

# Great Yarmouth Third River Crossing

---

OUTLINE BUSINESS CASE

MARCH 2017

Appendix F – Risk Register and QRA

# Great Yarmouth Third River Crossing

## Risk Register and Quantified Risk Assessment

March 2017

*Produced For*  
Norfolk County Council

## Document Control Sheet

Project Title            Great Yarmouth Third River Crossing

Report Title            Quantified Risk Assessment– March 2017

Revision                1

Status                    Final

Control Date            March 2017

### Record of Issue

| Issue | Status | Author | Date       | Check | Date       | Authorised | Date      |
|-------|--------|--------|------------|-------|------------|------------|-----------|
| 1.0   | Final  | RSC    | 13/03/2017 | JL    | 22/03/2017 | JL         | 24/3/2017 |
|       |        |        |            |       |            |            |           |

### Distribution

| Organisation | Contact | Copies |
|--------------|---------|--------|
|              |         |        |
|              |         |        |

*This Report is presented to Norfolk County Council in respect of the 'Risk Strategy for the Great Yarmouth Third River Crossing and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this Report.*

*Notwithstanding anything to the contrary contained in the Report, Mouchel Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by Norfolk County Council and Mouchel Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.*

*This report has been prepared by Mouchel Limited. No individual is personally liable in connection with the preparation of this Report. By receiving this Report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.*

# Contents

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>Introduction .....</b>  | <b>1</b>  |
| 1.1      | Risk Review Process.....   | 1         |
| 1.2      | Structure.....   | 1         |
| <b>2</b> | <b>Risk Management.....</b>  | <b>2</b>  |
| 2.1      | Project Risk Identification .....  | 2         |
| 2.2      | Project Risk Assessment.....   | 3         |
| 2.3      | Strategic Risk Identification .....                                      | 5         |
| <b>3</b> | <b>GYTRC Project Risks .....</b>   | <b>6</b>  |
| 3.1      | Major Risks.....   | 6         |
| <b>4</b> | <b>GYTRC Strategic Risks.....</b>  | <b>7</b>  |
| 4.1      | Strategic Risks .....  | 7         |
| <b>5</b> | <b>Quantified Risk Assessment.....</b>                                   | <b>8</b>  |
| 5.1      | Overview .....   | 8         |
| 5.2      | Assessment.....  | 8         |
| <b>6</b> | <b>Summary .....</b>   | <b>14</b> |
| 6.1      | Overview .....   | 14        |
| 6.2      | GYTRC Quantified Risk Allowance .....                                    | 14        |
| 6.3      | Next Steps.....  | 14        |
|          | <b>Annex A: GYTRC Risk Register Core Scheme .....</b>                    | <b>15</b> |
|          | <b>Annex B: Quantified Risk Assessment Output Core Scheme.....</b>       | <b>16</b> |
|          | <b>Annex C: GYTRC Risk Register Sensitivity Test.....</b>                | <b>17</b> |
|          | <b>Annex D: Quantified Risk Assessment Output Sensitivity Test .....</b> | <b>18</b> |

## Tables

|  |    |
|--|----|
| Table 1-1 – Project Life Cycle Risk Review Stages..... | 1  |
| Table 2-1 – The Risk Matrix.....                       | 4  |
| Table 2-2 – Probability Impact Grid .....              | 4  |
| Table 2-3 – Addressing Risk Aspects.....               | 5  |
| Table 3-1 – GYTRC Major Risks .....                    | 6  |
| Table 4-1 – GYTRC Major Strategic Risks .....          | 7  |
| Table 5-1 – GYTRC Cost Risks.....                      | 8  |
| Table 6-1 – GYTRC Quantified Risk Allowance .....      | 14 |

# 1 Introduction

The purpose of this report is to confirm the approach to the risk review process for the Great Yarmouth Third River Crossing (GYTRC) Scheme and present a strategy for the management of risks as the scheme progresses.

The report sets out the process adopted to identify, assess and manage the risks associated with the following two areas:

1. **Project Risks:** Those affecting the delivery and cost of the GYTRC scheme; and
2. **Strategic Risks:** Those affecting the ability of the Norfolk County Council (NCC) to deliver the wider GYTRC programme.

## 1.1 Risk Review Process

The risk management, assessment and identification processes outlined within this document are continuous and all mitigation measures are regularly reviewed. As such the following table details the stages in the life of the project where risks will be assessed and reviewed. To date the GYTRC project risks have been reviewed during Stage 1/2.

*Table 1-1 – Project Life Cycle Risk Review Stages*

| Project Stage | Description   |
|---------------|---|
| 1/2           | Business justification / Delivery strategy                  |
| 3a            | Investment decision (statutory procedures and powers stage) |
| 3b            | Investment decision (construction preparation stage)        |
| 4             | Readiness for service                                       |
| 5a            | Operational review and benefits realisation                 |
|               |   |

## 1.2 Structure

The remainder of this document is structured as follows:

- Section 2 provides an overview of the methodology and systematic approach used to assess risk throughout all stages of the project;
- Section 3 outlines the significant project risks to the GYTRC delivery or budget;
- Section 4 details the significant strategic risks to the delivery of the wider GYTRC project; and
- Section 5 provides a summary and details of the next steps in terms of risk management.

## 2 Risk Management

### 2.1 Project Risk Identification

**A Project Risk Register** has been developed to consider the risks associated with the delivery of the scheme. The register logs risks identified during the planning and design phases and outlines any unrealised issues that have the potential to adversely impact the scheme delivery programme and cost.

The risk register is a live document and has been in place since the GYTRC preferred options report stage. It was initially updated on an ad hoc basis and then through the more formal risk workshops (involving technical experts from Mouchel) undertaken during February of 2017.

The aims of the risk workshops were as follows:

- To update the risk register;
- To agree the probability, cost and time impact of risks; and
- Where possible, to assign responsibility to risks.

As discussed in this document, this allows for the management of risks going forward and allows the Optimism Bias (OB) associated with the scheme to be replaced, in part, with a quantified risk allowance (note that optimism bias will still be used to inform the scheme economic appraisal as per DfT WebTAG guidelines).

Initially the cost estimates contained a generic risk allowance of 25% (prior to any quantified risk assessment) and would have attracted the higher levels of OB associated with Stage 1 which, for this combined highways and structures scheme, would be around 60%.

Following the risk workshops undertaken in 2017, a quantified risk assessment (QRA) for the scheme has been completed (note that separate registers have been prepared for the core scheme and for the sensitivity test which includes improvements to the Harfreys junction). This has allowed the risk and OB allowances described above to be replaced with separate, updated values, which account for the additional design work and risk identification which has taken place since the initial cost estimates were prepared. For example, the highway scheme has been developed to a sufficient level of detail to enable a Stage 1 Road Safety Audit to be undertaken.

The risk workshops involved:

- undertaking a review of the existing risks contained within the risk register;
- consideration of new and emerging risks; and

- consideration of appropriate mitigation and the degree to which the risk remains in terms of both probability and impact.

Each risk was classified and grouped into one of the following areas:

- Engineering – including scheme design, structures and earthworks;
- Planning & Site Supervision – including legal/statutory processes, site supervision, policy changes and overall programme;
- Delivery – including funding, policy, planning, and stakeholder consultation;
- Statutory Undertakers – including unforeseen statutory services and delivery programme risks;
- Environment – including contaminated land, construction phase impact, and protected species discoveries;
- Ground Conditions – including land drainage and unforeseen ground conditions; and
- Contractual/ Construction - including adverse weather, programme delays and resource issues.

The scope of the risk register is all risks associated with the planning, funding, design and construction of the Great Yarmouth Third River Crossing.

## **2.2 Project Risk Assessment**

All risks within the register are assessed and classified across three areas: the probability of the risk occurring and the most likely impact on costs and time which would arise if the risk did occur. The register assesses all risks across the three areas using the evaluation scale detailed in Table 2-1. The register then qualifies each of the risks based on the combination of the likelihood of occurrence and the impact. The probability impact grid is shown in Table 2-2 and determines if the risk category is low, medium or high based on the red-amber-green (RAG) assessment.



Table 2-1 – The Risk Matrix

| The Risk Matrix                           |           |  |           |                |                         |  |          |          |                |    |    |
|---|-----------|--|-----------|----------------|-------------------------|--|----------|----------|----------------|----|----|
|   |           | Overall Risk =<br>Impact x Probability |           | PROBABILITY →  |                         |  |          |          |                |    |    |
|   |           | HIGH RISK                              |           |                | Negligible              | Unlikely   | Possible | Probable | Almost Certain |    |    |
|   |           | MEDIUM RISK                            |           |                | Very Low                | Low  | Medium   | High     | Very High      |    |    |
|   |           | LOW RISK                               |           |                | <5%                     | 6-20%  | 21-50%   | 51-80%   | >80%           |    |    |
|   |           |  |           |                |                         | ①  | ②        | ③        | ④              | ⑤  |    |
| IMPACT →                                  | > 5%      | > £1m                                  | > 20%     | Major          | Very High / Showstopper | ⑤  | 5        | 10       | 15             | 20 | 25 |
|   | 3 to 5%   | £100k - £1m                            | 10 to 20% | Large          | High                    | ④  | 4        | 8        | 12             | 16 | 20 |
|   | 1 to 3%   | £10k - £100k                           | 5 to 10%  | Moderate       | Medium                  | ③  | 3        | 6        | 9              | 12 | 15 |
|   | 0.5 to 1% | £1k - £10k                             | 1 to 5%   | Minor          | Low                     | ②  | 2        | 4        | 6              | 8  | 10 |
|   | < 0.5%    | <£1,000                                | < 1%      | Minimal        | Very Low                | ①  | 1        | 2        | 3              | 4  | 5  |
| Cost as % of Project cost (not just fees) |           | Time                                   | Quality   | Overall IMPACT | Score                   | Cost / time and quality may be affected differently by a single risk. If overall risk is required, use the most severe affected component or give consideration to managing each separately. |          |          |                |    |    |

Table 2-2 – Probability Impact Grid

|             |     |     |    |    |    |    |    |
|-------------|-----|-----|----|----|----|----|----|
| PROBABILITY | VH  | 0   | 5  | 10 | 15 | 20 | 25 |
|             | H   | 0   | 4  | 8  | 12 | 16 | 20 |
|             | M   | 0   | 3  | 6  | 9  | 12 | 15 |
|             | L   | 0   | 2  | 4  | 6  | 8  | 10 |
|             | VL  | 0   | 1  | 2  | 3  | 4  | 5  |
|             | Nil | 0   | 0  | 0  | 0  | 0  | 0  |
|             |     | Nil | VL | L  | M  | H  | VH |
| COST IMPACT |     |     |    |    |    |    |    |

During the risk workshops undertaken in Q1 2017, the probability, cost and time impacts were reviewed for each existing risk and the register amended accordingly. The workshops involved a review of the proposed risk mitigation and assessed whether it remained valid and appropriate. The workshops also involved the identification of any new or emerging risks, assessing them using the same criteria and assigning any appropriate mitigation measures.

The process adopted for outlining such mitigation measures follows the approach proposed within the HM Orange Book<sup>1</sup> as summarised in Table 2-3.

<sup>1</sup> HM Treasury, 2004. *The Orange Book: Management of Risk - Principles and Concepts* [online]. [Accessed on 27 May 2011]. Available from: [http://www.hm-treasury.gov.uk/d/orange\\_book.pdf](http://www.hm-treasury.gov.uk/d/orange_book.pdf)

Table 2-3 – Addressing Risk Aspects

| Aspect           | Applicable for  | Action  |
|------------------|---|---|
| <b>Tolerate</b>  | Risks which mitigation opportunities are limited or which the cost of any mitigation measure is disproportionate to the risk the measure is designed to control | Risk tolerated and no further action taken                            |
| <b>Transfer</b>  | Risks linked to construction works that can be transferred to contractor or risks that can be covered by insurance  | Appropriate clauses included to contract to ensure risk transfer      |
| <b>Terminate</b> | Risks that can be eliminated by incorporating changes to the scheme design  | Scheme design amendments as appropriate                               |
| <b>Treat</b>     | All other risks   | Mitigation actions taken to constrain the risk to an acceptable level |

### 2.3 Strategic Risk Identification

The identification and recording of strategic risks follows the same format and process as the programme risks. However, as these are judged to impact the ability of LCC to deliver the wider programme as opposed to impacting on the scheme costs, they are not included in the quantified risk assessment.

The strategic risks were reviewed at the Q1 2017 workshops with the new risks added to the risk register. The major strategic risks are detailed in Section 4.

## 3 GYTRC Project Risks

### 3.1 Major Risks

The core scheme Risk Register contains 50 current risks. The table below summarises those risks with an overall risk ranking of 'High' or 'Very High', i.e. with a ranked score of 15 or over, as shown on the latest version of the risk register which was taken forward for quantified assessment, found in **Appendix A**.

Table 3-1 – GYTRC Major Risks

| Hazard/Risk Name  | Probability | Cost Impact | Overall Risk Rank | Mitigation/ Risk Reduction Measures / Other Comments   |
|---|-------------|-------------|-------------------|--|
| Failure to secure funding in time to commence construction in 2020          | 3           | 5           | 25                | Delays to programme whilst priority is agreed<br>Integration activities between scheme planners at extra cost1.<br>Unknown surrounding planned schemes<br>2. Access and road closure permissions |
| Local funding contributions may be withheld                                 | 1           | 5           | 25                | 1. Higher priority work<br>2. Lack of funding<br>3. Lack of confidence in scheme benefit   |
| Unforeseen archaeological finds   | 4           | 4           | 16                | Increased cost to protect and remove (where applicable)<br>Schedule delays   |
| Environmental contamination is uncovered on the land                        | 3           | 5           | 15                | Additional cost for testing and treating and removal   |
| Sediment and transportation - Narrowing may alter sediment transport regime | 5           | 3           | 15                | Increased dredging requirements of operator<br>Potential compensation  |

# 4 GYTRC Strategic Risks

## 4.1 Strategic Risks

The table below summarises the major strategic risks to the GYTRC programme. As defined in Section 1, strategic risks are those which affect the ability of NCC to deliver the GYTRC programme, as opposed to impacting on the scheme

Table 4-1 – GYTRC Major Strategic Risks

| Risk Type          | Risk Description<br>There is a risk that .....                     | Mitigation/ Risk Reduction Measures / Other Comments   |
|--------------------|--|--|
| Strategic / Policy | Failure to secure funding in time to commence construction in 2020 | Delays to programme whilst priority is agreed<br>Integration activities between scheme planners at extra cost <sup>1</sup> . Unknown surrounding planned schemes<br>2. Access and road closure permissions |
| Strategic / Policy | Local funding contributions may be withheld                        | 1. Higher priority work<br>2. Lack of funding<br>3. Lack of confidence in scheme benefit   |

## 5 Quantified Risk Assessment

### 5.1 Overview

Following the three risk validation workshops the risk register for the core scheme was finalised (see **Annex A**) for this stage of the project and used to undertake a quantified risk assessment. The register for the sensitivity test is in Annex C.

The impact of each risk identified within the register has also been quantified and an overall risk value calculated using the Palisade @RISK analysis software. The purpose of which is to provide a robust risk value that can be included within the overall scheme cost estimate. The @RISK software performs risk analysis using Monte Carlo simulation, importantly this method is considered robust and is recommended by DfT<sup>2</sup>.

### 5.2 Assessment

The results of the quantified risk assessment for the core scheme are summarised below and in **Annex B**. Annex D contains the results for the sensitivity test.

Table 5-1 – GYTRC Cost Risks

| Risk ID | Description   | Expected impact   | Risk Rank | At Risk output value |
|---------|---|---|-----------|----------------------|
| F2      | Environmental contamination is uncovered on the land                                  | Additional cost for testing and treating and removal  | 15        | 2,891,822.43         |
| P4      | Unforeseen archaeological finds   | Increased cost to protect and remove (where applicable)<br>Schedule delays  | 16        | 1,335,609.33         |
| C17     | Variation between actual site conditions and assumptions used in design               | risk more expansive ground works  | 12        | 1,272,207.78         |
| C10     | Inability to achieve perpendicular to the river channel                               | Re-design, rework and time related cost impact  | 8         | 1,267,573.49         |
| P7      | Integration with existing bridge communications and networking may become problematic | Increase to cost to make the systems operational<br>More design to understand interface issues<br>Delays whilst solution is found | 9         | 929,451.87           |

<sup>2</sup> DfT, 2011. TAG Unit 3.5.9: The Estimation and Treatment of Scheme Costs [online]. [Accessed on 27 May 2011]. Available from: <https://www.gov.uk/government/publications/webtag-tag-unit-a1-2-scheme-costs>

|     |   |   |   |            |
|-----|---|---|---|------------|
| C14 | Client may require bridge design for heavy loads                                  | Additional funds required. Re-design and delays to plan implementation  | 6 | 886,551.75 |
| C13 | Departures may not be granted   | Redesign<br>Increased costs<br>Delays   | 9 | 870,254.88 |
| P13 | Construction disrupts sediment  | Objections from EA. Project on hold or activities curtailed. Increased costs. Claims  | 9 | 861,080.36 |
| G6  | Port is found to have services eg fibre optics in place not previously known      | Increased costs<br>Delays   | 9 | 771,947.64 |
| P12 | Access may become problematic during construction                                 | Potential delays. Cost increase   | 9 | 747,975.35 |
| O2  | Land may be required for compensation   | Increased cost associated with land acquisition<br>Compensation   | 6 | 746,287.26 |
| O3  | Risk of mine workings in or around scheme location                                | Increased costs.<br>Delay to plan   | 6 | 717,157.71 |
| O4  | Services may be uncovered above the levels assumed in the estimate                | Increased cost<br>Delays to activities whilst services are addressed  | 9 | 706,004.41 |
| C1  | The size of the bridge design may be increased from a 50M tie-in                  | 1. Client change to specification<br>2. New information shows an increase is needed in order to accommodate additional vessels<br>3. Stakeholder concerns that the bridge may open more frequently if certain size of vessel can not move through | 9 | 704,238.67 |
| P8  | Adverse weather conditions less than 1 in 10 year storm                           | Delays to ground works<br>Complaints<br>Compensation for contractors  | 9 | 700,710.26 |
| C8  | Project location may extend to wider area residential area than first anticipated | Increased costs to residents impacted. More relocation required. Associated delays  | 6 | 655,938.06 |

|     |  |   |    |            |
|-----|--|---|----|------------|
| N1  | Sediment and transportation - Narrowing may alter sediment transport regime        | Increased dredging requirements of operator<br>Potential compensation   | 15 | 638,895.68 |
| D1  | Adverse weather conditions greater than 1 in 10 year storm                         | Delays to ground works<br>Complaints<br>Compensation for contractors  | 9  | 619,416.43 |
| P14 | Suds drainage  | increase in drainage requirements   | 9  | 583,385.60 |
| G1  | Access may become problematic pre construction for stats diversion                 | Potential delays. Cost increase   | 9  | 480,723.92 |
| I1  | Existing quay walls may be compromised near the approach embankments by the scheme | Weight and engineering in the scheme design.  | 2  | 333,783.04 |
| C7  | Quay walls may prove unsuitable for assumed design                                 | Exact parameters of quay walls not yet fully understood   | 4  | 332,661.22 |
| G8  | Utility relocation cost/risk/timescale   | Increased costs   | 4  | 325,342.78 |
| C15 | Inability to make knuckle work at 45 degrees                                       | Potential re-design.<br>Increased cost of construction<br>Objection from ports<br>Compensation for loss of land use | 6  | 325,064.68 |
| K2  | Tender - Limited interest in construction tender                                   | higher than expected tenders  | 4  | 297,347.82 |
| F4  | invasive species may be found to be present in location of project                 | Additional cost for testing and treating and removal  | 4  | 294,633.87 |
| C9  | Objections to Bascule Bridge design may transpire                                  | Re-design. Programme slippage. Reputational damage  | 4  | 276,554.77 |
| B2  | Planning process results in unexpected planning condition being imposed            | Delays<br>Renegotiation<br>Increased cost to meet condition   | 6  | 276,303.09 |
| K1  | Tender - Challenge to tender process   | Delays to schedule  | 6  | 265,035.51 |
| O5  | Unknown buried structures  | Increased cost<br>Delays to activities  | 4  | 262,802.40 |
| P2  | Presence of soft ground around the approach embankments is uncovered               | 1. Type of ground is assumed as stable<br>2. Weather / floods   | 4  | 261,996.02 |

|     |   |   |   |            |
|-----|---|---|---|------------|
| P3  | Potential for unexploded ordinance  | Delay in start of the scheme<br>Analysis and study<br>Removal costs   | 6 | 253,169.51 |
| C18 | Additional land following redesign  | Need to buy land  | 2 | 248,170.79 |
| P11 | Supplier may underperform   | Delays<br>Renegotiation<br>Increased cost to meet condition   | 4 | 246,401.97 |
| P5  | Complaints to the project and stakeholders due to noise                               | Change to working hours resulting in delays<br>Damage to reputation as work cannot complete to schedule   | 6 | 243,549.95 |
| H1  | River levels raise and leading to flooding  | Increased costs   | 4 | 240,226.88 |
| G7  | Increase cost of power supply to bridge   | Increased costs   | 4 | 239,963.13 |
| F1  | Endangered species may be found to be present in location of project                  | Make area safe for endangered species<br>Relocate where applicable<br>Schedule relocation at suitable time<br>Delays to project and associated cost for rehoming and delays | 6 | 233,570.80 |
| P10 | Vandalism to project or project property may occur                                    | Increased costs to secure area<br>Increased costs for repair and replace  | 4 | 227,508.87 |
| P9  | Protestors to the project may physically stop work                                    | Delays to project   | 2 | 221,606.37 |
| M1  | Specialist materials / equipment for bridge may not be ready available                | increase cost and time  | 4 | 219,945.73 |
| L1  | Changes in legislation or regulation  | Increased costs<br>Delays to schedule   | 6 | 214,293.26 |
| G2  | Land value may increase   | Cost increase. Delays whilst land value negotiations take place   | 2 | 210,973.03 |
| C2  | Port operations and development plans are incompatible with preferred bridge location | 1. Port operators deem operations will be impacted by scheme introduction<br>2. Plans for development of the area mean bridge cannot be located as scheme scope assumes     | 2 | 150,509.82 |



|     |  |   |   |            |
|-----|--|---|---|------------|
| P6  | Construction of the bridge may be perceived as causing damage to the environment           | Increase cost<br>Protests<br>Reputational damage  | 2 | 139,735.85 |
| G5  | Potential inability to make Suffolk road 2 way in the future                               | Re-design. Substantial growth in cost. Plan slippage to incorporate new activities        | 1 | 133,955.42 |
| C16 | May be unable to achieve safe NMU facilities with identified land                          | May not be resolved until safety audit complete<br>Potential delay<br>Increased cost      | 1 | 116,479.90 |
| J1  | Change to employer/ designer team members  |   | 1 | 100,765.28 |
| G4  | King centre owner may object to the scheme   | Potential delays. Cost increase to agree a more acceptable 'look'.<br>Reputational damage | 2 | 85,814.41  |
| B4  | DOC statutory process/ High court challenge  | DOC statutory / High court challenge process goes on longer than expected                 | 1 | 77,730.83  |
| P17 | Requirements to allow continued access by river vessels                                    | Changers to access by river vessels requirement's during construction                     | 4 | 67,343.56  |
| B5  | Risk arising from land acquisition   | unwillingness to sell, delays in CPO process  | 1 | 63,823.96  |
| P15 | urban design works changes due to on site not being as assumed                             | on site conditions make installation more difficult                                       | 9 | 57,966.18  |
| C4  | DfT may not accept traffic modelling used for assessment and economic appraisal            | 1. Inability to support the findings extra modelling work and delay                       | 1 | 57,802.93  |
| P16 | Requirements for additional traffic management   | Changers to TM requirement's during construction  | 4 | 55,917.11  |
| P18 | Temporary availability of land for compounds, staging areas, etc.                          | increase as compound would not be local to site   | 1 | 49,490.16  |
| C3  | The assumed speed / impact force of vessels used to inform the design may prove inaccurate | 1. Incorrect information provided<br>2. Vessel speed increases<br>3. Poor calculations    | 3 | 41,188.85  |
| F3  | Lack of access to undertake environmental surveys  | 1. Land owners restrict access<br>2. Port restricts access                                | 4 | 40,213.40  |

|     |   |  |   |           |
|-----|---|--|---|-----------|
| P1  | There may a requirement for construction work in the river channel requirement for floating plant | The assumed river work has not been accommodated in the base estimate IE floating plant                    | 4 | 15,708.79 |
| C20 | Need to make late changes to design for planning reasons  |  | 2 | 5,426.28  |
| C19 | Changes in junction design  | where the crossing joins South Denes, where it crosses Southtown and where it hits the Harfreys roundabout | 2 | 5,327.35  |
| C21 | Unexpected aesthetic requirements   |  | 2 | 4,348.33  |
| C11 | Inability to achieve acceptable gradients   | Project may be forced to accept steeper gradient and be non-compliant with legislation                     | 4 | 3,360.98  |
| C6  | Variation between actual site conditions / topo and assumptions used in design                    | 1. lack of scope definition  | 4 | 3,170.27  |

## 6 Summary

### 6.1 Overview

This report demonstrates that a structured and systematic process is being employed to identify, assess and manage risks for the GYTRC Scheme. The process is robust and based on an accepted methodology and ensures that the uncertainty associated with the scheme delivery is effectively managed. It provides a clear understanding of the risks inherent in the scheme and their likely impact.

The use of Monte Carlo analysis through the @RISK software provides a robust quantification of the risk, allowing the potential impact to be considered as part of the overall scheme cost estimate.

### 6.2 GYTRC Quantified Risk Allowance

The base cost estimate for the scheme does not include any specific quantified contractor’s risk due to the early stage of the scheme assessment, however the quantified risk value does included for contractors risk and Optimism Bias has been applied which is considered to be sufficient to cover this risk.

The total GYTRC quantified risk allowance following the review process described in this document is as follows:

*Table 6-1 – GYTRC Quantified Risk Allowance*

| Risk Value            | @Risk Value (£m) |
|-----------------------|------------------|
| Quantified Risk Value | £25,714          |

### 6.3 Next Steps

The next risk review will be undertaken prior to the Gateway 3a Investment decision (statutory procedures and powers stage).

*We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available. Having issued the range of conclusions it is for the client to decide how to proceed with this project.*

## Annex A: GYTRC Risk Register Core Scheme

Project Risk, Issue and Opportunity Register

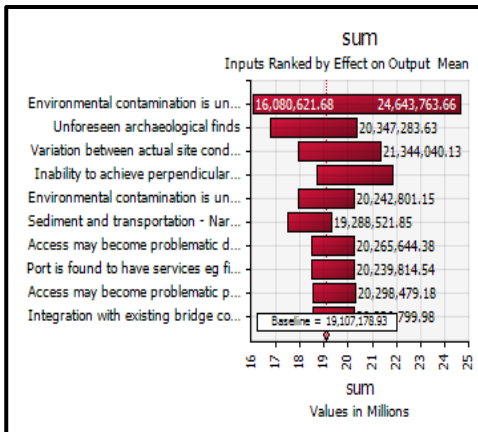
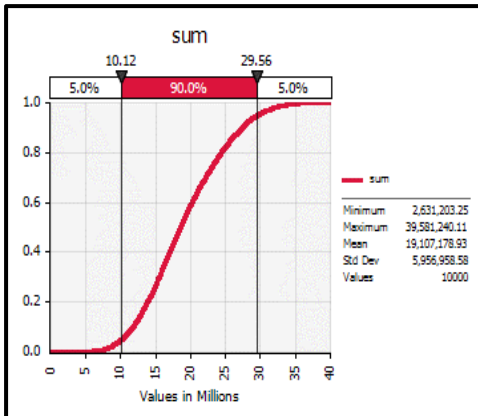
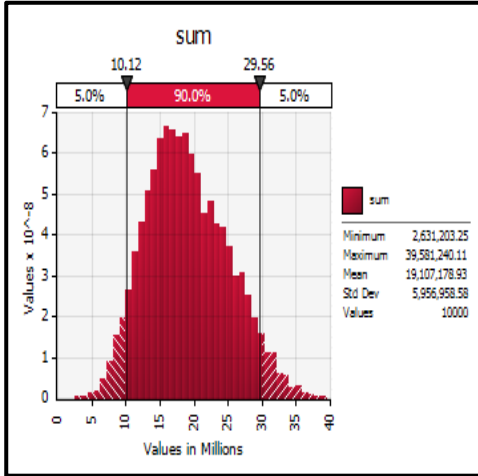
|                        |  |  |            |
|------------------------|--|--|------------|
| <b>Project Number</b>  |  | <b>Date</b>  | 10/03/2017 |
| <b>Project Title</b>   | Great Yarmouth Third River Crossing (Core) | <b>Version</b>                                     | 2          |
| <b>Client</b>          | Norfolk County Council / DfT               | <b>Current Risk Status of Project (gross risk)</b> | M          |
| <b>Project Manager</b> |  | <b>Risk Status of Project if all mitigation</b>    | L          |



| Risk Register Ref                         | Hazard/Risk Name  | Effect/Consequence  | Open / Closed | Risk owner     | Rank | %  | Cat | Initial Risk Exposure |             |           | (P x CI)  | Spreadsheet Construction Risk Value |             |           |           |           |
|---|---|---|---------------|----------------|------|----|-----|-----------------------|-------------|-----------|-----------|-------------------------------------|-------------|-----------|-----------|-----------|
|   |   |   |               |                |      |    |     | Min                   | Most Likely | Max       |           | Min                                 | Most Likely | Max       |           |           |
| <b>A Funding / Third parties</b>          |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| A1  | Failure to secure funding in time to commence construction in 2020  | Delays to programme whilst priority is agreed<br>Integration activities between scheme planners at extra cost1. Unknown surrounding planned schemes<br>2. Access and road closure permissions   | Open          | NCC            | 3    | M  | 36% | 5                     | VH          |           |           |                                     | 15          |           |           |           |
| A2  | Local funding contributions may be withheld   | 1. Higher priority work<br>2. Lack of funding<br>3. Lack of confidence in scheme benefit  | Open          | NCC            | 1    | VL | 3%  | 5                     | VH          |           |           |                                     | 5           |           |           |           |
| A3  | Assumed frequency of vessel movements exceeds expectations  | 1. Increased usage<br>2. Inaccurate usage statistics  | Closed        | NCC / Designer |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| <b>B Programme / Contract</b>             |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| B2  | Planning process results in unexpected planning condition being imposed                                   | Delays<br>Renegotiation<br>Increased cost to meet condition   | Open          | NCC            | 3    | M  | 36% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 6           | 148,456   | 222,684   | 296,912   |
| B3  | Harfreys roundabout build schedule compromises this scheme -  | Delays to programme. Increased cost   | Closed        |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| B4  | DOC statutory process/ High court challenge   | DOC statutory / High court challenge process goes on longer than expected   | Open          | NCC            | 1    | VL | 3%  | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 1           | 2,091     | 6,273     | 10,455    |
| B5  | Risk arising from land acquisition  | unwillingness to sell, delays in CPO process  | Open          | NCC            | 1    | VL | 3%  | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 1           | 2,091     | 6,273     | 10,455    |
| <b>C Scope Change</b>                     |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| C1  | The size of the bridge design may be increased from a 50M tie-in  | 1. Client change to specification<br>2. New information shows an increase is needed in order to accommodate additional vessels<br>3. Stakeholder concerns that the bridge may open more frequently if certain size of vessel can not move through | Open          | NCC / Designer | 3    | M  | 36% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 9           | 296,912   | 593,823   | 890,735   |
| C2  | Port operations and development plans are incompatible with preferred bridge location                     | 1. Port operators deem operations will be impacted by scheme introduction<br>2. Plans for development of the area mean bridge can not be located as scheme scope assumes  | Open          | NCC / Designer | 2    | L  | 13% | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 2           | 10,873    | 32,618    | 54,364    |
| C3  | The assumed speed / impact force of vessels used to inform the design may prove inaccurate                | 1. Incorrect information provided<br>2. Vessel speed increases<br>3. Poor calculations  | Open          | NCC / Designer | 3    | M  | 36% | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 3           | 29,691    | 89,073    | 148,456   |
| C4  | DfT may not accept traffic modelling used for assessment and economic appraisal                           | 1. Inability to support the findings extra modelling work and delay   | Open          | NCC / Designer | 1    | VL | 3%  | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 1           | 2,091     | 6,273     | 10,455    |
| C5  | Timely agreement of Highways England proposals for A12 including Harfrey's Roundabout may not be achieved | The A12 scheme and proposed changes to Harfreys roundabout may change the design / timing of this scheme.   | Closed        |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| C6  | Variation between actual site conditions / topo and assumptions used in design                            | 1. lack of scope definition   | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 5,000     | 10,000    | 15,000                              | 4           | 650       | 1,300     | 1,950     |
| C7  | Quay walls may prove unsuitable for assumed design  | Exact parameters of quay walls not yet fully understood   | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 4           | 54,364    | 81,546    | 108,728   |
| C8  | Project location may extend to wider area residential area than first anticipated                         | Increased costs to residents impacted. More relocation required. Associated delays  | Open          | NCC / Designer | 2    | L  | 13% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 6           | 108,728   | 217,456   | 326,185   |
| C9  | Objections to Bascule Bridge design may transpire   | Re-design. Programme slippage. Reputational damage  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 4           | 54,364    | 81,546    | 108,728   |
| C10                                       | Inability to achieve perpendicular to the river channel   | Re-design, rework and time related cost impact  | Open          | NCC / Designer | 2    | L  | 13% | 4                     | H           | 2,509,113 | 3,345,484 | 4,181,854                           | 8           | 326,185   | 434,913   | 543,641   |
| C11                                       | Inability to achieve acceptable gradients   | Project may be forced to accept steeper gradient and be non compliant with legislation  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 5,000     | 10,000    | 15,000                              | 4           | 650       | 1,300     | 1,950     |
| C12                                       | Sutton road may need reverse in direction to accommodate new signal junction                              | now included in design  | Closed        | NCC / Designer |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| C13                                       | Departures may not be granted   | Redesign<br>Increased costs<br>Delays   | Open          | NCC / Designer | 3    | M  | 36% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 9           | 296,912   | 593,823   | 890,735   |
| C14                                       | Client may require bridge design for heavy loads  | Additional funds required. Re-design and delays to plan implementation  | Open          | NCC / Designer | 2    | L  | 13% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 6           | 108,728   | 217,456   | 326,185   |
| C15                                       | Inability to make knuckle work at 45 degrees  | Potential re-design. Increased cost of construction<br>Objection from ports<br>Compensation for loss of land use  | Open          | NCC / Designer | 3    | M  | 36% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 6           | 148,456   | 222,684   | 296,912   |
| C16                                       | May be unable to achieve safe NMU facilities with identified land   | May not be resolved until safety audit complete<br>Potential delay<br>Increased cost  | Open          | NCC / Designer | 1    | VL | 3%  | 1                     | VL          | 83,637    | 250,911   | 418,185                             | 1           | 2,091     | 6,273     | 10,455    |
| C17                                       | Variation between actual site conditions and assumptions used in design                                   | risk more expansive ground works  | Open          | NCC / Designer | 3    | M  | 36% | 4                     | H           | 2,509,113 | 3,345,484 | 4,181,854                           | 12          | 890,735   | 1,187,647 | 1,484,558 |
| C18                                       | Additional land following redesign  | Need to buy land  | Open          | NCC / Designer | 1    | VL | 3%  | 2                     | L           | 418,185   | 627,278   | 836,371                             | 2           | 10,455    | 15,682    | 20,909    |
| C19                                       | Changes in junction design  | where the crossing joins South Denes, where it crosses Southtown and where it hits the Harfreys roundabout  | Open          | NCC / Designer | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| C20                                       | Need to make late changes to design for planning reasons  |   | Open          | NCC / Designer | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| C21                                       | Unexpected aesthetic requirements   |   | Open          | NCC / Designer | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| <b>D Weather - Greater than a 1:10</b>    |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| D1  | Adverse weather conditions greater than 1 in 10 year storm  | Delays to ground works<br>Complaints<br>Compensation for contractors  | Open          | NCC            | 3    | M  | 36% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 9           | 296,912   | 593,823   | 890,735   |
| <b>E Design Risk Products / Materials</b> |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| E1  |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| <b>F Environmental</b>                    |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| F1  | Endangered species may be found to be present in location of project                                      | Make area safe for endangered species<br>Relocate where applicable<br>Schedule relocation at suitable time<br>Delays to project and associated cost for rehoming and delays   | Open          | NCC / Designer | 3    | M  | 36% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 6           | 148,456   | 222,684   | 296,912   |
| F2  | Environmental contamination is uncovered on the land  | Additional cost for testing and treating and removal  | Open          | NCC / Designer | 3    | M  | 36% | 5                     | VH          | 4,181,854 | 8,363,709 | 12,545,563                          | 15          | 1,484,558 | 2,969,117 | 4,453,675 |
| F3  | Lack of access to undertake environmental surveys   | 1. Land owners restrict access<br>2. Port restricts access  | Open          | NCC            | 2    | L  | 13% | 2                     | L           | 50,000    | 100,000   | 200,000                             | 4           | 6,500     | 13,000    | 26,000    |
| F4  | invasive species may be found to be present in location of project  | Additional cost for testing and treating and removal  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 418,185   | 627,278   | 836,371                             | 4           | 54,364    | 81,546    | 108,728   |
| <b>G Third parties stats</b>              |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| G1  | Access may become problematic pre construction for stats diversion  | Potential delays. Cost increase   | Open          | NCC            | 3    | M  | 36% | 3                     | M           | 836,371   | 1,672,742 | 2,509,113                           | 9           | 296,912   | 593,823   | 890,735   |
| G2  | Land value may increase   | Cost increase. Delays whilst land value negotiations take place   | Open          | NCC            | 1    | VL | 3%  | 2                     | L           | 418,185   | 627,278   | 836,371                             | 2           | 10,455    | 15,682    | 20,909    |

|  |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
|--|---|---|------|----------------|---|----|-----|---|----|------------|------------|------------|----|------------|------------|------------|
| G3   | Land to provide queen Anne tie in is not available  | Delays whilst an effective compromise, alternative or solution can be established. Potential increase to cost                     | Open | NCC            | 1 | VL | 3%  | 1 | VL | 0          | 0          | 0          | 1  | 0          | 0          | 0          |
| G4   | King centre owner may object to the scheme  | Potential delays. Cost increase to agree a more acceptable 'look'. Reputational damage  | Open | NCC            | 2 | L  | 13% | 1 | VL | 83,637     | 250,911    | 418,185    | 2  | 10,873     | 32,618     | 54,364     |
| G5   | Potential inability to make Suffolk road 2 way in the future                                      | Re-design. Substantial growth in cost. Plan slippage to incorporate new activities  | Open | NCC            | 1 | VL | 3%  | 1 | VL | 83,637     | 250,911    | 418,185    | 1  | 2,091      | 6,273      | 10,455     |
| G6   | Port is found to have services e.g. fibre optics in place not previously known                    | Increased costs<br>Delays   | Open | NCC            | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| G7   | Increase cost of power supply to bridge   | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| G8   | Utility relocation cost/risk/timescale  | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| <b>H Flooding</b>                          |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| H1   | River levels raise leading to flooding  | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| <b>I Existing Structures</b>               |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| I1   | Existing quay walls may be compromised near the approach embankments by the scheme                | Weight and engineering in the scheme design.  | Open | Shared         | 1 | VL | 3%  | 2 | L  | 418,185    | 627,278    | 836,371    | 2  | 10,455     | 15,682     | 20,909     |
| <b>J Resources</b>                         |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| J1   | Change to employer/ designer team members   |   | Open |                | 1 | VL | 3%  | 1 | VL | 83,637     | 250,911    | 418,185    | 1  | 2,091      | 6,273      | 10,455     |
| <b>K Tender / Contract</b>                 |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| K1   | Tender - Challenge to tender process  | Delays to schedule  | Open | NCC / Designer | 3 | M  | 36% | 2 | L  | 418,185    | 627,278    | 836,371    | 6  | 148,456    | 222,684    | 296,912    |
| K2   | Tender - Limited interest in construction tender  | higher than expected tenders  | Open | NCC / Designer | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| <b>L Approvals</b>                         |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| L1   | Changes in legislation or regulation  | Increased costs<br>Delays to schedule   | Open | NCC / Designer | 3 | M  | 36% | 2 | L  | 418,185    | 627,278    | 836,371    | 6  | 148,456    | 222,684    | 296,912    |
| <b>M Products</b>                          |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| M1   | Specialist materials / equipment for bridge may not be ready available                            | increase cost and time  | Open | NCC / Designer | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| <b>N Modelling /Standard of Protection</b> |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| N1   | Sediment and transportation - Narrowing may alter sediment transport regime                       | Increased dredging requirements of operator<br>Potential compensation   | Open | Designer       | 5 | VH | 90% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 15 | 752,734    | 1,505,468  | 2,258,201  |
| <b>O Site Conditions</b>                   |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| O1   | Ground conditions are more favourable than expected   | Reduced in ground engineering work and costs  | Open | Designer       | 2 | L  | 13% | 2 | L  | -50,000    | -100,000   | -250,000   | 4  | -6,500     | -13,000    | -32,500    |
| O2   | Land may be required for compensation   | Increased cost associated with land acquisition<br>Compensation   | Open | Designer       | 2 | L  | 13% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 6  | 108,728    | 217,456    | 326,185    |
| O3   | Risk of mine workings in or around scheme location  | Increased costs.<br>Delay to plan   | Open | Designer       | 2 | L  | 13% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 6  | 108,728    | 217,456    | 326,185    |
| O4   | Services may be uncovered above the levels assumed in the estimate                                | Increased cost<br>Delays to activities whilst services are addressed  | Open | Designer       | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| O5   | Unknown buried structures   | Increased cost<br>Delays to activities  | Open |                | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| <b>P Construction</b>                      |   |   |      |                |   |    |     |   |    |            |            |            |    |            |            |            |
| P1   | There may a requirement for construction work in the river channel requirement for floating plant | The assumed river work has not been accommodated in the base estimate IE floating plant   | Open | Shared         | 2 | L  | 13% | 2 | L  | 15,000     | 25,000     | 50,000     | 4  | 1,950      | 3,250      | 6,500      |
| P2   | Presence of soft ground around the approach embankments is uncovered                              | 1. Type of ground is assumed as stable<br>2. Weather / floods   | Open | NCC            | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| P3   | Potential for unexploded ordnance   | Delay in start of the scheme<br>Analysis and study<br>Removal costs   | Open | NCC            | 3 | M  | 36% | 2 | L  | 418,185    | 627,278    | 836,371    | 6  | 148,456    | 222,684    | 296,912    |
| P4   | Unforeseen archaeological finds   | Increased cost to protect and remove (where applicable)<br>Schedule delays  | Open | NCC            | 4 | H  | 66% | 4 | H  | 2,509,113  | 3,345,484  | 4,181,854  | 16 | 1,643,469  | 2,191,292  | 2,739,115  |
| P5   | Complaints to the project and stakeholders due to noise   | Change to working hours resulting in delays<br>Damage to reputation as work can not complete to schedule                          | Open | Contractor     | 3 | M  | 36% | 2 | L  | 418,185    | 627,278    | 836,371    | 6  | 148,456    | 222,684    | 296,912    |
| P6   | Construction of the bridge may be perceived as causing damage to the environment                  | Increase cost<br>Protests<br>Reputational damage  | Open | NCC            | 2 | L  | 13% | 1 | VL | 83,637     | 250,911    | 418,185    | 2  | 10,873     | 32,618     | 54,364     |
| P7   | Integration with existing bridge communications and networking may become problematic             | Increase to cost to make the systems operational<br>More design to understand interface issues<br>Delays whilst solution is found | Open | NCC            | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| P8   | Adverse weather conditions less than 1 in 10 year storm   | Delays to ground works<br>Complaints<br>Compensation for contractors  | Open | Contractor     | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| P9   | Protestors to the project may physically stop work  | Delays to project   | Open | Shared         | 1 | VL | 3%  | 2 | L  | 418,185    | 627,278    | 836,371    | 2  | 10,455     | 15,682     | 20,909     |
| P10  | Vandalism to project or project property may occur  | Increased costs to secure area<br>Increased costs for repair and replace  | Open | Contractor     | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| P11  | Supplier may underperform   | Delays<br>Renegotiation<br>Increased cost to meet condition   | Open | Contractor     | 2 | L  | 13% | 2 | L  | 418,185    | 627,278    | 836,371    | 4  | 54,364     | 81,546     | 108,728    |
| P12  | Access may become problematic during construction   | Potential delays. Cost increase   | Open | Contractor     | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| P13  | Construction disrupts sediment  | Objections from EA. Project on hold or activities curtailed. Increased costs. Claims  | Open | Contractor     | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| P14  | Suds drainage   | increase in drainage requirement's  | Open | NCC            | 3 | M  | 36% | 3 | M  | 836,371    | 1,672,742  | 2,509,113  | 9  | 296,912    | 593,823    | 890,735    |
| P15  | urban design works changes due to on site not being as assumed                                    | on site conditions make installation more difficult   | Open | NCC            | 3 | M  | 36% | 3 | M  | 100,000    | 150,000    | 200,000    | 9  | 35,500     | 53,250     | 71,000     |
| P16  | Requirements for additional traffic management  | Changers to TM requirement's during construction  | Open | NCC            | 2 | L  | 13% | 2 | L  | 100,000    | 150,000    | 200,000    | 4  | 13,000     | 19,500     | 26,000     |
| P17  | Requirements to allow continued access by river vessels   | Changers to access by river vessels requirement's during construction   | Open | NCC            | 2 | L  | 13% | 2 | L  | 100,000    | 150,000    | 200,000    | 4  | 13,000     | 19,500     | 26,000     |
| P18  | Temporary availability of land for compounds, staging areas, etc.                                 | in crease as compound would not be local to site  | Open | NCC            | 1 | VL | 3%  | 1 | VL | 83,637     | 250,911    | 418,185    | 1  | 2,091      | 6,273      | 10,455     |
|  |   |   |      |                |   |    |     |   |    | 35,969,399 | 62,876,449 | 89,763,499 |    | 10,674,071 | 18,620,074 | 26,561,902 |

# Annex B: Quantified Risk Assessment Output Core Scheme



| Simulation Summary Information |                              |
|--------------------------------|------------------------------|
| Workbook Name                  | Great Yarmouth Risk Register |
| Number of Simulations          | 1                            |
| Number of Iterations           | 10000                        |
| Number of Inputs               | 131                          |
| Number of Outputs              | 66                           |
| Sampling Type                  | Monte Carlo                  |
| Simulation Start Time          | 14/03/2017 15:58             |
| Simulation Duration            | 00:00:07                     |
| Random # Generator             | Mersenne Twister             |
| Random Seed                    | 750505131                    |

| Summary Statistics for sum |             |            |            |
|----------------------------|-------------|------------|------------|
| Statistics                 |             | Percentile |            |
| Minimum                    | 2,631,203   | 5%         | 10,121,637 |
| Maximum                    | 39,581,240  | 10%        | 11,711,467 |
| Mean                       | 19,107,179  | 15%        | 12,875,743 |
| Std Dev                    | 5,956,959   | 20%        | 13,836,001 |
| Variance                   | 3.54854E+13 | 25%        | 14,723,887 |
| Skewness                   | 0.323543379 | 30%        | 15,503,233 |
| Kurtosis                   | 2.644879336 | 35%        | 16,233,012 |
| Median                     | 18,585,455  | 40%        | 17,037,976 |
| Mode                       | 17,101,793  | 45%        | 17,776,742 |
| Left X                     | 10,121,637  | 50%        | 18,585,455 |
| Left P                     | 5%          | 55%        | 19,352,179 |
| Right X                    | 29,561,780  | 60%        | 20,177,247 |
| Right P                    | 95%         | 65%        | 21,090,973 |
| Diff X                     | 19,440,143  | 70%        | 22,165,755 |
| Diff P                     | 90%         | 75%        | 23,210,782 |
| #Errors                    | 0           | 80%        | 24,397,520 |
| Filter Min                 | Off         | 85%        | 25,714,218 |
| Filter Max                 | Off         | 90%        | 27,368,593 |
| #Filtered                  | 0           | 95%        | 29,561,780 |

| Change in Output Statistic for sum |                      |            |            |
|------------------------------------|----------------------|------------|------------|
| Rank                               | Name                 | Lower      | Upper      |
| 1                                  | Environmental cont   | 16,080,622 | 24,643,764 |
| 2                                  | Unforeseen archaeo   | 16,779,375 | 20,347,284 |
| 3                                  | Variation between    | 17,908,695 | 21,344,040 |
| 4                                  | Inability to achieve | 18,700,740 | 21,858,863 |
| 5                                  | Environmental cont   | 17,922,624 | 20,242,801 |
| 6                                  | Sediment and trans   | 17,475,093 | 19,288,522 |
| 7                                  | Access may become    | 18,480,065 | 20,265,644 |
| 8                                  | Port is found to hav | 18,476,249 | 20,239,815 |
| 9                                  | Access may become    | 18,536,608 | 20,298,479 |
| 10                                 | Integration with exi | 18,516,068 | 20,226,800 |

## Annex C: GYTRC Risk Register Sensitivity Test



Project Risk, Issue and Opportunity Register

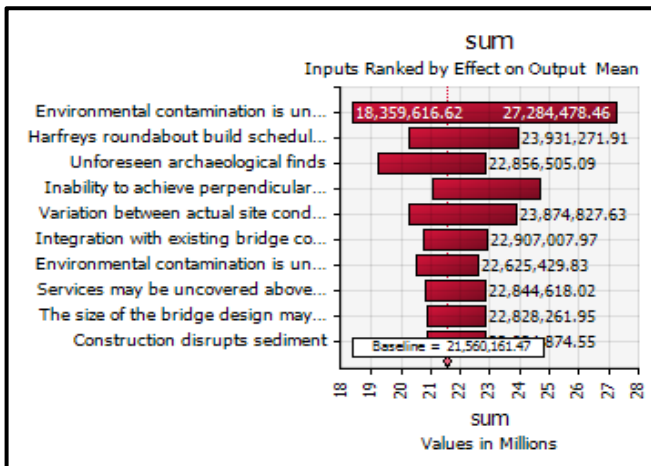
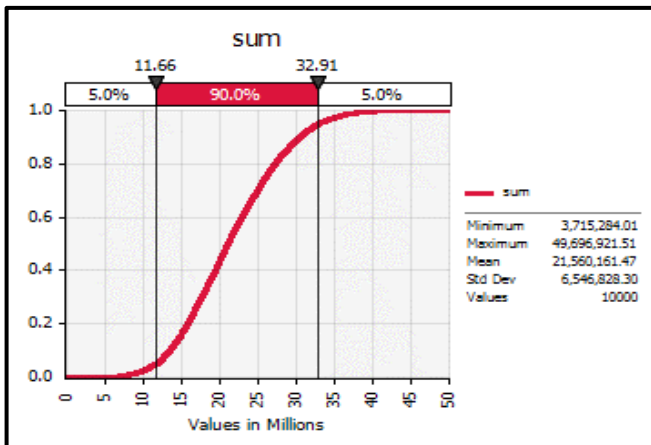
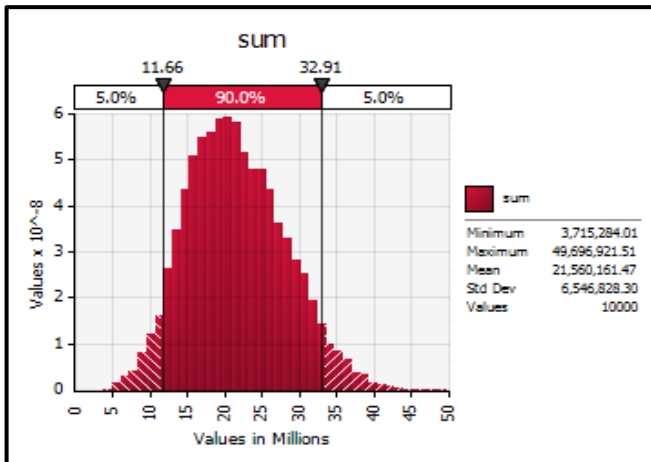
|                        |                                     |   |            |
|------------------------|-------------------------------------|---|------------|
| <b>Project Number</b>  |                                     | <b>Date</b>                                     | 10/03/2017 |
| <b>Project Title</b>   | Great Yarmouth Third River Crossing | <b>Version</b>                                  | 1          |
| <b>Client</b>          | Norfolk County Council / DfT        | <b>Current Risk Status of Project (gross)</b>   | M          |
| <b>Project Manager</b> |                                     | <b>Risk Status of Project if all mitigation</b> | L          |



| Risk Register Ref                         | Hazard/Risk Name  | Effect/Consequence  | Open / Closed | Risk owner     | Rank | %  | Cat | Initial Risk Exposure |             |           | (P x CI)  | Spreadsheet Construction Risk Value |             |           |           |           |
|---|---|---|---------------|----------------|------|----|-----|-----------------------|-------------|-----------|-----------|-------------------------------------|-------------|-----------|-----------|-----------|
|   |   |   |               |                |      |    |     | Min                   | Most Likely | Max       |           | Min                                 | Most Likely | Max       |           |           |
| <b>A Funding / Third parties</b>          |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| A1  | Failure to secure funding in time to commence construction in 2021  | Delays to programme whilst priority is agreed<br>Integration activities between scheme planners at extra cost1. Unknown surrounding planned schemes<br>2. Access and road closure permissions   | Open          | NCC            | 3    | M  | 36% | 5                     | VH          |           |           |                                     |             |           |           |           |
| A2  | Local funding contributions may be withheld   | 1. Higher priority work<br>2. Lack of funding<br>3. Lack of confidence in scheme benefit  | Open          | NCC            | 1    | VL | 3%  | 5                     | VH          |           |           |                                     |             |           |           |           |
| A3  | Assumed frequency of vessel movements exceeds expectations  | 1. Increased usage<br>2. Inaccurate usage statistics  | Closed        | NCC / Designer |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| <b>B Programme / Contract</b>             |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| B2  | Planning process results in unexpected planning condition being imposed                                   | Delays<br>Renegotiation<br>Increased cost to meet condition   | Open          | NCC            | 3    | M  | 36% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 6           | 159,113   | 238,670   | 318,226   |
| B3  | Harfreys roundabout build schedule compromises this scheme -  | Delays to programme. Increased cost   | Open          | NCC            | 3    | M  | 36% | 4                     | H           | 2,689,234 | 3,585,646 | 4,482,057                           | 12          | 954,678   | 1,272,904 | 1,591,130 |
| B4  | DOC statutory process/ High court challenge   | DOC statutory / High court challenge process goes on longer than expected   | Open          | NCC            | 1    | VL | 3%  | 1                     | VL          | 89,641    | 268,923   | 448,206                             | 1           | 2,241     | 6,723     | 11,205    |
| B5  | Risk arising from land acquisition  | unwillingness to sell, delays in CPO process  | Open          | NCC            | 1    | VL | 3%  | 1                     | VL          | 89,641    | 268,923   | 448,206                             | 1           | 2,241     | 6,723     | 11,205    |
| <b>C Scope Change</b>                     |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| C1  | The size of the bridge design may be increased from a 50M tie-in  | 1. Client change to specification<br>2. New information shows an increase is needed in order to accommodate additional vessels<br>3. Stakeholder concerns that the bridge may open more frequently if certain size of vessel can not move through | Open          | NCC / Designer | 3    | M  | 36% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 9           | 318,226   | 636,452   | 954,678   |
| C2  | Port operations and development plans are incompatible with preferred bridge location                     | 1. Port operators deem operations will be impacted by scheme introduction<br>2. Plans for development of the area mean bridge can not be located as scheme scope assumes  | Open          | NCC / Designer | 2    | L  | 13% | 1                     | VL          | 89,641    | 268,923   | 448,206                             | 2           | 11,653    | 34,960    | 58,267    |
| C3  | The assumed speed / impact force of vessels used to inform the design may prove inaccurate                | 1. Incorrect information provided<br>2. Vessel speed increases<br>3. Poor calculations  | Open          | NCC / Designer | 3    | M  | 36% | 1                     | VL          | 89,641    | 268,923   | 448,206                             | 3           | 31,823    | 95,468    | 159,113   |
| C4  | DfT may not accept traffic modelling used for assessment and economic appraisal                           | 1. Inability to support the findings extra modelling work and delay   | Open          | NCC / Designer | 1    | VL | 3%  | 1                     | VL          | 89,641    | 268,923   | 448,206                             | 1           | 2,241     | 6,723     | 11,205    |
| C5  | Timely agreement of Highways England proposals for A12 including Harfrey's Roundabout may not be achieved | The A12 scheme and proposed changes to Harfreys roundabout may change the design / timing of this scheme.   | Open          | NCC / Designer | 1    | VL | 3%  | 1                     | VL          | 2,500     | 5,000     | 7,500                               | 1           | 63        | 125       | 188       |
| C6  | Variation between actual site conditions / topo and assumptions used in design                            | 1. lack of scope definition   | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 5,000     | 10,000    | 15,000                              | 4           | 650       | 1,300     | 1,950     |
| C7  | Quay walls may prove unsuitable for assumed design  | Exact parameters of quay walls not yet fully understood   | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 4           | 58,267    | 87,400    | 116,533   |
| C8  | Project location may extend to wider area residential area than first anticipated                         | Increased costs to residents impacted. More relocation required. Associated delays  | Open          | NCC / Designer | 2    | L  | 13% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 6           | 116,533   | 233,067   | 349,600   |
| C9  | Objections to Bascule Bridge design may transpire   | Re-design. Programme slippage. Reputational damage  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 4           | 58,267    | 87,400    | 116,533   |
| C10                                       | Inability to achieve perpendicular to the river channel   | Re-design, rework and time related cost impact  | Open          | NCC / Designer | 2    | L  | 13% | 4                     | H           | 2,689,234 | 3,585,646 | 4,482,057                           | 8           | 349,600   | 466,134   | 582,667   |
| C11                                       | Inability to achieve acceptable gradients   | Project may be forced to accept steeper gradient and be non compliant with legislation  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 5,000     | 10,000    | 15,000                              | 4           | 650       | 1,300     | 1,950     |
| C12                                       | Sutton road may need reverse in direction to accommodate new signal junction                              | now included in design  | Open          | NCC / Designer |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| C13                                       | Departures may not be granted   | Redesign<br>Increased costs<br>Delays   | Open          | NCC / Designer | 3    | M  | 36% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 9           | 318,226   | 636,452   | 954,678   |
| C14                                       | Client may require bridge design for heavy loads  | Additional funds required. Re-design and delays to plan implementation  | Open          | NCC / Designer | 2    | L  | 13% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 6           | 116,533   | 233,067   | 349,600   |
| C15                                       | Inability to make knuckle work at 45 degrees  | Potential re-design. Increased cost of construction<br>Objection from ports<br>Compensation for loss of land use  | Open          | NCC / Designer | 3    | M  | 36% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 6           | 159,113   | 238,670   | 318,226   |
| C16                                       | May be unable to achieve safe NMU facilities with identified land   | May not be resolved until safety audit complete<br>Potential delay<br>Increased cost  | Open          | NCC / Designer | 2    | L  | 13% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 6           | 116,533   | 233,067   | 349,600   |
| C17                                       | Variation between actual site conditions and assumptions used in design                                   | risk more expansive ground works  | Open          |                | 3    | M  | 36% | 4                     | H           | 2,689,234 | 3,585,646 | 4,482,057                           | 12          | 954,678   | 1,272,904 | 1,591,130 |
| C18                                       | Additional land following redesign  | Need to buy land  | Open          |                | 1    | VL | 3%  | 2                     | L           | 448,206   | 672,309   | 896,411                             | 2           | 11,205    | 16,808    | 22,410    |
| C19                                       | Changes in junction design  | where the crossing joins South Denes, where it crosses Southtown and where it hits the Harfreys roundabout  | Open          |                | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| C20                                       | Need to make late changes to design for planning reasons  |   | Open          |                | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| C21                                       | Unexpected aesthetic requirements   |   | Open          |                | 1    | VL | 3%  | 2                     | L           | 5,000     | 10,000    | 20,000                              | 2           | 125       | 250       | 500       |
| <b>D Weather - Greater than a 1:10</b>    |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| D1  | Adverse weather conditions greater than 1 in 10 year storm  | Delays to ground works<br>Complaints<br>Compensation for contractors  | Open          | NCC            | 3    | M  | 36% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 9           | 318,226   | 636,452   | 954,678   |
| <b>E Design Risk Products / Materials</b> |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| E1  |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| <b>F Environmental</b>                    |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| F1  | Endangered species may be found to be present in location of project                                      | Make area safe for endangered species<br>Relocate where applicable<br>Schedule relocation at suitable time<br>Delays to project and associated cost for rehoming and delays   | Open          | NCC / Designer | 3    | M  | 36% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 6           | 159,113   | 238,670   | 318,226   |
| F2  | Environmental contamination is uncovered on the land  | Additional cost for testing and treating and removal  | Open          | NCC / Designer | 3    | M  | 36% | 5                     | VH          | 4,482,057 | 8,964,114 | 13,446,171                          | 15          | 1,591,130 | 3,182,261 | 4,773,391 |
| F3  | Lack of access to undertake environmental surveys   | 1. Land owners restrict access<br>2. Port restricts access  | Open          | NCC            | 2    | L  | 13% | 2                     | L           | 50,000    | 100,000   | 200,000                             | 4           | 6,500     | 13,000    | 26,000    |
| F4  | invasive species may be found to be present in location of project  | Additional cost for testing and treating and removal  | Open          | NCC / Designer | 2    | L  | 13% | 2                     | L           | 448,206   | 672,309   | 896,411                             | 4           | 58,267    | 87,400    | 116,533   |
| <b>G Third parties stats</b>              |   |   |               |                |      |    |     |                       |             |           |           |                                     |             |           |           |           |
| G1  | Access may become problematic pre construction  | Potential delays. Cost increase   | Open          | NCC            | 3    | M  | 36% | 3                     | M           | 896,411   | 1,792,823 | 2,689,234                           | 6           | 318,226   | 636,452   | 954,678   |
| G2  | Land value may increase   | Cost increase. Delays whilst land value negotiations take place   | Open          | NCC            | 1    | VL | 3%  | 2                     | L           | 448,206   | 672,309   | 896,411                             | 2           | 11,205    | 16,808    | 22,410    |

|  |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
|--|---|---|------|----------------|---|----|-----|---|----|------------|------------|-------------|----|------------|------------|------------|
| G3   | Land to provide queen Anne tie in is not available  | Delays whilst an effective compromise, alternative or solution can be established. Potential increase to cost                     | Open | NCC            | 1 | VL | 3%  | 1 | VL | 0          | 0          | 0           | 1  | 0          | 0          | 0          |
| G4   | King centre owner may object to the scheme  | Potential delays. Cost increase to agree a more acceptable 'look'. Reputational damage  | Open | NCC            | 4 | H  | 66% | 1 | VL | 89,641     | 268,923    | 448,206     | 4  | 58,715     | 176,145    | 293,575    |
| G5   | Potential inability to make Suffolk road 2 way in the future                                      | Re-design. Substantial growth in cost. Plan slippage to incorporate new activities  | Open | NCC            | 1 | VL | 3%  | 1 | VL | 89,641     | 268,923    | 448,206     | 1  | 2,241      | 6,723      | 11,205     |
| G6   | Port is found to have services e.g. fibre optics in place not previously known                    | Increased costs<br>Delays   | Open | NCC            | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| G7   | Increase cost of power supply to bridge   | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| G8   | Utility relocation cost/risk/timescale  | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| <b>H Flooding</b>                          |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| H1   | River levels raise and leading to flooding  | Increased costs   | Open | NCC            | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| <b>I Existing Structures</b>               |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| I1   | Existing quay walls may be compromised near the approach embankments by the scheme                | Weight and engineering in the scheme design.  | Open | Shared         | 1 | VL | 3%  | 2 | L  | 448,206    | 672,309    | 896,411     | 2  | 11,205     | 16,808     | 22,410     |
| <b>J Resources</b>                         |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| J1   | Change to employer/ designer team members   |   | Open |                | 1 | VL | 3%  | 1 | VL | 89,641     | 268,923    | 448,206     | 1  | 2,241      | 6,723      | 11,205     |
| <b>K Tender / Contract</b>                 |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| K1   | Tender - Challenge to tender process  | Delays to schedule  | Open | NCC / Designer | 3 | M  | 36% | 2 | L  | 448,206    | 672,309    | 896,411     | 6  | 159,113    | 238,670    | 318,226    |
| K2   | Tender - Limited interest in construction tender  | higher than expected tenders  | Open | NCC / Designer | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| <b>L Approvals</b>                         |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| L1   | Changes in legislation or regulation  | Increased costs<br>Delays to schedule   | Open | NCC / Designer | 3 | M  | 36% | 2 | L  | 448,206    | 672,309    | 896,411     | 6  | 159,113    | 238,670    | 318,226    |
| <b>M Products</b>                          |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| M1   | Specialist materials / equipment for bridge may not be ready available                            | increase cost and time  | Open | NCC / Designer | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| <b>N Modelling /Standard of Protection</b> |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| N1   | Sediment and transportation - Narrowing may alter sediment transport regime                       | Increased dredging requirements of operator<br>Potential compensation   | Open | Designer       | 5 | VH | 90% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 15 | 806,770    | 1,613,541  | 2,420,311  |
| <b>O Site Conditions</b>                   |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| O1   | Ground conditions are more favourable than expected   | Reduced in ground engineering work and costs  | Open | Designer       | 2 | L  | 13% | 2 | L  | -50,000    | -100,000   | -250,000    | 4  | -6,500     | -13,000    | -32,500    |
| O2   | Land may be required for compensation   | Increased cost associated with land acquisition<br>Compensation   | Open | Designer       | 2 | L  | 13% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 6  | 116,533    | 233,067    | 349,600    |
| O3   | Risk of mine workings in or around scheme location  | Increased costs.<br>Delay to plan   | Open | Designer       | 2 | L  | 13% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 6  | 116,533    | 233,067    | 349,600    |
| O4   | Services may be uncovered above the levels assumed in the estimate                                | Increased cost<br>Delays to activities whilst services are addressed  | Open | Designer       | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| O5   | Unknown buried structures   | Increased cost<br>Delays to activities  | Open |                | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| <b>P Construction</b>                      |   |   |      |                |   |    |     |   |    |            |            |             |    |            |            |            |
| P1   | There may a requirement for construction work in the river channel requirement for floating plant | The assumed river work has not been accommodated in the base estimate IE floating plant   | Open | Shared         | 2 | L  | 13% | 2 | L  | 15,000     | 25,000     | 50,000      | 4  | 1,950      | 3,250      | 6,500      |
| P2   | Presence of soft ground around the approach embankments is uncovered                              | 1. Type of ground is assumed as stable<br>2. Weather / floods   | Open | NCC            | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| P3   | Potential for unexploded ordnance   | Delay in start of the scheme<br>Analysis and study<br>Removal costs   | Open | NCC            | 3 | M  | 36% | 2 | L  | 448,206    | 672,309    | 896,411     | 6  | 159,113    | 238,670    | 318,226    |
| P4   | Unforeseen archaeological finds   | Increased cost to protect and remove (where applicable)<br>Schedule delays  | Open | NCC            | 4 | H  | 66% | 4 | H  | 2,689,234  | 3,585,646  | 4,482,057   | 16 | 1,761,448  | 2,348,598  | 2,935,747  |
| P5   | Complaints to the project and stakeholders due to noise   | Change to working hours resulting in delays<br>Damage to reputation as work can not complete to schedule                          | Open | Contractor     | 3 | M  | 36% | 2 | L  | 448,206    | 672,309    | 896,411     | 6  | 159,113    | 238,670    | 318,226    |
| P6   | Construction of the bridge may be perceived as causing damage to the environment                  | Increase cost<br>Protests<br>Reputational damage  | Open | NCC            | 2 | L  | 13% | 1 | VL | 89,641     | 268,923    | 448,206     | 2  | 11,653     | 34,960     | 58,267     |
| P7   | Integration with existing bridge communications and networking may become problematic             | Increase to cost to make the systems operational<br>More design to understand interface issues<br>Delays whilst solution is found | Open | NCC            | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| P8   | Adverse weather conditions less than 1 in 10 year storm   | Delays to ground works<br>Complaints<br>Compensation for contractors  | Open | Contractor     | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| P9   | Protestors to the project may physically stop work  | Delays to project   | Open | Shared         | 1 | VL | 3%  | 2 | L  | 448,206    | 672,309    | 896,411     | 2  | 11,205     | 16,808     | 22,410     |
| P10  | Vandalism to project or project property may occur  | Increased costs to secure area<br>Increased costs for repair and replace  | Open | Contractor     | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| P11  | Supplier may underperform   | Delays<br>Renegotiation<br>Increased cost to meet condition   | Open | Contractor     | 2 | L  | 13% | 2 | L  | 448,206    | 672,309    | 896,411     | 4  | 58,267     | 87,400     | 116,533    |
| P12  | Access may become problematic during construction   | Potential delays. Cost increase   | Open | Contractor     | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| P13  | Construction disrupts sediment  | Objections from EA. Project on hold or activities curtailed. Increased costs. Claims  | Open | Contractor     | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| P14  | Suds drainage   | increase in drainage requirement's  | Open | NCC            | 3 | M  | 36% | 3 | M  | 896,411    | 1,792,823  | 2,689,234   | 9  | 318,226    | 636,452    | 954,678    |
| P15  | urban design works changes due to on site not being as assumed                                    | on site conditions make installation more difficult   | Open | NCC            | 3 | M  | 36% | 3 | M  | 100,000    | 150,000    | 200,000     | 9  | 35,500     | 53,250     | 71,000     |
| P16  | Requirements for additional traffic management  | Changers to TM requirement's during construction  | Open | NCC            | 2 | L  | 13% | 2 | L  | 100,000    | 150,000    | 200,000     | 4  | 13,000     | 19,500     | 26,000     |
| P17  | Requirements to allow continued access by river vessels   | Changers to access by river vessels requirement's during construction   | Open | NCC            | 2 | L  | 13% | 2 | L  | 100,000    | 150,000    | 200,000     | 4  | 13,000     | 19,500     | 26,000     |
| P18  | Temporary availability of land for compounds, staging areas, etc.                                 | in crease as compound would not be local to site  | Open | NCC            | 1 | VL | 3%  | 1 | VL | 89,123     | 267,369    | 445,615     | 1  | 2,228      | 6,684      | 11,140     |
|  |   |   |      |                |   |    |     |   |    | 42,025,113 | 72,465,462 | 102,885,811 |    | 12,551,737 | 21,590,176 | 30,624,439 |

# Annex D: Quantified Risk Assessment Output Sensitivity Test



| Simulation Summary Information |                              |
|--------------------------------|------------------------------|
| Workbook Name                  | Great Yarmouth Risk Register |
| Number of Simulations          | 1                            |
| Number of Iterations           | 10000                        |
| Number of Inputs               | 135                          |
| Number of Outputs              | 68                           |
| Sampling Type                  | Monte Carlo                  |
| Simulation Start Time          | 24/03/2017 13:10             |
| Simulation Duration            | 00:00:07                     |
| Random # Generator             | Mersenne Twister             |
| Random Seed                    | 1757710075                   |

| Summary Statistics for sum |             |            |
|----------------------------|-------------|------------|
| Statistics                 |             | Percentile |
| Minimum                    | 3,715,284   | 5%         |
| Maximum                    | 49,696,922  | 10%        |
| Mean                       | 21,560,161  | 15%        |
| Std Dev                    | 6,546,828   | 20%        |
| Variance                   | 4.2861E+13  | 25%        |
| Skewness                   | 0.306395241 | 30%        |
| Kurtosis                   | 2.780571231 | 35%        |
| Median                     | 21,064,217  | 40%        |
| Mode                       | 19,488,872  | 45%        |
| Left X                     | 11,661,753  | 50%        |
| Left P                     | 5%          | 55%        |
| Right X                    | 32,913,368  | 60%        |
| Right P                    | 95%         | 65%        |
| Diff X                     | 21,251,615  | 70%        |
| Diff P                     | 90%         | 75%        |
| #Errors                    | 0           | 80%        |
| Filter Min                 | Off         | 85%        |
| Filter Max                 | Off         | 90%        |
| #Filtered                  | 0           | 95%        |

| Change in Output Statistic for sum |                      |            |            |
|------------------------------------|----------------------|------------|------------|
| Rank                               | Name                 | Lower      | Upper      |
| 1                                  | Environmental cont   | 18,359,617 | 27,284,478 |
| 2                                  | Harfreys roundabou   | 20,248,869 | 23,931,272 |
| 3                                  | Unforeseen archaeo   | 19,198,300 | 22,856,505 |
| 4                                  | Inability to achiev  | 21,088,432 | 24,707,372 |
| 5                                  | Variation between    | 20,272,861 | 23,874,828 |
| 6                                  | Integration with exi | 20,765,235 | 22,907,008 |
| 7                                  | Environmental cont   | 20,498,523 | 22,625,430 |
| 8                                  | Services may be un   | 20,849,936 | 22,844,618 |
| 9                                  | The size of the brid | 20,870,016 | 22,828,262 |
| 10                                 | Construction disrupt | 20,881,919 | 22,834,875 |