associated with each risk was estimated, and each risk was assigned a high, medium or low value. The likelihood of each risk occurring was then estimated, and assigned a high, medium, or low value, both before and, where appropriate, after mitigation.

For each risk, the cost multiplied by its likelihood gives an expected value. Commercial software programme @RISK was used to undertake a Monte Carlo simulation with 1,000 iterations per run, each representing a different risk occurrence scenario in order to determine the probability distribution of the total risk cost for the scheme.

From this distribution, the 85th percentile value was used as an overall estimate of the quantified risk for the scheme. Using this methodology, the 85th percentile value of quantified risk was calculated to be **£25.714m**, at 2016 Q3 prices. This represents 29.92% of the non-adjusted base cost.

The risk adjusted total cost at 2016 prices is shown in Table 6. The total base cost including risk amounts to **£111,651,306**.

Table 6 - Risk Adjusted Cost

	Capital Cost 2016 Q3 prices (£)
Base cost at 2016 q3 prices	85,937,088
Quantified Risk (85th percentile value)	25,714,218
Risk-adjusted Base cost at 2016 Q3 prices	**111,651,306**

1.6 Present Value

In line with TAG Unit A1.1 Cost Benefit Analysis and Unit A1.2 Scheme Costs, all future investment and operating costs, estimated over the appraisal period, should be converted to Present Value Cost (PVC).

This initially involves the following key steps, before finally arriving at market costs:

- Re-basing to the DfT's current Base Year;
- Discounting to the DfT's current Base year; and
- Converting costs to Market Prices.

1.6.1 *Re-basing*

TAG Unit A1.1 Cost Benefit Analysis explains that, when applying monetary values to impacts over a long appraisal period, it is very important to take the effects of inflation in to account. Failure to do so, would distort the results by placing too much weight on future impacts, where values would be higher simply because of inflation.

For Cost Benefit Analysis purposes, all values should be in real prices (including inflation) to stop the effects of inflation distorting the results. To convert nominal prices (not including inflation) to real prices, a price base year and an inflation index are needed.

The real price in any given year is then the nominal price deflated by the change in the inflation index between that year and the Base year (2010).

The GDP price deflator[1] contained in the TAG data book has been used to convert prices from the 2016 q3 price year base to 2010 costs (2010 index = 100, 2016 = 110.01).

1.6.2 *Discounting*

TAG Unit A1.1 outlines that all monetised costs (and benefits) arising in the future need to be adjusted to take account of 'social time preference', that is peoples preference to consume goods and services now, rather than in the future. The technique used to perform this adjustment is known as discounting.

A discount rate which represents the extent to which people prefer current over future consumption, is applied to convert future costs (and benefits) to their present value which is the equivalent value of a cost (or benefit) in the future occurring today.

As such, the cost estimate has been discounted to the DfT's Base year (2010) using the discount rates outlined in the current TAG Data book.

Table 7 - Discount Rates

Years from current year	Discount rate
0-30	3.50%
31-75	3.00%
76-125	2.50%

[1] https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/mnf2

1.6.3 Market Prices

The final stage in preparing the cost for appraisal is to convert the aggregate scheme cost from the 'factor cost' to the 'market price' unit of account using the Webtag indirect tax correction factor of 1.19, which reflects the average rate of indirect taxation in the economy.

1.7 Infrastructure Operating and Maintenance Cost

The assessment of traffic related maintenance costs focuses on the plan for non-routine reconstruction and resurfacing of the carriageway. The aim of the process is to calculate the net maintenance and operating cost impact of the scheme to ensure that this is robustly captured in the present value of costs.

It is assumed that major maintenance would take place every few years for resurfacing of the new built sections of carriageway and for reconstruction works.

Operating costs of the Bridge structure are known, and professional experience of similar infrastructure has informed the costs associated with the operation and maintenance activities. For these reasons an additional 'risk' factor has not been applied to the Operation and Maintenance tasks.

At the Outline Business Case stage, the exact profile of maintenance spend has to be confirmed but because this is a bridge structure that requires constant operation, the assumed maintenance profiles for both the bridge and the roads have been calculated over a 60 year period and then combined with the bridge operating costs to arrive at an average annual cost.

Inflation has not been applied to maintenance and operation costs due to the uncertainty in forecasting economic conditions far in the future.

1.7.1 Bridge Maintenance Cost

The through-life maintenance cost of the bridge has been calculated at a 2016 q3 price base.

The elements included within this cost are:

- Routine servicing costs;
- Exceptional repairs and maintenance; and
- Refurbishment.

The total cost of bridge maintenance is **£1.027m** (2010 prices).

1.7.2 Road Maintenance Cost

The total cost of Road Maintenance equates to **£0.977m** over the 60 year appraisal period (2010 prices).

1.7.3 Bridge Operating Cost

The daily operating cost of the bridge has been calculated from a 2016 Q3 price base, giving a total cost of **£1.502m** (2010 prices) over a 60 year appraisal period.

1.8 Optimism Bias

In line with the guidance in TAG Unit A1-2, an allowance for Optimism Bias has been applied to all costs. The allowance is designed to compensate for the systematic tendency for appraisers to be overly optimistic about key parameters.

The Treasury Green Book (HMT, last updated in November, 2016) suggests that appraisers should make explicit, empirically based adjustments to the estimates of costs, and TAG provides recommended adjustment factors based on the project category and stage of development.

The relevant project types identified in guidance are:

- Fixed link (bridges and tunnels); and
- Roads (Motorways, Trunk Roads, local roads, cycle and pedestrian facilities etc).

The proposed scheme comprises a Bascule bridge and the approach roads (with cycle and pedestrian facilities) connecting the bridge to the local highway network.

Examination of the basic construction cost estimates shows that the proportion of total scheme cost attributable to each part of the scheme is:

- Bascule bridge (69.7% of total scheme cost); and
- Roads (30.3% of total scheme cost).

These proportions have been used to calculate the overall allowance for Optimism Bias.

As a project develops, the scheme cost estimate is expected to be refined, based on better quality data.

Then as project-specific risks become better understood, quantified sand valued, the factors that contribute to Optimism Bias are better captured within the risk management process.

Therefore, as risk analysis improves it is expected that the risk-adjusted scheme cost estimate will become more certain, whilst the applicable level of Optimism Bias will decrease.

TAG Unit A1-2 states that the allowance for Optimism Bias should be largest at the initial stage of the life of a transport project (Strategic Outline Business Case), should

decrease in a more detailed Business Case (Outline Business Case), and be smallest in the presence of a fully detailed business case (e.g. Full Business Case).

The recommended Optimism Bias uplifts for each stage of a transport project (with the weighted average based on construction cost for the proposed scheme) are listed in Table 8.

Table 8 - Levels of Optimism Bias

Stage Category	Stage 1 "Programme entry"	Stage 2 "Conditional approval"	Stage 3 "Full approval"
Fixed link (bridge)	66%	23%	6%
Roads	44%	15%	3%
Weighted average	*59%*	*21%*	*5%*

The guidance in TAG Unit A1-2 does not give an exact equivalence between the above stages and the three levels of business case approval. However, the DfT guidance 'The Transport Business Cases' identifies three phases of scheme development (Figure 2).

Figure 2 - Stages of Scheme Development

The refined scheme costs are now submitted to support an Outline Business Case, and have been prepared in support of a bid for DfT investment in the scheme. The next and final stage will be the submission of a Full Business Case.

This Outline Business Case develops the scheme which was first identified in the successful 2016 Application for Scheme Development Funds (Local Majors Bid).

This, together with a detailed Options Appraisal Report, included most of the material normally provided for a Strategic Outline Business Case, and was based on outline scheme designs and cost estimates.

The Optimism Bias used was 65%, reflecting the level of uncertainty at that initial stage of scheme development.

For the preparation of the Outline Business Case:

- The option assessment process was developed further, to identify a single preferred option

- The bridge and highways elements of the scheme have been subject to a significantly more detailed level of design
- A more detailed estimate of costs has been prepared
- A full quantified risk assessment (QRA) has been undertaken, including a risk identification work shop and statistical calculations of volume and cost risks for individual project components

This detailed QRA has been undertaken at an 85th percentile level of certainty, meaning that the costs are expected to be within the calculated risk allowance in all but 15% of cases.

The total quantified risk has been assessed at **£25.714m** (29.9% of the Base cost of the scheme). The base costs also include allowances for estimating uncertainty.

This robust approach to scheme design, cost estimation and quantified risk assessment gives a high degree of confidence in the risk-adjusted cost estimates and for this reason the allowances for optimism have been reduced to the Stage 2 levels with 23% for the fixed link and 15% for the road elements.

A weighted average has been calculated, based on the proportions of bridge and road costs (69.7:30.3) and therefore the economic assessment has used an Optimism Bias of 21%, applied to the total risk-adjusted costs.

Sensitivity tests have also been undertaken with a higher allowance for Optimism Bias of 40% and represents a mid-point between the Stage 1 and Stage 2 values. A weighted average for the Stage 1 Optimism Bias sensitivity test indicates a value of 59%.

The purpose of allowing for Optimism Bias is to ensure that the cost-benefit analysis is robust.

The Present Value of Cost relative to the level of Optimism Bias used in the Core Scheme and its sensitivity tests is shown in Table .

Table 9 - Present Value of Cost at levels of Optimism Bias (£m)

Optimism Bias	21%	40%	59%
Present Value of Cost	111.563	128.426	145.289

1.9 Summary

Table 10 summarises the construction and operating costs in the Financial appraisal which have been adjusted to 2010 prices and values over the 60 year appraisal period.

Table 10 - Summary of Scheme Costs (£m) – Financial Appraisal

Component	Cost	Price Base
Construction	60.427	2016 Q3
Land	14.110	2016 Q3
Other Fees	11.402	2016 Q3
Sub-Total	**85.937**	**2016 Q3**
Risk	25.714	2016 Q3
Risk adjusted sub-total	**111.651**	**2016 Q3**
Inflation adjusted Sub-Total	**122.610**	**2016 Q3**
Outturn cost	**122.610**	**2016 Q3**
Outturn cost exc. land purchase pre-2017	**119.910**	**2016 Q3**

Table 11 presents the derivation of the Present Value of Cost (PVC) for the Economic appraisal.

Table 11 - Summary of Scheme Costs (£m) - Economic Appraisal

Component	Cost	Price Base
Construction	60.427	2016 Q3
Land	14.110	2016 Q3
Other Fees	11.402	2016 Q3
Sub-Total	**85.937**	**2016 Q3**
Inflation Adjusted Sub-Total	88.698	2016 Q3
Risk Adjusted Sub-Total	114.817	2016 Q3
Optimism Bias (21%) Adjusted Sub-Total	138.929	2016 Q3
Total Present Value of Investment Cost	**107.391***	**Discounted to 2010 at 2010 prices**
Total Present Value of Operation and Maintenance Costs	**4.172***	**Discounted to 2010 at 2010 prices**
Total PVC	**£111.563***	**Discounted to 2010 at 2010 prices**

** converted to Market Prices*