Great Yarmouth
Third River Crossing

OUTLINE BUSINESS CASE

MARCH 2017

Supporting Document 9 – Economic Appraisal Report

Norfolk County Council

Great Yarmouth Borough Council

New Anglia Local Enterprise Partnership for Norfolk and Suffolk

Great Yarmouth Third River Crossing

Economic Appraisal Report

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Prepared by

Mouchel

Export House
Cawsey Way
Woking
Surrey
GU21 6QX
UK

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Contents

List of Figures

List of Tables

Appendices

1 Study Overview

1.1 Introduction

This report details the economic appraisal process for the Great Yarmouth Third River Crossing (GYTRC) proposals. The proposed scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula.

The purpose of this report is to outline the evidence used and the key assumptions made in preparing the Outline Business Case (OBC) in line with DfT WebTAG guidance. The report also assesses the Value for Money (VfM) of the scheme and details how the effects of the scheme have been monetised and combined with the construction and maintenance costs to give an indication of the economic value of the scheme over a 60 year appraisal period.

The economic appraisal of the scheme follows the guidance outlined by the relevant WebTAG modules to ensure that a robust assessment is made. The cost benefit analysis was undertaken on the following categories:

- Transport User Benefits
- Accident Benefits
- Reliability Benefits
- Wider Benefits
- Active Mode Benefits

1.2 Structure of Report

This Economic Appraisal Report (EAR) is structured to include the following sections:

- Study Overview
- Economic Assessment Approach
- Estimation of Costs
- Estimation of Benefits
- Economic Appraisal Results
- Summary and Conclusions

1.3 Scheme Objectives

Following WebTAG guidance, a number of strategic (high level), intermediate (specific) and operational objectives were derived in order to meet the strategic aims set out by Norfolk County Council. These objectives are described in full in the Options Report and are as follows:

The desired high level or strategic outcomes are:

- To support the creation of new jobs, especially in the South Denes Local Development Order area and the Enterprise Zone, by being a catalyst for investment
- To support Great Yarmouth as a Centre for Offshore Renewable Engineering, and as a port
- To support the regeneration of Great Yarmouth, including the town centre and the seafront, helping the visitor and retail economy
- To improve strategic connectivity, and reduce community severance
- To protect and improve the environment

The specific, or intermediate, objectives are:

- To provide traffic relief to Breydon Bridge and Haven Bridge
- To reduce congestion and delay in the town centre
- To improve journey time reliability
- To reduce traffic in historic areas
- To improve vehicular access to South Denes and the outer harbour, especially from the SRN
- To improve access to the Great Yarmouth peninsula for buses
- To improve access to the Great Yarmouth peninsula for cyclists
- To improve access to the Great Yarmouth peninsula for pedestrians
- To reduce road accident casualties
- To reduce emissions of greenhouse gases
- To improve the resilience of the local road network

The operational objectives are:

- To provide an additional crossing of the River Yare for vehicles, cyclists and pedestrians
- To reduce overall journey times and vehicle kilometres in Great Yarmouth
- To minimise environmental impact, compulsory purchase and demolition of residential and commercial property
- To achieve a balance between the needs of road and river traffic

It is noted that the intermediate and operational objectives are specific, measurable, realistic and time-bound (SMART).

1.4 Scheme Description

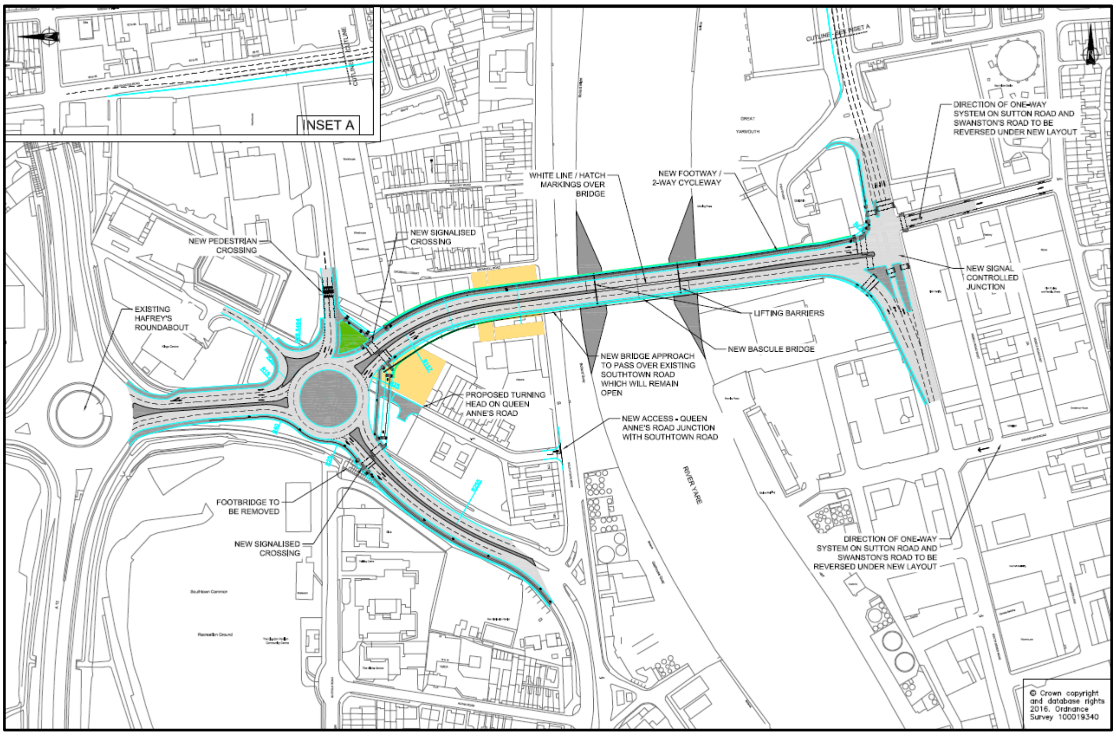
A new lifting bridge will be provided to carry a dual carriageway road across the River Yare, opening when required to allow shipping to pass through. Traffic will be controlled by lifting barriers at either end of the bridge, and queueing space will be provided.

The new structure will be a single span, double leaf trunnion Bascule Bridge with a clear span of 55m between the abutment faces, giving a 50m navigational clearance between knuckle wall fenders. It will cross the River Yare at 90% - i.e. with no skew.

The superstructure will comprise a steel deck. Each leaf (lifting section) will use three longitudinal steel box beams, which will continue behind the trunnion positions to carry the counterweights. They will be raised and lowered by three hydraulic cylinders on the underside of each leaf. The main piers will be hollow reinforced concrete box structures, founded on reinforced concrete piles and protected from the river by knuckle walls. The piers will support the trunnions, about which the bridge leafs will rotate, and will house the hydraulic cylinders and control systems.

When the bridge is fully raised at approximately 80°, the tips will be positioned to provide unlimited air draft across the 50m navigational channel. With the bridge fully lowered, and open to road traffic, the air draft below the structure will allow smaller vessels to pass under the new bridge without the need for it to be closed to road traffic. The approach embankments will be retained either by reinforced soil or reinforced concrete retaining walls, with a maximum height of about 7m.

Figure 1-1 - Scheme Proposals



1.5 Previous Economic Assessments

A Stage 2 Traffic and Economic Assessment report[1] was produced in October, 2009 by Mott MacDonald and which included detailed information on traffic modelling, forecast traffic flows and journey times for three scheme options (two bridge options and one tunnel option). Results showed that all scheme options produced high levels

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[1] Great Yarmouth Third River Crossing – Stage 2 Scheme Assessment Report, September 2009. Mott Macdonald for Norfolk County Council

of benefits, with the two bridge options producing the highest levels with a benefit to cost ratio (BCR) ranging from 4.5 to 4.8. The report concluded that the tunnel option provided a low value for money and should therefore be discounted from further analysis.

2 Economic Assessment Approach

2.1 Transport Model

The traffic data used in the current economic assessments has been derived from a 2016 SATURN model built by Mouchel and forms a fully Webtag compliant update of the earlier work by consultant Mott MacDonald (MM).

The Fixed and Variable Demand SATURN models have been developed for the following time periods:

- AM peak (08:00 – 09:00)
- Average interpeak (10:30 – 15:30)
- PM peak (16:30 – 17:30)

This is consistent with advice presented in Section 2.5 of TAG Unit M3.1 (January, 2014).

The traffic assignments were carried out with the following vehicle and user classes:

- UC1: Car – Commuting
- UC2: Car – Employer's Business
- UC3: Car – Other
- UC4: LGV
- UC5: HGV

The model forecast years are 2023 (assumed scheme Opening Year), 2038 (Design Year) and 2051 (Horizon Year).

2.1.1 Travel Demand Scenarios

The principal requirement of the traffic model was the provision of traffic forecasts for the scheme Opening year (2023), Design year (2038) and Horizon year (2051). Future travel demands take into account the existing traffic flows together with the effects of traffic growth and the additional traffic that is expected to arise from new development activity in the town.

2.2 Economic Assessment Process

The process of economic assessment for the scheme consists of several steps, as follows.

2.2.1 User Benefits (TUBA)

User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues typically form the major element of benefit attributable to highway schemes. The assessment reported here uses the Department for Transport's (DfT) Transport Users Benefit Appraisal tool (TUBA) Version 1.9.8.

The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do Minimum and Do Something tests for the opening and design years are fed into TUBA generating the following economic outputs:

- Time savings
- Vehicle Cost Operating savings
- Greenhouse gases
- Taxes

Analysis of the benefits has been carried out:

- By year, over the 60 year appraisal period
- By trip purpose/ vehicle type/by time period (AM/IP/PM periods)
- By sector of origin and destination

The appraisal area for estimating user benefits includes the full model area, and analysis at an aggregated sector level provides a summary of the findings.

2.2.2 Accident Benefits (COBA-LT)

Benefits associated with accident savings were calculated using the DfT's Cost and Benefit to Accidents – Light Touch Programme (COBA-LT) which assesses the safety impacts of schemes using detailed inputs of link and junction accident rates and traffic flow forecasts from the traffic model. Accident benefits were calculated over a 60 year period for a cordoned area of the model.

2.2.3 Annualisation of Benefits

Benefits of the scheme have been converted from the weekday traffic model period outputs to annual totals over a 60 year appraisal period. Annualisation factors for conversion of period model outputs are explained in detail in Appendix G of the OBC.

2.2.4 Appraisal Period

The economic appraisal was carried out for a 60-year period, from 2023 (Opening Year), in accordance with DfT guidance.

2.2.5 Cost Benefit Assessment

A full cost benefit assessment was undertaken to assess the scheme's value for money. The results from TUBA and COBA-LT were combined to calculate the overall economic benefits of the scheme. By comparing the construction and maintenance costs with the traffic benefits of the scheme over a 60 year assessment period, a Benefit Cost Ratio (BCR) was calculated, which represents the value for money afforded by the scheme.

2.2.6 Sensitivity Tests

As recommended in the WebTAG 3.15.5, sensitivity tests have been carried out whereby high and low growth projections are applied in addition to the Core Scenario forecasts.

2.3 Non-standard Procedures and Economic Parameters

The economic assessment has adopted procedures, economic parameters and values recommended in current DfT and Highways England (HE) guidance.

3 Estimation of Costs

3.1 Overview

The estimation of costs for the scheme has been carried out following the principles set out in WebTAG Unit A1.2. The costs have been estimated under three broad headings – investment, operating and maintenance costs.

The base cost of the scheme is made up of investment, maintenance and operating costs, for a given price base. This includes estimates for construction, land, preparation, supervision. It incorporates a realistic assumption of changes in real costs over time (e.g. cost increases or reductions relative to the rate of general inflation). The base cost also takes into account the cost of land compensation.

3.2 Investment Cost

3.2.1 Works Cost

All costs have been estimated using a Quarter 3, 2016 price base and are detailed in Table 3-1. The total cost exclusive of risk and inflation amounts to **£85.9 million.**

Table 3-1 - Great Yarmouth Third River Crossing Scheme Cost Estimate

Cost Area	Costs (£000)
Construction	
West Section	*11,465*
Bascule Bridge	*40,013*
East Section	*5,909*
Sub-total Construction Cost (Inc. Ancillary Works/Prelims)	**57,386**
Work by Statutory undertakers and others	3,040
Survey/Investigate/Design/Procure/Supervise/Manage & Liaise	11,400
Sub-total including Stats/Others & Design (excl. Land & Risk)	**71,827**
Land*	14,110
Total work cost (exclusive of risk)	**85,937**

*Land Cost includes potential Part 1 Compensation Claims

3.2.2 Adjustment for Risk

A Risk Management Workshop was held on 30th January 2017 to consider risks associated with the preferred scheme.

A structured and systematic process for identifying, assessing and managing risk has been established for the scheme. A risk log has been generated which identifies risks that may occur during the planning, design and construction phases and outlines any unrealised issues that have the potential to adversely impact on the scheme delivery, programme or cost. The Risk Register and Quantified Risk Assessment were submitted as Appendix F as part of the Outline Business Case.

Table 3-2 shows the scheme costs inclusive of risk. The risk value calculated for the scheme amounts to **£25,714,218**. The total work cost including risk amounts to **£111,651,306**.

Table 3-2 – Scheme Cost Estimate (£000) (inclusive of risk)

Cost Area	Cost (£000)
Base Cost at 2016 Q3 prices	85,937
Quantified Risk (85th percentile value)	25,714
Risk-adjusted Base Cost at 2016 Q3 prices	111,651

3.2.3 *Scheme Cost Profile*

The scheme cost profile based on the current scheme programme is set out in Table 3-3 and is exclusive of risk.

Table 3-3 – Scheme Cost Profile (£000) (exclusive of risk)

Type	Year							Total (£000)
	Prior to 2017/18	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	
Construction	0	0	10,048	1,773	18,226	22,783	4,557	**57,387**
	0%	0%	17.5%	3.1%	31.8%	39.7%	7.9%	
Utilities	0	0	456	1,368	1,216	0	0	**3,041**
	0%	0%	15.0%	45.0%	40.0%	0%	0%	
Land	2,700	282	423	4,233	4,939	988	545	**14,110**
	18.9%	2.0%	3.0%	30.0%	35.0%	7.0%	3.9%	
Fees	0	1,112	2,223	2,594	3,078	1,995	399	**11,400**
	0%	9.8%	19.5%	22.8%	27%	17.5%	3.5%	
Total (£000)	**2,700**	**1,394**	**13,150**	**9,968**	**27,459**	**25,766**	**5,501**	**85,937**

3.2.4 *Inflation – Financial Case*

Inflation will mean that the actual amount of money to be spent on the scheme will differ from the 2016 Q3 estimates. An allowance for inflation has therefore been calculated for each future year.

The 2016 prices will be inflated through the delivery and construction period based on the Bank of England CPI latest forecasts of general inflation as set out in Table 3-4.

Table 3-4 - Inflation Rates

Factors applied to 2016 Q3 to give outturn prices	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
General Inflation Rate	2.44%	2.69%	2.48%	2.36%	2.36%	2.36%
Factor	**1.024**	**1.052**	**1.078**	**1.103**	**1.129**	**1.156**

It is worth noting that construction inflation has previously been assessed and agreed by the Norfolk County Council (NCC) Highway Authority, based on an assessment of local contractors' rates, and set at 2% per annum for the years 2013 to 2018.

Similarly, the Building Cost Information Service (BCIS) and other construction inflation indices show forecast construction inflation to be at a lower level than forecast background inflation from RPI over the short term. Consequently, the Bank of England inflation rates are considered both realistic and reliable in the context of setting out robust scheme costs for an Outline Business Case. Therefore, the rates as shown in Table 3-4 have been used to account for inflation in the preparation of the Outturn Scheme Cost as detailed within the Financial Case of the OBC.

3.2.5 *Outturn Cost Estimate*

Table 3-5 summarises the outturn cost for the scheme, comprising of investment cost, inflation, and risk. The outturn cost estimate for the package is **£124,696,533** (2016 prices).

Table 3-5 - Scheme Outturn Cost Estimate (£000)

Cost Area	Base Costs (£000)
Base construction	57,387
Work by Statutory undertakers and others	3,040
Survey/Investigate/Design/Procure/Supervise/Manage & Liaise	11,400
Land	14,110
Risk	25,714
Total base cost (risk adjusted)	**111,651**
Inflation	10,959
Other expenditure prior to 17/18	2,087
Total outturn cost (Inc. inflation)	**124,697**
Total scheme cost (Inc. inflation, exc. other prior expenditure)	**122,610**
Total scheme future cost (exc. value of land acquired)	**119,910**

3.3 Operating and Maintenance Costs

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

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

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

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

All maintenance and operation costs have been estimated at 2016 Q3 prices.

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

3.3.1 Bridge Maintenance Cost

The through-life maintenance cost of the bridge has been calculated at a 2016 Q3 price base. The elements included within this cost are:

- Routine servicing costs;
- Exceptional repairs and maintenance; and
- Re-planting and refurbishment.

The total cost over a 60 year appraisal period amounts to **£5,533,462**.

3.3.2 Bridge Operating Cost

The operating cost for 24/7 coverage of the bridge has been calculated at a 2016 Q3 price base, amounting to a total cost of **£5,946,334** over a 60 year appraisal period.

3.3.3 Road Operating and Maintenance Cost

The operating and maintenance cost for the road sections of the scheme has been calculated at 2016 Q3 prices. Included within this cost are the following:

- Highways maintenance liabilities including communications equipment, drainage clearance, road and street lighting operation, winter maintenance (i.e. application of salt and snow clearance) and infrastructural and safety inspections.

- Longer term highways renewals, including re-surfacing and renewing the new bridge approaches and bridge surface (included in the annual average cost)

The total cost amounts to **£1,221,673** over a 60 year appraisal period.

3.4 Present Value Cost (PVC)

3.4.1 Overview

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

This involves three key steps:

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

Before these three steps, inflation, risk and Optimism Bias was applied to the total scheme cost.

3.4.2 Inflation- Economic Case

The cost of the scheme has been modelled in the Economic Case to determine the effect of forecast construction inflation relative to general inflation to take account of a set of inflation rates and factors.

Table 3-6 summarises the inflation rates derived from the WebTAG data book (July 2016) and the Office for National Statistics (ONS) construction output price indices (Oct-Dec 2016). These rates were subsequently used to calculate the inflation factors listed in Table 3-7, to account for the difference between construction inflation and general inflation. The factors shown in Table 3-7 have been applied to the scheme cost in line with the spend profile.

Table 3-6 - General Inflation Rates- Economic Case

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

Note: General Inflation Rates taken from WebTAG Data Book and Construction Inflation Rates taken from ONS Construction Price Indices

Table 3-7 - Inflation Factors – Economic Case

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

Table 3-8 - Inflation Adjusted Sub-Total

Component	Scheme Cost (£000)
Total Investment Cost	85,937
Inflation	2,761
Inflation Adjusted Sub-Total	88,698

3.4.3 *Risk*

As outlined in section 3.2.2, a structured and systematic process for identifying, assessing and managing risk has been established for the scheme. The total risk associated cost of the scheme is **£26.1 million (**Table 3-9).

Table 3-9 - Risk Adjusted Sub-Total

Component	Scheme Cost (£000)
Sub-Total	88,698
Risk (inc Inflation)	26,119
Risk Adjusted Sub-Total	114,817

3.4.4 *Optimism Bias*

An Optimism Bias was applied to costs to reflect the uncertainty of the current cost estimates, based on guidance in TAG Unit A1-2. This figure is derived from a weighted average, calculated, based on the proportions of bridge and road costs (69.7:30.3) giving an overall optimism bias allowance of **21%** (Table 3-10) applied to the total risk-adjusted costs**.** Further detail on this process is provided within the OBC Economic Case.

Table 3-10 - Optimism Bias

Component	Scheme Cost (£000)
Risk Adjusted Sub-Total	114,817
Optimism Bias (21%)	24,112
Total	138,929

3.4.5 *Re-basing*

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

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

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

The GDP price deflator[2] contained in the TAG data book has been used to convert prices from the 2016 q3 price year base to 2010 costs (2010 index = 100, 2016 = 110.01).

3.4.6 Discounting

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

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

As such, the cost estimate has been discounted to the DfT's Base year (2010) using the discount rates outlined in the current TAG Data book summarised in Table 3-11.

Table 3-11 - Discount Rates

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

3.4.7 Market Prices

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

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

3.4.8 *Present Value Cost Summary*

Table 3-12 summarises the investment and operating costs which have been adjusted to 2010 prices and values. It demonstrates that the total PVC estimate over the 60 year appraisal period for the scheme is **£111.6 million.**

Table 3-12 - Summary of Scheme Costs

Cost Categories	Costs £000
Total Investment Cost (2016 Prices)	138,929
Total Present Value of Investment Cost (2010 Prices & values)	107,391
Total Operation and Maintenance Costs (2016 Prices)	15,347
Total Operation and Maintenance Costs (2010 Prices and values)	4,172
Total PVC (2010 Prices and Values)	**111,563**

4 Estimation of Benefits

4.1 Introduction

The following scheme benefits were calculated for the Core Scenario forecasts and subsequently, for user benefits only, for the Low and High Growth Scenarios:

- User Benefits (time, vehicle operating cost and tax savings); and
- Accident Cost Savings
- Other Benefits (reliability, wider impacts, regeneration, active mode appraisal and environment)

4.2 User Benefits

The following section provides an overview of the TUBA economic assessment, including the key inputs and parameters used within the assessment and the outputs and results.

TUBA 1.9.8 was used to carry out an assessment of the 'user benefits' for the proposed scheme.

The Transport Economic Efficiency (TEE) benefits arise from time and vehicle operating cost savings over the 60 year appraisal period and are evaluated from the difference in costs between the Do-Minimum and Do-Something forecasts.

4.2.1 Scheme Parameters

Table 4-1 shows the main parameters that have been used in the TUBA scheme file.

Table 4-1 - Scheme Parameters

Parameter	Option – Do-Something
TUBA Version	v1.9.8
Opening Year	2023
Design Year	2038
Horizon Year	2051
Final Appraisal Year	2082
Modelled Years	2023, 2038 and 2051

4.2.2 Time Slices

TUBA is able to provide user benefits for up to 8,760 hours within a year and it allocates each hour into one of 5 time slices:

Table 4-2 - TUBA Time Slices

Period	Time
Weekday AM Period	(07:00-10:00)
Weekday Inter-Peak Period	(10:00-16:00)
Weekday PM Period	(16:00-19:00)
Weekday Off-Peak Period	(19:00-07:00)
Weekend + Bank Holiday	(24-hours)

The traffic models developed for the proposed scheme, consists of the three distinct time periods: AM peak hour (08:00-09:00), Inter-peak (average of 10:00-15:30), and PM Peak (16:30-17:30). Non-modelled hours should therefore be included in the TUBA analysis either by expanding the modelled hour to the relevant period or by adopting “donor” models. (Detail of the method, of annualisation, is provided in the subsequent section and in Appendix G of the OBC). The TUBA analysis periods and the corresponding modelled hours are summarised as follows:

Table 4-3 - TUBA Analysis Periods and Corresponding Model Input Hours

TUBA Analysis Periods	Model Input Periods
AM Peak Period (0700-1000)	AM Peak Hour (08:00-09:00);
Inter-Peak Period (1000-1600)	Average Inter-peak Hour (10:00-15:30)
PM Peak Period (1600-1900)	PM Peak Hour (16:30-17:30).
Off-Peak Period (1900-0700)	Average Inter-Peak Hour (1000-1600)
Weekend + Bank Holiday	Average Inter-Peak Hour (1000-1600)

4.2.3 *Vehicle Type and Trip Purpose*

In accordance with the DfT WebTAG guidance, TUBA benefits are required to be assessed with disaggregation to vehicle type and journey purposes. Seven user classes are defined in the TUBA standard economic file, representing 3 distinct trips purposes for car, two for LGV’s and 2 for HGV’s that is based on different values of time (VoT) and fuel consumptions for each vehicle types and purposes:

Car – Employer Business;
Car – Commuting;
Car – Other;
LGV – Personal;
LGV – Freight;
OGV 1;
OGV2

The traffic models developed for the proposed scheme however consist of 5 user classes (user class 1: Car – Business, user class 2: Car – Commuting, user class 3: Car – other, user class 4: LGV and user class 5: HGV):

Car – Employer Business;
Car – Commuting;
LGV
HGV

Car – Other;

The user classes from the Great Yarmouth traffic forecast variable demand models were therefore converted to the standard TUBA user classes, using the adjustment factors applied for each modelled user class as provided in Table 4-4.

Table 4-4 Modelled User Classes to TUBA User Classes

Model User Class	TUBA User Class	TUBA Input		
		Vehicle/Submode	Trip Purpose	Factor Split
1	1	1 (Car)	1 (Business)	1.00
2	2	1 (Car)	2 (Commuting)	1.00
3	3	1 (Car)	3 (Other)	1.00
4	4	2 (LGV personal)	0 (Commuting and Other)	0.12
4	5	3 (LGV freight)	0 (Business)	0.88
5	6	4 (OGV1)	0 (Business)	0.40
5	7	5 (OGV2)	0 (Business)	0.60

A TUBA assessment was then undertaken using the parameters described above, with demand and skimmed time and distances for Do-Minimum and Do-Something forecast models to produce the user benefits for the 60 year appraisal period.

4.2.4 *Analysis of User Benefits*

User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues typically form the major element of benefit attributable to highway schemes. The assessment reported here uses TUBA Version 1.9.8.

The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do-Minimum (DM) and Do-Something (DS) tests for the Opening and Design years are fed into TUBA, generating the following types of economic outputs:

- User Time Savings
- Vehicle Operating Cost savings
- Greenhouse Gases
- Taxes

Analysis of the benefits has been carried out:

- By year, over the 60 year appraisal period
- By trip purpose/ vehicle type/ by time period (AM/ IP/ PM periods); and
- By sector of origin and destination

The appraisal area for estimating user benefits includes the full cordoned model area, although analysis at sector level provides the facility to assess benefits within only part of the modelled area.

4.2.5 *Annualisation Factors and Non Modelled Hours*

The forecast models consist of three distinct peak hours: AM peak hour (08:00-09:00), average inter-peak hour (10:00-15:30), and PM peak hour (16:30-17:30). TUBA analysis is, however, required to be carried out for all the hours for the whole year.

For non-modelled hours (i.e. AM Peak shoulders (07:00-08:00 and 09:00-10:00), PM peak shoulders (15:30-16:30 and 17:30-18:30), off-peak and weekend and Bank Holidays), it is only appropriate to calculate benefits for hours in which traffic levels are similar to the modelled hours.

For example, in the appraisal it would not be appropriate to expand the AM peak hour to the AM period in the event that observed traffic was significantly lower in the peak shoulders. In reality, this would result in significantly less actual delays caused by traffic in the peak shoulders as opposed to the peak hour, thus resulting in overestimating the modelled benefits of the proposed scheme if the peak shoulders were included in the calculation of benefits.

TUBA guidance suggests that a conservative approach should be used to identify benefits/dis-benefits for non-modelled periods so that it would represent as close as possible the changes in travel time between Do-Minimum and Do-Something compared to the changes in the modelled hours.

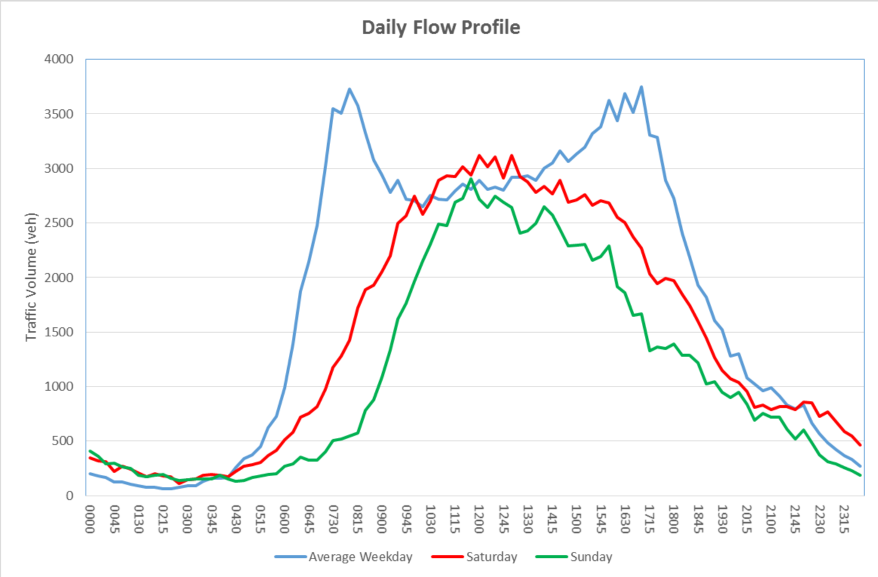
It is often considered good practice that the peak shoulder traffic exceeding 90% of that in the peak hour should be included in the derivation of the annualisation factors as the change in travel time between the Do-Minimum and Do-Something in the peak shoulders would be close to the changes experienced in the peak hour. The 90% threshold was used in the initial analysis.

Observed traffic counts from nine Automatic Traffic Counts (ATC) at the RSI locations in Great Yarmouth that were collected for the two weeks in November, 2016 for the purpose of the base year model validation were used to identify this profile.

The locations of the nine ATC counts can be found within the TUBA Methodology and Annualisation Factors Note (Appendix G of the OBC).

Figure 4-2 provides a summary of the daily traffic flow profile that was produced from the ATC sites.

Figure 4-1 - Traffic Flow Profile



As can be seen from the Figure 4-1, weekday traffic volume peaks between 08:00-09:00 before reducing significantly to the inter-peak. Peak conditions re-emerge at 15:30 and continue to 17:30 before receding into the off-peak period. During weekend, the traffic volume shows similarly to the inter-peak period on Saturday with slightly lower flow on Sunday. It was therefore suggested that only about 1.5 hours for the AM and about 2 hours for the PM period that will be used for the calculation of the benefits of the scheme. This was based on the assumption that traffic volume in the peak shoulders of more than 90% of the peak hour volume is deemed to be appropriate to be included in the derivation of the annualisation factors. Further detail on the annualisation and non-modelled hours is provided in Appendix G of the OBC.

The following factors were applied to the relevant modelled hours to include the non-modelled hours in the calculation of the TUBA benefits, and to derive the annualisation factors as provided in Table 4-5. The source of these calculations can be found in Tables 3-2 to 3-4 in Appendix G of the OBC.

Table 4-5 - Annualisation Factors

No	Time Slice	Duration (min)	Traffic Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1.51 x 253 = 383
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7.23 x 253 = 1,828
3	Weekday PM Period	60	PM Peak Hour model	2.20 x 253 = 556
4	Weekday Off-Peak period	60	Inter-Peak hour model	0.00 x 253 = 0
5	Weekend	60	Inter-Peak hour model	8.06 x 52 = 419
Total Annual Hours				**3,186 hours**

Around 36% of annual hours are reflected in the annualisation. It is noted that the ATC counts were collected for 2 weeks during November, 2016. They therefore do not represent the whole year of traffic travelling within the area, particularly during the summer seasons where weekend traffic volume are likely to be higher than those in November.

Furthermore, the ATC counts during November do not include any Bank Holidays, therefore these benefits are also excluded. The annualisation factors derived for the weekends using November are therefore considered conservative in the calculation of the benefits for the proposed scheme.

4.2.6 *Benefits at Sector Level*

The geographic distribution of benefits has been assessed through an analysis of sector-based cost changes. A 10 by 10 sector system was defined for the study area to provide an overview of the distribution of benefits derived from the transport model. These sectors are listed in Table 4-6 and illustrated in Figure 4-2.

Figure 4-2 - Sector Locations

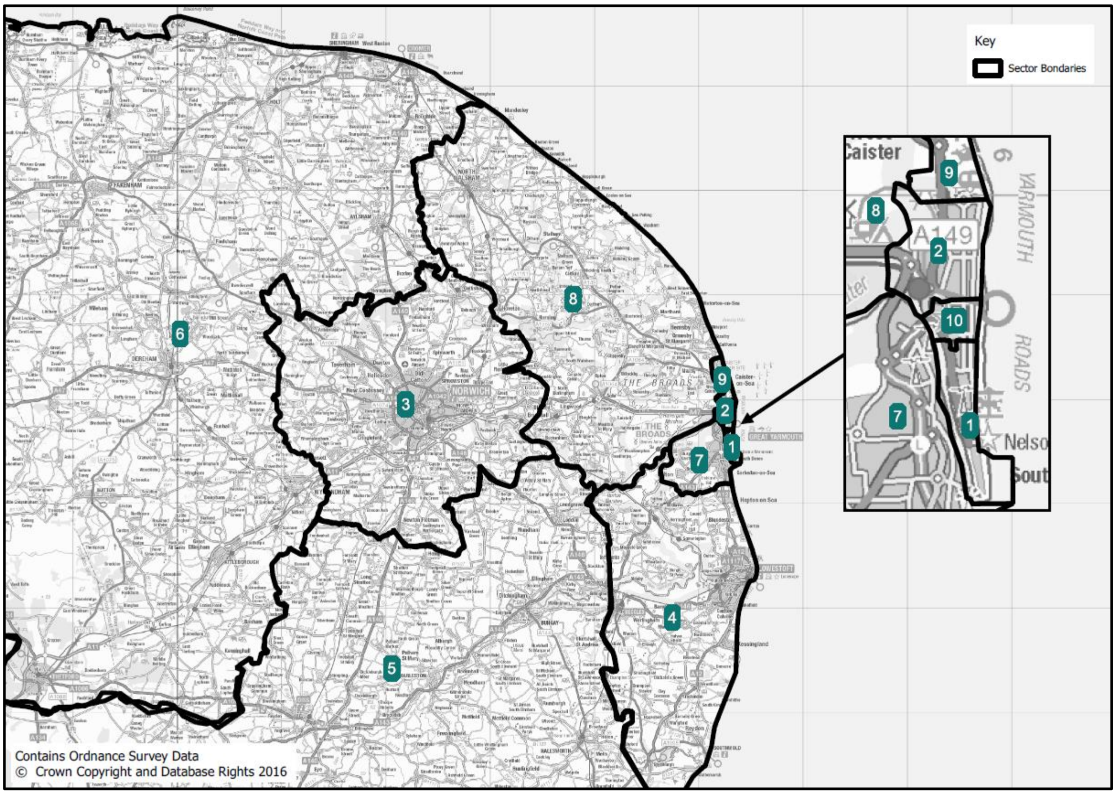


Table 4-6 – Sector System

Sector	Description
Sector 1	Great Yarmouth Peninsula
Sector 2	Great Yarmouth north town
Sector 3	Norwich
Sector 4	Lowestoft
Sector 5	South (London, Ipswich, etc.)
Sector 6	North/West (Midlands, Northwest, Northeast, etc.)
Sector 7	Rural areas south of Great Yarmouth
Sector 8	North of Great Yarmouth (Winterton-on-Sea, Horsey Corner, North Walsham)
Sector 9	Caister-on-Sea
Sector 10	Great Yarmouth mid-town

4.3 Accident Savings

The anticipated number of accidents and casualties saved as a result of the introduction of the proposed scheme were calculated using the DfT's software Cost and Benefit to Accidents – Light Touch (v2013_02COBA-LT).

As defined in the COBA-LT manual, the total cost of accidents on a network is calculated by multiplying the number of accidents predicted to occur on the network by the cost per accident. The number of accidents on a given length of road is expressed by accident rates, defined as the number of Personal Injury Accidents (PIA) per million vehicle kilometres travelled. The outputs are expressed as the change in the number of accidents and casualties when a scheme is introduced, and the economic cost implications of these changes.

The savings in the number of accidents / casualties as a result of the scheme were calculated from the difference between accident and casualty costs in the Do-Minimum and Do-Something The accident benefits were calculated over a 60 year appraisal period and discounted to 2010 base prices and values.

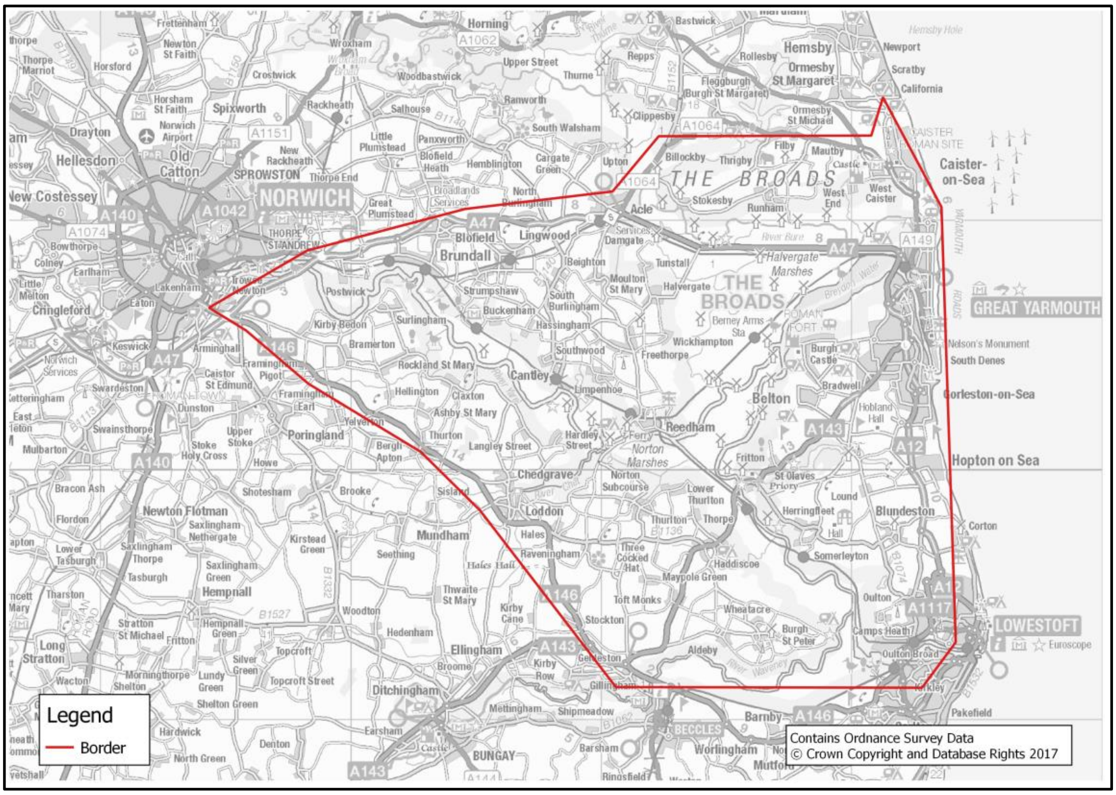
The latest standard economic parameter file was used which contains a series of data tables of standard parameters required to calculate accident impacts in line with WebTAG guidance. These data tables provide the inputs required to calculate accident and casualty numbers and costs by year using:

- Costs per accident type
- Rates of accidents and casualties of different severities by link type; and
- Junction class and allowance for changes in accident and casualty rates through time using change factors (known as beta factors).

Alongside the economic parameter file, the scheme specific input file is used to produce the output file. This contains comparable information for links and junctions, setting out the classification of types, traffic flows and historical accident data.

The extent of the study area was based on links with AADT flow differences of over 5%. The resulting study area is illustrated in Figure 4-3.

Figure 4-3 – COBA-LT Study Area



COBA-LT has the ability to run the analysis using two different modes as summarised as follows,

- Separate mode – accident benefits are calculated separately for links and junctions (defined as those accidents occurring within 20m of a junction); or
- Combined mode – accident benefits are calculated for links in way that the junction accidents are included.

The scheme is likely to result in a considerable redistribution of traffic thus impacting flows on a number of links and junctions. It is considered appropriate to assess links and junctions separately within COBA-LT. Default accident rates were used across the COBA-LT network.

For each link within the study area (for both the Do-Minimum and Do-Something scenarios), a COBA link type was assigned from the default set of fifteen available within COBA-LT. Link lengths, speed limits and AADT flows were also extracted for each link from the forecast models.

The COBA-LT study area includes a considerable number of junctions, including a number of minor junctions where safety is unlikely to be impacted by the scheme. The junctions included in the assessment were selected using the following methodology:

- All junctions where at least 1 Personal Injury Accident (PIA) was recorded in the 6-year period between 2010 and 2015 were included. This assessment of observed accidents was undertaken for selection purposes only. No observed accidents were included in the COBA-LT input file;
- Any other major junctions likely to be impacted by the scheme;
- The existing priority junction at Swanston's Road/South Denes Road on the Peninsula (to be replaced by the new signalised junction) was included with flows in the Do-Minimum scenario only;
- The proposed new roundabout and traffic signal junctions on the west and eastern side of the new bridge respectively were included with flows in the Do-Something scenario only.

The locations of the junctions that were included in the COBA-LT assessment can be found in Appendix C.

For each junction a COBA-LT junction type was assigned from the default set of eight available. The AADT flows for each approach were extracted from the forecast models.

A summary of the COBA-LT parameters is presented in Table 4-7.

Table 4-7 - Accident Benefits Calculation General Parameters

Parameter	Value
First Year of Assessment	2023
Evaluation Period	60 Years
Traffic Flow Input Format	AADT
Type of Accident Calculations	Link and Junction Separate (SEP)
Traffic Flow Input Year	2023, 2038, 2051
Traffic Growth Assumption	Default Central (DEFC)
Economic Growth Assumption	Default Central (DEFC)
Fuel Cost Growth Assumption	Default Central (DEFC)

4.4 Other Benefits

4.4.1 Reliability Benefits

The term reliability refers to variation in journey times that individuals are unable to predict (journey time variability). Such variation could come from recurring congestion at the same period each day (day-to-day variability), or from non-recurring events such as incidents. It however excludes predictable variation relating to varying levels of demand by time of day, day of week, and seasonal effects which travellers are assumed to be aware of.

Different methods to estimate reliability impacts have been developed for public transport and private vehicle trips on inter urban motorways and dual carriageways, urban roads, and other roads. All require a unit to measure travel time variability and this is generally the standard deviation of travel time (for private travel) or lateness (for public transport).

For inter-urban motorways and dual carriageways, impacts of journey time variability and incident delays is estimated using the Highways England's bespoke tool namely Motorways Reliability and Incident Delays (MyRIAD). For motorways and dual carriageways, alternative routes avoiding particular sections usually have limited capacity making it difficult for large number of drivers to divert if they encounter delays due to an incident, therefore, in the absence of significant demand exceeding capacity, it may be sufficient to assume that incidents are the main source of unpredictable variability.

For urban areas, alternative routes are more readily available than on the motorways and there are many ways for drivers to divert away from incidents which reduce capacity on a particular routes.

Building on previous research, a model has been developed to forecast changes in the standard deviation of travel time from changes in journey time and distance, as provided in the WebTAG A1.3:

$$\Delta\sigma_{ij} = 0.0018({t_{ij2}}^{2.02} - {t_{ij1}}^{2.02})\,{d_{ij}}^{-1.41}$$

where:

$\Delta\sigma_{ij}$	is the change in standard deviation of journey time from i to j (seconds)
t_{ij1} and t_{ij2}	are the journey times, before and after the change, from i to j (seconds)
d_{ij}	is the journey distance from i to j (km).

To estimate the monetised benefits of changes in journey time variability, money values are needed. The reliability ratio enables changes in variability of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of travel time / Value of travel time

The recommended value for the reliability ratio for all journey purposes by car, based on evidence compiled, is 0.8 as stated out in the WebTAG A1.3. The reliability benefits are then can be estimated using the "rule of half" formula:

$$Benefit = -\frac{1}{2}\sum_{ij}\Delta\sigma_{ij} * \left(T_{ij}^{0} + T_{ij}^{1}\right) * VOR$$

Note that the value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio and T_{ij}^0 and T_{ij}^1 are number of trips before and after the change.

From WebTAG A1.3, reliability benefits calculated using this method should be identified separately from other economic benefits and only reported in the AST.

To produce reliability benefits for each scenario, only travel time saving benefits from TUBA runs were extracted since reliability benefits are associated with travel time savings. Benefits associated with fuel, non-fuel, greenhouse gas and indirect tax revenues were not included from TUBA outputs.

Further detail on the methodology for calculating the reliability benefits for the scheme can be found in Appendix B.

4.4.2 *Wider Impacts*

Wider impacts, as defined in DfT guidance, are the economic impacts of transport that are additional to transport user benefits. In perfectly competitive markets, these impacts would be fully captured by a properly specified appraisal. But in practice, most markets are not perfectly competitive and as a result, wider impacts may result as direct user impacts are amplified through the economy. It has been demonstrated that these impacts can be large, and can therefore be an important part of the overall appraisal of a transport scheme.

The types of wider impacts that need to be considered are:

- WI1 – Agglomeration
- WI2 – Output change in perfectly competitive markets
- WI3 – Tax revenues arising from labour market impacts (from labour supply impacts and from moves to more or less productive jobs)

The quantitative assessment of these impacts can be undertaken using the DfT's WITA software (Wider Impacts in Transport Appraisal). In its absence, and in the initial stages of the Outline Business Case submission, appropriate uplifts may also provide some understanding of the magnitude of such benefits.

An indicative measure of the value of increased output in imperfectly competitive markets can be estimated using a 10% uplift to the business user benefits abstracted from the TUBA outputs for the Core Scheme. This represents the additional consumer surplus associated with increased output.

The likely impact of wider impacts and regeneration in Great Yarmouth has been reported by consultant Regeneris in the Regeneration and Wider Impacts Report (Supporting Document 11 to the OBC). Their 2017 assessment of benefits and impacts is largely qualitative but quantification is also outlined with the focus of the assessment being on the impacts on employment land and existing sites and premises, as well as on town centre regeneration and the visitor economy. There is also a commentary on demographic change and the how increased investment and development activity in Great Yarmouth will lead to requirements for, and supply of, a skilled labour market.

4.4.3 *Regeneration*

The DfT Value for Money note (2013) permits the use of regeneration benefits in the calculation of the adjusted BCR. Regeneration benefits (as defined by DfT) are not included in the calculation of the adjusted BCR here, and are reported here as qualitative benefits. This is because there is no “dependent development” associated with the scheme, and therefore no direct land value uplift (planning gain) that is directly attributable. The benefits captured in the other assessments above are considered to include regeneration benefits already. Inclusion of additional regeneration benefits would therefore “double-count” these benefits. This is considered a conservative approach to the calculation of scheme benefits.

Potential regeneration impacts have been considered by consultant Regeneris and reported in the Regeneration and Wider Impacts Report. As noted above, their 2017 assessment of benefits and impacts is largely qualitative but quantification is also outlined, with the focus of the assessment being on the impacts on employment land and existing sites and premises, as well as on town centre regeneration and the visitor economy.

4.4.4 *Active Mode Benefits*

As a result of the scheme, pedestrians and cyclists will have better access to the Great Yarmouth peninsula and a more pleasant environment. Dedicated facilities on the new bridge will improve journey quality and make encourage more people to walk or cycle. These impacts are expected to produce economic benefits due to:

- Increased physical activity leading to lower healthcare costs.
- Less absenteeism and fewer working days lost.
- The value placed on improved journey quality and ambience.
- Time savings for cyclists and pedestrians.

To quantity these benefits, an active mode appraisal has been conducted over a 30 year appraisal period in line with WebTAG guidance. The benefits have been discounted and reported in present values using the schedule of discount rates provided in the TAG Databook. As the appraisal has taken place in 2017, a discount rate of 3.50% per year has been applied until 2047, with a rate of 3.00% thereafter.

Again, in accordance with TAG, the values have included real growth in line with forecast GDP/capita.

A full report on the calculation of active modes benefits is contained in the Active Modes Appraisal Report (Supporting Document 10 to the OBC).

4.4.5 *Environment*

This section summarises the expected impacts of the proposed scheme on the environment. The assessed environmental impacts are:

- Noise;
- Air quality;
- Greenhouse gases;
- Townscape;
- Historic environment;
- Biodiversity; and
- Water environment.

Greenhouse gas benefits have been monetised and included in the BCR calculation. Other impacts have not been monetised, but have been quantified where appropriate and are described in the Environmental Options Assessment Report (submitted as Supporting Document 12 to the OBC).

The Environmental Appraisal of the proposed scheme will be updated for the full business case, and will include fully quantified and monetarised assessments where required by WebTAG.

4.5 Social and Distributional Impact (SDI) Analysis

The analysis of distributional impacts is mandatory in the appraisal process and is a key component of the Appraisal Summary Table (AST). The Distributional Impacts Appraisal compares the distribution of benefits arising from a transport intervention against the distributions of different social groups to assess the extent to which benefits are experienced by those groups and compared nationally.

Distributional impacts consider the benefits and disbenefits that transport interventions have across different social groups. For example, people with access to a car may experience less benefits to those without a car for an intervention that improves local public transport services. It is important to consider vulnerable groups and that they are not disadvantaged further by receiving a disproportionately low share of the benefits provided the intervention, or a disproportionately high share of the disbenefits.

Within TAG unit A4.2, there are eight transport benefit indicators that are assessed as part of the Distributional Impacts Appraisal:

- User benefits;
- Noise;
- Air quality;

- Accidents;
- Security;
- Severance;
- Accessibility; and
- Personal affordability.

The appraisal approach consists of the following three steps:

- **Step 1 – Screening Process**:
    - Identification of likely impacts for each indicator.
- **Step 2 – Assessment:**
    - Confirmation of the area impacted by the transport intervention (impact area)
    - Identification of social groups in the impact area; and
    - Identification of amenities in the impact area.
- **Step 3 – Appraisal of Impacts**:
    - Core analysis of the impacts; and
    - Full appraisal of DIs and input into AST

A full report on the methodology and outputs of the SDI analysis is contained in the Social and Distributional Impacts Report (Appendix A).

5 Economic Appraisal Results

5.1 Introduction

This section of this report provides the results of the assessment of user benefits and accident cost savings.

5.2 User Benefits (TUBA)

The user benefits derived from the scheme in the Core Scenario appraisal are summarised in Table 5-1. Also summarised in table is the total number of TUBA warnings. These warnings are produced by TUBA as part of the standard output file and are based on changes in distance and time between the Do Minimum and Do Something models. These have been investigated thoroughly in order to identify correct any erroneous results. The full breakdown of TUBA warnings by type are provided in the TUBA Methodology and Annualisation Factors Note (Appendix G of the OBC).

Table 5-1 - TUBA Benefits

Cost and Benefits	Core Scenario
Consumer User (Commute)	62,370
Consumer User (Other)	144,040
Business User and Provider	122,632
Indirect Tax Revenue	-3,485
Carbon Benefits	1,827
Present Value of Benefits (PVB)	**327,384**
Number of warnings	115,488

Note: All values are in £000 at 2010 prices and values and are as abstracted from TUBA outputs.

5.2.1 Benefits by Time Period

The contribution by type of benefit and by time period is summarised in Table 5-2 and Figure 5-1.

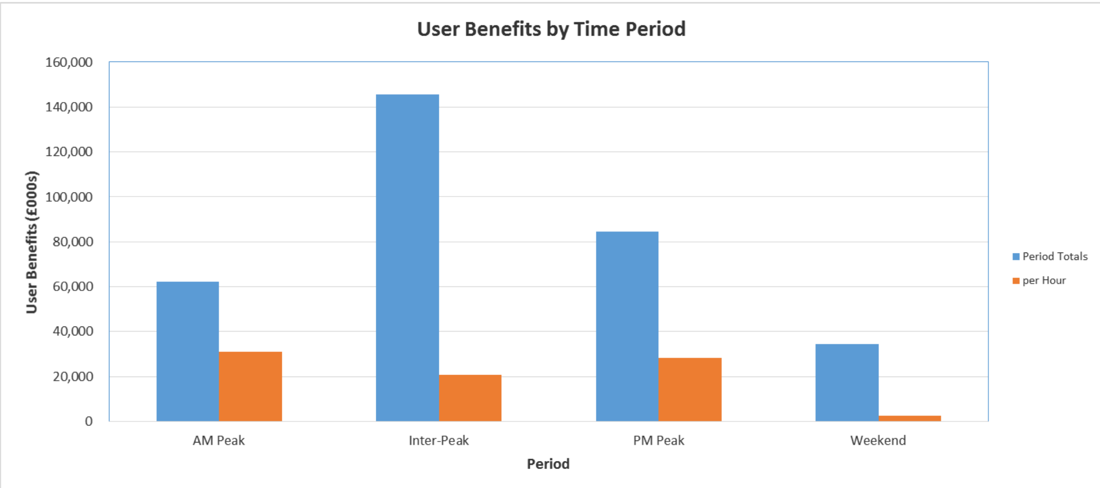
User Benefits (excluding costs associated with greenhouse gases and indirect tax revenue) across the 60 year appraisal period are over **£329 million**, of which 93% are made up of time savings, with the other 7% being made up of Vehicle Operating Cost savings. It is noted that there is a significantly larger contribution in total benefits from the PM period than the AM period in years 2038, 2051 and over the appraisal period as a whole. Conversely, the AM period contributes larger ‘per hour’ benefits than the PM period.

Table 5-2 - User Benefits by Type and Time Period (£000's)

Period	Type	2023	2038	2051	60 years
AM Period	Time Savings	612	973	1,153	58,244
	VOC	89	75	75	3,877
	Total	**701**	**1,048**	**1,228**	**62,121**
	per Hour	*351*	*524*	*614*	*31,061*
Inter-Peak Period	Time Savings	1,506	1,780	2,831	134,354
	VOC	392	202	193	11,161
	Total	**1,898**	**1,982**	**3,024**	**145,515**
	per Hour	*271*	*283*	*432*	*20,788*
PM Period	Time Savings	693	1,364	1,615	80,342
	VOC	94	76	83	4,155
	Total	**787**	**1,440**	**1,698**	**84,497**
	per Hour	*262*	*480*	*566*	*28,166*
Weekend	Time Savings	386	455	724	34,351
	VOC	90	47	44	2,558
	Total	**476**	**502**	**768**	**36,909**
	per Hour	*159*	*167*	*256*	*12,303*
Total	Time Savings	3,197	4,572	6,323	307,291
	VOC	665	400	395	21,751
	Total	**3,862**	**4,972**	**6,718**	**329,042**

Note: All values are in £000 at 2010 prices and values and are as abstracted from TUBA outputs and may contain rounding discrepancies

Figure 5-1- User Benefits by Time period



Further to the aforementioned, it can be seen that user benefits increase over the forecast years consistently across all the time periods. The order of magnitude of benefits by time periods are plausible with the highest benefits per hour attributed to the AM and PM periods. The levels of delay in the AM and PM period hours are significantly higher than those in the Inter-peak or weekend periods.

5.3 Benefits by Trip Purpose

Table 5-3 summarises travel time benefits by journey purpose. Some 30% of these savings are realised by freight movements whereas 44% of benefits are accrued by 'others' journey purposes. This is expected given the nature of the area (i.e. to serve as a major attraction for tourism and as a port for freight). Around 19% of benefits are attributed to commuters and 7% to business users (car).

Table 5-3 - Travel Time Savings by Trip Purpose

Purpose	Travel Time	Vehicle Operating Cost	Total	Proportion
Commuting	60,952	1,418	62,370	19.0%
Other	139,275	4,765	144,040	43.8%
Business (Car)	21,227	2,535	23,762	7.2%
Business (Freight)	85,838	13,032	98,870	30.0%
Total	**307,292**	**21,750**	**329,042**	**100.0%**

Note: All values are in £000 at 2010 prices and values and are as abstracted from TUBA outputs and may contain rounding discrepancies.

5.4 User Benefits by Vehicle Type and Magnitude of Time Savings

Table 5-4 provides a breakdown of travel time savings by car, LGV and OGV and the size of the time savings accrued by each vehicle type.

Table 5-4 Travel Time Savings by Vehicle Type

Veh. Type	Purpose	< -5min	-5 to -2min	-2 to 0min	0 to 2min	2 to 5min	> 5min	Total
Car	Business	0	-24	-1,205	6,107	9,878	6,471	**21,227**
Car	Commuting	-1	-205	-3,800	12,868	26,475	25,615	**60,952**
Car	Other	0	-205	-9,699	41,145	57,313	46,335	**134,889**
LGV	Personal	-4	-3	-293	1,009	1,838	1,839	**4,386**
LGV	Freight	-65	-46	-4,568	15,666	28,720	28,875	**68,582**
OGV1	Business	-2	-3	-530	1,703	2,709	3,024	**6,901**
OGV2	Business	-3	-4	-795	2,555	4,063	4,537	**10,353**
Total		**-75**	**-490**	**-20,890**	**81,053**	**130,996**	**116,696**	**307,290**

Table 5-4 shows that the majority of time savings are realised by those driving cars (71%). LGV's make up around 24% of savings whereas 6% of overall travel time savings are enjoyed by OGVs.

Benefits arise across all the time saving bands, which is expected as the objectives of the new bridge are to shorten travel time and distances for traffic to/from the Peninsula and also to relieve congestion that is currently an issue on the A47 at Gapton and Harfrey's roundabouts. It is noted that a small proportion of the dis-benefits are forecast and this is also expected as some of the local traffic would suffer delays as increases in traffic in the Peninsula arise from traffic re-assignment.

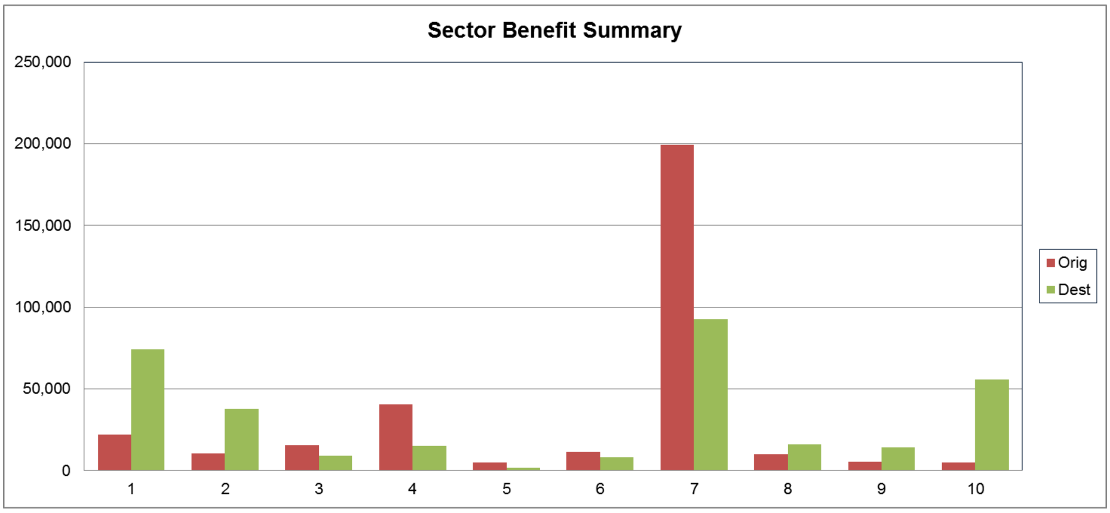
5.5 Geographical Distribution of Time Benefits

Guidance recommends that an aggregation of modelled zones into different geographical areas should be used in the TUBA analysis. This is to ensure that the benefits produced by the proposed scheme are geographically proportionate given the scale and location of the scheme.

The distribution of benefits has the same sector system as described in section 4.2.6 of this report.

Figure 5-2 shows the majority of the benefits are from/to sector 7 (south of Great Yarmouth), to the Peninsula (sectors 1 and 10). It is noted that the benefits are not proportional and that there are larger benefits associated with northbound movements as opposed to southbound movements. This is anticipated as the current major sources of delay on the network are on the A47 northbound approach at the Harfreys and Gapton roundabouts.

Figure 5-2 - User Benefits by Sector



Further detail on the geographical distribution of benefits can be found in the TUBA Methodology and Annualisation Factors Note (Appendix G of the OBC).

5.6 Safety Benefit Assessment

Table 5-5 summarises the accident benefits generated by the scheme over the 60 year assessment period, discounted to 2010 prices. It can be seen that the scheme is forecast to save 83 accidents with a resultant benefit of **£12.5 million**.

Table 5-5 – Scheme Accident Benefits

	DM	DS	Saving
Number of Accidents	7,698	7,615	83
Cost of Accidents (£000)	428,918	416,379	12,539

Table 5-6 summarises the savings in casualties. The scheme is forecast to result in a saving of 269 casualties over the 60 year appraisal period.

Table 5-6 – Scheme Casualty Benefit

Severity	DM	DS	Saving
Fatal	115	109	6
Serious	1,019	975	43
Slight	10,460	10,241	220
Total	**11,594**	**11,325**	**269**

Accident savings are broken down by links and junctions in Table 5-7. It can be seen that the accident savings are largely associated with savings at junctions. This can be attributed to the removal of trips from a number of junctions, resulting in a reduction in collisions, due to the reassignment of trips.

Table 5-7 – Accident Savings (£000) over 60 years

Location	DM
Links Only	-201
Junction Only	12,741
Total	**12,539**

Over the 60 year appraisal period, the overall impact of accident cost savings is £12.5m, with accidents making up approximately 4% of total scheme benefits.

5.7 Reliability Benefits

Table 5-8 provides a summary of the reliability benefits of the proposed scheme from the VDM core scenario for each appraisal year and the total over 60 years.

It is calculated that the present value of the reliability benefits for the Great Yarmouth Third River Crossing over the 60 year assessment period is **£33.925 million** (2010 prices).

Table 5-8 - Reliability Benefits (£000) – VDM Core scenario

Purpose	2023	2038	2051	Total
Business	22	33	53	2,483
Non-Business	248	412	686	31,442
Total	**270**	**445**	**739**	**33,925**

5.8 Wider Benefits

It is calculated that the present value of these wider benefits for the Great Yarmouth Third River Crossing over the 60 year assessment period is **£12.3 million** (2010 prices discounted to 2010).

In order to validate these assumptions the likely impact of regeneration in Great Yarmouth has been reported by consultant Regeneris in the Regeneration and Wider Impacts Report (Supporting Document 11 to the OBC). Their 2017 assessment of benefits and impacts is largely qualitative but quantification is also outlined with the focus of the assessment being on the impacts on employment land and existing sites and premises, as well as on town centre regeneration and the visitor economy. There is also a commentary on demographic change and the how increased investment and development activity in Great Yarmouth will lead to requirements for, and supply of, a skilled labour market.

Regeneris estimate that the potential for employment and gross value added (GVA) growth is derived from employment and development sites in the Borough. The sites are consistent with those used in the transport assessment for the third crossing and it is concluded that if these sites were developed and occupied by 2030, the net employment impact would be in the order of 3,300 full-time equivalent (FTE) jobs, with a total GVA contribution of around £240m. The gross average annual employment and GVA associated with these occupiers over this period would be in the order of 280 FTE jobs and £20m of GVA.

5.9 Active Mode Benefits

The Present Value of Benefits for each active mode impact are summarised in Table 5-9. It is calculated that the present value of the active modes benefits for the Great Yarmouth Third River Crossing, over a 30 year assessment period, is **£9.4 million** (2010 prices).

Table 5-9 - Present Value of Active Mode Impacts over 30Year Appraisal Period (£000) (2010 prices)

Impact	Pedestrian	Cycle user	Total
Physical Activity (Health)	£2,536	£915	£3,451
Absenteeism	£143	£59	£203
Journey Quality/Ambience	£1,014	£810	£1,825
Journey Time	£3,642	£232	£3,875
Total	**£7,336**	**£2,017**	**£9,353**

5.10 Social and Distributional Impact Benefits

The social and distributional impact assessment has been completed in line with the state of development of the scheme. Some degree of quantification is not possible at the present time because of the need to more fully assess certain social and environmental aspects. The indicators and their respective assessments that were carried out as included in the Social and Distributional Impact report in Appendix A and are summarised as follows:

- User Benefits – **Large Beneficial**
- Accidents – **Slight Adverse**
- Severance – **Slight Beneficial**
- Personal Affordability – **Moderate Beneficial**

Due to limited data, potential changes to noise and air quality as a result of altered traffic flow, speed and compositions brought on by the scheme has so far only been undertaken qualitatively. Both indicators were scored as **Slight Adverse**.

A full quantitative distributional assessment of noise and air quality impacts will be delivered in the Full Business Case.

The following indicators were scoped out during the initial screening proforma:

- Security
- Accessibility

5.11 Transport Economic Efficiency (TEE)

The results of the assessment in terms of user costs and benefits are summarised in the Transport Economic Efficiency (TEE) table, reproduced in Table 5-10.

Table 5-10 - Transport Economic Efficiency (TEE)

	ALL MODES		ROAD		BUS/COACH	RAIL		OTHER
Non-business: Commuting	**ALL MODES**		**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**		**Passengers**	**Passengers**		
Travel Time	60,952		60,952		0	0		0
Vehicle operating costs	1,418		1,418		0	0		0
User charges	0		0		0	0		0
During Construction & Maintenance	0		0		0	0		0
NET NON-BUSINESS BENEFITS: COMMUTING	**62,370**	*(1a)*	**62,370**		**0**	**0**		**0**
Non-business: Other	**ALL MODES**		**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**		**Passengers**	**Passengers**		
Travel time	139,275		139,275		0	0		0
Vehicle operating costs	4,765		4,765		0	0		0
User charges	0		0		0	0		0
During Construction & Maintenance	0		0		0	0		0
NET NON-BUSINESS BENEFITS: OTHER	**144,040**	*(1b)*	**144,040**		**0**	**0**		**0**
Business			**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Good Vehicles**	**Business Cars/LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	107,065		85,838	21,227	0	0	0	0
Vehicle operating costs	15,567		13,032	2,535	0	0	0	0
User charges	0		0	0	0	0	0	0
During Construction & Maintenance	0		0	0	0	0	0	0
Subtotal	**122,632**	*(2)*	**98,870**	**23,762**	**0**	**0**	**0**	**0**
Private sector provider impacts						**Freight**	**Passengers**	
Revenue	0							
Operating costs	0							
Investment costs	0							
Grant/subsidy	0							
Subtotal	**0**	*(3)*			**0**	**0**	**0**	**0**
Other business impacts								
Developer contributions	0	*(4)*						
NET BUSINESS IMPACT	**122,632**	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	**329,042**	*(6) = (1a) + (1b) + (5)*						

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values (£,000s)

5.12 Public Accounts

A summary of the scheme costs and their allocation between providers is accounted for in the Public Accounts (PA) table, shown in Table 5-11. The apportionment of costs between local and central government is discussed in the OBC.

Table 5-11 - Public Accounts (PA)

	ROAD INFRASTRUCTURE TOTAL	
Local Government Funding		
Operating Costs	4,172	
Investment Costs	21,478	
Developer and Other Contributions	0	
NET IMPACT	**25,650**	*(7)*
Central Government Funding: Transport		
Operating costs		
Investment Costs	85,913	
Developer and Other Contributions	0	
NET IMPACT	**85,913**	*(8)*
Central Government Funding: Non-Transport		
Indirect Tax Revenues	3,485	
TOTALS	**3,485**	*(9)*
Broad Transport Budget	**111,563**	*(10) = (7) + (8)*
Wider Public Finances	**3,485**	*(11) = (9)*

5.13 Summary of Monetised Costs and Benefits

A summary of all costs and benefits, providing an overall benefit to cost ratio (BCR) for the scheme is provided in Table 5-12. The total monetised benefits exceed the costs by **£237.7 million**. The BCR of the scheme is **3.1**. This means that the value for money category is **high**.

This initial value of BCR includes monetised benefits of accident savings, greenhouse gas reductions and indirect taxation impacts, but does not include benefits accruing from reliability or wider impacts.

Table 5-12 - Analysis of Monetised Costs and Benefits (AMCB)

Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	1,827	*(14)*
Journey Quality	5,653	*(15)*
Physical Activity	3,700	
Accidents	12,539	*(16)*
Economic Efficiency: Consumer Users (Commuting)	62,370	*(1a)*
Economic Efficiency: Consumer Users (Other)	144,040	*(1b)*
Economic Efficiency: Business Users and Providers	122,632	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-3,485	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Option Values		*(17)*
Present Value of Benefits (see notes) **(PVB)**	**349,276**	*(PVB) = (12) + (13) + (14) + (15) + (16) + (1a) + (1b) + (5) + (17) - (11)*
Broad Transport Budget	111,563	*(10)*
Present Value of Costs (see notes) **(PVC)**	**111,563**	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	**237,713**	*NPV = PVB - PVC*
Benefit to Cost Ratio (BCR)	**3.1**	*BCR = PVB/PVC*

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Table 5-13 demonstrates that the inclusion of reliability benefits and wider economic impacts gives an adjusted BCR of **3.5**. Businesses will benefit from reduced congestion, faster journeys and improved journey time reliability, with reduced costs and better access to markets, whilst commuters will similarly benefit from shorter, more reliable, journeys to work. These benefits, which are included in the BCR calculations will support local development and the regeneration of Great Yarmouth's economy.

Table 5-13 - Adjusted BCR

Adjusted BCR	2010 prices £000
Initial Present Value of Benefits (PVB)	349,276
Wider Impacts - Reliability	33,925
Wider Impacts – Economic	12,263
Adjusted Present Value of Benefits (PVB)	**395,464**
Investment Cost	107,391
Operating Costs	4,172
Present Value of Costs (PVC)	**111,563**
Net Present Value (NPV)	**283,901**
Adjusted BCR	**3.5**

The scheme is expected to lead to a reduction in greenhouse gas emissions; these have been monetised and included in the BCR.

5.14 Sensitivity Tests

In order to understand how sensitive the benefits are to a range of alternative parameters, a number of tests have been performed.

- Alternative growth scenarios
  - Core Low Growth
  - Core High Growth
- Alternative scenario including Harfrey's roundabout improvements
- Alternative levels of Optimism Bias allowance
- Annualisation

5.14.1 Alternative Growth Scenarios

The results of the TUBA runs for the low and high growth sensitivity tests are shown in Table 5-14.

The results show that benefits are much larger in the high growth scenario, although even the low growth scenario retains significant benefits.

Table 5-14 - Alternative Growth Scenario TUBA Benefit Sensitivity Tests

Benefits		Low Growth	Core	High Growth
TUBA	Consumer – Commuting user benefits	45,730	62,370	81,221
	Consumer – other user benefits	104,352	144,040	191,105
	Business benefits	88,885	122,632	164,526
	Indirect Tax Revenue	-3,049	-3,485	-3,940
	Greenhouse Gases	1,443	1,827	2,115
COBA-LT	Accident Benefits	16,843	12,539	11,494
Active Mode Appraisal		7,477	9,353	10,720
Initial Benefit		**261,681**	**349,276**	**457,241**
Additional Benefits	Reliability Benefits	20,567	33,925	53,162
	Wider Impacts	8,889	12,263	16,453
Total Benefits		**291,137**	**395,464**	**526,856**
BCR		**2.6**	**3.5**	**4.7**
VfM		**High**	**High**	**Very High**

5.14.2 *Alternative Scenario Test (Harfrey's Roundabout)*

The proposed scheme does not require alterations to the A47 Trunk Road. Highways England (HE) is currently investigating and consulting on possible improvements to junctions on the A47 as part of RIS 1, but are not currently progressing a scheme to improve Harfrey's roundabout, the junction closest to the Great Yarmouth Third River Crossing. However, because of the possibility that an improvement scheme could be re-introduced by HE, an alternative DS scenario has been tested which includes the signalisation of this roundabout. Using broad assumptions about the cost of an improvement, the impact on costs and benefits was found to be beneficial, with an increased adjusted PVB of **£445.3 million** and an increased PVC of **£119.3 million** giving a slightly increased BCR of **3.7** (with the value for money category remaining high). As noted elsewhere in the business case, NCC will continue to work closely with the HE, as a mutual stakeholders, and this could include sharing information to enable HE to appraise their package of schemes in more detail.

5.14.3 *Alternative Optimism Bias*

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

The purpose of allowing for Optimism Bias is to ensure that the cost-benefit analysis is robust, reflecting the level of uncertainty associated with the scheme at this stage of planning.

It is important to note that the transport projects are inherently risky due to the long term planning horizon required and the complex relationships associated with each element of the scheme. As a result the DfT require that base costs estimates are amended to account for optimism bias as well as risks and for these elements to be accounted for within the Economic Appraisal of the scheme.

The Present Value of Cost relative to the level of Optimism Bias used in the Core Scheme and its sensitivity tests is shown in Table 5-15. The table also shows that regardless of the level of Optimism Bias applied, the BCR remains as ‘High’.

Table 5-15 – Alternative Optimism Bias and Adjusted PVC, NPV and BCR

Optimism Bias	**21%**	**40%**	**59%**
Present Value of Cost (£000)	111,562	128,425	145,288
Net Present Value (£000)	283,901	267,038	250,175
BCR	**3.5**	**3.1**	**2.7**

5.14.4 *Alternative Annualisation*

Analysis of data from the two permanent WebTRIS sites on the A47 around Great Yarmouth for the whole of 2015 demonstrates that there are a high number of hours during summer weekend and Bank Holiday periods where traffic volumes are greater than or similar to the inter-peak traffic volumes derived from the November data - 717 hours can be claimed to account for the characteristics of summer weekends and Bank Holidays compared with the 419 weekend hours that has been currently adopted for the TUBA calculation.

Sensitivity tests were therefore undertaken with the inclusion of the additional hours for weekends and Bank Holidays in order to produce updated TUBA benefits. Table 5-16 provides a summary of the TUBA benefits with the additional hours of weekend and Bank Holidays accounted for.

Table 5-16 - Core Scheme vs Core with Additional Weekend and Bank Holiday Hours (£000)

TUBA Benefit	Core	Core with Additional Weekend and Bank Holiday Hours
Consumer – Commuting User Benefits	62,370	65,083
Consumer – Other User Benefits	144,040	157,684
Business Benefits	122,632	132,525
Indirect Tax Revenue	-3,485	-3,806
Greenhouse Gases	1,827	1,986
Total	**327,384**	**353,472**

The inclusion of additional hours to account for summer weekends and Bank Holidays produces approximately 8% additional TUBA benefits taking the total to **£353 million**, increasing the overall scheme benefit to **£395 million** (inclusive of active mode, accident, reliability and wider benefits).

However, it is acknowledged that the available traffic data on which this enhanced methodology has been based is limited and taken from just two sites on the strategic road network. It does however indicate that the results presented in the Outline Business Case are a robust and conservative estimate of the user benefits that are likely to arise from the scheme.

Further detail on alternative annualisation can be found in Appendix G of the OBC.

5.15 Appraisal Summary

The AST presents in a single table of all the evidence from the economic appraisal. It records all the impacts which have been assessed and described above – economic, fiscal, social distributional and environmental impacts – assessed using monetised, quantitative or qualitative information as appropriate. The AST for the scheme, in line with WebTAG requirements, is shown in Table 5-17.

Table 5-17 - Appraisal Summary Table

Appraisal Summary Table

Date produced:	28	3	2017

Contact:	
Name	Ian Parkes
Organisation	Norfolk County Council
Role	Promoter/Official

Name of scheme:	River Yare Third River Crossing, Great Yarmouth
Description of scheme:	New River crossing to connect the west and east areas of Great Yarmouth between A47 and the South Denes Peninsula which includes the Outer Harbour and local port activities. The scheme is proposed to be completed by 2023 and involve the construction of a new roundabout and traffic signal junction, approach roads and a lifting bridge able to accommodate four

	Impacts	Summary of key impacts	Assessment: Quantitative	Assessment: Qualitative	Assessment: Monetary £(NPV)	Assessment: Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	Scheme primarily impacts on short journey times of less than 5 minutes within the study area but also benefits longer distance travel. Access to the peninsula to the south of the town centre is improved and this reduces the amount of congestion at key junctions to the north and critically allows traffic to use an alternative river crossing between the port and the business areas to the east and the A47 to the west.	Value of journey time changes(£): £107.1m Net journey time changes (£): 0 to 2min £18.9m; 2 to 5min £45.3m; > 5min £42.8m	large beneficial	£122.6m	
Economy	Reliability impact on Business users	The proposed scheme produces small benefits in terms of reliability for private travel (business users) as the proportion of car business users is low relative to total car travel		slight beneficial	£2.5m	
Economy	Regeneration	Regeneris Report considers the GVA impacts of the scheme and assesses the attributable impacts to be of the order of 330 FTE jobs and £24m GVA by 2030.	GVA to £24m by 2030	slight beneficial		
Economy	Wider Impacts	Wider impact assumes 10% from the Business User benefits produced from TUBA		slight beneficial	£12.3m	
Environmental	Noise	The scheme is likely to cause some increases in noise level at the dwellings and other noise sensitive receptors in the immediate vicinity of the both the new and improved sections of carriageway due to increases in road traffic generated noise. Preliminary traffic data indicates that there are road links in the immediate area of the scheme which will experience significant changes in traffic flow and hence noise level as a result of the introduction of this option.	There are 663 sensitive receptor buildings and no Defra Noise Important Areas within the 300m study area.	slight adverse	not calculated	not assessed
Environmental	Air Quality	There are no designated AQMAs within 200m of the scheme. There are also no ecologically designated sites considered sensitive to air pollution situated within 200m of the scheme. An overall neutral local air quality impact is likely given the traffic data provided (AM, IP & PM flows). A beneficial impact on regional emissions can be expected given the likelihood of the new bridge to reduce the distance travelled to cross the River Yare.	There are 252 potentially sensitive receptors within 200m of this option. Background mapped air pollutant concentrations are well below national objective values. Max roadside PCM concentrations, 2015: 29.4µg/m3 , 2020: 23µg/m3. This is well below the threshold of 40µg/m3 for the Annual Mean level and unlikely to be exceeded by the proposed scheme	slight adverse	not calculated	not assessed
Environmental	Greenhouse gases	Redistributional effects of traffic are likely to result in an insignificant change in the traded carbon equivalent - scoped out by environment team	Change in non-traded carbon over 60y (CO2e) (tonnes): -40,121 Change in traded carbon over 60y (CO2e) (tonnes): 85	slight beneficial to neutral	£1.8m	
Environmental	Landscape	Scoped out by environment team		neutral	not calculated	
Environmental	Townscape	The loss of some existing residential townscape although not of particularly strong or defined townscape value. Existing vistas along the river corridor may be interrupted or fore-shortened by the structure, although the bridge would not appear out of context in respect of existing townscape	The density and mix of development will not substantially differ. The bascule bridge would be in scale with the river environment	neutral	not calculated	
Environmental	Historic Environment	The setting of at least 2 Grade II Listed Buildings and two conservation areas may be indirectly impacted upon by this Option. Four non-designated heritage assets, including a railway line, a bomb crater and WWII defensive features may be directly impacted. There is potential to impact upon currently unknown below ground heritage assets.	Two Grade II Listed Buildings and two conservation areas may be indirectly impacted upon by this Option. Four non-designated heritage assets, including a railway line, a bomb crater and WWII defensive features may be directly impacted.	moderate adverse	not calculated	
Environmental	Biodiversity	No adverse effects expected to any international or national designated nature conservation sites. Potential to impact bat roosts, breeding birds, water voles, black redstarts and hedgehogs due to the loss of suitable habitat for these species associated with land take.	The Outer Thames Estuary Special Protection Area is within 2km of the proposed bridge crossing point. This site is designated because it supports 38% of the Great British population of red throated diver. There are no non-statutory designated sites within 2km.	slight adverse	not calculated	
Environmental	Water Environment	Water environment impacts include increased discharge into water bodies (surface and groundwater), which may cause a slight decrease in water quality. Increased potential for accidental spillage contaminating surface water or groundwater.	Potential adverse impact to local aquifers during construction. Increase in flood risk along the watercourse due to increased run-off and reduction of floodplain.	moderate adverse	not calculated	
Social	Commuting and Other users	Scheme primarily impacts on short journey times of less than 5 minutes within the study area but also benefits longer distance travel.. Access to the peninsula to the south of the town centre is improved and this reduces the amount of congestion at key junctions to the north and critically allows traffic to use an alternative river crossing between the port and the business areas to the east and the A47 to the west.	Value of journey time changes(£): £200.2m Net journey time changes (£): 0 to 2min £41.2m; 2 to 5min £85.2m; > 5min £73.8m	large beneficial	£206.4m	
Social	Reliability impact on Commuting and Other users	The proposed bridge would produce modest benefits in terms of reliability benefits as reduction in delays and congestion on the existing A47 at the Gapton and Harfreys roundabouts while providing faster and shorter travel time and distance to the Peninsula	Moderate flows reported in traffic modelling	Beneficial	£31.4m	
Social	Physical activity	The proposed scheme assists walking/cycling/physical activity	Pedestrians and cyclists counted as part of the assessment	slight beneficial	£3.7m	
Social	Journey quality	The scheme promotes walking/cycling, and improves journey quality for all users	Reduction in traveller stress from fewer queues and shorter journeys	slight beneficial	£5.7m	
Social	Accidents	The proposed scheme produces benefits in terms of accident savings, with total number of accidents saved over the appraisal period is 6 fatal, 43 serious and 220 slight accidents	269 accidents saved over 60 years - from COBALT	large beneficial	£12.6m	
Social	Security	No change is predicted	no assessment required	neutral	not calculated	not assessed
Social	Access to services	Bus, pedestrian and cycle journeys improved in addition to major benefits for commercial traffic. Produces town centre traffic relief and therefore improves travel throughout the town.	Existing bus services will benefit from improved journey times	large beneficial	not calculated	not assessed
Social	Affordability	Reduced travel times produces fuel savings and operating costs for all income groups	The scheme leads to commute benefits in excess £60m	slight beneficial	not calculated	not assessed
Social	Severance	Severance is reduced by the provision of a new crossing in a location that involves transfer distances of up to around 3km to be saved for the same journey	Scheme produces network wide lower levels of veh kms travelled and significantly reduces some journey distances to/from the peninsula	moderate beneficial	not calculated	not assessed
Social	Option and non-use values	Not assessed	not assessed	neutral	not calculated	
Public Accounts	Cost to Broad Transport Budget	The scheme has been costed at 2016 risk adjusted prices. Sunk costs have been removed and all costs converted to a 2010 price-base year and discounted to 2010, giving a present value of cost of just under £112m when 21% Optimism Bias is added.	Delivery period over 5 years to 2023 opening	Cost Note	£111.6m	
Public Accounts	Indirect Tax Revenues	Assessed in TUBA over 60 years. Indirect tax income reduces as the efficiency of the road network improves	60 year assessment period	TUBA benefits	-£3.5m	

6 Summary

The purpose of this report has been to detail how the benefits and costs of the Great Yarmouth Third River Crossing scheme have been derived as part of the economic appraisal process, and to subsequently present the results.

6.1 Economic Assessment Process

The following is a summary of the steps taken and methodology used to undertake the economic assessment:

- The economic assessment has been undertaken in accordance with the relevant guidance documents (WebTAG).
- Industry-standard computer programmes TUBA and COBA-LT have been used to undertake the user benefit and accident assessments respectively.
- The study area used for the economic analysis has been based on the study area used for the strategic traffic model.
- All traffic data used in the economic assessment is consistent with those presented in the Traffic Forecasting Report.
- The economic assessment has been undertaken over the standard 60 year assessment period. All costs and benefits have been discounted to the Present Value Year of 2010.
- The different types of benefits which are being assessed as part of the economic analysis, and the computer programs used to assess them, are as follows:
    - Travel time savings which involves multiplying savings by monetary values and user benefits using TUBA;
    - Vehicle Operating Costs (VOCs), which is a mixture of increases and decreases, due to changes in fuel consumption and changes in distances travelled was also assessed using TUBA;
    - Carbon emissions (both in tonnes and in monetary terms) for the life of the scheme was estimated using TUBA; and
    - Accident saving benefits assessed using COBA-LT;

6.2 Assumptions

The scheme produces significant time savings, improves safety and also reduces carbon emissions.

The total scheme Present Value of Benefits (PVB) is **£395.5 million** (2010 prices) for the core scenario. The total Present Value of Costs (PVC) of the scheme is **£111.6 million** (2010 prices).

6.3 Confirmation of Results

The Great Yarmouth Third River Crossing achieves the key scheme objectives of relieving congestion, improving journey time reliability and improving safety.

In accordance with categorisation taken from “Guidance on Value for Money” from the DfT website (Table 1-1), schemes with a BCR over 2.0 represent a high value for money. <u>The BCR for the core scenario is **3.1** with an adjusted BCR of **3.5**</u> (including reliability and wider benefits), therefore the scheme offers high value for money under all scenarios.

Appendix A – Social and Distributional Impacts Assessment Report

Great Yarmouth Third River Crossing

Social and Distributional Impacts Report

April, 2017

Produced for

Norfolk County Council

Prepared by

Mouchel

Export House
Cawsey Way
Woking
Surrey
GU21 6QX
UK

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Contents

Table of Figures

Tables

Appendices

1 Introduction

1.1 Purpose of the Report

This report has been prepared as supporting information for the Great Yarmouth Third River Crossing (GYTRC) to be submitted to the Department for Transport (DfT).

The report sets out the methodology and outputs of the Social and Distributional Impact (SDI) analysis for the appraisal of the GYTRC and presents a full appraisal undertaken for the identified Distributional (DI) indicators. The report is structured by providing a scheme background before detailing a three step approach for each indicator, in line with TAG Unit A4.2:

- **Step 1 – Screening Process**:
    - Identification of likely impacts for each indicator.
- **Step 2 – Assessment:**
    - Confirmation of the area impacted by the transport intervention (impact area)
    - Identification of social groups in the impact area; and
    - Identification of amenities in the impact area.
- **Step 3 – Appraisal of Impacts**:
    - Core analysis of the impacts; and
    - Full appraisal of DIs and input into AST

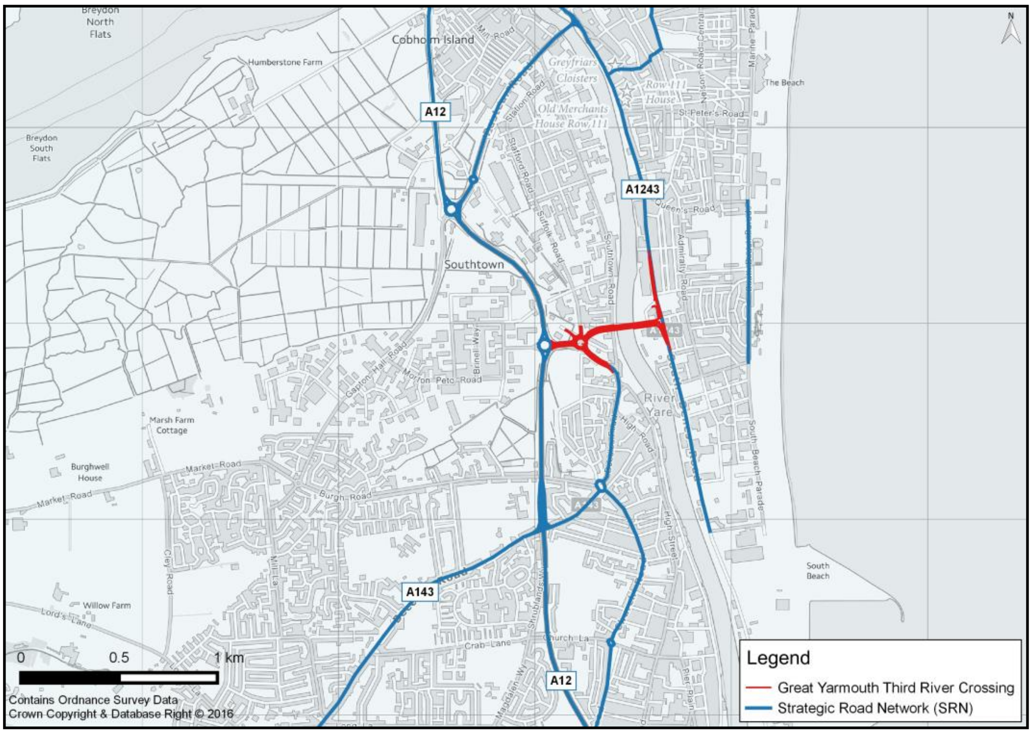
1.2 Scheme Background

Great Yarmouth currently suffers from high levels of congestion from local, regional and strategic traffic, particularly around Haven Bridge, due to a lack of a direct crossing to the southern part of the peninsula. The Haven Bridge currently experiences moderately high and inappropriate access and egress of Heavy Goods Vehicles (HGV's) travelling to the Peel Ports and Outer Harbour causing delays and making journey times unreliable. The mixture of port-related and local traffic makes it more difficult for people to access the town centre, seafront, and leisure facilities and presents a limitation on future growth in the area.

The lack of a direct river crossing makes Great Yarmouth seem remote, and discourages inward investment. Bus users, cyclists and pedestrians have long, indirect journeys into the peninsula, which discourages commuting to work by more sustainable modes.

The scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula (Figure 1-1).

Figure 1-1 – Great Yarmouth Third River Crossing Location Plan



The Great Yarmouth Enterprise Zone has the potential to create 5,000 new jobs by 2025, and there are plans for 2,000 new homes and 20-30 hectares of employment development5. A new river crossing is needed to accommodate the traffic generated by this planned growth, to improve connectivity to the strategic road network, and to avoid making existing problems worse. Without a new crossing, the full potential for growth in the Enterprise Zone and LDO area, including the port and outer harbour, may not be fully realised.

GYTRC is recognised by Norfolk County Council, Norfolk and Suffolk Local Transport Body, New Anglia LEP and the A47 Alliance as a “strategic priority for unlocking future economic growth in the area”. It is considered to be necessary to alleviate the existing problems on the highway network and to support the delivery of national and local policy agendas identified for Great Yarmouth.

1.3 Scope of Social and Distributional Impacts

The analysis of distributional impacts is mandatory in the appraisal process and is a key component of the Appraisal Summary Table (AST). The Distributional Impacts Appraisal compares the distribution of benefits arising from a transport intervention against the distributions of different social groups to assess the extent to which benefits are experienced by those groups and compared nationally.

Distributional impacts consider the benefits and disbenefits that transport interventions have across different social groups. For example, people with access to a car may experience less benefits to those without a car for an intervention that improves local public transport services. It is important to consider vulnerable groups and that they are not disadvantaged further by receiving a disproportionately low share of the benefits provided the intervention, or a disproportionately high share of the disbenefits.

Within TAG unit A4.2, there are eight transport benefit indicators that are assessed as part of the Distributional Impacts Appraisal:

- User benefits;
- Noise;
- Air quality;
- Accidents;
- Security;
- Severance;
- Accessibility; and
- Personal affordability.

The appraisal of SDI focuses on eight specific impacts, as detailed within Table 1-1.

Table 1-1 – The Eight Social and Distributional Impacts

SD Impact	Summary of Importance
1. User Benefits *(TAG Unit 3.5.3)*	It is important to gain an understanding of the distribution of user benefits by social group and by area. This analysis assists in understanding how user benefits accrue to different groups in society and across a geographic area. Analysing a wider area outside of the immediate vicinity of the intervention is vital as user benefits are often generated significantly beyond the immediate area of the scheme. Note that SDI analysis is only applicable for individuals and not in-work trips experienced by businesses.
2. Noise *(TAG Unit 3.3.2)*	It is important to understand the distributional effects of changes to noise generated by the transport intervention – both in terms of improvements and deterioration. Changes in noise levels resulting from the intervention will be experienced to varying extents in different areas and by different groups of people. It is therefore important to understand the noise-related social and distributional impacts of a scheme
3. Air Quality *(TAG Unit 3.3.3)*	Changes in emission levels resulting from the transport intervention will vary by location and social group. It is therefore important to understand the distribution of air quality changes – both in terms of improvements and deteriorations.
4. Accidents *(TAG Unit 3.4.1)*	Transport schemes can have significant impacts on safety and accidents and as these issues can have varying impacts on different areas and social groups, it is important to understand the specific impacts of an individual scheme.
5.Personal Security *(TAG Unit 3.4.2)*	Transport schemes can have impacts on personal security (both real and perceived) and these benefits can differ according to area and social group. It is therefore important to gain an understanding of the social and distributional impacts of the transport intervention from the personal security perspective.
6. Severance *(TAG Unit 3.6.2)*	Transport interventions can result in changes to levels of severance within the transport network through influencing traffic flows and providing new infrastructure. As severance issues impact on different social groups and areas to differing extents, it is important to analyse how individual scheme will alter levels of severance.
7. Accessibility *(TAG Unit 3.6.3)*	Access to services often presents significant difficulties to certain social groups and those living remotely. Transport interventions can have an impact of the ability of people to access services they require.
8. Personal Affordability *(TAG Unit 3.6.4)*	Changes in costs (both increases and reductions) need to be assessed in terms of understanding the social and distributional effects. Any changes in transport costs due to changes to the transport network could impact on the lower income groups.

Table 1-2 sets out the groups of people to be identified in the analysis for each of the indicators listed above.

Table 1-2 - Social Groups and SDI indicators

Dataset / Social Group	User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability
Income Distribution	✓	✓	✓				✓	✓
Children (proportion of population aged under 16)		✓	✓	✓	✓	✓	✓	
Young Adults (proportion of population aged 16-25				✓			✓	
Older People (proportion of population aged over 70)				✓	✓	✓	✓	
Proportion of population with a disability					✓	✓	✓	
Proportion of population of Black and Minority Ethnic (BME) origin					✓		✓	
Proportion of households without access to a car						✓	✓	
Carers (proportion of households with dependent children)							✓	

Distributional impacts are assessed on a seven-point scale against bespoke guidance given for each indicator. This seven point scale follows the broad principles set out in Table 1-3.

Table 1-3 - General System for Grading of Distributional Impacts for each of the Identified Social Groups

Impact	Assessment
Beneficial and the population impacted is significantly greater than the proportion of the group in the total population	Large Beneficial ✓✓✓
Beneficial and the population impacted is broadly in line with the proportion of the group in the total population	Moderate Beneficial ✓✓
Beneficial and the population impacted is smaller than the proportion of the group in the total population	Slight Beneficial ✓
There are no significant benefits or disbenefits experienced by the group for the specified impact	Neutral
Adverse and the population impacted is smaller than the proportion of the group in the total population	Slight Adverse ×
Adverse and the population impacted is broadly in line with the proportion of the group in the total population	Moderate Adverse ××
Adverse and the population impacted is significantly greater than the proportion of the group in the total population	Large Adverse ×××

2 User Benefits

User benefits of transport schemes are experienced by different groups of people in different areas. Although it is not possible to attribute social impacts to user benefits, the analysis of distributional impacts is more attainable.

2.1 Screening (Step 1)

The proposed scheme is a transport intervention that has been developed for the purpose of generating benefits to users. A user benefit DI analysis should be undertaken, in line with TAG Unit 4.2, where user benefit analysis has been used in the scheme appraisal.

An initial screening proforma was undertaken which assessed the user benefits in TUBA, the DfT's appraisal software, where they have been quantified in conjunction with a spatially disaggregate transport model.

User benefits in TUBA comprise the following benefit types:

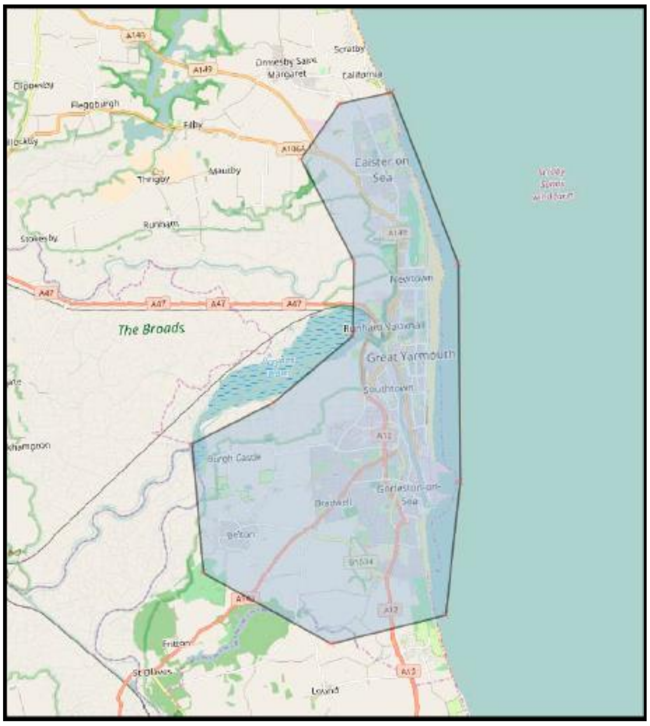
- Time benefits;
- Local Authority tolls;
- Fuel vehicle operating cost benefits; and
- Non-fuel vehicle operating cost benefit.

TUBA outputs were then used to spatially assess the areas that will have the most significant impacts in relation to income distribution for people living within the impact area.

2.2 Assessment – Areas of Impact (Step 2a)

The impact area for user benefits is defined as the core modelled area within the SATURN transport model, defined by the Great Yarmouth borough (Figure 2-1). The transport model zones were used to define the SDI study area as this would provide a defined area where impacts could be quantified. The area is considered large enough to capture the biggest impacts expected due to the scheme. Areas where impacts are quite likely but are expected to be relatively small such as the city of Norwich and wider Norfolk were all included within 'rest of England and Wales' due to inaccuracies associated with data aggregation at this geographical level.

Figure 2-1 – Core Modelled Area



2.3 Assessment – Identification of Social Groups in Impact Area (Step 2b)

It is important to understand the distribution of user income within the impact area. To achieve this, the income domain from the Index for Multiple Deprivation has been mapped at LSOA level throughout the scheme area.

The resolution of the majority of model zones within the impact area were found to be larger than LSOA level and did not share a high degree of commonality. It was therefore recommended to convert the model data from model zone level to LSOA level. The zones were initially split based on geographical area but were then further disaggregated based on population weighted centroids of each respective LSOA. This was found to be the most robust method to capture changes in population density and to meet the requirements set out in TAG Unit 4.2.

Table 2-1 shows the distribution of user benefits across the population within the scheme area by national income deprivation quintile.

Table 2-1 - Distribution of User Benefit Costs by Income Deprivation Quintile

	IMD Income Domains £m					
	0%<20%	20%<40%	40%<60%	60%<80%	80%<100%	Rest of England and Wales
Total user benefits of LSOA's within impact area (£M)	67.797	36.923	8.775	21.192	8.408	24.532
Share of user benefits within impact area	47%	26%	6%	15%	6%	-
Share of user benefits within Modelled Area (Inc. rest of England and Wales)	40%	22%	5%	13%	5%	-
Population	28,243	29,666	22,006	13,676	3,686	55.98
Share of population in the impact area	29%	30%	23%	14%	4%	-
Assessment	✓✓✓	✓✓	✓	✓	✓	✓

2.4 Appraisal of Impacts (Step 3)

Around 85% of the benefits of the scheme are experienced by the population within the impact area. Of this, approximately 47% of the benefits within the impact area are accrued by people within the lowest 20% of the IMD income domain. This translates to around 44% when including the rest of England and Wales. Over a quarter of the scheme user benefits were accrued by people within the second income quintile (20-40%). Only 6% of people within the impact area are receiving benefits from the scheme within the highest 20% income domain. No disbenefits were observed for any area.

The TUBA outputs have also been assessed and disaggregated across the resident population of Great Yarmouth to identify benefits for each LSOA. Figure 2-2 spatially demonstrates the calculated user benefits per LSOA within the impact area. Every LSOA experiences a benefit with the highest amount being accrued on the Peninsula and around the town centre therefore the DI appraisal of user benefits has been assessed as **Large Beneficial**.

Figure 2-2 - User Benefits Disaggregated Across Lower Super Output Areas (LSOA)

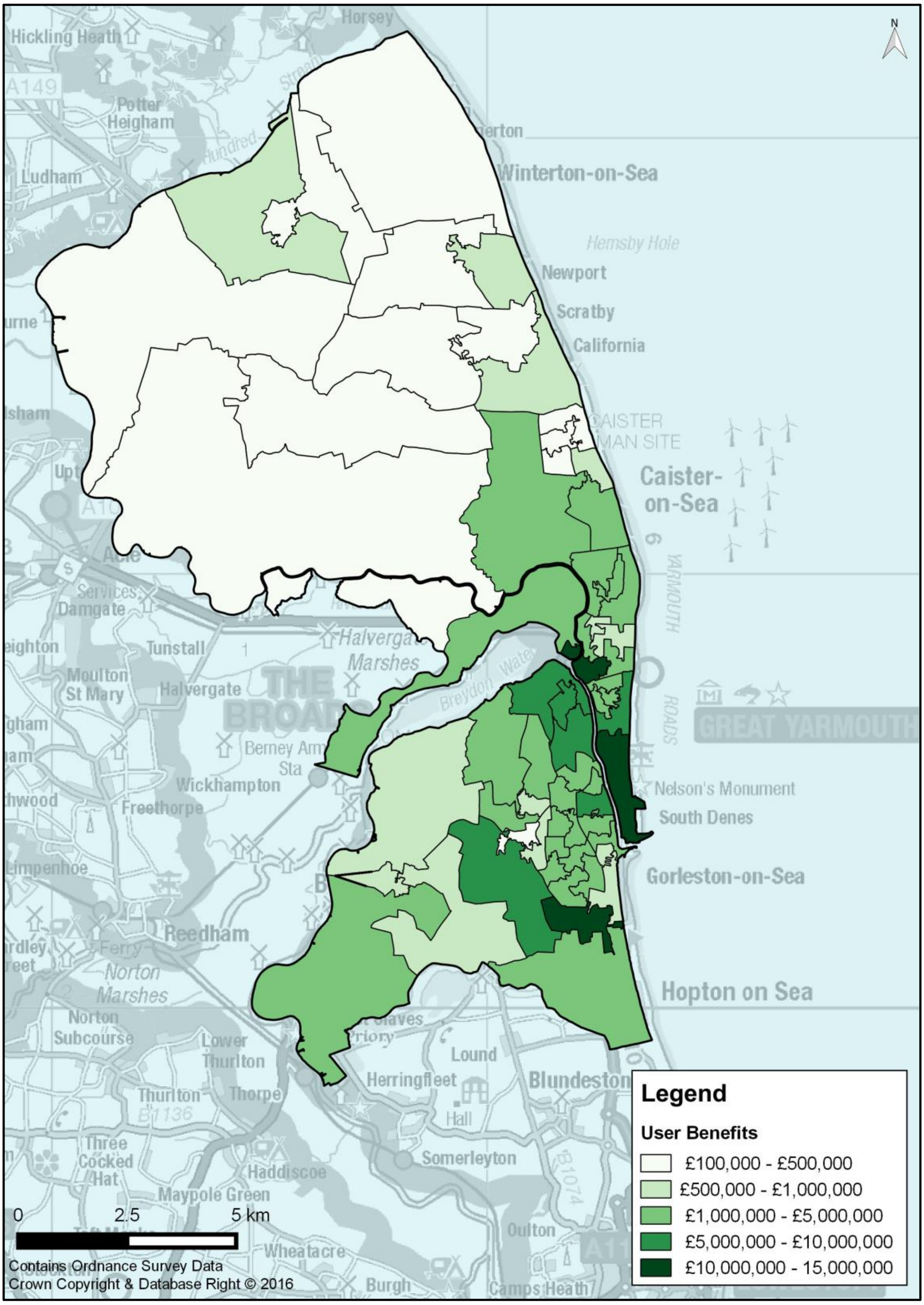
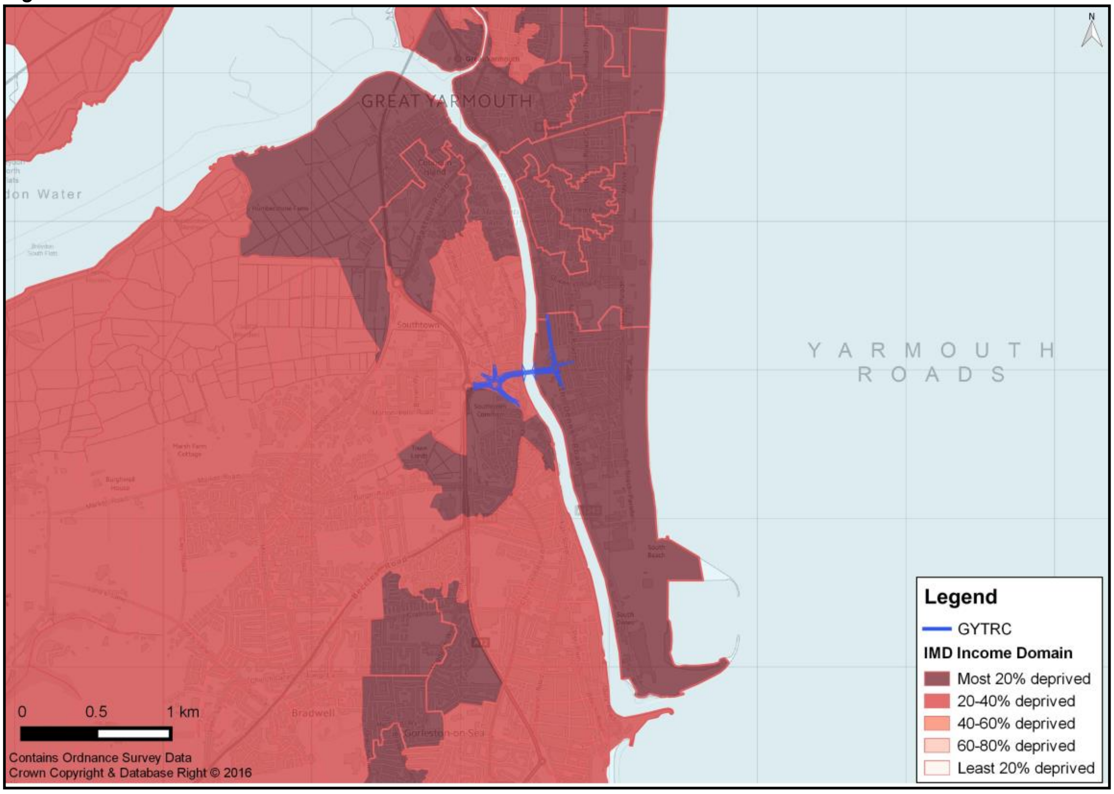


Figure 2-3 - IMD Income Domain



3 Noise and Air Quality

Noise and Air Quality impacts are likely to occur where an intervention results in changes to traffic flows or speeds or where the physical gap between people and traffic is altered.

As the scheme will result in both changes to traffic flows and road alignment, it is necessary to carry out both noise and air quality distributional analysis. Impacts on the existing network through the redistribution of traffic will also lead to changes in noise and air quality levels.

Due to limited data, the potential changes in noise levels and air quality as a result of altered traffic flow, speed and compositions brought on by the scheme has so far only been undertaken qualitatively.

A full quantitative distributional assessment of noise and air quality impacts will be delivered in the Full Business Case.

3.1 Screening (Step 1)

The data shows that as a result of the GYTRC there will likely be an impact on noise and air quality across the study area. There are a number of receptors located within the scheme area where the most significant air and noise quality impacts are likely to occur. Further to this, there is a significant proportion of those aged under 16 living close to the scheme that are particularly sensitive to changes in air and noise quality.

3.2 Assessment – Areas of Impact (Step 2a)

The impact area has been created to accurately capture the effects of noise and air quality in the vicinity of the scheme. This is currently set to 1km around the scheme boundary with an inner study area of 250m to align with the environment appraisal. The study shows that there are approximately 4616 households within 1km, and 970 households within 250m of the scheme.

Areas experiencing significant changes in traffic flows give indication as to where there would be anticipated measurable change in noise and air quality levels.

The road links showing potentially significant change are as follows:

- Significant increases in traffic flow are anticipated on William Adams Way between the A47 roundabout and the scheme tie in point at the Suffolk Road junction
- There are also significant increases in traffic flow predicted on South Denes Road, again at the scheme tie in point on the eastern bank of the scheme.
- Significant decreases in traffic flow are predicted to occur on Suffolk Road and Southtown Road.

3.3 Assessment - Identification of Social Groups in Impact Area (Step 2b)

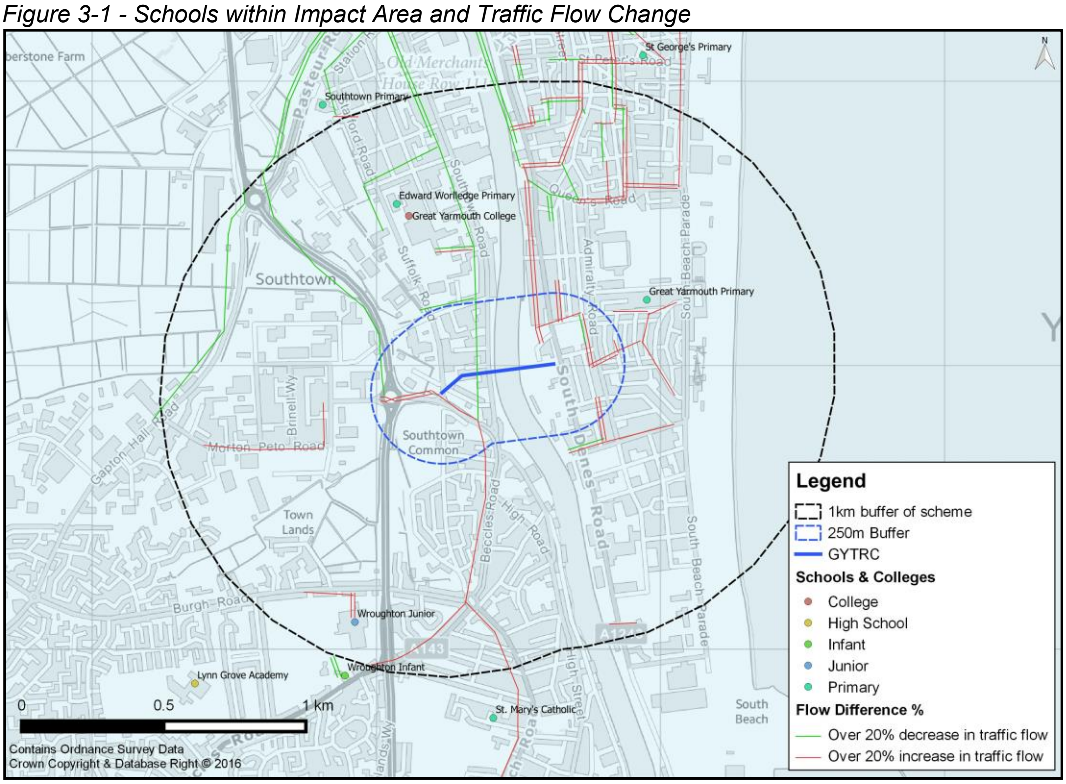
WebTAG guidance states that attention should be paid to the impact of noise and air quality on children as a key at-risk group. Figure B1 in Appendix B shows that there is a high proportion of children under 16 within the impact area.

The assessment of noise and air quality impacts against IMD income domain quintiles was also undertaken in line with TAG Unit 4.2. Figure 2-3 shows that approximately half of the proposed scheme alignment runs through areas within the 20% most income deprived within England, whilst the other half runs through areas in the second most deprived quintile (20-40%).

3.4 Assessment – Amenities in the Impact Area (step 2c)

With children being a key at-risk social group, it is therefore necessary as part of the SDI assessment to examine the impact of noise and air quality on schools in the area. There are no schools located within 250m of the scheme, however, within 1km of the scheme, there are three primary schools, one junior school and one college (Figure 3-1). Although the quantitative change in noise is unknown in the areas where these schools are located, it is observed that Great Yarmouth Primary and both Wroughton Junior School and Wroughton Infant School are likely to experience an adverse noise impact due to significant increased traffic flows (over 20%) on Barkis Road and Beccles Road respectively. Conversely, Edward Worlledge Primary and Great Yarmouth College are likely to experience beneficial impacts due to the reduced traffic flows on Southtown Road, Gordon Road (over 20%) and Suffolk Road (over 10%).

Figure 3-1 - Schools within Impact Area and Traffic Flow Change



3.5 Appraisal of Impact (Step 3)

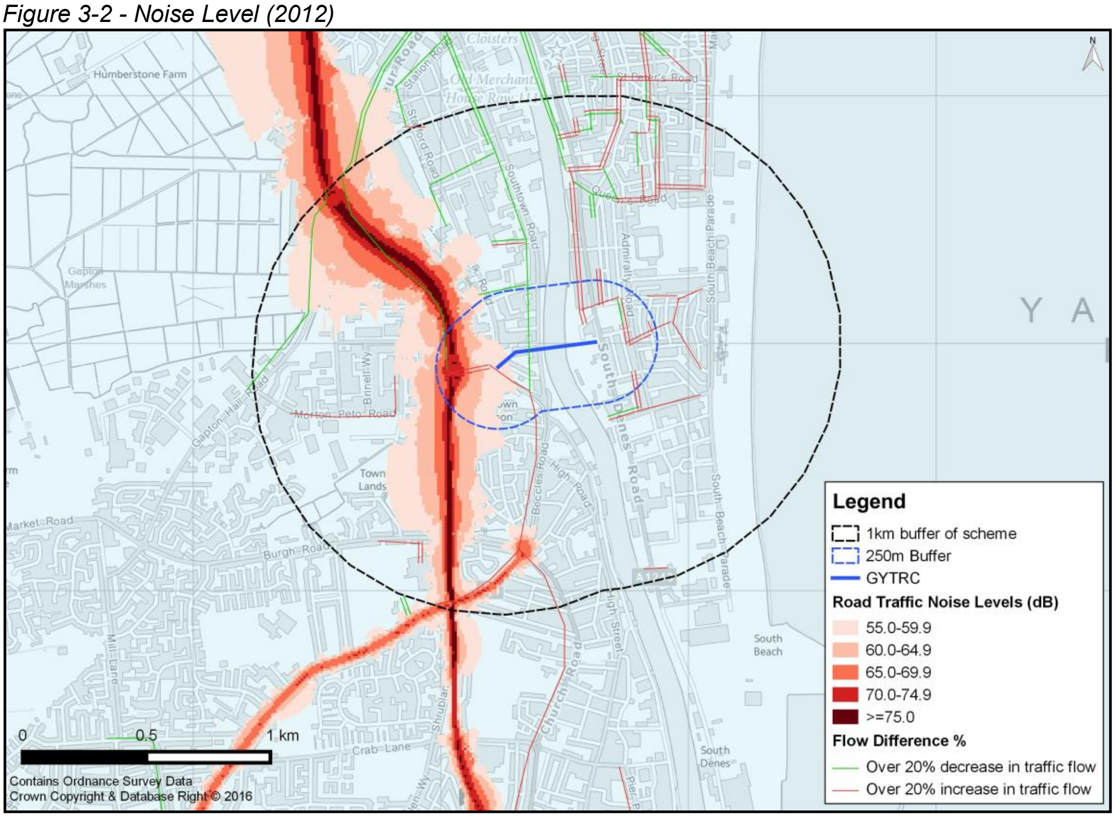
3.5.1 Noise

There are no Defra Noise Important Areas within 300m of the Proposed Scheme. There are a number of NIAs within the wider area of Great Yarmouth at distances from 600m and further away from the scheme which are all associated with high levels of road traffic noise on the A47 and the A149 to the north.

The introduction of a third crossing and any potential mitigation measures which could be incorporated within the scheme design will not be of direct benefit to receptors in those areas. However, there is the potential for vehicle flows and routes to be significantly altered due to the introduction of a new crossing, which could be of benefit to any existing roads where traffic numbers are reduced.

Currently, receptors located close to the A47 experience high levels of noise (Figure 3-2). The traffic flows along the A47 have been predicted to decrease significantly by over 20%. It is therefore likely that these receptors will experience some benefits as a result of the scheme. On the other hand, receptors close to Beccles Road are likely to experience adverse impacts due to traffic flows increasing (over 20%) on links that already have relatively high noise levels.

Figure 3-2 - Noise Level (2012)



The appraisal demonstrates that although no quantitative changes in noise have been identified, receptors located north of the scheme are generally likely to receive a benefit as a result of reduced traffic flows. Receptors situated south of the scheme a more likely to experience adverse impacts from increased traffic flows on the strategic highway network.

Overall, taking into account that there are a significant amount of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise, the scheme has been appraised as having a **slight adverse** impact on noise SDIs.

3.5.2 Air Quality

Similarly to noise, the distributional appraisal for air quality has considered the likely population affected by potential changes in air quality (as a result of changes in traffic levels). A number of links within the impact area experience an increase in traffic levels which is likely to adversely impact on air quality, and these are in proximity to concentrations of vulnerable groups, including children aged under 16. The overall impact assessment has therefore preliminarily been appraised as **slight adverse**.

4 Accidents

Changes in accident rates are often attributed to the integration of transport schemes which result in changes in traffic flows. Most accidents related to transport occur on the road network where there is a strong link between both vulnerable groups and deprivation. Further to this, it is noted that a child from a more deprived area is more likely to be involved in a fatal road accident than a child from a higher social class.

Any intervention that results in increases to traffic levels and speeds or reduces physical separation between people and traffic can give rise to increases in accidents. The approach for the DI appraisal of accidents uses data from the accident assessment as well as STATS 19 data from the DfT's Road Casualties online database for the years 2011 to 2015.

The approach identifies the screening process (Step 1) before identifying the accident locations (Step 2a). Step 2b assesses any impacts on vulnerable groups while Step 2c identifies any amenities within the impact area that are likely to be used by these vulnerable groups.

A full appraisal is carried out in Step 3 to determine the impacts.

4.1 Screening (Step 1)

The scheme is expected to impact on vehicle flow, speed and HDV use in addition to a shift in the number of pedestrians and cyclists (+/- 10%) using the local road network. The scheme also includes changes to road alignments around the landings of the bridge on either side of the river and therefore a full distributional accident assessment is appropriate.

4.2 Assessment – Areas of Impact (Step 2a)

The impact area has been defined from the COBA-LT analysis and includes links within the modelled network directly affected by the scheme as shown in Figure 4-1. This impact area was adopted as it outlines the extent to which accident benefits as a result of the scheme can be quantified.

Analysis was undertaken to identify all links on the modelled network with a change in traffic flow of +/- 10% (Figure 4-2). This involved mapping the Core Do-Minimum road network in GIS. Through this process the traffic flow for the Do Something 2016 scenario was compared with the flows from the Do Minimum 2016 scenario where the identified changes in traffic flows were displayed within GIS.

Following this, each link was then classified according to the rate of change of the number of accidents between the Do Minimum and Do Something scenarios over a 60 year appraisal period (Figure 4-3).

Figure 4-1 - Accident Impact Area based on COBA-LT Analysis

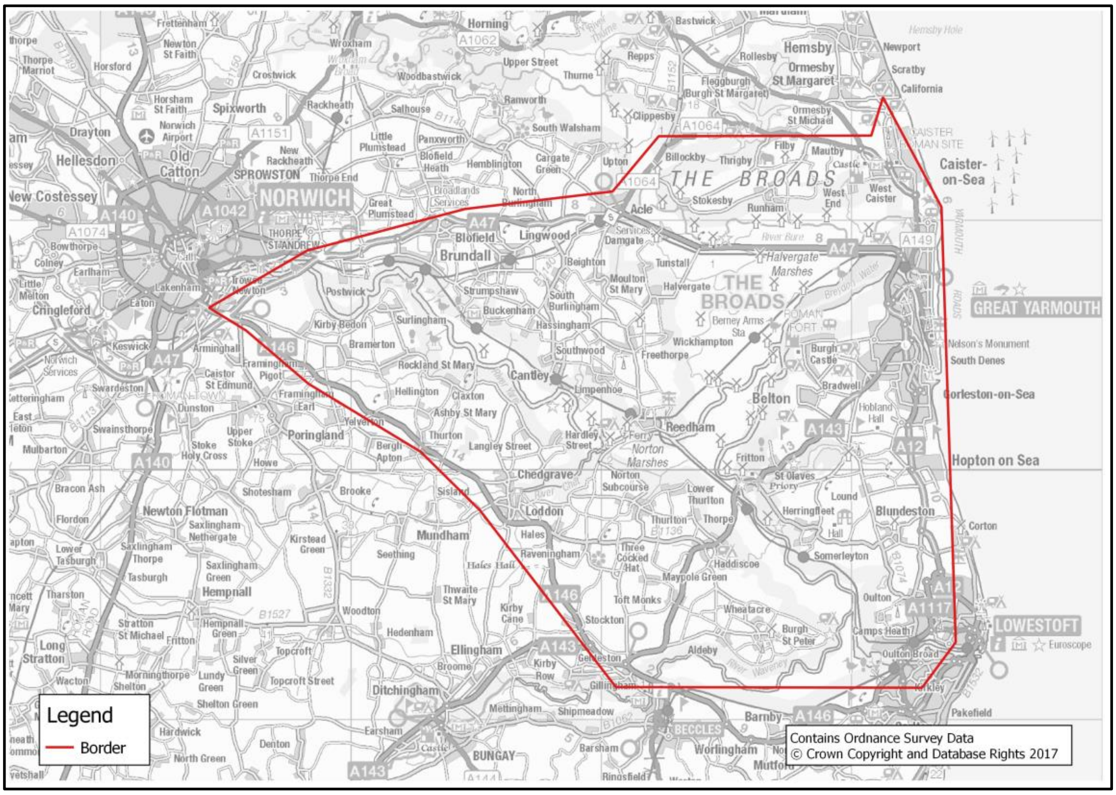


Figure 4-2 - Changes in Traffic Flow (+/- 10%)

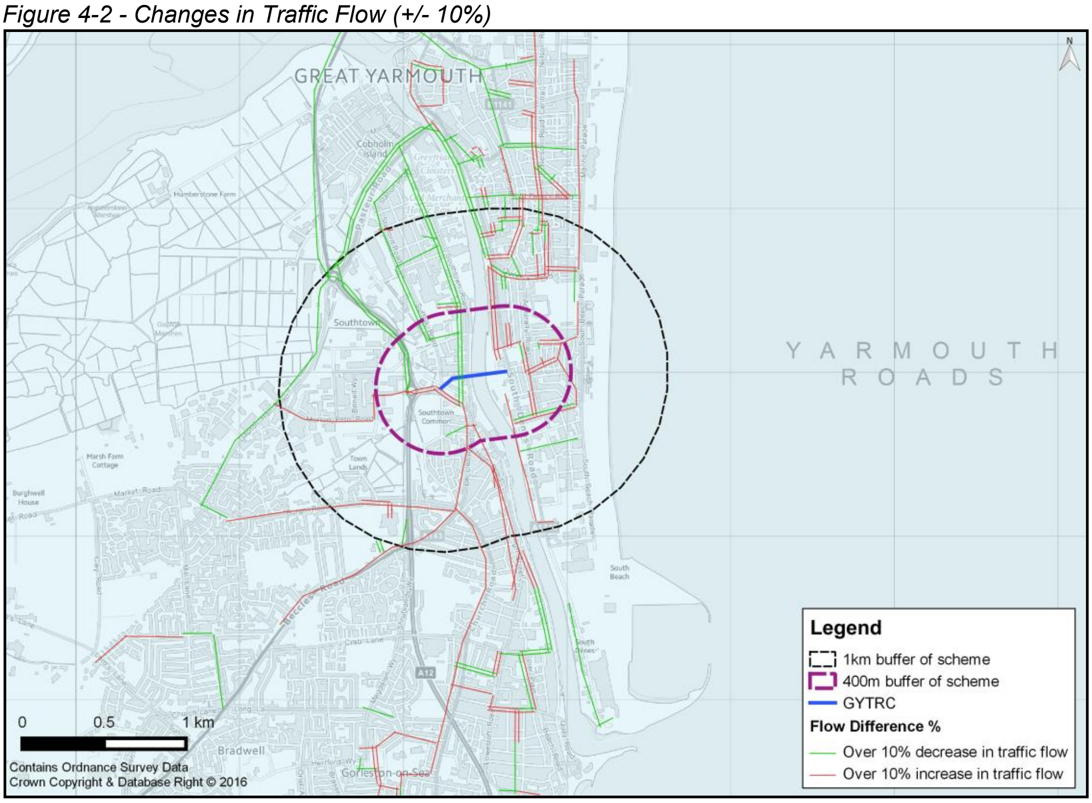
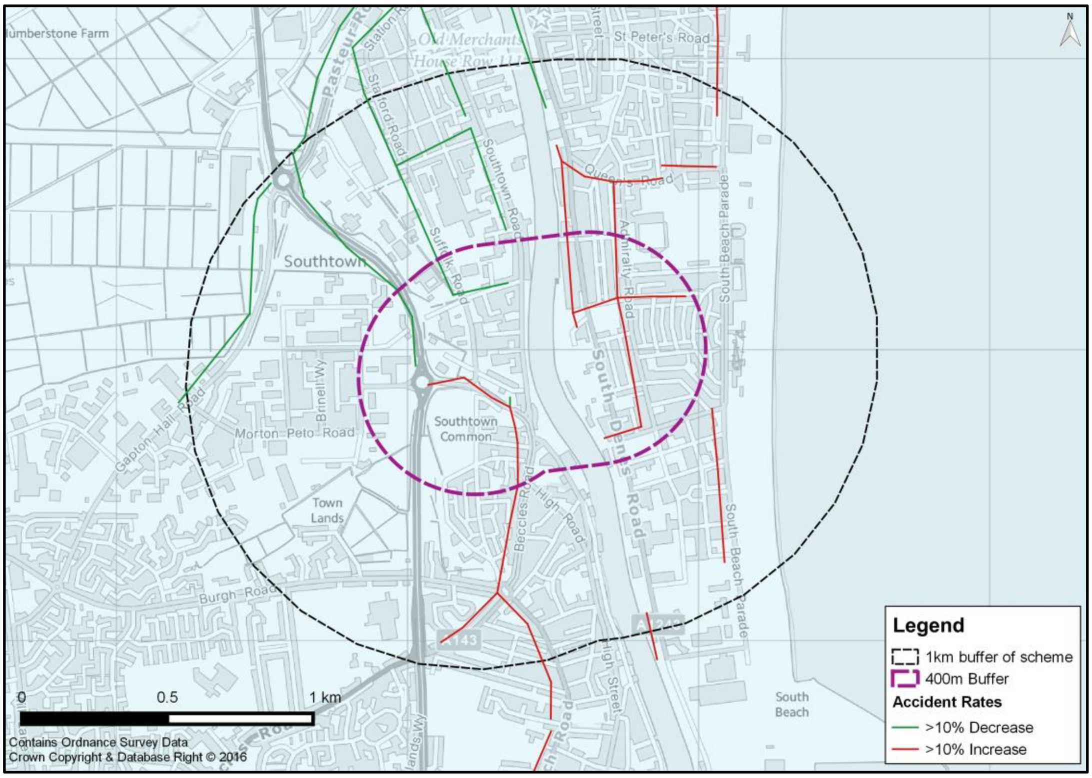


Figure 4-3 - Links where Accidents Rates are likely to Increase or Decrease by 10%



4.3 Assessment - Identification of Vulnerable Groups in Impact Area (Step 2b)

Within the impact area, there are a number of vulnerable groups including children, young people, older people and those living within the IMD most 5% deprived areas.

The potential impacts on pedestrians living in the area were captured by adding a 400m (5 minute walk) buffer to the scheme alignment. Within this buffer, links where the number of accidents are expected to change significantly were assessed.

Figure's B-1 to B-4 in Appendix B provide a visual representation of the distribution of the vulnerable groups listed above within 1km of the scheme alignment, which captures those within close proximity of the proposed crossing.

Notably, there are significantly high concentrations of children under 16 and young adults (16-25 years) living within proximity of Beccles Road which shows a significant increase in accident rates. Beccles Road is also within an area where there are high levels of deprivation as can be seen in Figure B-4.

4.4 Assessment – Amenities in the Impact Area (step 2c)

The concentration of vulnerable groups is not only dependant on the resident population but also on local amenities within the impact area that may attract visitors from vulnerable groups.

A number of amenities have been identified within 1km of the scheme including 2 primary schools, 1 junior school, 1 infant school, 1 college, 2 places of worship in addition to numerous hotels and tourist attractions.

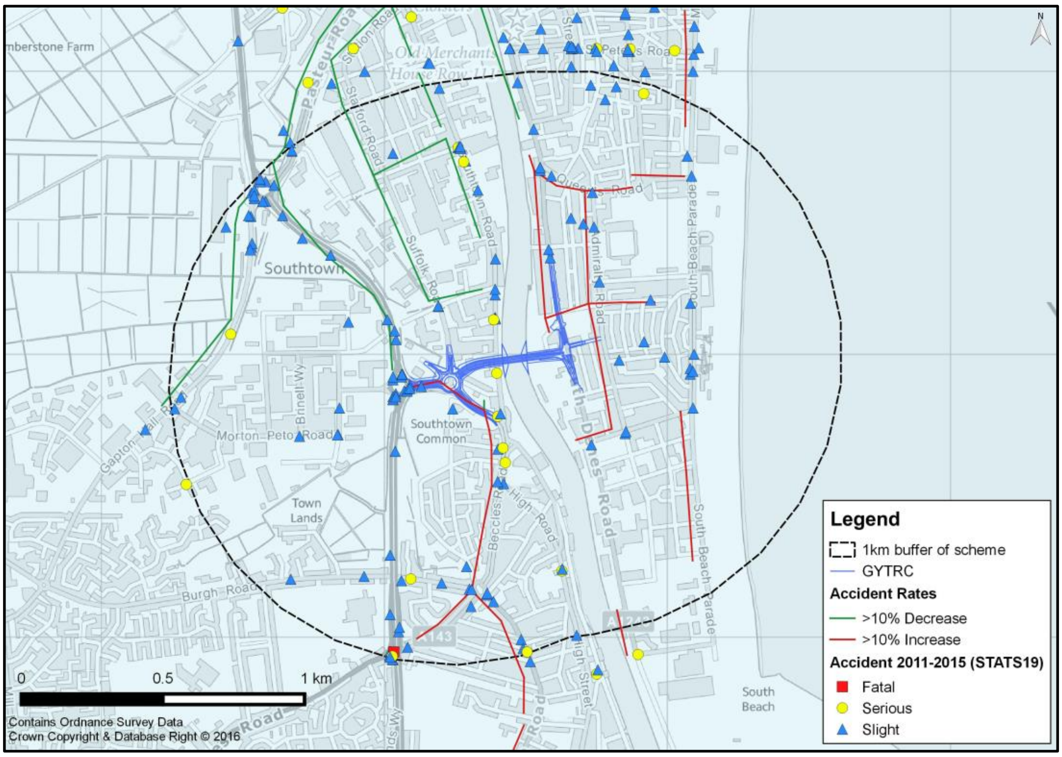
4.5 Appraisal of Impact (Step 3)

The distributional impact appraisal of accidents uses STATS 19 data from the DfT's Road Casualties online database for the years 2011 to 2015.

The accident locations identified in Step 2a have been plotted on a map by severity alongside the links that experience a -/+10% change in accident rates (Figure 4-4).

Figure 4-4 illustrates that Beccles Road, Church Road and South Denes Road (north of the scheme) are forecast to experience an increase in accidents in the Do Something scenario over the 60 year appraisal period. The majority of existing clusters of accidents on these links are of 'slight' severity, however, serious accidents are also observed. It is noted that these links coincide with significant forecasted increases in traffic flow (over 10%) which is likely to exacerbate accident impacts.

Figure 4-4 - Links with +/-10% Change in Accident Rates and STATS19a Data 2011 to 2015 by Severity



Analysis has been undertaken to identify vulnerable groups that might be affected within the impact area.

Table 4-1 shows the proportion of casualties for each vulnerable group within the impact area and across the nation as a whole between 2011 and 2015 based on STATS19 data.

Table 4-1 - Proportion of Casualties for each Vulnerable Group

Vulnerable Group	Total	% Casualties impact area (2011-2015)	% in accidents (2015 national average)
Children (under 16 years old)	47	12%	9%
Young People (16-25)	127	33%	25%
Older People (66+)	29	8%	9%
Other ages	179	47%	58%
Total	382	100%	100%

Similarly, Table 4-2 shows the proportion of casualties for each road user type within the impact area and across the nation as a whole.

Table 4-2 - Proportion of Casualties for each Road User Type

User Type	Total	% Casualties impact area (2011-2015)	% in accidents (2015 national average)
Pedestrian	82	12%	13%
Cyclist	40	10%	11%
Motorcycle	52	14%	10%
Other (Inc. car drivers, passengers)	208	54%	66%
Total	382	100%	100%

Within the impact area, children account for a greater proportion of casualties than the average across Great Britain. It is therefore anticipated that any changes in accident rates within the area could be considered to have a greater impact on children than others road users.

The proposed scheme will result in traffic being removed from local roads, particularly in areas with vulnerable groups. This is reflected in the COBA-LT accident analysis reported in the Business Case that shows a significant reduction in slight (220) serious (43) and fatal (6) injury accidents.

New pedestrian and cyclist crossing facilities incorporated as part of the scheme design within the impact area will further help towards achieving lower accident rates.

A detailed analysis of accident data demonstrates that the proposed scheme will remove traffic from local roads, particularly in areas with vulnerable groups. However, when cross referenced with Figures B-1 to B-4 (Appendix B) showing the distribution of vulnerable users, it can be seen that there are still high proportions of vulnerable users in areas where both accident rates and traffic flows are forecast to significantly increase, particularly around Beccles Road.

Analysis of the data demonstrates that there are more links forecast to experience an increase in accidents than are forecast to decrease over the 60 year appraisal period. For these reasons, the scheme has been assessed as **Slight Adverse.**

5 Severance

The severance impacts of a transport scheme are often an unintended consequence and are a measure of the scheme's impact on residents' access to local community facilities and services. An assessment is required of for non-motorised users, particularly pedestrians, as stated in TAG Unit 4.1.

5.1 Screening

Severance impacts were assessed by considering the detailed drawings of the scheme and forecast changes in vehicle flow. As the scheme provides new road across over the River Yare, one of Great Yarmouth's largest physical barriers, it is expected that the 'severance' of communities would be reduced. The scheme's design incorporates a new pedestrian footway along with a dedicated off-carriageway cycle lane.

There are some roads within the impact area that would experience potential changes in severance as a result of increases or decreases in traffic volumes. Therefore it is appropriate to examine these areas further to understand the severance impacts on vulnerable groups.

5.2 Assessment – Areas of Impact (Step 2a)

The impact area has been defined through the severance analysis, described in the social impacts appraisal section in TAG Unit A4.1. A 1km buffer was applied around the scheme alignment within the impact area. Within this 1km buffer, changes in severance as a result of changes to road alignments, road closures, infrastructure and vehicle flow were assessed. Although there are links outside of the 1km buffer that experience significant changes in the above, the assessment only focuses on the local area where the most concentrated impacts are anticipated.

5.3 Assessment - Identification of Social Groups in Impact Area (Step 2b)

Vulnerable groups are particularly sensitive to the effects of severance. Within these vulnerable groups are children, older people, people with disabilities and households with no access to a car. **Error! Reference source not found.** shows the proportion of these vulnerable groups within the scheme area along with regional and national comparisons.

Table 5-1 - Vulnerable Groups within Impact Area

Vulnerable Group	% Impact Area	% Norfolk	% England
Older People (Aged 70+)	9.2%	15.4%	7.7%
Children (Aged Under 16)	22.7%	16.9%	18.9%
No Car Households	16.8%	18.8%	25.8%
Residents with long-term health problems or disabilities	20.2%	20.1%	7.8%

5.4 Assessment – Amenities in the Impact Area (step 2c)

The severance impact area contains a number of local amenities (Figure 5-1) that are likely to generate trips from the wider area in addition to local residents. These include 2 Primary schools, 1 Junior school, 1 Infant school, 1 College and various hotels and shops. Also within the impact area is the Gapton Hall Retail Park, Southtown Common Recreation Ground, the Sea Life Centre, Pleasure Beach and a number of different attractions along the sea front which are likely to attract high numbers of children.

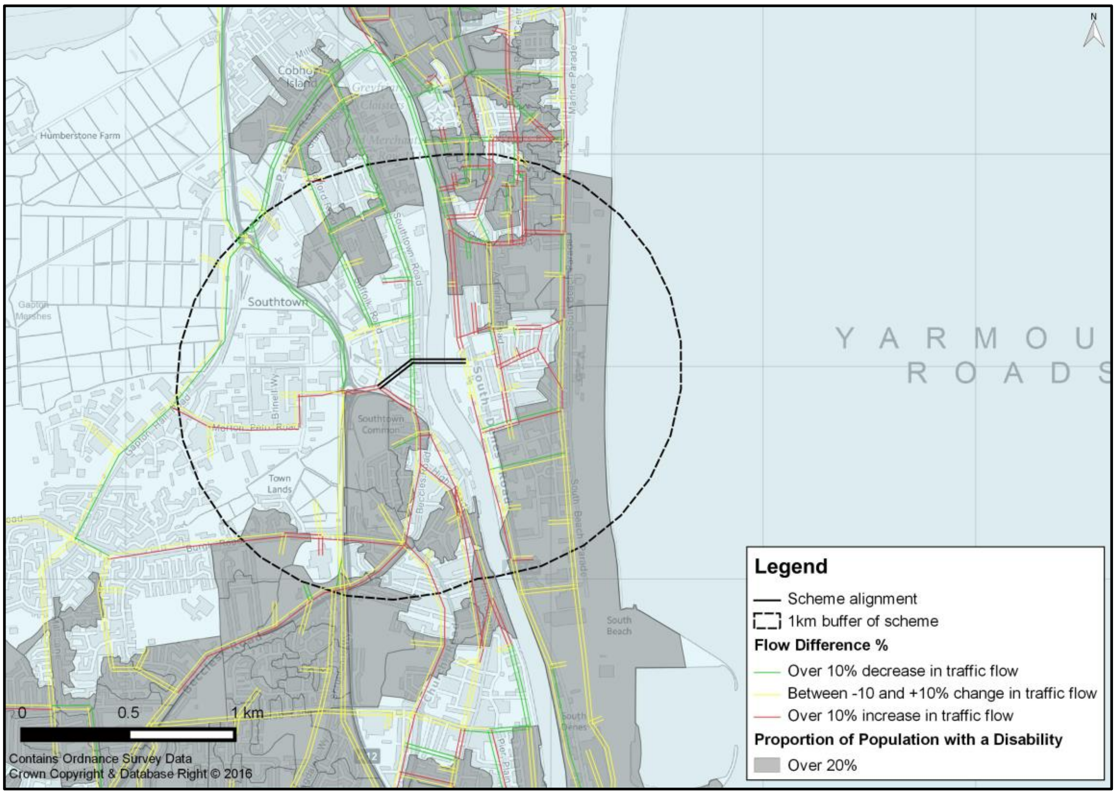
Figure 5-1 - Amenities within Impact Area and Traffic Flow Changes

5.5 Appraisal of Impact (Step 3)

Changes in vehicle flow can affect the permeability of roads, resulting in a small positive or negative impact on severance, particularly for residents or those visiting amenities in the immediate area.

During the severance assessment, the populations of vulnerable groups at output area level have been examined to identify any areas where there are high concentrations in close proximity to links where vehicle flows are expected to significantly increase of decrease.

Figure 5-2 - Distribution of Traffic Flow Changes against Concentrations of Older People (Aged over 70)



It can be seen that in some areas, the redistribution of traffic across the highway network leads to an increase in directional traffic flows in areas with high concentrations of vulnerable groups. Those links close to the scheme alignment include Beccles Road, Church Road, South Denes Road and Burgh Road amongst other smaller links.

Figure 5-3 - Distribution of Traffic Flow Changes against Concentrations of People with a Disability

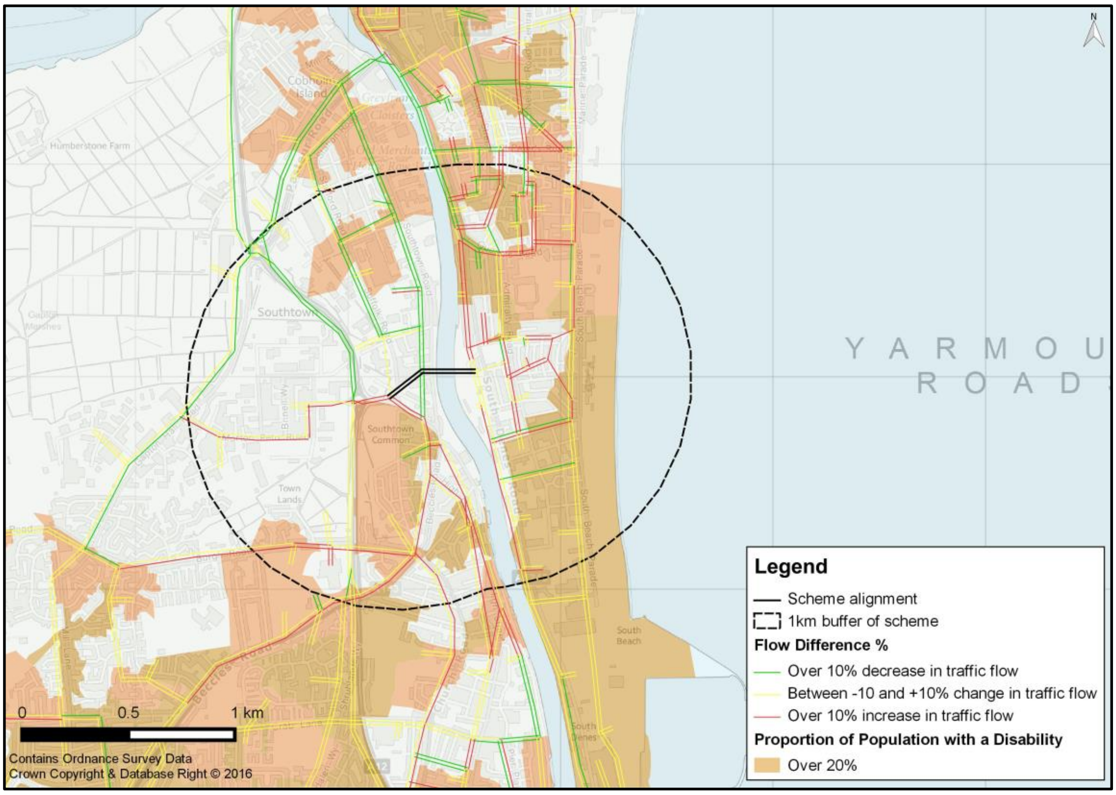


Figure 5-4 - Distribution of Traffic Flow Changes against Concentrations of Children (Aged under 16)

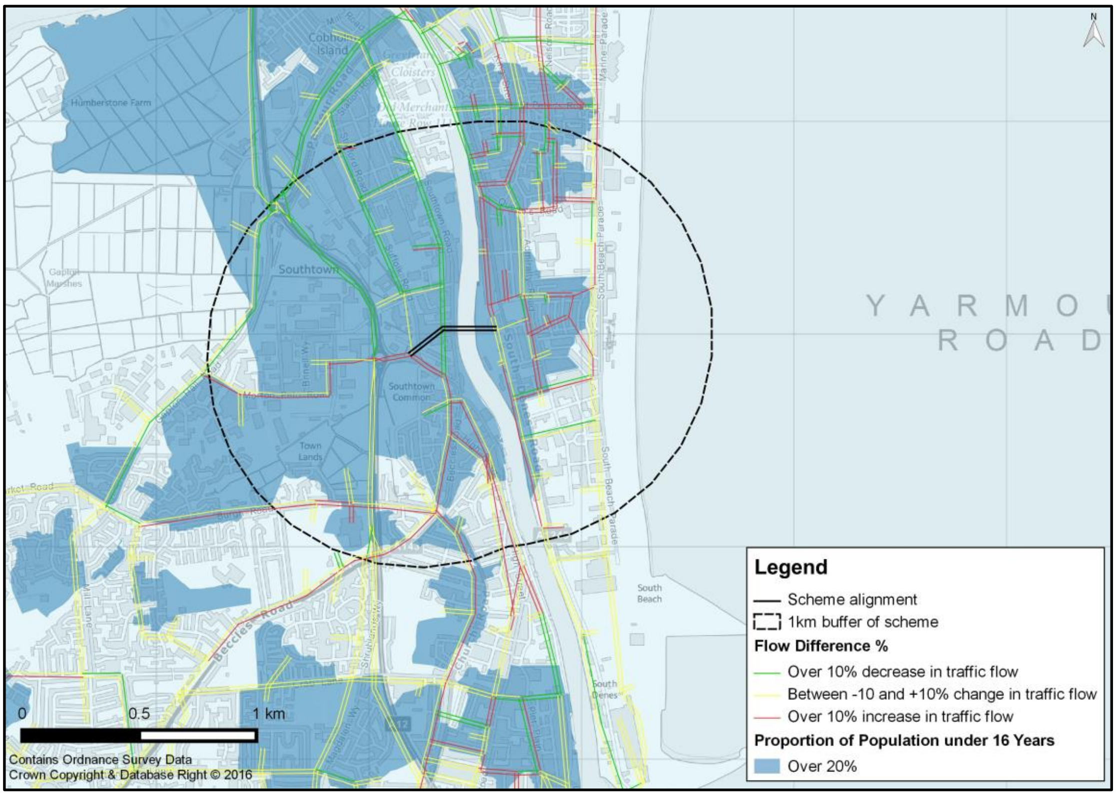
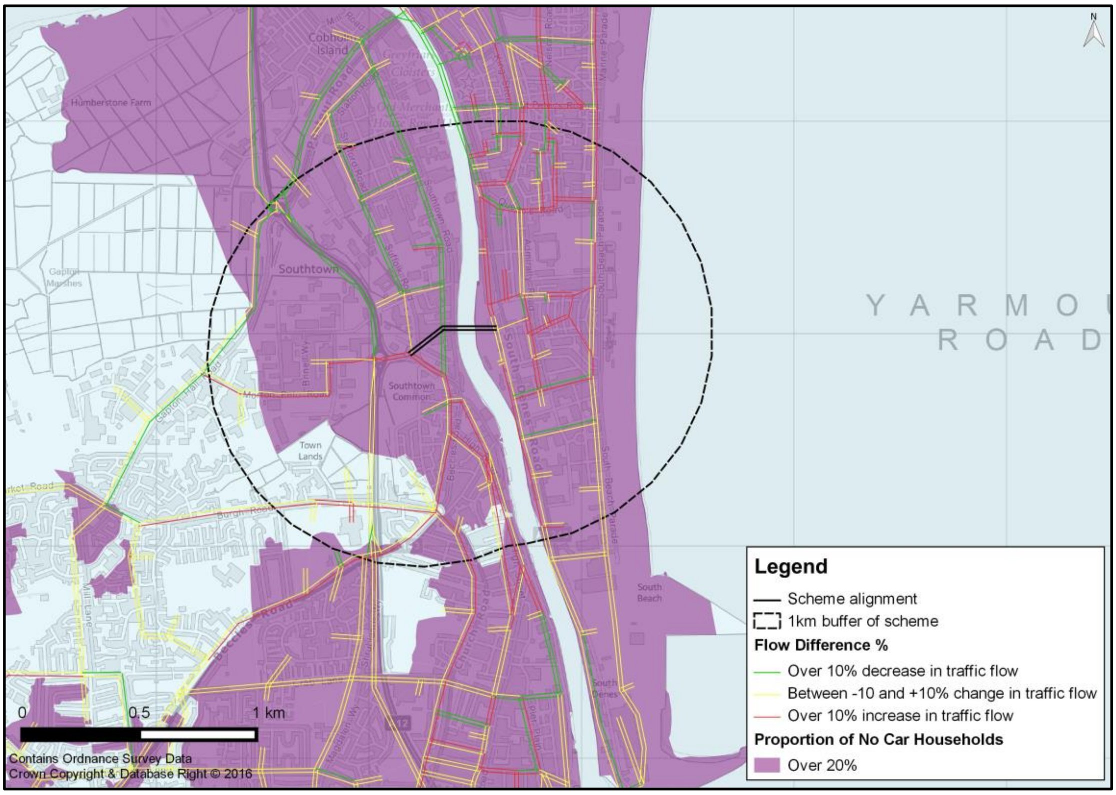


Figure 5-5 - Distribution of Traffic Flow Changes against Concentrations No Car Households



Figures 6-2 to 6-5 show that there are significant increased traffic flows on the local road network in areas where there are concentrations of vulnerable groups. As a result, there is a potential impact on these groups' ability to access key amenities and services.

As can be seen in Figure 5-4 there are many areas where no car households make up over 20% of the population in proximity to the links likely to be affected by increased traffic flows, and may therefore experience increased severance.

Conversely, there are a number of links that show a reduction in traffic flow, including the A47, Southtown Road, Pasteur Road and Gapton Hall Road which may provide benefits to the community (including vulnerable users) through reduced severance caused by traffic.

Figure 5-6 shows some of the key pedestrian crossing points on links within 1km of the scheme alignment that would have a 10% change in traffic flow as a result of the scheme. Identifying these areas allowed the severance directly caused by the GYTRC to be identified and analysed. The severance worksheet in Appendix D details the number of people in potential vulnerable groups likely to be affected by severance as a result of the intervention at these particular sites.

Figure 5-6 - Key Pedestrian Crossing Locations

It should be noted that as part of the scheme, there are additional pedestrian facilities being provided on the crossing itself and on William Adams Way (site 1) which are likely to have a positive impact on severance. The overall SDI assessment on severance is considered to be **slight beneficial**.

Table 5-2 – Benefit Assessment

Impact	Children	Older People	People with a Disability	Older People
Slight Adverse				
Moderate Adverse				
Large Adverse				
Neutral				
Slight Beneficial	✓	✓	✓	✓
Moderate Beneficial				
Large Beneficial				

6 Personal Affordability

In line with WebTAG, the personal affordability impacts of the scheme have been considered throughout the appraisal process. Changes in transport costs have the potential to disproportionately affect areas where there are few or no travel alternatives, particularly in areas where income levels preclude car ownership. As a result, impact on travel to work, education and affordable food for example can be expected. These impacts are likely to be exacerbated in areas with low income, low car ownership and a high elderly population.

6.1 Screening (Step 1)

The only element assessed for the affordability impact appraisal was fuel and non-fuel operating costs (TUBA benefit) as shown in Table 6-1.

Table 6-1 - Personal Affordability Screening

Mode	Cost Change	Cost Change Expected	Change Captured in TUBA	Impact
Car	Car fuel and non-fuel cost	Yes	Yes	Changes due to congestion relief and rerouting.
	Road user charges	No	-	
	Public parking charges	No	-	
	Other car charge/costs	No	-	
Public Transport	Bus fares	No	-	
	Rail fares	No	-	
	Rapid transit fares	No	-	
	Mode shift between public transport modes due to change in supply	No	-	
	Concessionary fares	No	-	
	Other public transport charges/costs	No	-	

Non-motorised modes	Walking costs	No	-	
	Cycling costs	No	-	

6.2 Assessment – Areas of impact (Step 2a)

The impact area for the personal affordability distributional appraisal follows the boundary of the strategic traffic model, as identified in the user benefits analysis. This impact area outlines the area in which passengers' cost of travel is being directly affected by the scheme.

6.3 Assessment – Identification of social groups in the impact area (Step 2b)

In line with WebTAG methodology, the primary group of interest is people on low incomes. To ensure consistency, the same method for the user benefit appraisal was adopted whereby five quintiles were identified using the IMD income domain at LSOA level throughout the scheme area as shown in Figure B-5 (Appendix B).

6.4 Appraisal of Impact (Step 3)

Overall, across the study area, there would be a benefit of £17.3 million in car user fuel vehicle operating costs (VOC's) and £4.5 million in non-fuel vehicle operating costs giving a combined benefit of **£21.7 million** over the 60 year appraisal period (2010 prices).

At this stage, a detailed assessment on how these fuel and non-fuel cost changes will affect different groups of the population has yet to be undertaken.

As both low income and medium-high income groups experience a large user benefit from the scheme as described earlier in this report, it is expected that similar benefits will be experienced by these groups in the form of a net reduction in costs. Therefore, it is anticipated that the personal affordability DI impacts are likely to be **moderate beneficial**.

7 Summary of Findings

Indicator	Summary of Impact	Assessment
1. User Benefits	There are significant overall net benefits from the scheme with residents in the most deprived quintile experiencing the largest share of the benefits. No disbenefits were observed.	Large Beneficial
2. Noise	Due to limited data, the potential changes in noise levels as a result of altered traffic flow, speed and compositions brought on by the scheme has so far only been undertaken qualitatively. There are a significant amount of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise.	Slight Adverse
3. Air Quality	Due to limited data, the potential changes in air quality as a result of altered traffic flow, speed and compositions brought on by the scheme has so far only been undertaken qualitatively. A number of links within the impact area experience an increase in traffic levels and are in proximity to concentrations of vulnerable groups, including children aged under 16.	Slight Adverse
4. Accidents	More links are forecast to experience an increase in accidents than are forecast to decrease over the 60 year appraisal period. Links forecasted to experience an increase in accidents coincide with significant forecasted increases in traffic flow (over 10%) which is likely to exacerbate accident impacts.	Slight Adverse
5.Personal Security	Scoped out of appraisal.	N/A
6. Severance	There are a number of links that show a reduction in traffic flow, including the A47, Southtown Road, Pasteur Road and Gapton Hall Road which may provide benefits to the community (including vulnerable users) through reduced severance caused by traffic. Additional pedestrian facilities being provided on the crossing itself and on William Adams Way are likely to have a positive impact on severance.	Slight Beneficial
7. Accessibility	Scoped out of appraisal.	N/A
8. Personal Affordability	At this stage, a detailed assessment on how these fuel and non-fuel cost changes will affect different groups of the population has yet to be undertaken. As both low income and medium-high income groups experience a large user benefit from the scheme as described earlier in this report, it is expected that similar benefits will be experienced by these groups in the form of a net reduction in costs.	Moderate Beneficial

Appendix A – Initial Screening Proforma

Figure A-0-1 - Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
User benefits	The TUBA user benefit analysis software or an equivalent process has been used in the appraisal; and/or the value of user benefits Transport Economic Efficiency (TEE) table is non-zero.	Yes. Expected to be positive overall .	TUBA will used to assess user benefits. Significant positive benefits anticipated.	**YES.**
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Yes. Not known at this stage whether overall impact on sensitive receptors will be positive or negative.	GYTRC results in the introduction of a new link where significant traffic flow changes are anticipated.	**YES.**
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV content: • Change in 24 hour AADT of 1000 vehicles or more • Change in 24 hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or more • Change in peak hour speed of 20kph or more • Change in road alignment of 5m or more	Yes. Not known at this stage whether overall impact on sensitive receptors will be positive or negative.	GYTRC results in the introduction of a new link where significant traffic flow changes are anticipated.	**YES.**
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	Yes. Expected to be positive overall.	GYTRC results in the introduction of a new link where significant changes in the number of pedestrians, cyclists/motorcyclists using the the road network are anticipated.	**YES.**
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	No. Social impacts will be considered but the scheme is not expected to impact on women, younger people (teenagers), older people, people with disabilities and Black and Minority Ethnic (BME).	No direct impact on PT waiting/interchange facilities which would affect user perception of security.	**NO.**
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	Yes. Expected to be positive overall.	GYTRC includes the provision of pedestrian and cycling crossing facilities, together with an anticipated reduction in traffic flows along the two existing bridges (A12 Breydon Bridge and A1243 Haven Bridge), both of which are anticipated to reduce levels of severance for significant numbers of users.	**YES.**
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & re-location of a school).	Likely positive impact but not considered as part of this scheme.	No demolition or relocation of key facilities is required. Indirectly, the implementation of the scheme may provide the opportunity for PT operators to reschedule services, as a result of JT savings afforded by GYTRC.	**NO.**
Affordability	In cases where the following charges would occur; Parking charges (including where changes in the allocation of free or reduced fee spaces may occur); Car fuel and non-fuel operating costs (where, for example, rerouting or changes in journey speeds and congestion occur resulting in changes in costs); Road user charges (including discounts and exemptions for different groups of travellers); Public transport fare changes (where, for example premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or Public transport concession availability (where, for example concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority[1]).	Yes. Expected to be positive overall impact on car fuel and non-fuel operating costs (no impact on other factors).	The scheme is anticipated to result in a positive impact on car fuel and non-fuel operating costs, as a result of reduced congestion. No other personal affordability factors are impacted on.	**YES.**

Appendix B - Socio-demographic Assessment Figures

Figure B-1 - Proportion of Children (Aged under 16)

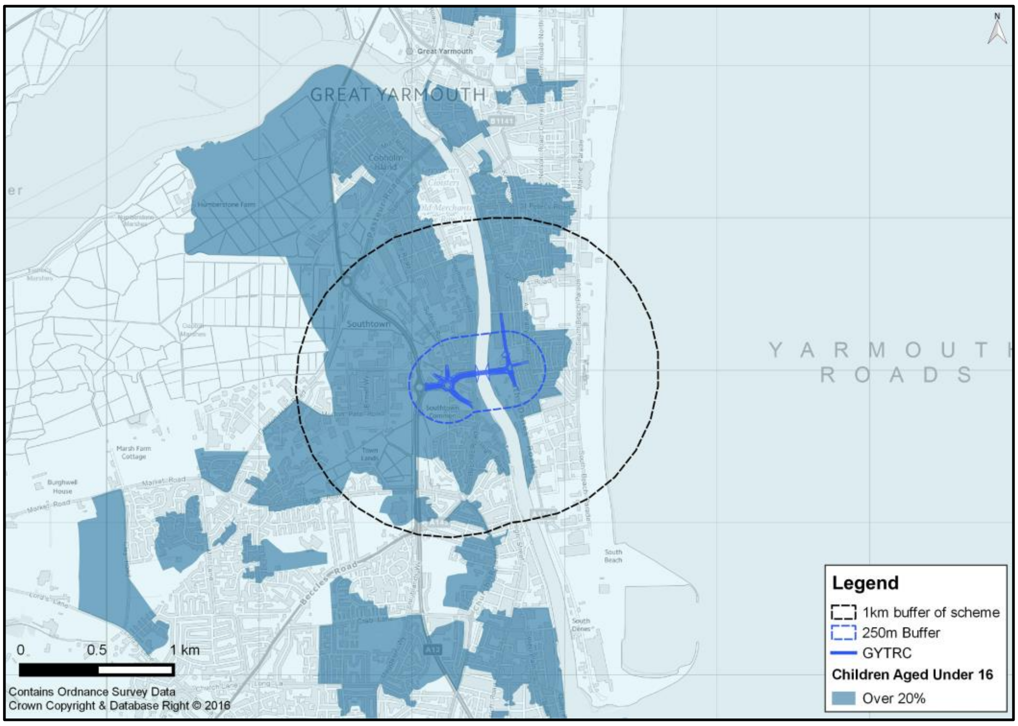


Figure B-2 - Proportion of Young People (Aged 16-25)

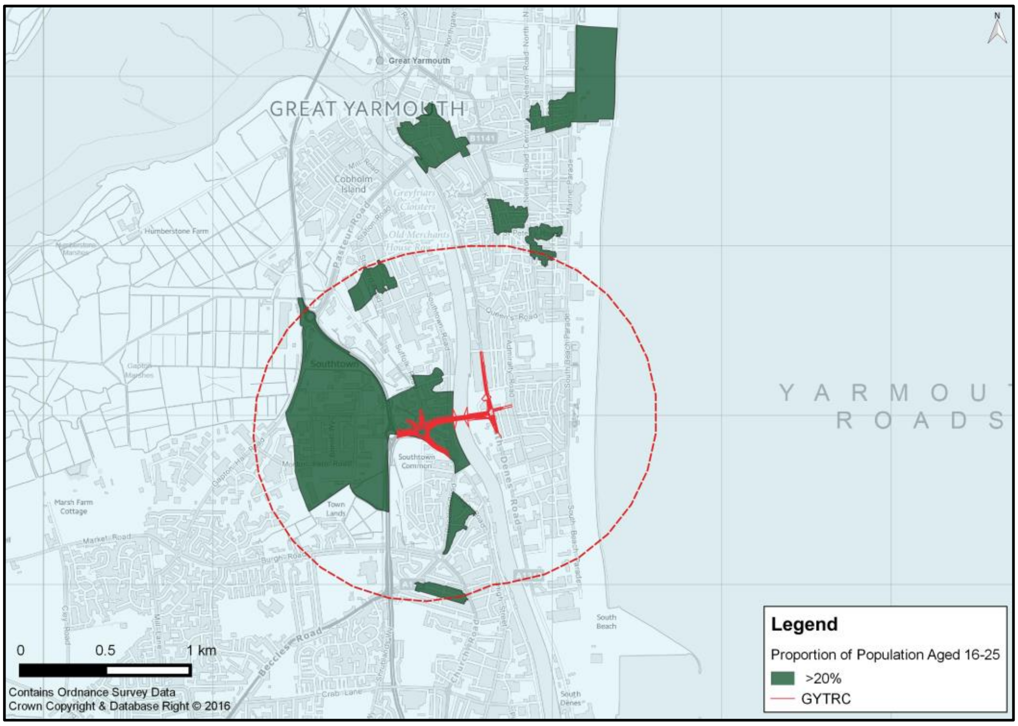


Figure B-3 - Proportion of Older People (Aged over 70)

Figure B-4 - Proportion of Households Living within 5% most Deprived LSOA's (Income Domain)

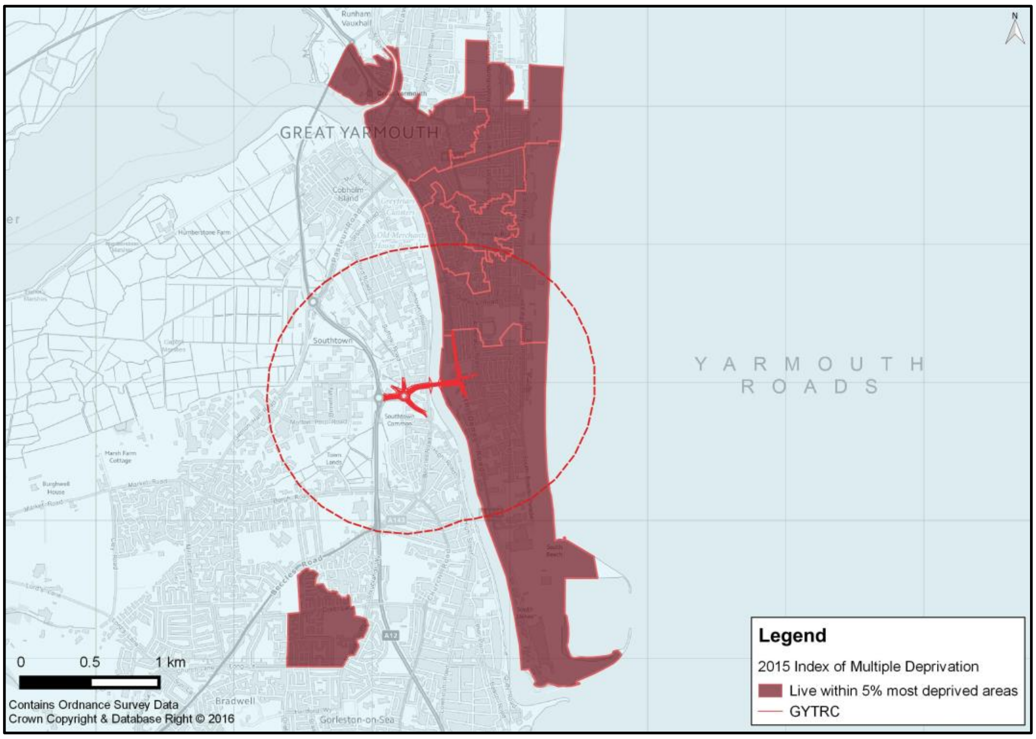
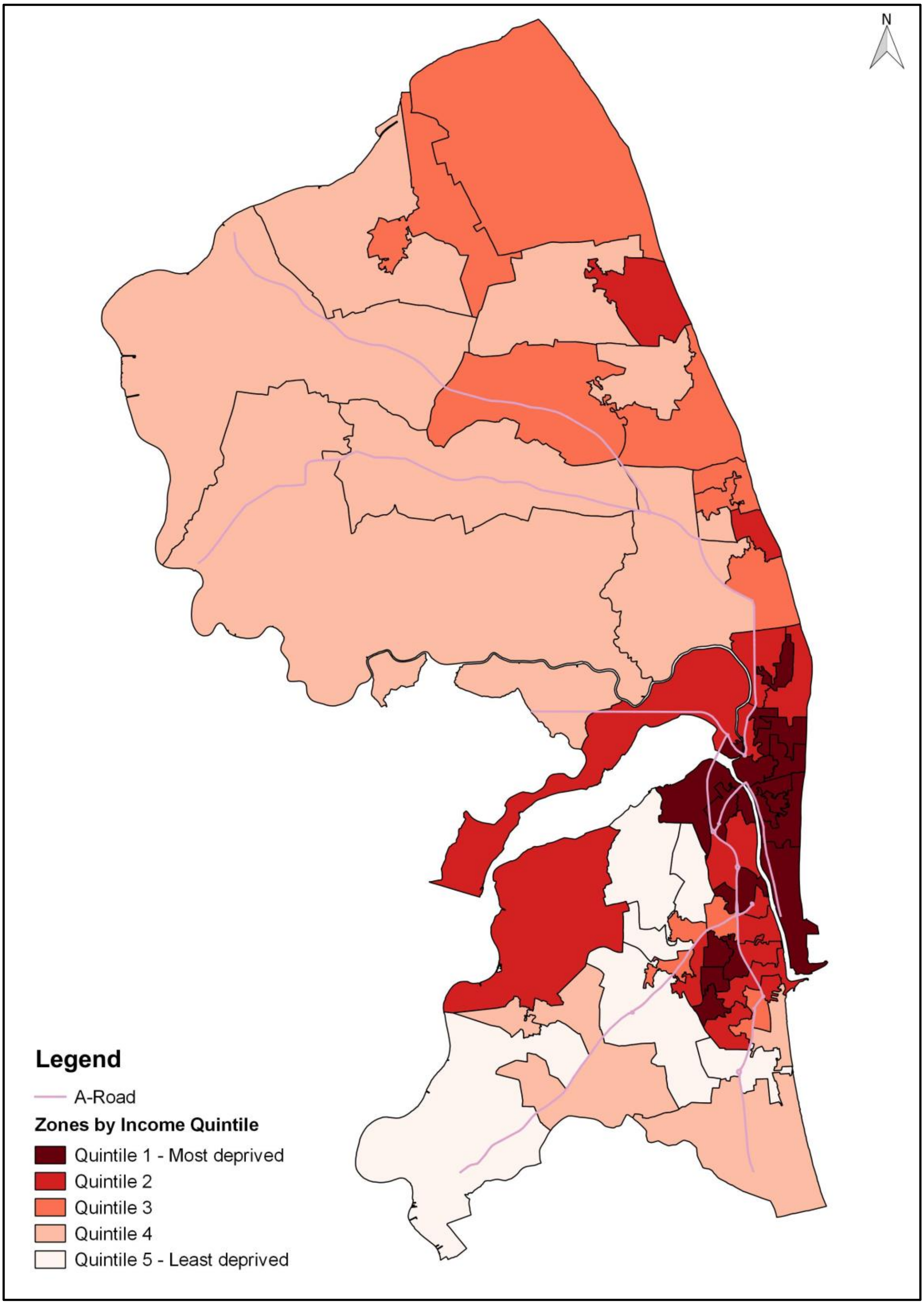


Figure B-5 - IMD Income Domain



Appendix C – Accidents Worksheet

Distributional Impacts: Accidents

	Existing Casualty Rate for Vulnerable Users		
	Defined Vulnerable Casualty Group:		
	Low (more than 30% of average rate for class of road)	**Medium** (<30% lower to <30% higher than average rate for class of road)	**High** (more than 30% higher than average rate for class of road)
1. Change in physical layout that could impact on defined vulnerable group			
Significant improvement	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight improvement	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral	Neutral	Neutral	Neutral
Slight worsening	Slight Adverse	Slight Adverse	Moderate Adverse
Significant worsening	Moderate Adverse	Moderate Adverse	Large Adverse
2. Change in traffic flow OR speed			
Significant reduction (>15% decrease)	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight reduction (>5%, <15% decrease)	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral (<5% increase or decrease)	Neutral	Neutral	Neutral
Slight increase (>5%, <10% increase)	Slight Adverse	Slight Adverse	Moderate Adverse
Significant increase (>10% increase)	Moderate Adverse	Moderate Adverse	Large Adverse

3. Change in numbers of pedestrians, cyclists and motorcyclists

Likely to increase due to new pedestrian and cyclist provision on Williams Adams Way, Suffolk Road and the bridge itself

Overall assessment for link, based on criteria 1, 2 and 3 above

Slight Adverse. More links are forecast to experience an increase in accidents than are forecast to decrease over the 60 year appraisal period.

Qualitative Commentary

Links forecasted to experience an increase in accidents coincide with significant forecasted increases in traffic flow (over 10%) which is likely to exacerbate accident impacts.

Appendix D – Severance Worksheet

Distributional Impacts: Severance

	All social groups			No-car households			Young people			Older people			People with disabilities		
	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of households affected	Overall effect [A]*[B]	Change in severance [A]	people affected [B]	Overall effect [A]*[B]	Change in severance [A]	people affected [B]	Overall effect [A]*[B]	Change in severance [A]	people affected [B]	Overall effect [A]*[B]
Site 1: William Adams Way	3	818	2454	3	134	402	2	129	258	3	74	222	3	174	522
Site 2: South Denes Road	0	1639	0	0	750	0	0	240	0	-1	158	-158	-1	364	-364
Site 3: Southtown Road	2	1370	2740	2	186	372	2	227	454	2	92	184	2	245	490
Site 4: Burgh Road	-1	1155	-1155	-1	273	-273	-1	145	-145	-1	177	-177	-1	243	-243
Site 5: Suffolk Road	2	806	1612	2	90	180	1	123	123	2	64	128	2	145	290
Site 6: Morton Peto Road	-1	513	-513	-1	151	-151	-1	72	-72	-1	44	-44	-1	75	-75
Total			**5138**			**530**			**618**			**155**			**620**

Appendix B – Reliability Benefits

Great Yarmouth Third River Crossing – Reliability Benefits

Project:	Great Yarmouth Third River Crossing	**Date:**	28/03/17
		TN Ref:	001
Subject:	Reliability Benefits		
Author:	NN	**Project Ref:**	1076653
Reviewed:	PS		

1 Introduction

This technical note outlines the methodology that was adopted to produce the reliability benefits for the Great Yarmouth Third River Crossing (GYTRC). The calculation of reliability follows the methodology as stated in the section 6.3 of the WebTAG A1.3. The latest TUBA version v1.9.8 was then utilised to produce the reliability benefits for the proposed scheme to take into account the latest WebTAG Databook values.

1.1 Reliability Benefits

The terms reliability refers to variation in journey times that individuals are unable to predict (journey time variability). Such variation could come from recurring congestion at the same period each day (day-to-day variability), or from non-recurring events such as incidents. It however excludes predictable variation relating to varying levels of demand by time of day, day of week, and seasonal effects which travellers are assumed to be aware of.

Different methods to estimate reliability impacts have been developed for public transport and private vehicle trips on inter urban motorways and dual carriageways, urban roads, and other roads. All the method require a unit to measure travel time variability and this is generally the standard deviation of travel time (for private travel) or lateness (for public transport).

For inter-urban motorways and dual carriageways, impacts of journey time variability and incident delays is estimated using the Highways England's bespoke tool namely Motorways Reliability and Incident Delays (MyRIAD). For motorways and dual carriageways, alternative routes avoiding particular sections usually have limited capacity making it difficult for large number of drivers to divert if they encounter delays due to an incident, therefore, in the absence of significant demand exceeding capacity, it may be sufficient to assume that incidents are the main source of unpredictable variability.

For urban areas, alternative routes are more readily available than on the motorways and there are many ways for drivers to divert away from incidents which reduce capacity on a particular routes.

Building on previous research, a model has been developed to forecast changes in the standard deviation of travel time from changes in journey time and distance, as provided in the WebTAG A1.3 below:

$$\Delta\sigma_{ij} = 0.0018({t_{ij2}}^{2.02} - {t_{ij1}}^{2.02}){d_{ij}}^{-1.41}$$

where:

$\Delta\sigma_{ij}$	is the change in standard deviation of journey time from i to j (seconds)
t_{ij1} and t_{ij2}	are the journey times, before and after the change, from i to j (seconds)
d_{ij}	is the journey distance from i to j (km).

To estimate the monetised benefits of changes in journey time variability, money values are needed. The reliability ratio enable changes in variability of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of travel time / Value of travel time

The recommended value for the reliability ratio for all journey purposes by car, based on evidence compiled, is 0.8 as stated out in the WebTAG A1.3. The reliability benefits are then can be estimated using the "rule of half" formula as below:

$$Benefit = -\frac{1}{2}\sum_{ij}\Delta\sigma_{ij} * (T_{ij}^{0} + T_{ij}^{1}) * VOR$$

Note that the value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio and T_{ij}^{0} and T_{ij}^{1} are number of trips before and after the change.

According to the WebTAG A1.3, reliability benefits calculated using this method should be identified separately from other economic benefits and only reported in the AST.

2 Reliability Benefits for GYTRC

2.1 Introduction

As the calculation of reliability benefits adopts “rule of half” similarly to the method used for the calculation of user benefits within TUBA. The tool adopted for the calculation of reliability benefits for the Great Yarmouth Third River Crossing proposed scheme therefore utilises the TUBA software (Transport User Benefit Analysis), a computer programme developed for the Department for Transport (DfT) to undertake the appraisal of highway schemes and multi-modal transport studies, as number of reasons below:

- The latest TUBA version v1.9.8 uses the latest WebTAG Databook parameters;
- The calculation of reliability benefits uses “rule of half”, similar to the method currently implemented within TUBA
- All the parameters such as vehicle class, purposes, time slices and annualisation factors should be consistent with those used for the calculation of TUBA benefits.

2.2 Main Parameters

To be consistent with the parameters set up for TUBA benefits, calculation of reliability benefits adopt the same parameters as for TUBA, as below:

- TUBA version: v1.9.8 (with the varying VoT by travelled distance);
- Opening Year: 2023
- Design Year: 2038
- Horizon Year: 2082 (60 years from the Opening year)
- Modelled years: 2023, 2038 and 2051

2.3 Time Slices

Similar to TUBA, reliability benefits requires that the benefits should be produced for all the hours within a year and allocates each of the hours in a year into one of the 5 time slices, as below:

- Weekday AM Period (07:00-10:00);
- Weekday Inter-Peak period (10:00-16:00);
- Weekday PM period (16:00-19:00);
- Weekday Off-peak period (19:00-07:00); and
- Weekend + bank holiday (24-hours).

The traffic models developed for the proposed scheme, however, only consists of the three distinct peak hours: AM peak hour (08:00-09:00), Inter-peak (average of 10:00-15:30), and PM Peak (16:30-17:30), it was therefore required that all the non-modelled hours should be included in the TUBA analysis either by expanding the modelled hour to the relevant period or by adopting a “donor” models. (Detail of this method, so called annualisation factors, is provided in the subsequent section). The TUBA analysis periods and the corresponding modelled hours are summarised in below:

- Weekday AM Period: adopt AM peak hour model (08:00-09:00);
- Weekday Inter-Peak period: adopt average Inter-Peak hour model (10:00-15:30);
- Weekday PM Period: adopt PM peak hour model (16:30-17:30);
- Weekday Off-peak period: adopt average inter-peak hour model; and
- Weekend + bank holiday: adopt average inter-peak hour model.

2.4 Vehicle Types and User Classes

As stated in the WebTAG A1.3, reliability benefits are only calculated for private travel (or car). The impacts of good vehicles are therefore excluded in the calculation of the reliability benefits. Table 2-1 below provides the correspondence between the model's user classes and the TUBA vehicle types/purposes to be used for the reliability benefits calculation, with the associated conversion factors.

Table 2-1 Model User classes and TUBA standard User Classes

Model User Class	TUBA User Classes	TUBA Input		
		Veh / submode	purpose	Factor Split
1	1	1 (Car)	1 (Business)	1.00
2	2	1 (Car)	2 (Commuting)	1.00
3	3	1 (Car)	3 (Other)	1.00

2.5 Non-modelled Hours and Annualisation factors

To be consistent with the calculation of TUBA benefits, reliability benefit calculation adopts the same annualisation factors as for TUBA benefits, as provided in Table 2-2 below.

Table 2-2 Annualisation Factors

No	Time Slice	Duration (min)	Traffic Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1.51 x 253 = 383
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7.23 x 253 = 1,828
3	Weekday PM Period	60	PM Peak Hour model	2.20 x 253 = 556
4	Weekday Off-Peak period	60	Inter-Peak hour model	0.00 x 253 = 0
5	Weekend	60	Inter-Peak hour model	8.06 x 52 = 419
Total annualised Hours				**3,186 hours**

2.6 Derivation of Data for Reliability Benefits

In order to utilise TUBA to calculate reliability benefits, travel time matrices produced from the forecast assignments were required to be pre-processed to produce the right format and unit to be input into TUBA, as below:

$$Time\ _{ij} = 0.0018 * (Time_{ij} * 3600)^{2.02} * \quad is\ _{ij}^{-1.41} * 0.8$$

Where:

- $Time\ _{ij}$ – converted reliability travel time from zone I to zone j
- $Time_{ij}$ – travel time (in hour) from zone I to zone j as produced from forecast assignments
- $\ is\ _{ij}$ – travel distance (in km) from zone I to zone j as produced from forecast assignments
- 0.8 is the reliability ratio as stated in the WebTAG A1.3

The distance and demand data that were extracted from the Great Yarmouth highway forecast models to be used for TUBA benefit calculation remain unchanged for the calculation of reliability benefits.

As mentioned in the previous section, three modelled years forecasts have been developed for the proposed scheme (opening year 2023, Design year 2038 and the horizon year 2051), the following skimmed time, distance and demand data were extracted for the TUBA calculation:

- 2023 Do-Minimum/Do-Something AM, IP and PM peak hours by 5 user classes;
- 2038 Do-Minimum/Do-Something AM, IP and PM peak hour models models by 5 user classes; and
- 2051 Do-Minimum/Do-Something AM, IP and PM peak hour models by 5 user classes.

2.7 TUBA Runs

As mentioned in the previous section, TUBA was utilised to run to calculate reliability benefits for the following scenarios for both Fixed demand and Variable demand models:

- Core scenario;
- Core scenario with Harfreys roundabout improvements as part of the proposed scheme;
- Core scenario with RIS schemes on the A12 in both Do-Minimum and Do-Something;
- Low growth scenarios;
- High growth scenarios;

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building great relationships

3 Summary of Reliability Benefits

3.1 Introduction

To produce reliability benefits for each scenario, only travel time saving benefits from TUBA runs were extracted since reliability benefits are associated with travel time savings. Benefits associated with fuel, non-fuel, greenhouse gas and indirect tax revenues were not included from TUBA outputs.

For the purpose of this note, TUBA benefits for the fixed demand models and other scenarios will be reported at a high level summary, this section only reports in detailed the TUBA benefits for the VDM Core scenario.

3.2 Reliability Benefits – VDM Core scenario

Table 3-1 below provides a summary of the reliability benefits of the proposed scheme from the VDM core scenario.

Table 3-1 Reliability Benefits – VDM Core scenario

Purpose	2023	2038	2051	Total
Business	22	33	53	2,483
Non-Business	248	412	686	31,442
Total	**270**	**445**	**739**	**33,925**

The reliability benefits produced by the proposed scheme is £34m, about 11% of the TUBA travel time saving benefits.

3.3 Reliability Benefits – Other Scenarios

Table 3.10 below provides a summary of the TUBA benefits for the Fixed demand assignments and other scenarios forecasts.

Table 3-2 Reliability Benefits for Other Scenarios (£000s)

Reliability Benefit Summary	Fixed demand assignments					Variable demand assignments			
Element	Core Standard	Core + Harfreys (DS) Standard	Low Standard	High Standard		Core Standard	Core + Harfreys (DS) Standard	Low Standard	High Standard
Additional Benefits									
Reliability Benefits - Business	5,752	5,980	2,751	9,974		2,483	2,672	1,508	3,781
Reliability Benefits - Non-Business	76,043	79,179	35,985	133,985		31,442	33,797	19,059	49,381
Total Benefits	**81,795**	**85,159**	**38,736**	**143,959**		**33,925**	**36,469**	**20,567**	**53,162**

Appendix C – COBA-LT Junction Locations