Norfolk County Council

NORWICH WESTERN LINK

Economic Appraisal Report

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NORWICH WESTERN LINK

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1

INTRODUCTION

1 INTRODUCTION

1.1 OVERVIEW

1.1.1. WSP was commissioned by Norfolk County Council (NCC) to undertake transport modelling to support the evidence base for the Norwich Western Link Outline Business Case (OBC) and the planning application.

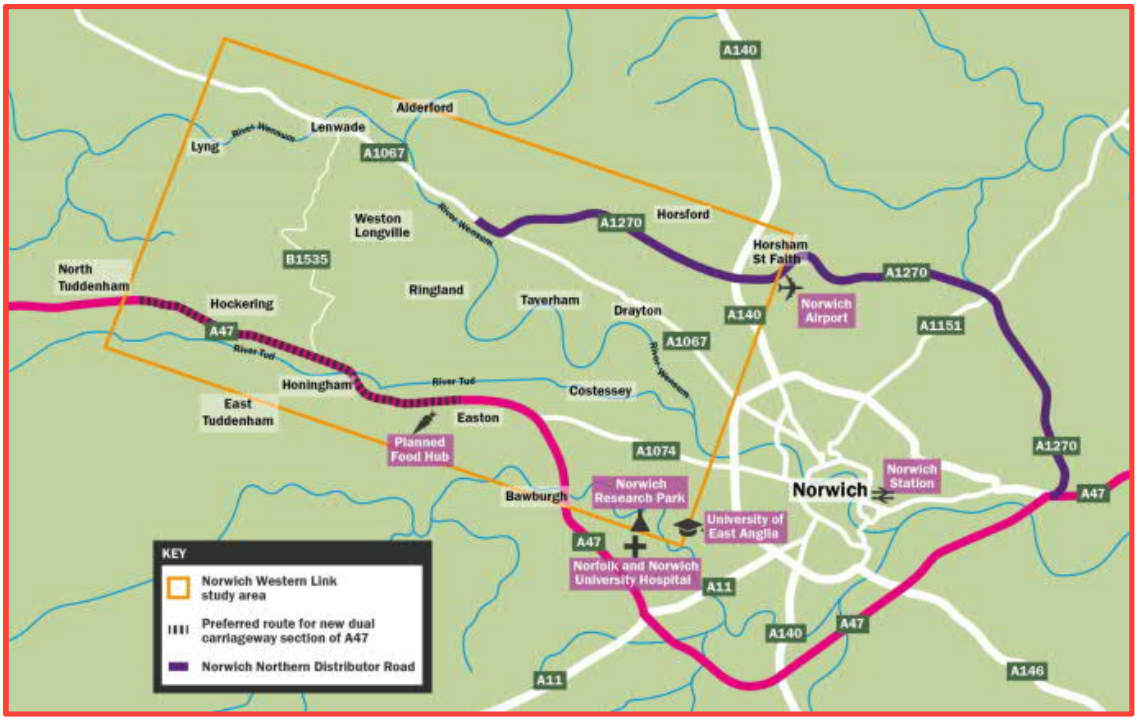
1.1.2. The Norwich Area Transportation Strategy (NATS) model is a multi-modal model with a Base Year of 2019. The Base Year model development has been detailed in the NATS 2019 Local Model Validation Report, November 2020. Development of the model has been undertaken in accordance with Department for Transport (DfT) Transport Appraisal Guidance (TAG) and has been satisfactorily checked for accuracy against TAG criteria. The report concluded that the 2019 NATS model gives a sufficiently accurate overall representation of highway and public transport conditions that provides a robust foundation to project forecasts from.

1.1.3. Future year scenarios, Do Minimum (without Norwich Western Link) and Do Something (with Norwich Western Link), have been developed from this base year for the forecast years 2025 and 2040. These scenarios form the basis of a comparison for the economic appraisal that provide the inputs for the Economic Case within the overall OBC.

1.1.4. This report provides an overview of the economic appraisal of the Norwich Western Link scheme.

1.2 NORWICH WESTERN LINK SCHEME

1.2.1. The Norwich Western Link scheme is located north-west of Norwich, in the Norwich Western Quadrant (NWQ) illustrated in Figure 1-1. The broad study area includes the key radial routes of the A47 trunk road, the A1074 (Dereham Road), and the A1067 (Drayton High Road / Fakenham Road).



SOURCE: ABOUT THE NORWICH WESTERN LINK, LOCATION MAP (NORFOLK COUNTY COUNCIL)

Figure 1-1: Norwich Western Link Study Area

1.2.2. Figure 1.2 shows the location of the Norwich Western Link route.

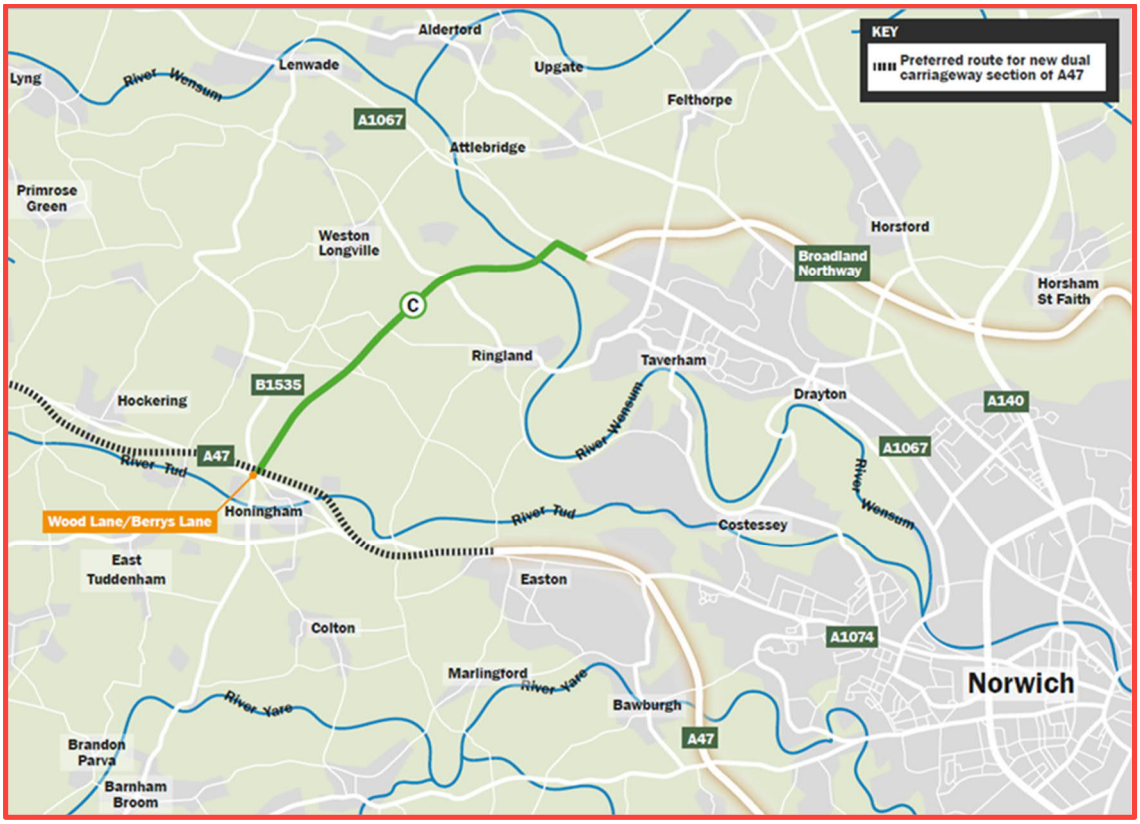


Figure 1-2: Norwich Western Link Route

1.2.3. The Norwich Western Link will comprise a new dual carriageway all-purpose road to the west of Norwich, from the A47 to the A1067/A1270, including a new viaduct bridge over the River Wensum and its floodplain. The scheme will provide a direct connection between the Strategic Road Network i.e. Highways England North Tuddenham to Easton scheme and the A1270 Broadland Northway through the west of Norwich. This will complete an orbital route around Norwich, which forms part of the Major Road Network.

1.2.4. The scheme is comprised of:

- A dual carriageway road, including a viaduct over the River Wensum and associated floodplain
- An “at grade” junction with the A1067
- Dualling of a section of the existing A1067 between the proposed Norwich Western Link scheme roundabout and existing A1270 roundabout
- Changes to local road network and Public Rights of Way (PRoW)
- The scheme also includes landscaping, planting, ancillary works, environmental mitigation work and Biodiversity Net Gain measures.

1.2.5. Figure 1-3 shows the route of the Norwich Western Link scheme and where it connects into the Highways England A47 North Tuddenham to Easton scheme at the southern end and the A1067 Fakenham Road art the northern end.

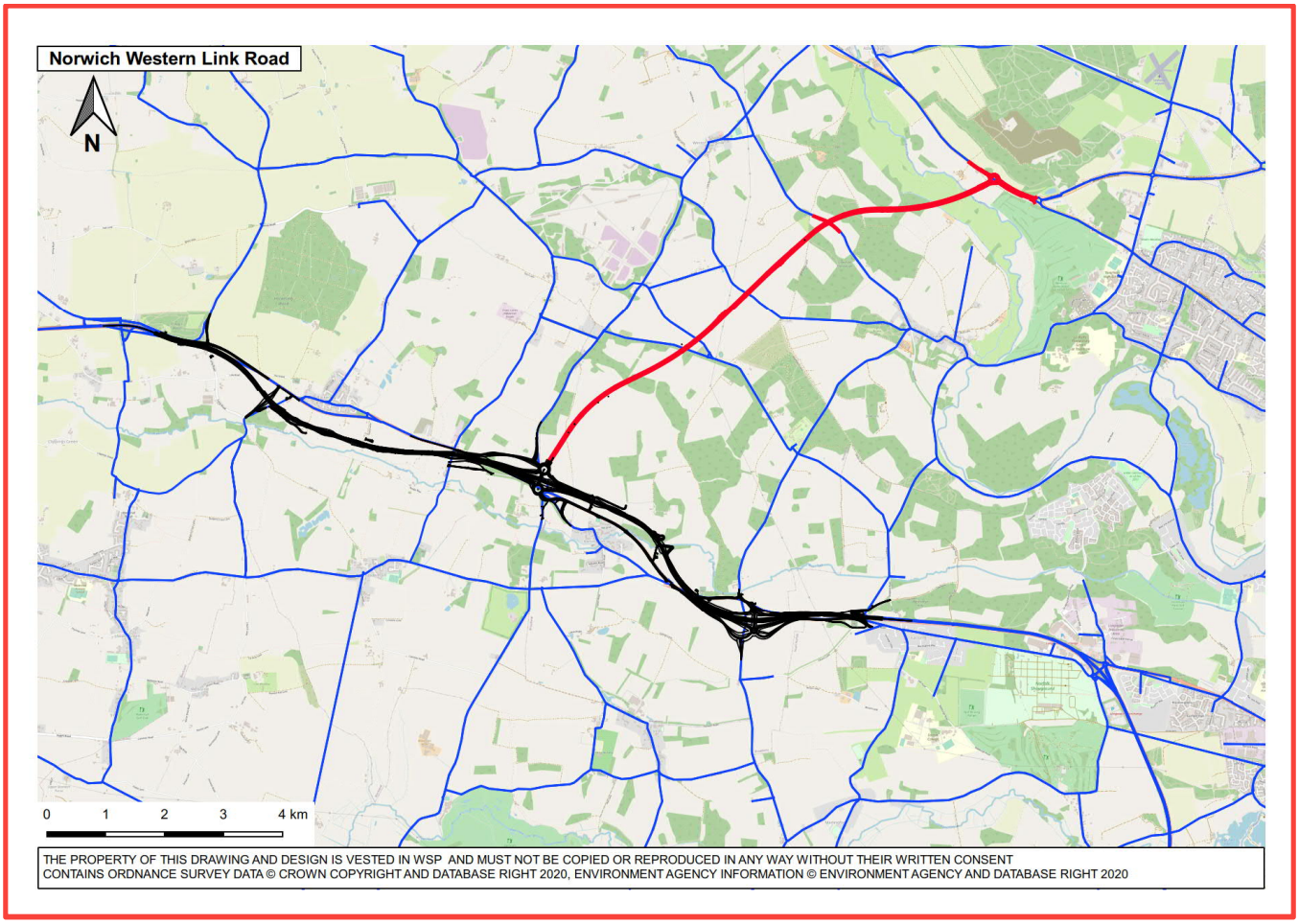


Figure 1-3: Norwich Western Link Route connection to A47 and to the A1067

1.3 PURPOSE OF THE REPORT

1.3.1. The purpose of this report is to document the details of the economic appraisal process used to assess the Norwich Western Link scheme. This EAR outlines the results for:

- Core Growth scenario
- Low Growth scenario
- High Growth scenario
- Core Growth (Sensitivity) scenario.

1.4 REPORT STRUCTURE

1.4.1. The report structure is as follows:

- Section 1: Introduction
- Section 2: Transport Model
- Section 3: Appraisal Methodology
- Section 4: Estimation of Costs
- Section 5: Estimation of Benefits
- Section 6: Economic Appraisal Results
- Section 7: Conclusion.

2

TRANSPORT MODEL

2 TRANSPORT MODEL

2.1.1. This section of the report describes the transport model that has been used for the economic appraisal. The calibration and validation of the model is detailed in the NATS 2019 Local Model Validation Report (November 2020).

2.2 MODELLED AREA

2.2.1. The Fully Modelled Area (FMA) of the NATS 2019 model is shown in Figure 2-1. The FMA encompasses the area of Norfolk between King's Lynn in the west and Lowestoft in the south-east. The FMA was chosen as it covers a sufficient area to accurately model the reassignment and redistribution effects that are likely to be produced by new development and infrastructure schemes in Norwich, specifically the Norwich Western Link.

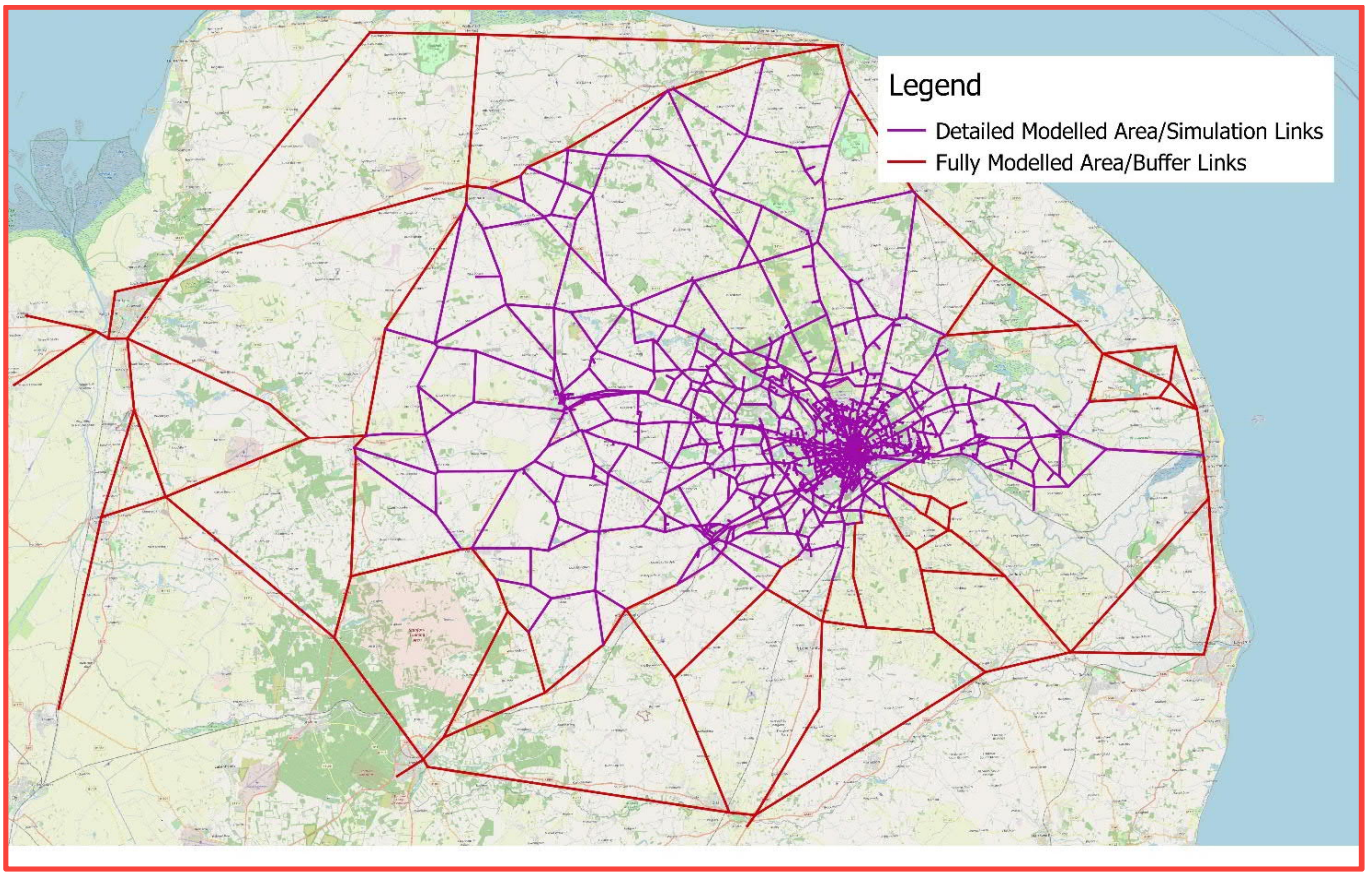


Figure 2-1: Fully Modelled Area

2.2.2. The FMA is further subdivided into:

- The Detailed Modelling Area (DMA) as shown in Figure 2-1. This is the area over which significant impacts of interventions are certain. Modelling detail in this area is characterised by representation of all trip movements, small zones, very detailed networks and junction modelling. This area has enough model network and zoning detail to be able to assess the likely impact of the scheme to an appropriate level for the purposes of the scheme appraisal
- The rest of the Fully Modelled Area. This is the area over which the impacts of interventions are considered to be quite likely but relatively weak in magnitude. It is characterised by representation of all trip movements, somewhat larger zones and less network detail than for the DMA, and speed/flow modelling (primarily link-based but possibly also including a representation of strategically important junctions)
- The rest of the UK represents the External Area. In this area impacts of interventions are likely to be negligible. The External Area is characterised by skeletal networks and simple speed/flow relationships or fixed speed modelling and a partial representation of demand (trips to, from and through the FMA).

2.3 ZONING SYSTEM

2.3.1. The zone plan in the NATS 2019 model was devised to give a fine level of detail in the Norwich urban area. The zoning system is coarser outside of the DMA, and ultimately covers the whole of the UK (excluding Northern Ireland) in 542 zones.

2.3.2. In the DMA, Census Middle Super Output Areas (MSOA) have been split up into model zones based on land use. This enables more detailed representation of trips loading onto the network and enhances the model calibration and validation. The zoning system is coarser further away from the Norwich urban area, and MSOA have been grouped together for areas a significant distance away from the study area e.g. North of England and Scotland.

2.3.3. Park and Ride (P&R) sites in Norwich have been modelled as separate zones.

2.3.4. The NATS 2019 model zone boundaries are shown in Figure 2-2.

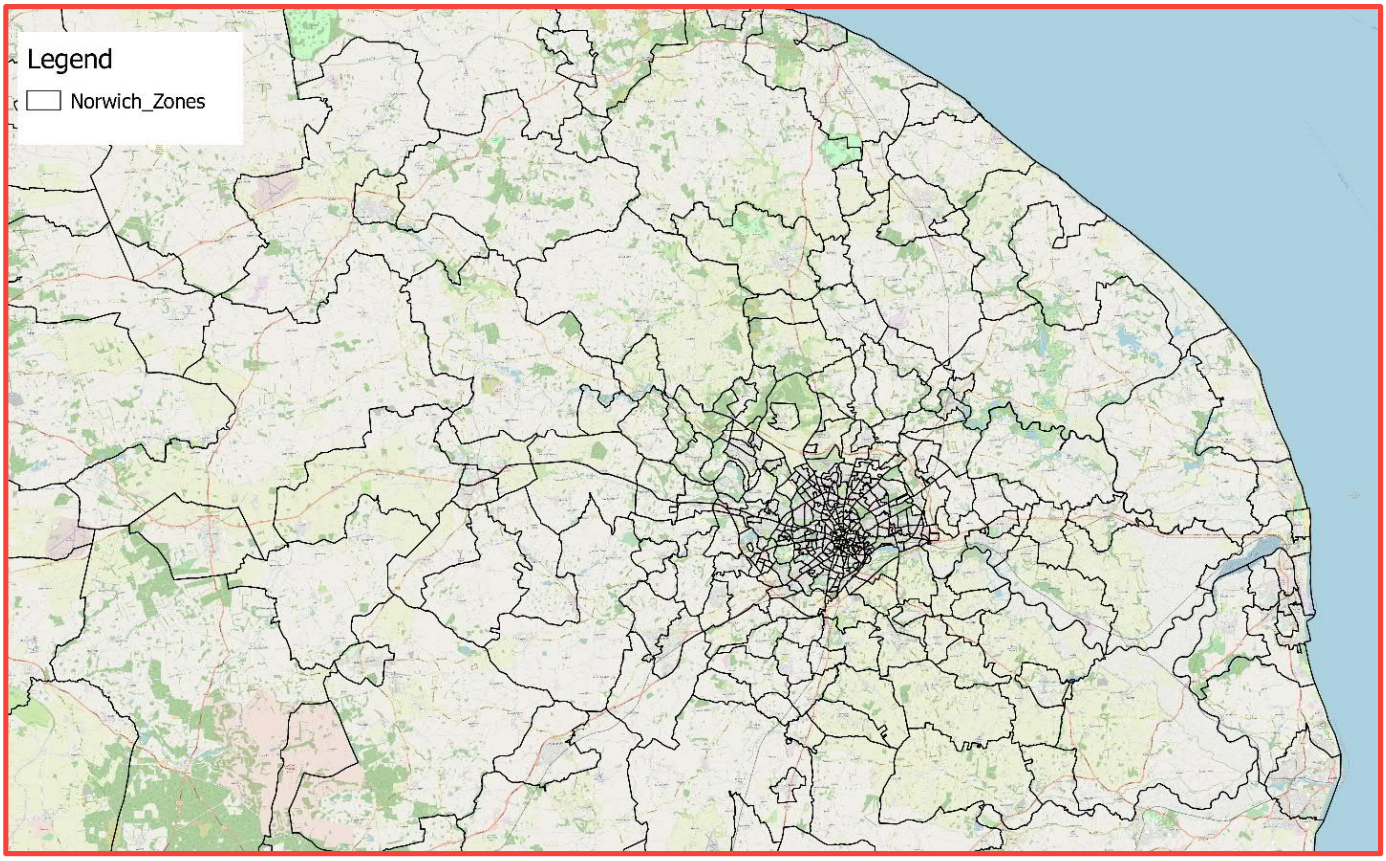


Figure 2-2: Zoning system

2.4 SECTORING SYSTEM

2.4.1. The zoning system has been aggregated into 16 model sectors, which are listed in Table 2-1 and displayed in Figure 2-3. The sectoring system enables data to be extracted and summarised into more strategic datasets.

Table 2-1: Sectoring System

Sector ID	Sector Description
1	Scotland/North
2	East/West Midlands (plus Wales)
3	South East (excluding London)
4	London
5	King's Lynn District
6	North Norfolk District
7	Great Yarmouth District
8	Breckland North (north of A47)
9	Breckland South (south of A47)
10	South Norfolk West (west of A11)
11	South Norfolk Central (between A11 and A140)
12	South Norfolk East (east of A140)
13	Broadland West (west of A140)
14	Broadland East (east of A140)
15	Norwich North (north of river)
16	Norwich South (south of river)

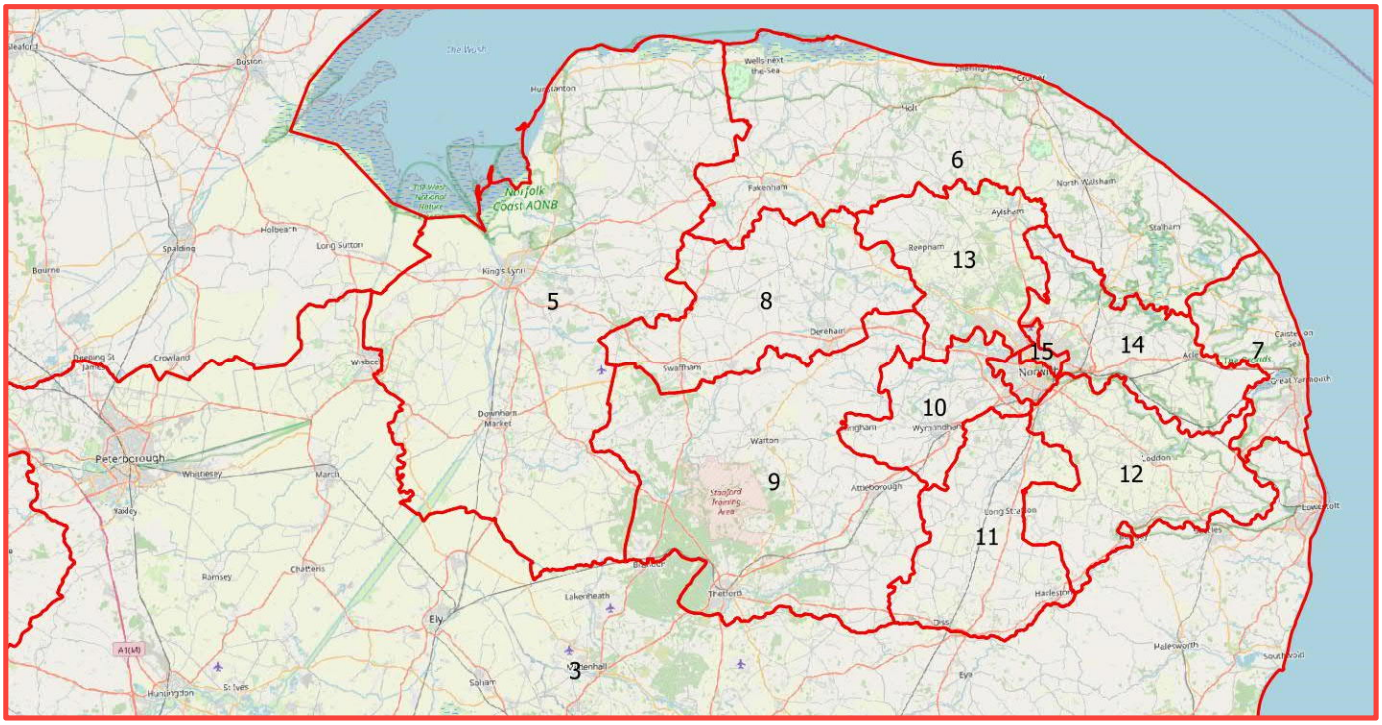


Figure 2-3: Sectoring System

2.5 MODEL YEARS

2.5.1. The base year of the NATS model is 2019.

2.5.2. The forecast years are 2025 and 2040.

2.6 TIME PERIODS

2.6.1. The models have been developed for the following time periods:

- Average weekday (Monday to Thursday) AM peak hour (08:00 – 09:00);
- Average weekday (Monday to Thursday) Inter peak hour (average 10:00 – 16:00); and
- Average weekday (Monday to Thursday) PM peak hour (17:00 – 18:00).

2.6.2. The time periods defined above have been used because traffic data analysis shows that 08:00-09:00 and 17:00-18:00 are the busiest hours within the FMA. Since traffic flow is reasonably consistent throughout the Inter peak period (10:00-16:00), an average Inter peak hour has been considered.

2.7 MODEL STRUCTURE AND DEMAND SEGMENTATION

2.7.1. The NATS 2019 model has inherited the structure of the previous NATS model which consists of the following sub-models:

- Highway model
- Public Transport (PT) model
- Variable Demand Model (VDM).

2.7.2. The PT model has been used to provide generalised cost information for input into the VDM.

2.7.3. The highway model includes the following five user classes, as consistent with advice presented in Section 2.6 of TAG Unit M3.1 (January 2014):

- Car Work
- Car Commuting
- Car Other
- LGV
- HGV.

2.7.4. The PT model includes the following three user classes:

- PT Work
- PT Commuting
- PT Other.

2.8 SOFTWARE PLATFORM

2.8.1. The NATS highway model has been developed in SATURN (Simulation and Assignment of Traffic in Urban Road Networks) version 11.5.05H MC N4. The NATS PT model has been developed using PTV's VISUM 2020. The VDM has been set up in DIADEM version 7.

2.9 DATA COLLECTION

2.9.1. The update of the model used the following datasets:

- Automatic Traffic Counts (ATC)
- Manual Classified Turning Counts (MCTC)
- DfT TrafficMaster Journey Time Data
- Mobile Network Data
- National Trip End Model Data (TEMPro)
- National Travel Survey
- Census journey to work
- INRIX Origin Destination and Journey Time Data.

2.9.2. The NATS LMVR (November 2020) provides detail on how the above datasets were used within the development and validation of the NATS model for the highway and public transport elements.

2.10 FUTURE YEAR CORE SCENARIO

2.10.1. The future year scenario development has been detailed within the Norwich Western Link Traffic Forecasting Report (TFR), March 2021.

2.10.2. A Core Growth Scenario has been developed that reflects growth due to 'near certain' and 'more than likely' development within the county of Norfolk.

2.10.3. Traffic growth in the Core Growth Scenario has been constrained to the level of growth in the latest NTEM (TEMPro dataset version 7.2). The Traffic Forecasting Report provides further detail on which development sites are explicitly represented in the Core Scenario and includes details of highway and public transport improvement schemes that have been added to the network.

2.10.4. For the purpose of the Economic Appraisal two scenarios have been considered:

- Do Minimum: Base year network with all committed (near certain and more than likely) schemes due for completion by the corresponding forecast year
- Do Something: Do Minimum plus the Norwich Western Link scheme.

2.10.5. Each scenario has been created for the following years:

- 2025 – Scheme opening year
- 2040 – Scheme Design Year (scheme opening plus 15 years).

2.10.6. Traffic flow information from the transport models has been utilised in the environmental appraisal, which uses air quality and noise models. For each modelled year and design option, the following data has been provided:

- Average link flow data:
  - 24-hour Annual Average Daily Traffic (AADT) flow data for air quality modelling
  - 24-hour Annual Average Weekday Traffic (AAWT) flow data for noise modelling
- Percentage mix of Heavy Goods Vehicles (HGV) traffic (all vehicles greater than 3.5 tonnes)
- Average speeds.

2.10.7. In line with TAG guidance, a Low Growth scenario and a High Growth scenario have been developed around the Core Growth scenario. In addition, a further scenario has been developed using updated Office for Budget Responsibility (OBR) projections, providing an OBR Core Growth (Sensitivity) scenario. The OBR scenario includes updates to long-term economic and population projections as well as updated medium-term economic projections which reflect the impact of COVID-19 on economic growth. All these scenarios are described in greater detail in the Traffic Forecasting Report (March 2021).

3

APPRAISAL METHODOLOGY

3 APPRAISAL METHODOLOGY

3.1 OVERVIEW

3.1.1. The economic appraisal includes monetisation of the following:

- Travel time benefits and vehicle operating costs
- Change in the number of accidents on the network
- Active modes appraisal
- Impact to Greenhouse Gas emissions
- Impact to Air quality
- Impact to Noise levels.

3.1.2. An overview of the assessment of each of these impacts is provided below.

3.1.3. In addition, other impacts have been considered and monetised:

- Wider impacts
- Regeneration impacts
- Reliability impacts.

3.2 PEAK HOURS AND DEMAND SEGMENTATION

3.2.1. The modelled peaks have been listed below:

- AM Peak hour (08:00 - 09:00)
- Inter peak hour (average hour for 10:00 until 16:00)
- PM Peak hour (17:00 - 18:00)

3.2.2. Highway trip matrices are disaggregated into multiple user classes by trip purpose and vehicle type as shown in Table 3-1. This procedure allows to distinguish the trips travelling within the network that have different perceived costs and values of time.

Table 3-1: Modelled Trip Purposes and Vehicle Types

User Class	Vehicle Type	Trip Purpose
1	Car	Commute [Home-based Work] (HBW)
2	Car	Home-based Employer's Business (HBEB)
3	Car	Home-based Other (HBO)
4	Car	Non Home-based Employer's Business (NHBEB)
5	Car	Non Home-based Other (NHBO)
6	Light Goods Vehicle	Employer's Business (EB)
7	Heavy Goods Vehicle	Employer's Business (EB)

3.3 VARIABLE DEMAND

3.3.1. DfT TAG Unit M2 (July 2020) states that “any change to transport conditions will, in principle, cause a change in demand. The purpose of variable demand modelling is to predict and quantify these changes.

3.3.2. Any transport improvement that reduces journey times and costs will, in principle, affect the level of demand for travel. Schemes that improve travel conditions can encourage travellers to make trips they did not make before the improvement, to change to a different mode, or to travel further to different destinations. This additional demand for travel mainly appears as induced traffic either through or around the scheme. To take into account these impacts, a Variable Demand Model (VDM) was developed to estimate the future year traffic matrices.

3.3.3. The calibration of the demand model parameters is shown in detail within the NATS LMVR (November 2020). The process involved calibrating demand response parameters that replicated a change in fuel cost called ‘Demand Realism Testing’.

3.3.4. The Norwich Western Link demand model uses the DIADEM software (v7) issued on behalf of the DfT for the purpose of producing the traffic forecasts. DIADEM is an incremental hierarchical logit model and works by adjusting an input reference demand matrix according to changes between forecast travel costs and input reference travel costs.

3.3.5. The VDM process consists of a series of iterations between DIADEM and SATURN (assignment model) during which demand matrices are assigned, skimmed cost matrices are extracted and, based on comparative travel costs, the demand matrices are updated;

3.3.6. DIADEM provides a means of achieving convergence between the assignment (supply) and demand models. It is to be noted that equilibrium between the demand and supply models is not found exactly and therefore, a TAG specified convergence criterion is used to determine when the solution is close enough to equilibrium. The VDM for the Norwich Western Link traffic model uses trip matrices in the Origin-Destination (OD) and Production-Attraction (PA) format.

3.4 ECONOMIC APPRAISAL

3.4.1. The appraisal of the economic elements associated with the scheme has been undertaken using the DfT’s standard appraisal software:

- Transport Users Benefit Appraisal (TUBA) version 1.9.14, that corresponds with TAG data book (July 2020, V1.13.1) (which were used in the model assignments), for the Core Growth scenario, Low Growth scenario and the High Growth scenario
- TUBA version 1.9.14, based on updated Office of Budget Responsibility (OBR) economic projection and fleet data using TAG Data Book (July 2020, V1.14) (as a result of the Covid-19 pandemic), as a sensitivity test for the Core Growth scenario
- COst and Benefit to Accidents – Light Touch (COBALT).

3.4.2. Both appraisals, using TAG Databook v1.13.1 (July 2020) and v1.14 (July 2020), were undertaken in accordance with TAG Unit A1.1 Cost-Benefit Analysis (May 2018).

3.4.3. The Norwich Western Link scheme, like most road projects, is considered to be an asset with an indefinite life, with maintenance and renewal taking place as required. Scheme appraisal has therefore been undertaken for a 60-year period in accordance with HM Treasury’s Green Book, from the assumed scheme opening in 2025 to 2084.

TUBA

3.4.4. Scheme benefits have been assessed using the DfT TUBA (Transport Users Benefit Appraisal) software. This is an industry-standard tool for undertaking economic appraisal in accordance with guidelines published in TAG Unit A1 (December 2018). The full economic assessment methodology adopted including choice of parameters, definition of inputs, discounting, and reporting is compliant with TAG Unit A1.

3.4.5. The following economic elements have been considered for the assessment of the Norwich Western Link:

- Time Savings
- Vehicle Operating Costs
- Carbon Savings
- Scheme Costs
- Indirect tax revenue.

COBALT

3.4.6. An appraisal of accident savings has been undertaken using the DfT COBALT-LT spreadsheet tool[1]. COBALT is a computer program developed by the DfT to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme.

3.4.7. This tool applies accident rates to traffic flows extracted from the traffic model to predict the change in the number of accidents with and without the scheme in place. The most recent version of the tool (COBALT 2013.02) has been used with parameters file version '2020.1 WebTAG 2020 parameters.

3.4.8. It uses detailed inputs of separate road links and road junctions impacted by the scheme. The assessment is based on a comparison of accidents by severity and associated costs across an identified network in 'Without-Scheme' and 'With-Scheme' forecasts, using details of link and junction characteristics, relevant accident rates and costs and forecast traffic volumes by link and junction.

1 https://www.gov.uk/government/publications/cobalt-software-and-user-manuals

4

ESTIMATION OF COSTS

4 ESTIMATION OF COSTS

4.1 INTRODUCTION

4.1.1. The cost of the proposed scheme has been estimated at 2020 Q3 prices, as set out in the Financial Case. It includes all costs associated with scheme preparation and construction, including land costs.

4.1.2. The costs have been calculated in line with TAG A1.2 Scheme Costs (July 2017), which uses the following methodology:

- Estimation of a base cost estimate
- Incorporation of real cost increases
- Application of risk-cost adjustment
- Application of optimism bias-cost adjustment
- Rebase cost to DfT base year
- Discount cost to DfT base year
- Convert costs to market prices.

4.1.3. Costs have been estimated under two broad headings:

- Investment costs (scheme preparation and construction)
- Maintenance and renewal costs.

4.1.4. The breakdown of costs presented above, aligns with the breakdown required for the DfT Cost Pro-forma (See Appendix A).

4.2 ESTIMATION OF BASE COST ESTIMATES

4.2.1. The initial capital cost estimate for the scheme is **£140.770m** in 2020 Q3 prices as shown in Table 4-1. This includes costs for construction, statutory undertakers work, land and other costs such as professional fees. In line with TAG Unit A1.2 (Scheme Costs), sunk costs have not been included in the following tables as these are costs that represent expenditure prior to the economic appraisal and cannot be retrieved apart from land costs.

Table 4-1: Investment Costs at 2020 Q3

Investment costs	Total Cost	Cost excluding Sunk Costs
Construction cost	103,513,730	103,454,395
Statutory undertakers	732,210	732,210
Professional fees	23,780,932	14,825,127
Land	12,742,825	12,742,825
Total	**140,769,697**	**131,754,557**

4.2.2. This base cost estimate does not take account of real increases in costs and must therefore be adjusted to provide real costs that account for the effects of inflation which is addressed in Section 4.4.

4.3 SCHEME MAINTENANCE AND RENEWAL COSTS

4.3.1. The whole life costs of the scheme have also been estimated. A breakdown of the estimated capital renewal, annual maintenance and operation costs is presented in Table 4-2.

Table 4-2: Breakdown of capital maintenance, renewal and operating costs (£m)

Year after opening	Costs at base price 2020 Q3	Costs adjusted for inflation
Total (60 years)	Still awaiting information so not included at this time	

4.4 INFLATION ADJUSTMENT

4.4.1. The current forecast is based on 2.50% per annum for general activities (i.e. fees, utilities and land), 1.60% per annum for Stage One activities as the contract mechanism relies on Consumer Price Index (CPI) and 3.96% per annum for Stage Two activities as the contract mechanism relies on a set of weighted Building Cost Information Service (BCIS) indices. Based on this information inflation accounts for a value of £17.683m.

4.5 INCORPORATION OF REAL COST INCREASES

4.5.1. The first step of cost adjustment is to incorporate real cost increases. A real cost adjustment is calculated by inflating base costs by the construction cost index to bring them to their nominal values, and then dividing by the rate of general inflation to give their 'real' value. Using the real cost adjustment to multiply by the initial base estimate derives a 'real' capital cost estimate.

4.5.2. Only the general inflation rate has been applied to the maintenance and renewals costs. Therefore, it assumes zero real cost inflation over the appraisal period.

4.5.3. Table 4-3 sets outs the profile of real adjusted costs between 2020 and 2025 (scheme opening year).

Table 4-3: Real adjusted Costs (£m)

Costs	2020	2021	2022	2023	2024	2025	Total
Costs excluding Sunk Costs	2.535	9.201	6.646	17.634	64.360	31.378	131.754
Inflation	0.001	0.064	1.884	10.245	5.489		17.683
Capital (outturn), public sector	2.536	9.265	8.530	27.879	69.849	31.378	149.437
Real Adjustment Factor	1	1.02	1.04	1.06	1.10	1.12	
Capital (real), public sector	2.536	9.089	8.205	26.222	63.774	28.005	137.831

4.5.4. The investment cost taking into account the real cost increase is **£137.831m**.

4.6 APPLICATION OF RISK-COST ADJUSTMENT

4.6.1. Once the base cost estimate has been adjusted to incorporate real cost increases, the risk contribution is calculated as set out in Table 4-4. A Quantified Risk Assessment (QRA) of scheme investment costs was undertaken The QRA provides the weighted average of all risk outcomes and probabilities. The process of capturing and quantifying risk for the scheme is presented in the Outline Business Case (OBC) Management Case.

4.6.2. As noted in the OBC Financial Case, the total quantified risk value added to the scheme base costs is **£39.975m** at 2020 Q3 prices. This equates to approximately 28.4% of base costs.

4.6.3. No risk-adjustment has been applied to the maintenance and renewal costs.

Table 4-4: Risk adjusted Costs (£m)

Costs	2020	2021	2022	2023	2024	2025	Total
Total real costs (without risk)	2.536	9.089	8.205	26.222	63.774	28.005	137.831
Total quantified risk cost in real prices		3.211	4.825	6.311	17.392	8.236	39.975
Total risk adjusted costs with real cost adjustment	2.536	12.300	13.030	32.533	81.166	36.241	177.806

4.6.4. The total risk adjusted costs with real cost adjustment is **£177.806m**.

4.7 OPTIMISM BIAS

In line with the guidance in TAG Unit A1.2, an Optimism Bias (OB) uplift to scheme costs, which is necessary to counter the systematic tendency of appraisers to be overly optimistic (and underestimate scheme costs) has been applied. The recommended optimism bias uplifts for each stage of a transport project and type of scheme for Local Authority schemes are set out in Table 4-5.

Table 4-5: Recommended Optimism Bias uplifts

Stage Category	Type of Project	Stage 1 Strategic Outline Business Case	Stage 2 Outline Business Case	Stage 3 Full Business Case
Road	Motorway, Trunk roads, local roads	44%	15%	3%

Source: TAG Unit A1.2, Scheme Costs, Table 8

4.7.1. As funding is sought via the production of an Outline Business Case, and the scheme is comprised of both roads and structures, optimism bias has been applied at 15% of the scheme costs as shown in Table 4-6.

Table 4-6: Costs adjusted for Optimism Bias (£m)

Costs	2020	2021	2022	2023	2024	2025	Total
Public Sector Risk adjusted costs	2.536	12.300	13.030	32.533	81.166	36.241	177.806
Optimism bias (15%)	0.380	1.845	1.954	4.880	12.175	5.436	26.670
Public investment costs with 15% optimism bias	2.917	14.145	14.984	37.413	93.341	41.677	204.477

4.7.2. The public investment costs with 15% Optimism Bias cost is **£204.77m**.

4.8 REBASE COST TO DFT BASE YEAR

4.8.1. For appraisal purposes, all costs should be presented in the DfT's base year, 2010. Costs are deflated to the correct price base by multiplying them by the ratio of the inflation index in the desired base year to the inflation index in the year currently being used.

4.8.2. Costs have been adjusted to 2010 prices using TAG data book (v1.13.1, July 2020) values as set out in Table 4-7 which are applied as set out in Table 4-8.

Table 4-7: Adjustment to 2010 Prices

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
GDP Deflator	100.00	102.04	103.73	105.70	107.63	108.26	110.57	112.66	115.07	117.21	119.37	121.66	124.04	126.50	129.41	132.39

Table 4-8: Rebased Costs to 2010 Prices (£m)

Costs	2020	2021	2022	2023	2024	2025	Total
Public investment costs with 15% optimism bias	2.917	14.145	14.984	37.413	93.341	41.677	204.477
GDP deflator factor	0.8337	0.8337	0.8337	0.8337	0.8337	0.8337	
Public investment costs with deflation	2.432	11.793	12.493	31.192	77.821	34.747	170.478

4.8.3. The public investment costs with deflation cost is **£170.478m**.

4.9 DISCOUNT COST TO DFT BASE YEAR

4.9.1. For the purposes of the Economic Appraisal, all the costs have been adjusted to 2010 prices using TAG data book (v1.13.1, July 2020) values as set out in the annual parameters table.

4.9.2. A discount factor based on the HM Treasury "Green Book" is applied, to adjust costs occurring in different periods to a standard base year of 2010 as set out in Table 4-9. An annual discount rate of 3.5% was applied for the first 30 years and 3% for years 31 to 60. This reflects the lower weighting placed on costs (and benefits) incurred at a future date compared to those incurred in the present.

Table 4-9: Scheme Costs Discounted to 2010 Present Value (£m)

Costs	2020	2021	2022	2023	2024	2025	Total
Public investment costs with deflation	2.432	11.793	12.493	31.192	77.821	34.747	170.478
Discount factor	0.7089	0.6849	0.6618	0.6394	0.6178	0.5969	
Public investment costs with deflation & discounting	1.724	8.078	8.267	19.945	48.077	20.740	106.831

4.9.3. The public investment costs with deflation & discounting cost is **£106.831m**.

4.10 CONVERT COSTS TO MARKET PRICES

4.10.1. The last stage in preparing costs for appraisal is to convert them from the factor cost to the market price unit of account. This is done by using the indirect tax correction factor of 1.19, as per the TAG Data Book.

4.10.2. In line with TAG Unit A1.2 (Scheme Costs), the Present Value of Costs (PVC) only includes investment and operating costs incurred by the public sector. Private sector contributions to the scheme costs are not included in the PVC but are recorded as negative values in the Transport Economic Efficiency (TEE) table and Present Value of Benefits (PVB).

4.10.3. The Present Value of Costs (PVC) is presented in Table 4-10.

Table 4-10: Present Value of Costs (£m)

Risk adjusted costs in £	Scheme Preparation and Construction Cost	Maintenance, Renewal and Operation (60 yrs)	Total
Public Sector risk adjusted costs	177.806	44,084	221.890
Public investment costs with 15% optimism bias	204.477	44,084	248.561
Public investment costs with deflation	106.831	7,073	113.904
Public investment costs with deflation & discounting	127.129	8,416	134.545
PVC with Market Price Adjustment - Public sector costs only	**127.129**		**127.129**

4.10.4. The total discounted Present Value of Costs (PVC) is **£127.129m**.

5

ESTIMATION OF BENEFITS

5 ESTIMATION OF BENEFITS

5.1.1. In developing the Economic Case, the Do Something scenario which includes the Norwich Western Link has been assessed against a Do Minimum scenario. The benefits have been assessed for the AM Peak, Inter peak and PM peak time periods.

5.2 ASSUMPTIONS

5.2.1. The Economic Case has been compiled in accordance with the guidance set out in TAG. However, there are some assumptions that have been made in relation to specific areas of the assessment, and these are discussed in the following sections.

5.3 TRAVEL TIME BENEFITS

5.3.1. Scheme benefits have been assessed using the DfT's TUBA (Transport Users Benefit Appraisal) software. This is an industry-standard tool for undertaking economic appraisal in accordance with guidelines published in TAG Unit A1 (December 2018). The full economic assessment methodology adopted including choice of parameters, definition of inputs, discounting, and reporting is compliant with TAG Unit A1.

5.3.2. TUBA v1.9.14 has been used for the appraisal as this was the latest version available at the time of undertaking the assessment.

5.3.3. The economics parameters file version 1.9.14 (file 'Economics_TAG_db1_13_1.txt') has been used. This is the latest version and is in line with current guidance.

5.3.4. Economic benefits are estimated for a 60-year period from the scheme opening year of 2025. Traffic model outputs are available for the following two future years:

- 2025
- 2040.

5.3.5. TUBA interpolates growth between these years, and after 2040 the default TUBA assumption of no growth beyond this point has been retained, in the absence of more detailed information. Calculated benefits are therefore likely to represent a conservative estimate.

5.3.6. TUBA requires the following inputs for the calculation of economic benefits:

- Trip matrices from the traffic model
- Skims of time and distance from the traffic model
- Annualisation factors to expand hourly model outputs to annual inputs for TUBA's calculations.

5.3.7. Various checks and analyses have been undertaken to ensure that the TUBA outputs are sensible and that there are unlikely to be errors in the traffic model outputs, nor any errors in the output's 'translation' into TUBA inputs. These include a review of TUBA warnings and analysis of delay changes in the traffic model with and without the scheme in place.

Trip Purposes

5.3.8. Table 5-1 shows that the trip matrices from the traffic model are already segmented into trip purposes equivalent to TUBA.

Table 5-1: User class definitions

User Class	Model Definition	TUBA Parameter		
		Vehicle Type	Purpose	Person Type
1	Car: Commuting Home-based Work (HBW)	Car	Commuting	All
2	Car: Home-based Employer's Business (HBEB)	Car	Business	All
3	Car: Home-based Other (HBO)	Car	Other	All
4	Car: Non Home-based Employer's Business (NHBEB)	Car	Business	All
5	Car: Non Home-based Other (NHBO)	Car	Other	All
6	LGV	LGV Personal	Business	All
6	LGV	LGV Freight	Business	All
7	OGV1	OGV1	Business	Driver
7	OGV2	OGV2	Business	Driver

5.3.9. TUBA requires that the trip matrices be entered as total trips, but SATURN defines trips in Passenger Car Units (PCU). It is, therefore, necessary to apply adjustment factors to convert the PCU matrices into total trips. These are set out in Table 5-2

Table 5-2: PCU to vehicle adjustment factors

User Class	Model Definition	PCU Factor	TUBA Factor
1	Car: Commuting	1.0	1.00000
2	Car: Employer's Business	1.0	1.00000
3	Car: Other	1.0	1.00000
4	LGV	1.0	1.00000
5	OGV	2.3	0.43478

5.3.10. Model skims were extracted for 2025 and 2040. The TUBA default assumption on growth has been applied, with no additional growth assumed beyond the final modelled year of 2040. The default assumptions on growth in the values of impacts have also been applied, meaning that the per unit benefits of the scheme decline over time.

5.3.11. The model forecasts have been completed in accordance with TAG principles, as set out in the Norwich Western Link Traffic Forecasting Report.

Annualisation Factors

5.3.12. Annualisation factors have been calculated to expand the user benefits for each modelled time period. Traffic count data from long term permanent traffic counters from six sites spread across the County of Norfolk has been used to derive suitable annualisation factors. The sites are listed in Table 5-3. The sites have been selected due to their proximity to the scheme and also as sites that will represent the trends within the peak hours and represent the tidal flow in and out of the City of Norwich.

Table 5-3: Annualisation Factors

Site No.	Site Location
ATC41	A140 Holt Road
ATC49	A47 Trunk Road
ATC56	A1074 Dereham Road
ATC61	A140 Sweet Briar Road
ATC80	A11 Newmarket Road
ATC103	A1067 Fakenham Road

5.3.13. The data has been used to create factors to convert the:

- AM peak hour (08:00-09:00) to the AM peak period (07:00-10:00)
- Inter peak average hour to Inter peak period (10:00-16:00)
- PM peak hour (10:00-18:00) to the PM peak period (16:00-19:00).

5.3.14. The conversion factors are shown in Table 5-4.

Table 5-4: Peak hour to peak period conversion factors

Peak hour	Peak hour to peak period factors
AM peak (08:00-09:00, weekdays)	2.71
Inter peak (10:00-16:00, weekdays, average hour)	6
PM peak (17:00-18:00, weekdays)	2.84

5.3.15. The conversion factors were then multiplied by 253 (number of working days in a year) to create annualisation factors to be input into TUBA.

5.3.16. Table 5-5 shows the annualisation factors used which convert modelled peak hour trips into annualised trip totals.

Table 5-5: Annualisation factors

Peak hour	Peak hour to peak period factors
AM peak (08:00-09:00, weekdays)	727
Inter peak (10:00-16:00, weekdays, average hour)	1,518
PM peak (17:00-18:00, weekdays)	685

5.3.17. The benefits at weekends and bank holidays are not considered within the process and therefore the calculated benefits are likely to represent a conservative estimate.

5.4 ACCIDENT ASSESSMENT

5.4.1. Assessment of the costs and benefits associated with accidents has been undertaken using the DfT's COBALT (COst – Benefit-Analysis Light Touch) software. Input parameters are the latest available, published February 2021.

5.4.2. COBALT uses information derived from the SATURN model, so a network has been built that replicates the NATS network. Traffic flows have been obtained from the SATURN model, for the following years:

- Base Year (2019)
- Opening year (2025)
- Design year with Scheme (2040).

5.4.3. Accident data for a period of five years from 2015 to 2019 has been obtained from NCC in order to provide accident rates for existing links in COBALT. The accidents have been geocoded to correspond to the selected highway network.

5.4.4. COBALT provides three options for assessment:

- Link only
- Junction only
- Link and junction combined.

5.4.5. The analysis for the Norwich Western Link has been carried out using the 'combined' method. This requires considerably less analysis than separate link and junction analysis, so is the appropriate proportional assessment for this scheme. TAG Unit A4-1 2.3.9 indicates that this is acceptable when local data is hard to distinguish between links and junctions.

5.4.6. A diagram of the network used in the COBALT assessment on accidents has been included in Appendix B.

5.5 ECONOMIC PARAMETERS

5.5.1. Economic parameters (such as Value of Time) are defined in the standard TUBA economic file. This is *Economics_TAG_db1_13_1.txt* for the Core Growth scenario, Low Growth scenario and the High Growth scenario. For the Sensitivity Testing Growth scenario, the *Economics_TAG_db1_14_0.txt* has been used

5.5.2. COBALT V2.0 has used *cobalt-tag-parameters .txt* for the Core Growth scenario, Low Growth scenario and the High Growth scenario. or the Sensitivity Testing Growth scenario, the *cobalt-tag-parameters-sensitivity-testing.txt* has been used.

5.6 ENVIRONMENTAL IMPACTS

5.6.1. Environmental Impacts have been assessed across six environmental categories, which are:

- Noise
- Landscape and Visual
- Heritage
- Air Quality and Greenhouse Gases
- Biodiversity
- Water Resources.

5.7 SOCIAL IMPACTS

5.7.1. Social Impacts across the nine categories are reported in full in the Social Impacts Report.

6

ECONOMIC APPRAISAL RESULTS

6 ECONOMIC APPRAISAL RESULTS

6.1 INTRODUCTION

6.1.1. The results of the economic appraisal of the Norwich Western Link are shown in the following sections.

6.2 TRAVEL TIME BENEFITS

6.2.1. Travel time savings are monetised as a perceived benefit, reflecting users' willingness to pay for a quicker journey. The value of those savings differs depending on the reason for the trip, of which three are defined in TAG; business users, commuters, and non-commuting consumers e.g. leisure trips.

6.2.2. The costs and benefits for travel time savings have been assessed using TUBA. The trip length, trip volume and journey time information needed for this has been taken from the relevant SATURN models.

TUBA WARNINGS

6.2.3. TUBA displays warnings when, for example, the ratio ('r') of the without-scheme (DM) scenario and with-scheme (DS) scenario travel time is lower than the limit. Warning messages have been checked in the output files and a sample of these was reviewed for each scenario.

6.2.4. The data checks that TUBA undertakes are shown in Table 6-1.

Table 6-1: TUBA - Data checks

Value of r	Action
r<A or r>D	Serious Warning
A<r<B or C<r<D	Warning
B<r<C	OK, No warning

6.2.5. The values of A, B, C and D are shown in Table 6-2.

Table 6-2: TUBA - Limit values

A	B	C	D
0.33	0.57	1.5	3.0

Core Growth scenario

6.2.6. Warnings reported by TUBA have been checked to verify that none indicated an issue in the models that required corrective action. There are 182,324 warnings in the Core Growth scenario which are split as follows (the second figure quoted in brackets is the number of warnings TUBA classes as serious):

- Ratio of DM to DS travel time lower than limit: 570 warnings (four serious) although the ratio is between 0.253 and 0.292
- Ratio of DM to DS travel time higher than limit: 15,275 warnings (none serious)
- Ratio of DM to DS travel distance lower than limit: 58,638 warnings (204 serious) with 106 having a ratio between 0.2 and 0.33
- Ratio of DM to DS travel distance higher than limit: 4,934 warnings (93 serious), with 48 have a ratio between 3.0 and 4.0
- DM speeds less than limit: 38,986 warnings
- DM speeds greater than limit: 10,146 warnings
- DS speeds less than limit: 42,123 warnings
- DS speeds greater than limit: 11,652 warnings.

6.2.7. All warnings have been investigated and a reasonable explanation has been found for all of them.

6.2.8. The “Ratio of DM to DS travel distance higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a shorter DS travel distance than the DM travel distance.

6.2.9. The “Ratio of DM to DS travel time higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a faster DS travel time than the DM travel time.

Low Growth scenario

6.2.10. Warnings reported by TUBA have been checked to verify that none indicated an issue in the models that required corrective action. There are 156,837 warnings in the Low Growth scenario which are split as follows (the second figure quoted in brackets is the number of warnings TUBA classes as serious):

- Ratio of DM to DS travel time lower than limit: 455 warnings (none serious)
- Ratio of DM to DS travel time higher than limit: 15,036 warnings (none serious)
- Ratio of DM to DS travel distance lower than limit: 49,426 warnings (190 serious) with 110 having a ratio between 0.2 and 0.33
- Ratio of DM to DS travel distance higher than limit: 5,167 warnings (73 serious), with 41 have a ratio between 3.0 and 4.0
- DM speeds less than limit: 30,494 warnings
- DM speeds greater than limit: 10,830 warnings
- DS speeds less than limit: 32,553 warnings
- DS speeds greater than limit: 12,876 warnings.

6.2.11. All warnings have been investigated and a reasonable explanation has been found for all of them.

6.2.12. The “Ratio of DM to DS travel distance higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a shorter DS travel distance than the DM travel distance.

6.2.13. The “Ratio of DM to DS travel time higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a faster DS travel time than the DM travel time.

High Growth scenario

6.2.14. Warnings reported by TUBA have been checked to verify that none indicated an issue in the models that required corrective action. There are 219,387 warnings in the High Growth scenario which are split as follows (the second figure quoted in brackets is the number of warnings TUBA classes as serious):

- Ratio of DM to DS travel time lower than limit: 200 warnings (two serious) although the ratio is 0.291 so only just less than 0.33
- Ratio of DM to DS travel time higher than limit: 18,208 warnings (six serious) although the ratio is between 3.053 and 3.575 so just above 3.0
- Ratio of DM to DS travel distance lower than limit: 69,137 warnings (247 serious) with 182 having a ratio between 0.2 and 0.33
- Ratio of DM to DS travel distance higher than limit: 5,815 warnings (99 serious), with 61 have a ratio between 3.0 and 4.0
- DM speeds less than limit: 51,773 warnings
- DM speeds greater than limit: 8,862 warnings
- DS speeds less than limit: 55,108 warnings
- DS speeds greater than limit: 10,284 warnings.

6.2.15. All warnings have been investigated and a reasonable explanation has been found for all of them.

6.2.16. The “Ratio of DM to DS travel distance higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a shorter DS travel distance than the DM travel distance.

6.2.17. The “Ratio of DM to DS travel time higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a faster DS travel time than the DM travel time.

Core Growth (Sensitivity) scenario

6.2.18. Warnings reported by TUBA have been checked to verify that none indicated an issue in the models that required corrective action. There are 187,739 warnings in the Core Growth (Sensitivity) scenario which are split as follows (the second figure quoted in brackets is the number of warnings TUBA classes as serious):

- Ratio of DM to DS travel time lower than limit: 636 warnings (four serious) although the ratio is between 0.129 and 0.32
- Ratio of DM to DS travel time higher than limit: 15,078 warnings (none serious).
- Ratio of DM to DS travel distance lower than limit: 56,583 warnings (173 serious) with 90 having a ratio between 0.2 and 0.33
- Ratio of DM to DS travel distance higher than limit: 5,616 warnings (130 serious), with 56 have a ratio between 3.0 and 4.0
- DM speeds less than limit: 42,270 warnings
- DM speeds greater than limit: 10,338 warnings
- DS speeds less than limit: 45,506 warnings
- DS speeds greater than limit: 11,712 warnings.

6.2.19. All warnings have been investigated and a reasonable explanation has been found for all of them.

6.2.20. The “Ratio of DM to DS travel distance higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a shorter DS travel distance than the DM travel distance.

6.2.21. The “Ratio of DM to DS travel time higher than limit” serious warnings were found to be due to the addition of the proposed infrastructure scheme which provides a faster DS travel time than the DM travel time.

TUBA tbn file information

6.2.22. Table 6-3, Table 6-4, Table 6-5 and Table 6-6 shows the analysis of the partitioned time benefits (*.tbn) file in TUBA for the Norwich Western Link Core Growth scenario, Low Growth scenario, High Growth scenario and Core Growth (Sensitivity) scenario respectively.

6.2.23. The partitioned time benefits files (*.tbn) cross-tabulates the percentage changes in travel time and trip numbers at OD level). TUBA uses the rule of a half (ROH) to calculate user benefits however, if the change in generalised cost between the DM and DS is too large then the ROH can become inaccurate.

6.2.24. As a general rule the ROH is acceptable, i.e. the error is less than ±10%, provided that the change in the generalised cost and the change in the number of trips are both less than 33%.

6.2.25. Table 6-3, Table 6-4, Table 6-5 and Table 6-6 shows that the majority of the total time benefits according to change in travel time and change in trip numbers are in the range 0% to 30% and 0% to -30% meaning that there is no need to include for an intermediate year between 2025 and 2040.

Table 6-3: TUBA - tbn file information for 2025 and 2040 (Core Growth scenario)

For Road and for Modelled Year: 2025																						
	Change in travel time																					
Change in trip	below	-100 to	-90 to	-80 to	-70 to	-60 to	-50 to	-40 to	-30 to	-20 to	-10 to	0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	over
numbers	-100%	-90%	-80%	-70%	-60%	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	1	0	1	2	2	0	0	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	3	2	2	-24	-3	0	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	1	1	6	2	2	-65	-9	-1	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	2	13	83	273	2	2	-64	-7	-3	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	4	52	2	2	-82	-1	-1	-1	0	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	1	5	57	2	2	-101	-3	-1	0	0	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	0	2	9	70	2	2	-54	0	-2	0	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	0	14	68	2	2	-14	0	0	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	3	17	71	2	0	-2	0	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	11	28	74	2	0	0	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	5	41	93	2	0	0	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	8	54	78	2	0	0	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	8	53	68	2	0	0	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	52	315	300	2	0	0	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For Road and for Modelled Year: 2040																						
	Change in travel time																					
Change in trip	below	-100 to	-90 to	-80 to	-70 to	-60 to	-50 to	-40 to	-30 to	-20 to	-10 to	0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	over
numbers	-100%	-90%	-80%	-70%	-60%	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	20	-1	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	41	-3	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	59	-6	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	101	-12	-2	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	1	170	-27	-4	0	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	5	211	-44	-35	-13	-1	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	0	0	17	270	-110	-53	-10	-2	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	3	18	82	334	2510	-674	-78	-11	-2	-1	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	2	49	507	-438	-94	-3	-1	-1	-1	-1	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	4	2	65	314	-203	-118	-5	-2	-1	-1	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	0	4	7	88	184	-80	-78	-5	-1	0	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	5	15	93	92	-36	-42	0	-2	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	4	29	108	47	-17	-19	-1	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	5	36	98	29	-7	-9	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	7	40	88	22	-5	-2	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	4	48	76	11	-2	-1	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	5	49	68	9	-2	-3	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	62	347	385	45	-3	-6	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-4: TUBA - tbn file information for 2025 and 2040 (Low Growth scenario)

For Road and for Modelled Year: 2025																						
	Change in travel time																					
Change in trip	below	-100 to	-90 to	-80 to	-70 to	-60 to	-50 to	-40 to	-30 to	-20 to	-10 to	0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	over
numbers	-100%	-90%	-80%	-70%	-60%	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	15	-1	0	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	0	32	-2	0	0	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	0	55	-15	-7	0	0	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	1	0	0	2	86	-19	-12	-1	0	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	2	22	182	438	1924	-232	-14	-3	0	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	1	19	347	-92	-6	-1	-1	0	0	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	4	2	31	126	-27	-4	-1	0	0	0	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	3	0	2	38	54	-8	0	0	0	0	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	0	6	36	26	0	0	0	0	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	1	9	40	20	0	0	0	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	7	19	44	10	0	0	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	3	27	56	10	0	0	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	3	30	49	7	0	0	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	4	33	39	7	0	0	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	1	29	199	189	17	0	0	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For Road and for Modelled Year: 2040																						
	Change in travel time																					
Change in trip	below	-100 to	-90 to	-80 to	-70 to	-60 to	-50 to	-40 to	-30 to	-20 to	-10 to	0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	over
numbers	-100%	-90%	-80%	-70%	-60%	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	31	-1	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	44	-3	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	74	-6	0	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	2	122	-13	-1	-1	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	5	157	-31	-13	-2	0	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	0	0	10	197	-67	-19	-4	-1	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	3	13	76	282	1851	-456	-38	-5	-1	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	4	38	342	-306	-34	-21	-1	-1	-1	-1	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	0	2	51	219	-160	-47	-28	-1	-1	0	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	0	2	10	66	138	-67	-35	-27	0	0	-1	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	1	14	71	70	-33	-21	-4	-1	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	4	24	94	39	-16	-6	-3	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	4	35	83	23	-7	-4	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	7	38	75	17	-4	-1	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	4	43	63	10	-2	0	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	5	43	60	8	-2	-1	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	67	333	317	31	-3	-2	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-5: TUBA - tbn file information for 2025 and 2040 (High Growth scenario)

id for Modelled Year: 2025																					
Change in travel time																					
Change in trip numbers	below -100%	-100 to -90%	-90 to -80%	-80 to -70%	-70 to -60%	-60 to -50%	-50 to -40%	-40 to -30%	-30 to -20%	-20 to -10%	-10 to 0%	0 to 10%	10 to 20%	20 to 30%	30 to 40%	40 to 50%	50 to 60%	60 to 70%	70 to 80%	80 to 90%	90 to 100%	over 100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	42	-1	0	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	1	95	-4	0	0	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	3	153	-29	-26	-2	0	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	0	1	12	211	-48	-73	-9	0	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	2	17	104	335	2411	-364	-76	-10	-1	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	2	7	95	950	-233	-83	-3	-1	-1	0	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	2	11	91	315	-61	-100	-2	-1	0	0	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	0	1	20	91	115	-20	-50	-2	0	0	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	1	21	82	48	-2	-13	0	0	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	3	24	78	31	-1	-1	0	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	12	38	77	16	0	0	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	7	48	98	17	0	0	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	11	60	80	12	0	0	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	1	9	68	65	15	0	0	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	66	359	309	38	0	0	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
id for Modelled Year: 2040																						
Change in travel time																						
Change in trip numbers	below -100%	-100 to -90%	-90 to -80%	-80 to -70%	-70 to -60%	-60 to -50%	-50 to -40%	-40 to -30%	-30 to -20%	-20 to -10%	-10 to 0%	0 to 10%	10 to 20%	20 to 30%	30 to 40%	40 to 50%	50 to 60%	60 to 70%	70 to 80%	80 to 90%	90 to 100%	over 100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	26	-1	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	54	-4	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	1	78	-9	-1	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	1	130	-17	-3	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	6	226	-38	-5	-1	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	1	2	13	286	-78	-41	-3	0	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	2	15	31	375	-176	-60	-7	0	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	1	0	3	41	198	451	3320	-989	-87	-4	0	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	14	36	80	740	-559	-66	-3	-1	-1	-1	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	15	36	92	440	-267	-84	-1	-1	-1	-1	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	2	10	28	120	243	-118	-61	-2	0	-1	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	11	39	119	116	-56	-33	0	0	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	6	40	116	68	-25	-20	0	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	1	0	0	7	43	109	40	-12	-9	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	5	47	98	32	-6	-2	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	5	54	86	15	-3	-1	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	1	1	0	5	50	83	12	-3	-3	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	58	326	493	67	-5	-6	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-6: TUBA - tbn file information for 2025 and 2040 (Core Growth (Sensitivity) scenario

For Road and for Modelled Year: 2025																						
Change in travel time																						
Change in trip numbers	below -100%	-100 to -90%	-90 to -80%	-80 to -70%	-70 to -60%	-60 to -50%	-50 to -40%	-40 to -30%	-30 to -20%	-20 to -10%	-10 to 0%	0 to 10%	10 to 20%	20 to 30%	30 to 40%	40 to 50%	50 to 60%	60 to 70%	70 to 80%	80 to 90%	90 to 100%	over 100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	19	-1	0	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	0	46	-4	0	0	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	0	90	-20	-24	-4	-1	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	0	0	4	115	-34	-62	-13	-2	0	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	2	12	80	252	1596	-310	-69	-8	-2	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	4	38	606	-177	-87	-5	-1	0	0	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	1	7	47	209	-51	-100	-3	0	0	0	0	0	-1	0	0
20 to 30%	0	0	0	0	0	0	0	1	10	64	86	-11	-44	0	-2	0	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	0	1	11	56	46	-2	-8	0	0	0	0	0	0	0	0	0
40 to 50%	0	0	0	0	0	0	0	2	15	57	28	0	-2	0	0	0	0	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	7	24	70	22	0	0	0	0	0	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	8	34	75	14	0	0	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	3	42	73	13	0	0	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	6	63	59	7	0	0	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	48	312	315	45	0	0	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For Road and for Modelled Year: 2040																						
Change in travel time																						
Change in trip numbers	below -100%	-100 to -90%	-90 to -80%	-80 to -70%	-70 to -60%	-60 to -50%	-50 to -40%	-40 to -30%	-30 to -20%	-20 to -10%	-10 to 0%	0 to 10%	10 to 20%	20 to 30%	30 to 40%	40 to 50%	50 to 60%	60 to 70%	70 to 80%	80 to 90%	90 to 100%	over 100%
below -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-100 to -90%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-90 to -80%	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
-80 to -70%	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
-70 to -60%	0	0	0	0	0	0	0	0	0	0	32	-3	0	0	0	0	0	0	0	0	0	0
-60 to -50%	0	0	0	0	0	0	0	0	0	0	48	-5	0	0	0	0	0	0	0	0	0	0
-50 to -40%	0	0	0	0	0	0	0	0	0	0	84	-11	-2	0	0	0	0	0	0	0	0	0
-40 to -30%	0	0	0	0	0	0	0	0	0	1	142	-24	-4	-1	0	0	0	0	0	0	0	0
-30 to -20%	0	0	0	0	0	0	0	0	0	3	182	-42	-29	-10	-1	0	0	0	0	0	0	0
-20 to -10%	0	0	0	0	0	0	0	0	0	12	245	-105	-46	-9	-1	-1	0	0	0	0	0	0
-10 to 0%	0	0	0	0	0	0	2	15	71	293	2198	-645	-68	-9	-3	0	0	0	0	0	0	0
0 to 10%	0	0	0	0	0	0	0	1	1	45	444	-390	-79	-3	0	-1	0	0	0	0	0	0
10 to 20%	0	0	0	0	0	0	0	0	1	59	263	-177	-105	-4	-1	0	0	0	0	0	0	0
20 to 30%	0	0	0	0	0	0	0	1	6	77	155	-83	-71	-5	-2	-1	0	0	0	0	0	0
30 to 40%	0	0	0	0	0	0	1	1	13	89	81	-43	-39	-2	0	-2	0	-1	0	-1	0	0
40 to 50%	0	0	0	0	0	0	3	4	27	94	42	-20	-21	-1	-1	-1	-1	0	0	0	0	0
50 to 60%	0	0	0	0	0	0	0	4	32	90	27	-8	-8	-1	0	-1	0	0	0	0	0	0
60 to 70%	0	0	0	0	0	0	0	7	36	76	19	-5	-3	0	0	0	0	0	0	0	0	0
70 to 80%	0	0	0	0	0	0	0	4	42	69	9	-3	-1	0	0	0	0	0	0	0	0	0
80 to 90%	0	0	0	0	0	0	0	5	48	62	9	-1	-3	0	0	0	0	0	0	0	0	0
90 to 100%	0	0	0	0	0	0	2	56	308	355	41	-3	-5	0	0	0	0	0	0	0	0	0
over -100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BENEFITS BY TIME SAVING AND DISTANCE TRAVELLED

6.2.26. The benefits for the Core Growth scenario, Core Growth (Sensitivity Assessment), Low Growth scenario and High Growth scenario as banded by size of travel time saving, as output by TUBA, are shown in Table 6-7 to Table 6-10 with the time bands being the defaults used in TUBA.

6.2.27. There are benefits delivered from journey time improvements of between 0 and >5 minutes, but also disbenefits from journey time reduction of between -5 and 0 minutes.

Table 6-7: Travel time benefits (TUBA) by size of travel time saving for the Core Growth scenario

Vehicle	Purpose	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Car	Business	-£1,111,000	-£2,415,000	-£5,689,000	£19,146,000	£6,162,000	£11,814,000	**£27,907,000**
Car	Commuting	-£5,366,000	-£10,799,000	-£31,731,000	£55,385,000	£19,449,000	£39,254,000	**£66,192,000**
Car	Other	-£4,822,000	-£11,254,000	-£20,829,000	£63,571,000	£19,160,000	£36,522,000	**£82,348,000**
LGV	Other	-£11,000	-£72,000	-£224,000	£889,000	£237,000	£514,000	**£1,333,000**
LGV	Business	-£224,000	-£1,462,000	-£4,535,000	£17,965,000	£4,783,000	£10,395,000	**£26,922,000**
OGV1	Business	-£58,000	-£405,000	-£1,408,000	£7,276,000	£1,885,000	£6,989,000	**£14,279,000**
OGV2	Business	-£52,000	-£359,000	-£1,249,000	£6,452,000	£1,671,000	£6,197,000	**£12,660,000**
Total	**Total**	**-£11,644,000**	**-£26,766,000**	**-£65,665,000**	**£170,684,000**	**£53,347,000**	**£111,685,000**	**£231,641,000**

Table 6-8: Travel time benefits (TUBA) by size of travel time saving for the Core Growth (Sensitivity) scenario

Vehicle	Purpose	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Car	Business	-£975,000	-£2,080,000	-£5,012,000	£14,930,000	£4,968,000	£9,852,000	**£21,683,000**
Car	Commuting	-£4,814,000	-£9,173,000	-£27,359,000	£44,003,000	£16,105,000	£32,863,000	**£51,625,000**
Car	Other	-£4,565,000	-£9,258,000	-£18,440,000	£49,801,000	£15,856,000	£30,100,000	**£63,494,000**
LGV	Other	-£10,000	-£70,000	-£193,000	£698,000	£192,000	£430,000	**£1,047,000**
LGV	Business	-£205,000	-£1,413,000	-£3,890,000	£14,107,000	£3,876,000	£8,698,000	**£21,173,000**
OGV1	Business	-£78,000	-£273,000	-£1,199,000	£5,663,000	£1,596,000	£5,640,000	**£11,349,000**
OGV2	Business	-£70,000	-£242,000	-£1,063,000	£5,022,000	£1,415,000	£5,002,000	**£10,064,000**
Total	**Total**	**-£10,717,000**	**-£22,509,000**	**-£57,156,000**	**£134,224,000**	**£44,008,000**	**£92,585,000**	**£180,435,000**

Table 6-9: Travel time benefits (TUBA) by size of travel time saving for the Low Growth scenario

Vehicle	Purpose	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Car	Business	-£853,000	-£895,000	-£4,305,000	£13,863,000	£4,688,000	£10,205,000	**£22,703,000**
Car	Commuting	-£4,255,000	-£3,690,000	-£22,965,000	£40,992,000	£14,771,000	£33,750,000	**£58,603,000**
Car	Other	-£3,930,000	-£4,647,000	-£15,870,000	£44,627,000	£14,899,000	£31,448,000	**£66,527,000**
LGV	Other	-£7,000	-£22,000	-£170,000	£639,000	£167,000	£437,000	**£1,044,000**
LGV	Business	-£139,000	-£450,000	-£3,426,000	£12,913,000	£3,370,000	£8,828,000	**£21,096,000**
OGV1	Business	-£43,000	-£88,000	-£917,000	£5,357,000	£1,622,000	£5,741,000	**£11,672,000**
OGV2	Business	-£38,000	-£78,000	-£814,000	£4,750,000	£1,438,000	£5,091,000	**£10,349,000**
Total	**Total**	**-£9,265,000**	**-£9,870,000**	**-£48,467,000**	**£123,141,000**	**£40,955,000**	**£95,500,000**	**£191,994,000**

Table 6-10: Travel time benefits (TUBA) by size of travel time saving for the High Growth scenario

Vehicle	Purpose	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Car	Business	-£950,000	-£3,116,000	-£7,656,000	£24,756,000	£8,015,000	£15,550,000	**£36,599,000**
Car	Commuting	-£4,631,000	-£15,174,000	-£41,520,000	£74,323,000	£23,564,000	£56,048,000	**£92,610,000**
Car	Other	-£4,285,000	-£13,015,000	-£27,531,000	£86,474,000	£24,708,000	£47,672,000	**£114,023,000**
LGV	Other	-£8,000	-£107,000	-£290,000	£1,137,000	£337,000	£712,000	**£1,781,000**
LGV	Business	-£171,000	-£2,158,000	-£5,856,000	£22,984,000	£6,808,000	£14,383,000	**£35,990,000**
OGV1	Business	-£337,000	-£559,000	-£1,819,000	£9,102,000	£2,078,000	£9,063,000	**£17,528,000**
OGV2	Business	-£299,000	-£495,000	-£1,613,000	£8,072,000	£1,843,000	£8,037,000	**£15,545,000**
Total	**Total**	**-£10,681,000**	**-£34,624,000**	**-£86,285,000**	**£226,848,000**	**£67,353,000**	**£151,465,000**	**£314,076,000**

TRANSPORT ECONOMIC EFFICIENCY

6.2.28. The Transport Economic Efficiency (TEE) benefits are presented in Table 6-11 for the Core Growth scenario and Core Growth (Sensitivity) scenario, Table 6-12 for the Low Growth scenario and Table 6-13 for the High Growth scenario. All values are in 2010 prices, discounted to 2010.

Table 6-11: Transport Economic Efficiency benefits (2010 prices, discounted to 2010) for the Core Growth scenario

User	Item	Core Growth (£m)	Core Growth (Sensitivity) (£m)
Non-business: Commuting	Travel time	£66.192	£51.625
	Vehicles operating costs	-£7.704	-£8.468
	Sub-total	**£58.488**	**£43.158**
Non-business: Other	Travel time	£83.680	£64.540
	Vehicles operating costs	£84.124	£75.572
	Sub-total	**£167.804**	**£140.112**
Business	Travel time	£81.766	£64.269
	Vehicles operating costs	£6.803	£5.222
	Sub-total	**£88.569**	**£69.491**
TOTAL		**£314.861**	**£252.761**

Table 6-12: Transport Economic Efficiency benefits (2010 prices, discounted to 2010) for the Low Growth scenario

User	Item	Low Growth (£m)
Non-business: Commuting	Travel time	£58.603
	Vehicles operating costs	-£6.369
	Sub-total	**£52.234**
Non-business: Other	Travel time	£67.572
	Vehicles operating costs	£74.700
	Sub-total	**£142.272**
Business	Travel time	£65.818
	Vehicles operating costs	£5.018
	Sub-total	**£70.836**
TOTAL		**£265.342**

Table 6-13: Transport Economic Efficiency benefits (2010 prices, discounted to 2010) for the High Growth scenario

User	Item	High Growth (£m)
Non-business: Commuting	Travel time	£92.611
	Vehicles operating costs	-£8.292
	Sub-total	**£84.319**
Non-business: Other	Travel time	£115.804
	Vehicles operating costs	£92.559
	Sub-total	**£208.363**
Business	Travel time	£105.664
	Vehicles operating costs	£10.407
	Sub-total	**£116.071**
TOTAL		**£408.753**

6.2.29. The Core Growth scenario generates benefits of £314.861m, the Low Growth scenario generates benefits of £265.342m, the High Growth scenario generates benefits of £408.753m while the Core Growth (Sensitivity) scenario generate benefits of £252.761m. The Transport Economic Efficiency (TEE) worksheets are included in Appendix B.

PROFILE OF BENEFITS (TIME PERIOD)

6.2.30. The user benefits by time period are shown in Figure 6-1 for the Core Growth scenario, Figure 6-2 for the Core Growth (Sensitivity) scenario, Figure 6-3 for the Low Growth scenario and Figure 6-4 for the High Growth scenario.

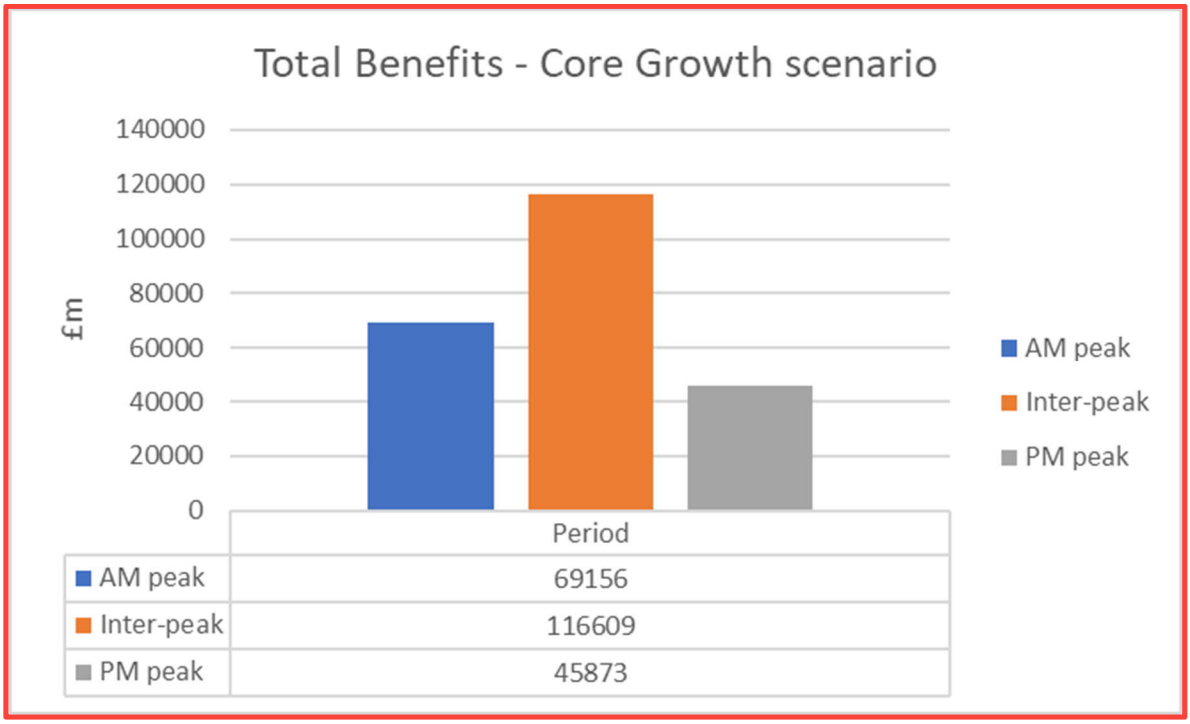


Figure 6-1: User Benefits by Time Period for the Core Growth scenario

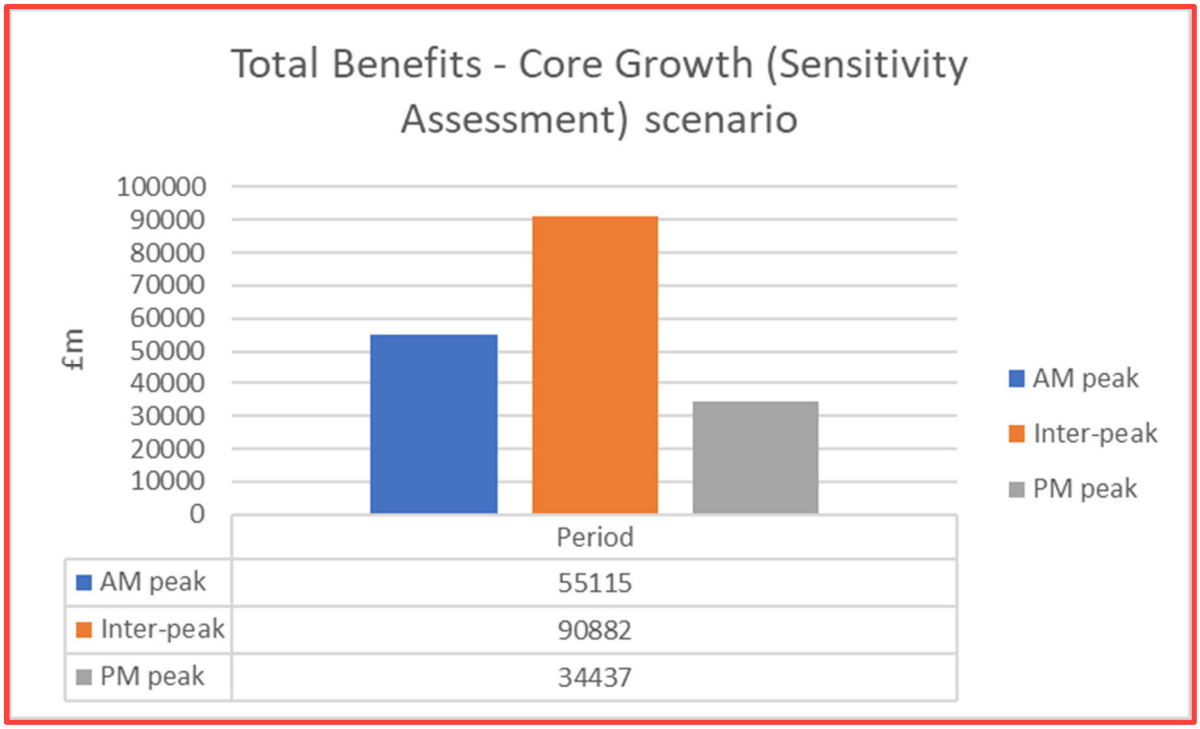


Figure 6-2: User Benefits by Time Period for the Core Growth (Sensitivity) scenario

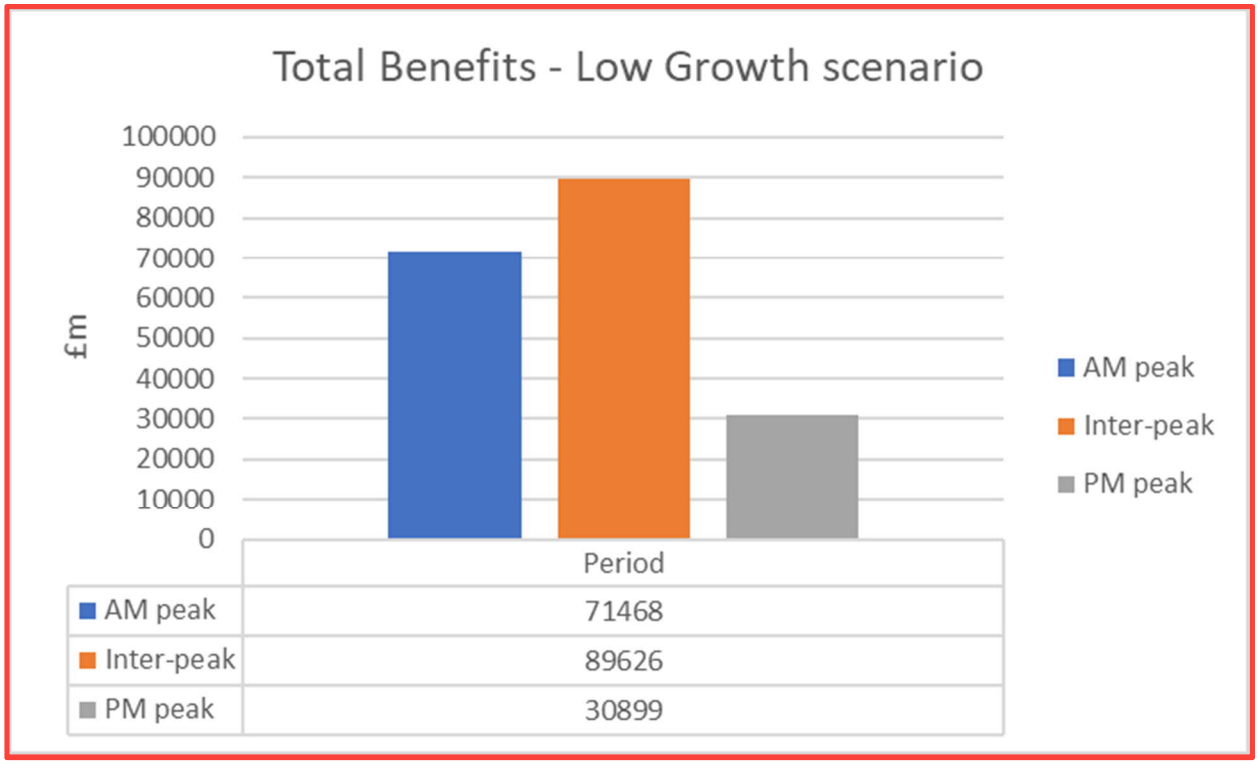


Figure 6-3: User Benefits by Time Period for the Low Growth scenario

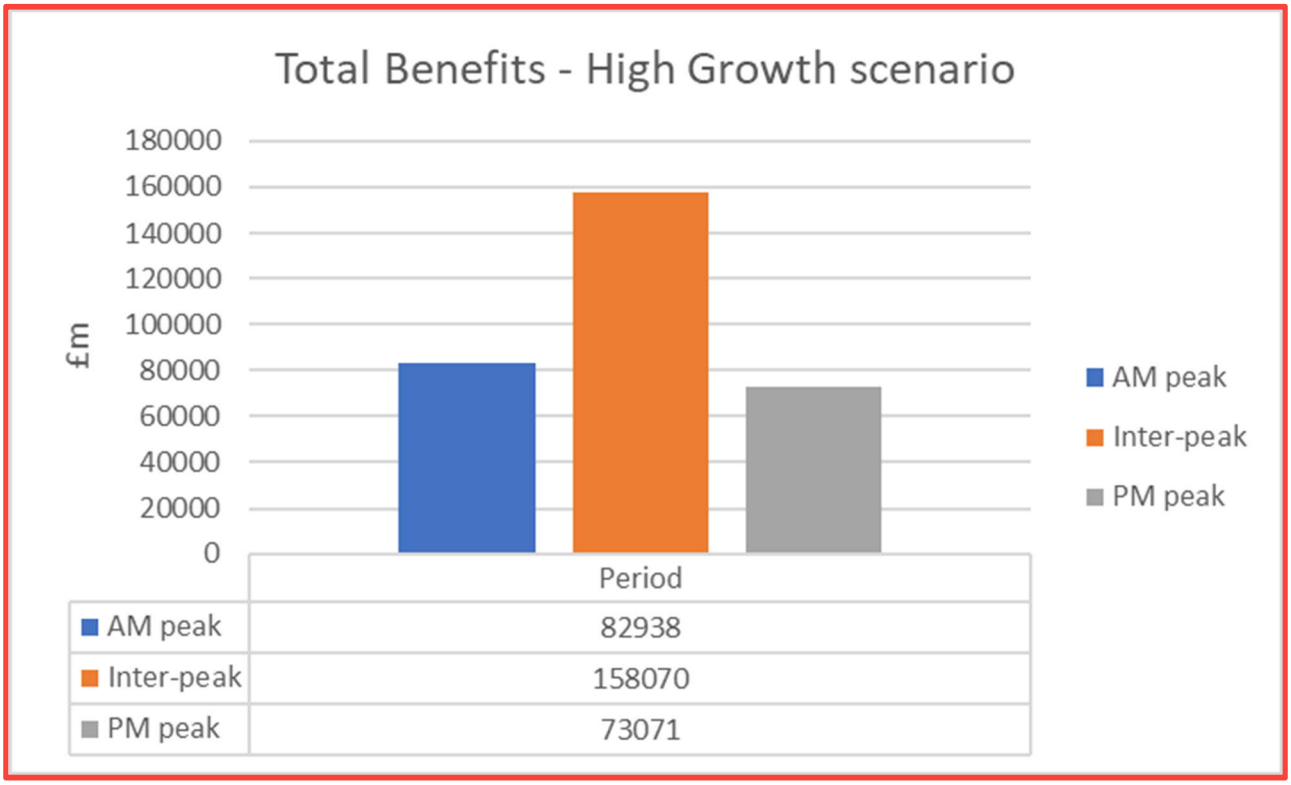


Figure 6-4: User Benefits by Time Period for the High Growth scenario

PROFILE OF BENEFITS (JOURNEY PURPOSE)

6.2.31. The user benefits by journey purpose are shown in Figure 6-5 for the Core Growth scenario, Figure 6-6 for the Core Growth (Sensitivity Assessment), Figure 6-7 for the Low Growth scenario and Figure 6-8 for the High Growth scenario.

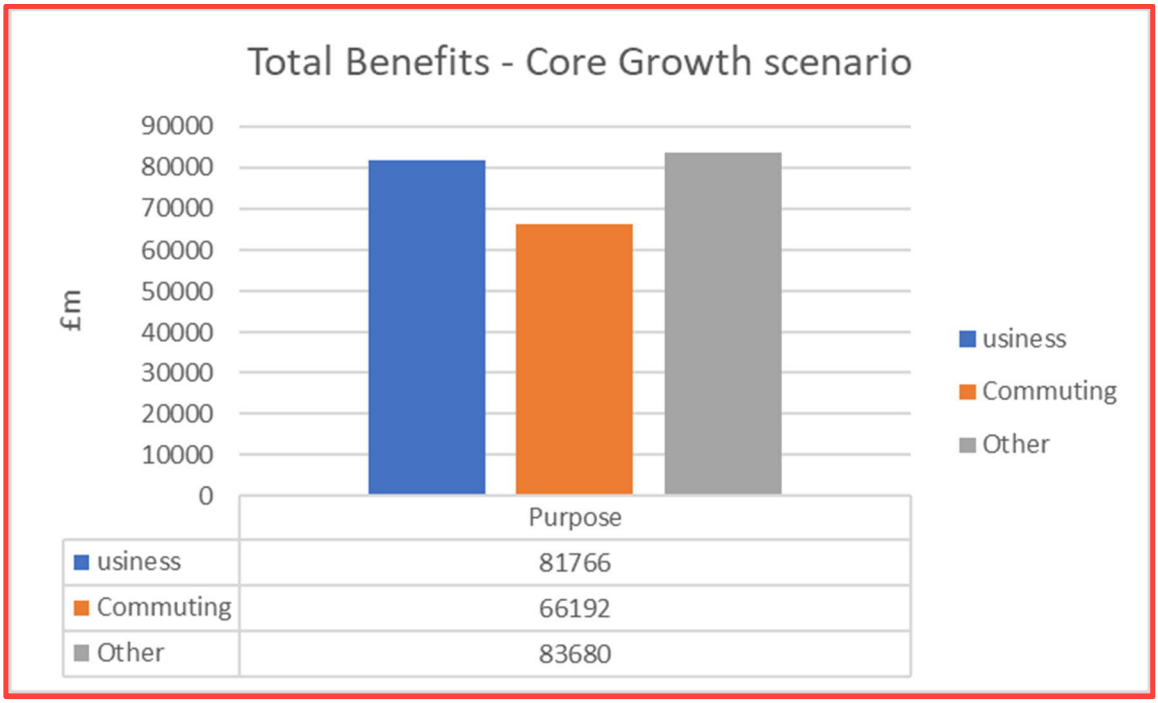


Figure 6-5: User Benefits by Journey Purpose for the Core Growth Scenario

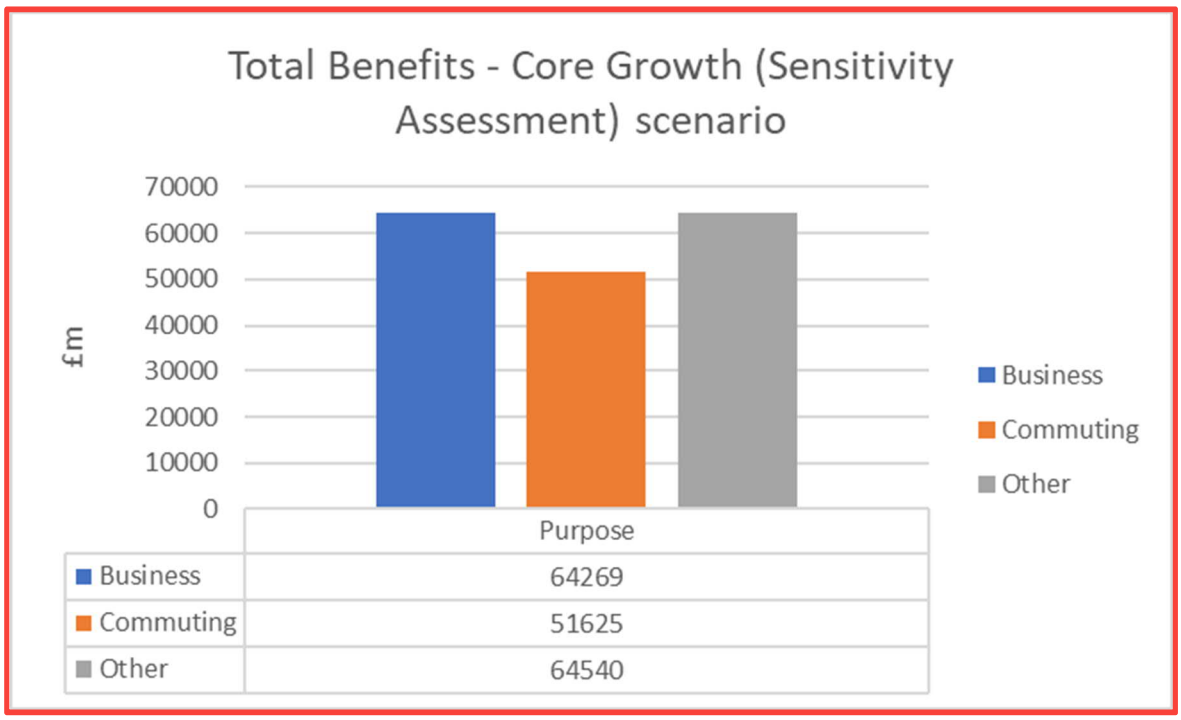


Figure 6-6: User Benefits by Journey Purpose for the Core Growth (Sensitivity Assessment) Scenario

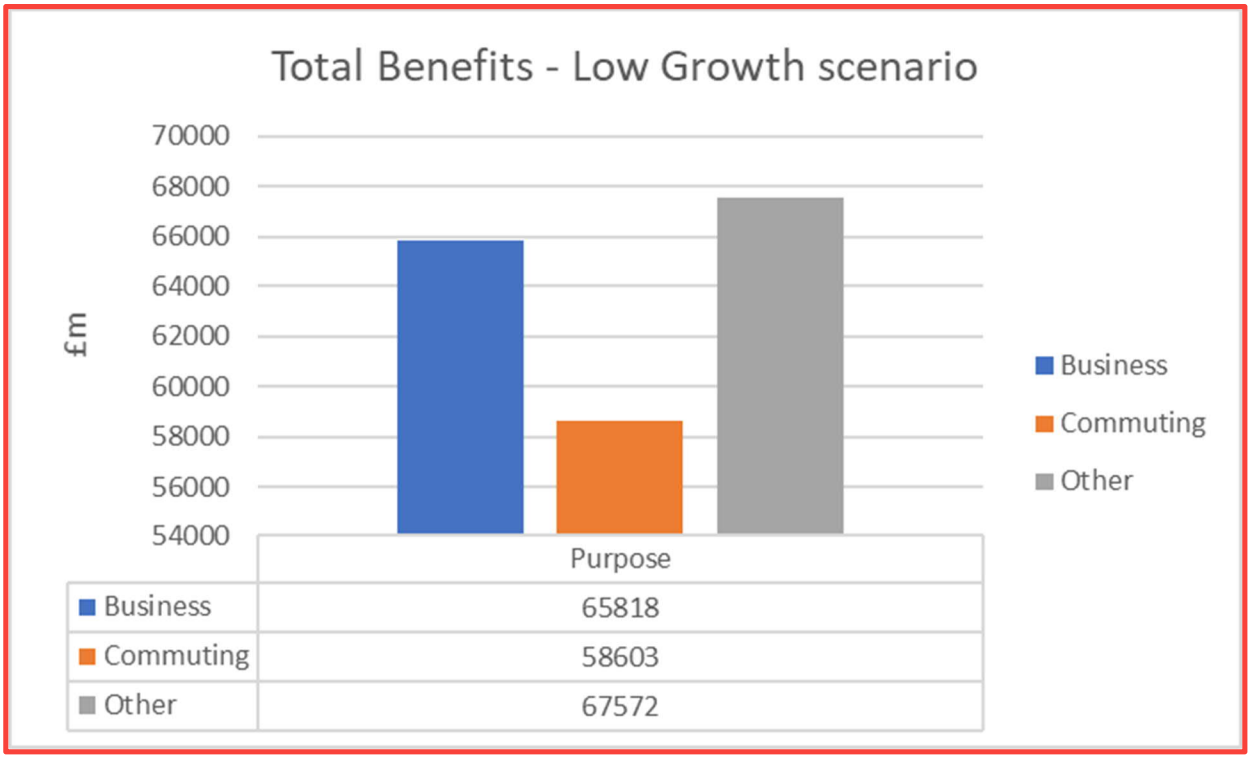


Figure 6-7: User Benefits by Journey Purpose for the Low Growth Scenario

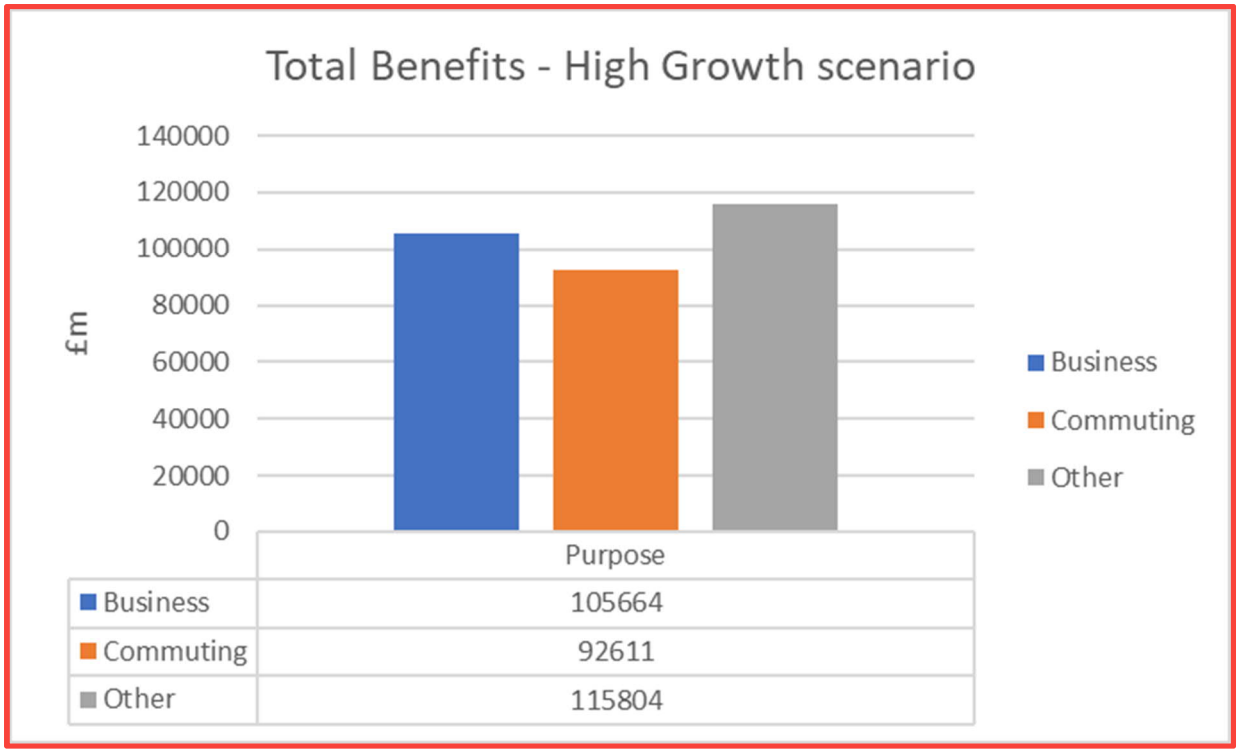


Figure 6-8: User Benefits by Journey Purpose for the High Growth Scenario

PROFILE OF BENEFITS OVER 60 YEARS

6.2.32. The scheme benefits are explicitly calculated only for the modelled years of 2025 and 2040. Benefits for each year between those years are interpolated from their outputs. The default assumption in TUBA is that there is no growth in the magnitude of impacts after the last modelled year, and this is assumed for the purposes of this scheme.

6.2.33. The benefits accrued in each year over the life of the scheme, given these assumptions, are shown in Figure 6-9. Scheme benefits peak in 2040 and thereafter scheme benefits are slowly reduced year-on-year after 2040 due to the effects of congestion, inflation and the discounting of benefits further into the future.

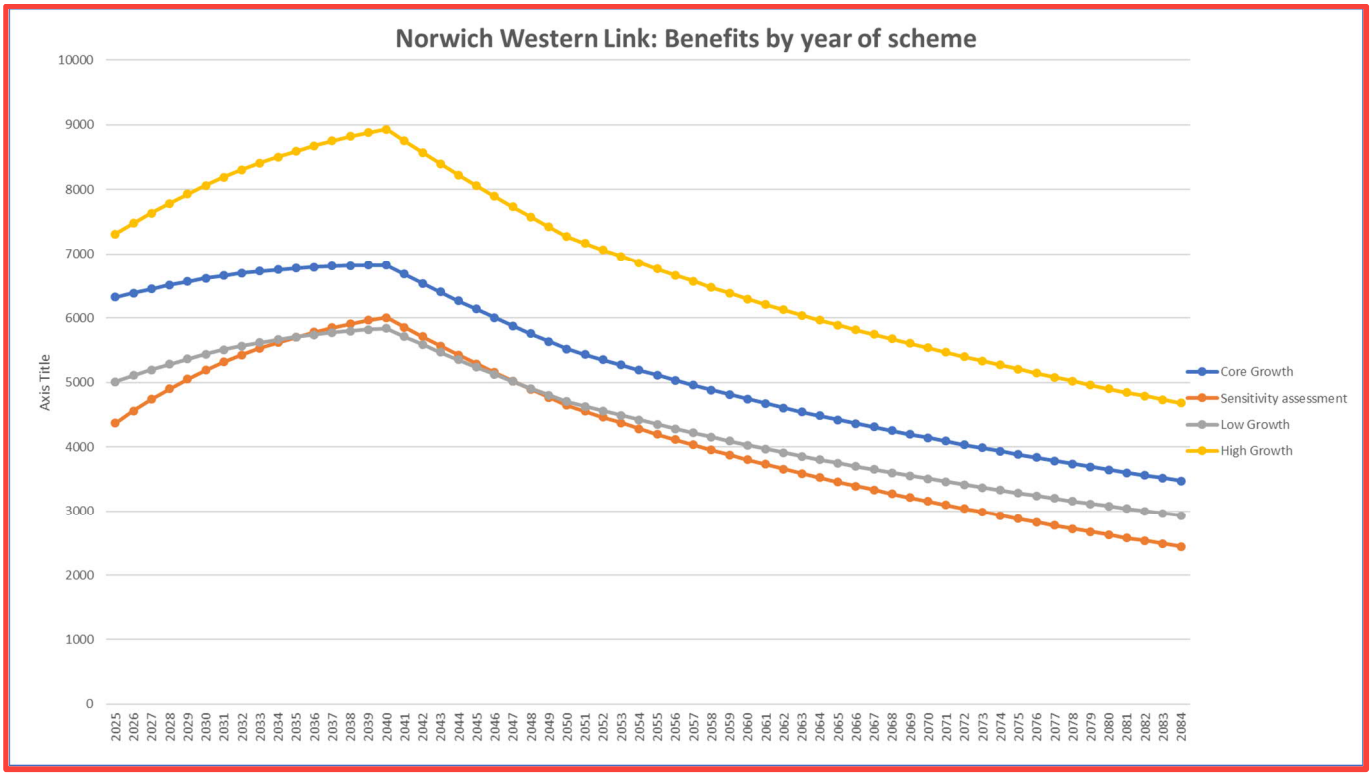


Figure 6-9: Benefits by year of scheme for all scenarios

SECTOR BENEFITS

6.2.34. Analysis has been carried out of benefits on a geographical basis. To do this TUBA was run with a sector file, which enables user benefits between each model zone origin and destination pair to be aggregated into larger geographical areas. The zoning system has been aggregated into 16 model sectors which are shown in Figure 6-10 and listed in Table 6-14. The scheme benefits have been shown in bands:

- Greater than -£30m
- Between -£10m and -£30m
- Between £0m and -£10m
- Zero
- Between £0m and £10m
- Between £10m and £30m
- Greater than £30m.

Table 6-14: Sectoring System

Sector ID	Sector Description
1	Scotland/North
2	East/West Midlands (plus Wales)
3	South East (excluding London)
4	London
5	King's Lynn District
6	North Norfolk District
7	Great Yarmouth District
8	Breckland North (north of A47)
9	Breckland South (south of A47)
10	South Norfolk West (west of A11)
11	South Norfolk Central (between A11 and A140)
12	South Norfolk East (east of A140)
13	Broadland West (west of A140)
14	Broadland East (east of A140)
15	Norwich North (north of river)
16	Norwich South (south of river)

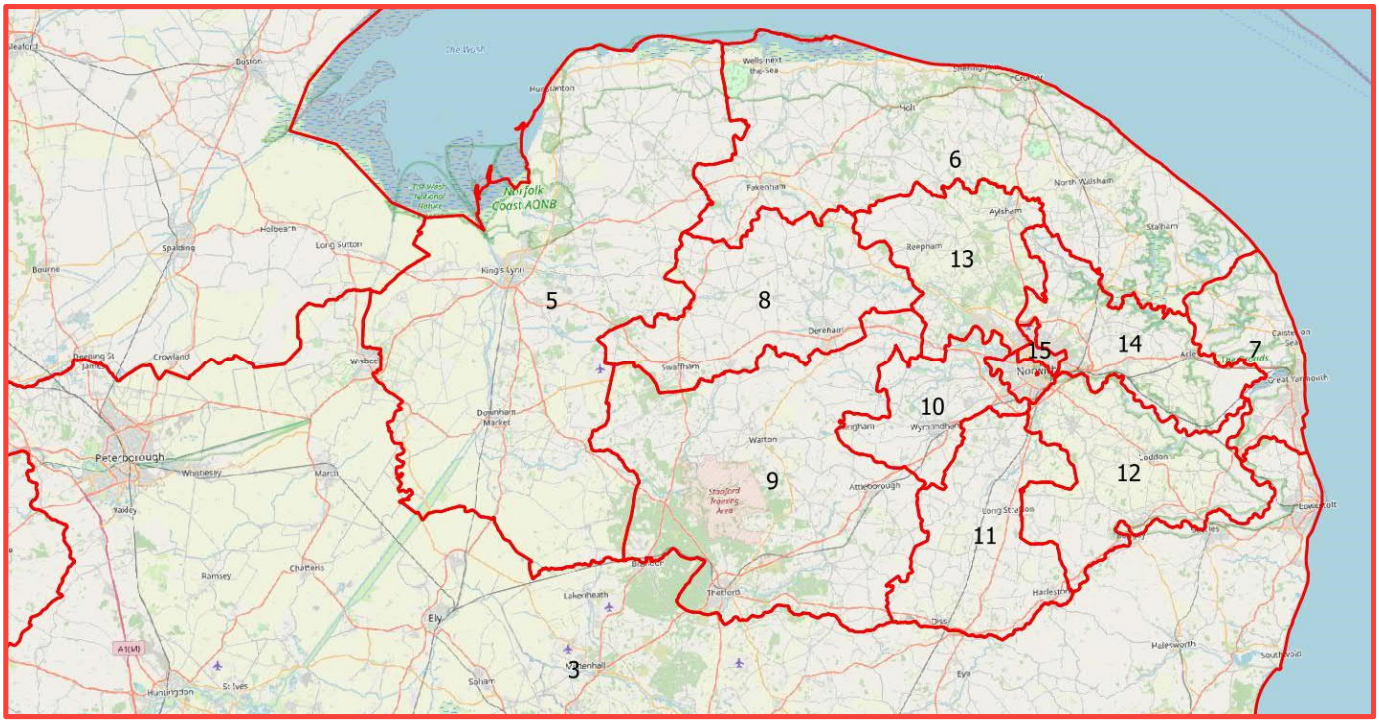


Figure 6-10: Sectoring System

Core Growth scenario

6.2.35. Figure 6-11 and Figure 6-12 and shows the sector to sector benefits for the 2025 and 2040 respectively for the Core Growth scenario.

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						492	216	-411	17	341	2	28	2190	637	246	431	4188
2		5879	4502		667	9948	12834	5650	2087	8628	658	1647	47502	65836	64835	24530	255202
3		3802	2847	32	1274	45144	25345	-6682	1811	12537	378	2906	61885	45160	19543	25521	241505
4		0	109			3878	3158	-585	4	95	9	126	1744	1000	357	1116	11010
5		3079	1615			13633	7635	1214	4775	36558	1694	4300	58552	56229	31105	68212	288600
6	699	26397	42527	6410	5806	9666	10124	28769	38799	53642	3988	2808	37199	11700	-3525	10055	285063
7	60	6761	9001	1203	6565	3867		15823	11635	17558	1989	1957	8558	24386	11358	27477	148200
8	459	6124	7648	97	5085	26941	17163	10998	21563	62526	13565	12878	184254	130706	105683	118947	724639
9	46	1193	1901	11	1845	32723	17612	-22125	4214	21382	4459	5846	128149	105944	53235	53358	409793
10	422	10112	15834	291	24373	48242	30466	71406	22386	63728	18549	25317	218563	124007	65786	168574	908055
11	3	461	909	37	954	5412	5774	22647	5300	13747	671	5121	27420	29407	5322	13428	136613
12	33	1576	3231	351	3913	4439	4305	19144	7547	23374	1787	754	14812	12573	11086	23825	132749
13	2515	44346	66891	6688	44855	20705	10258	122515	83540	152709	24458	6724	-1490	-36908	-32441	-71711	443652
14	685	51151	34170	1468	32176	24964	68097	138886	57944	80404	9973	11796	29285	19792	904	29576	591270
15	291	23600	22184	706	44604	8766	14809	72908	28123	32685	4908	3645	6639	9584	220	15651	289321
16	801	12383	19116	661	50891	27452	43843	121775	33625	41640	13181	4842	50424	-19945	-20285	-45712	334692
Grand Total	6014	196864	232483	17955	223009	286270	271639	601933	323367	621553	100270	90695	875686	580108	313428	463278	5204551

Figure 6-11: Sector benefits for Core Growth 2025 Opening Year (£m)

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						1031	376	-205	41	619	5	17	2691	776	-20	422	5753
2		12152	10750	0	1975	10445	24079	11598	4459	17327	1797	3625	44344	69218	69865	43016	324650
3		10192	6639	118	3151	63789	41586	2142	5204	20490	1145	3976	74846	52195	13305	19768	318545
4		0	260			5054	3785	-215	13	244	35	117	2706	1634	186	432	14252
5		4283	3211			8247	11054	19079	13242	68277	6789	7515	67162	102660	47404	120987	479909
6	1085	19123	53933	6593	5068	21018	13641	44686	44645	73032	7711	5716	40121	-11903	-28999	1581	297053
7	253	20525	28005	3455	12864	9580		22377	30998	31837	3667	4315	14155	52110	19367	43204	296711
8	507	11687	8219	42	20846	38804	23480	14500	26965	51935	14603	11456	174182	159473	110691	109402	776792
9	139	3013	4425	26	10241	40517	28441	-2844	17380	33881	14675	8102	119014	119736	47076	44399	488222
10	364	15381	-6075	57	43572	66745	32437	47458	2046	4800	5129	8944	228443	114889	20414	-10772	573830
11	14	1539	1560	100	4259	6426	4076	25841	18685	21068	985	-77	35646	-3931	-1384	-6503	108302
12	59	5078	6727	764	8554	7006	6418	21155	13129	22070	3188	1317	15179	15071	1614	8289	135615
13	2704	43228	84281	9227	68865	67216	18056	135719	103763	174488	30607	11189	11519	-57584	-36076	-64028	603173
14	1112	63431	47598	4016	73583	72045	128830	175367	87470	98979	8679	13910	-31845	14643	-31063	-109622	617133
15	269	33598	24218	853	65228	18689	27712	88300	34748	21469	2788	443	-15276	-3100	-9470	-56363	234107
16	1058	29588	29632	819	102079	40475	62745	119423	43304	7053	10507	7115	-1049	-102435	-80207	-155516	114589
Grand Total	7563	272817	303382	26069	420285	477085	426716	724382	446091	647568	112309	87681	781837	523452	142702	-11305	5388635

Figure 6-12: Sector benefits for Core Growth 2040 Opening Year (£m)

6.2.36. As you expect most of the benefits are from Sector 8, Sector 9 and Sector 10 to Sector, 13, Sector 14, Sector 15 and Sector 16 and vice versa given the traffic movements that the Norwich Western Link is accommodating.

Low Growth scenario

6.2.37. Figure 6-13 and Figure 6-14 and shows the sector to sector benefits for the 2025 and 2040 respectively for the Low Growth scenario.

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						356	107	-117	8	214	1	20	1908	368	181	319	3365
2		3580	2868		403	8734	8329	3891	863	5715	348	985	42230	56332	55394	17250	206923
3		1623	1603	24	294	33859	15296	-2054	1023	9001	145	1970	51682	32378	15293	14728	176864
4		1	39			3071	1512	-166	0	86	6	97	1280	654	256	756	7592
5		2283	902			12513	5548	1001	1669	21187	1075	2867	50468	46864	25994	44466	216837
6	734	24545	37467	6349	5538	6864	7267	17585	32449	44139	2961	2349	29661	10608	278	10800	239594
7	383	4150	9867	1179	5990	2932		11788	8559	12985	1873	1533	6305	16710	9297	23221	116772
8	94	3441	2922	51	3013	23846	11081	-88	3491	34794	5576	7732	156713	105797	89107	83832	531401
9	31	360	1479	9	1713	29280	10522	-11483	2559	13428	2669	4283	113045	87688	46104	39091	340777
10	292	6630	10121	245	11284	35922	18477	22665	13845	46321	11804	18005	169685	83411	49062	129527	627295
11	-1	233	504	21	615	2882	2153	4172	3537	9823	274	1248	21579	8524	2054	2280	59899
12	20	933	2778	390	1991	2369	2542	6988	6298	19580	1161	474	10258	6931	4028	11228	77970
13	1810	40749	58223	5400	40573	23007	7212	112703	82173	142129	22404	10714	22082	1458	-5056	-9760	555822
14	538	41860	27144	1310	25702	18357	39536	112720	48452	66622	7816	10632	21896	11277	3824	32505	470190
15	174	19115	17816	562	38769	6625	8894	58804	25075	32326	4588	3857	4826	2486	772	16790	241479
16	375	8118	12645	456	34654	25515	24465	38666	21608	55946	10242	6487	58235	19221	10078	14452	341162
Grand Total	4450	157619	186378	15996	170539	236131	162942	377075	251607	514295	72942	73252	761855	490707	306667	431483	4213941

Figure 6-13: Sector benefits for Low Growth 2025 Opening Year (£m)

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						655	217	-437	30	382	4	37	2312	574	4	320	4097
2		10020	9068	0	1391	8949	17846	8994	3908	14595	1610	3134	38072	60897	58953	34597	272033
3		7145	5053	80	2113	52781	28078	-6584	3457	10331	752	3429	64209	37187	11540	11720	231292
4		0	134			4218	2149	-600	8	128	21	61	2257	924	137	120	9556
5		4146	2969			9936	9618	13969	11404	60320	6113	6683	60361	94015	41201	105700	426436
6	560	19483	39478	5425	4814	16539	12042	39249	36098	52052	4252	3583	46585	-8018	-14566	-2412	255165
7	227	14053	17393	2272	8396	7147		18118	16252	18998	3024	2893	11295	40802	16185	31593	208647
8	368	10065	10040	164	18480	32876	18445	26152	29143	51971	13375	12312	159794	151131	98510	97216	730043
9	74	2634	3912	19	7953	34482	18591	-18470	11884	23861	11714	6202	107105	102327	41317	27834	381438
10	352	15169	2893	202	40265	58380	22206	49178	11538	8666	9047	9410	201916	95937	17241	-13280	529120
11	11	1362	1453	69	3752	5975	4193	22500	15462	14244	719	2724	31046	7459	155	1575	112699
12	34	3710	4101	373	6305	5334	4320	17128	8155	6429	2016	1355	14031	10049	4460	12566	100366
13	2146	35896	61186	5868	56361	54051	12581	115902	82484	137312	22897	8468	21150	-32405	-14233	-28425	541239
14	218	49208	32646	2237	62282	47996	87964	150001	64060	40059	334	10608	15710	14644	-10339	-77377	490252
15	155	25732	16544	123	54460	18447	18051	71855	22840	3476	-605	908	1701	2567	-3791	-35401	197062
16	411	26975	18566	238	86960	32158	42770	93046	19776	-34883	2775	5461	17647	-84050	-57567	-125112	45171
Grand Total	4557	225599	225435	17071	353533	389922	299070	600001	336499	407942	78047	77267	795191	494040	189207	41235	4534617

Figure 6-14: Sector benefits for Low Growth 2040 Opening Year (£m)

6.2.38. As you expect most of the benefits are from Sector 8, Sector 9 and Sector 10 to Sector, 13, Sector 14, Sector 15 and Sector 16 and vice versa given the traffic movements that the Norwich Western Link is accommodating.

High Growth scenario

6.2.39. Figure 6-15 and Figure 6-16 and shows the sector to sector benefits for the 2025 and 2040 respectively for the High Growth scenario.

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						787	230	-213	17	378	2	36	2838	1253	340	898	6567
2		7315	5525		901	10967	14877	7273	2584	10327	739	1939	52511	75419	75005	34722	300106
3		4504	3389	42	1494	62798	28316	-1111	1503	15405	438	3455	76665	61500	23434	35200	317030
4			148			5190	2500	-321	-89	118	11	144	2253	1449	401	1118	12921
5		3636	1881			14068	8569	4735	5164	39535	1929	4958	65029	64353	35296	75695	324849
6	704	27350	47996	8057	5740	11485	10619	30875	40638	62321	4498	2744	32629	-1093	-14494	7581	277648
7	164	8792	13210	1701	7460	4606		17722	15665	22833	2690	2586	9438	28105	11714	39566	186251
8	705	6717	8689	104	5210	29185	19186	16708	26696	70837	14790	14144	208114	152160	121887	145997	841129
9	62	1408	2200	15	3055	39352	19419	-12556	5246	25083	4779	6058	143639	128563	60898	64651	491871
10	439	12454	20840	348	26766	63901	34303	76308	27831	86590	22590	29996	274941	185207	87604	216971	1167087
11	6	413	492	57	1153	5085	1583	23267	6425	18956	842	-2171	36520	4410	6792	24284	128113
12	33	1841	4054	498	4614	7629	4283	20714	9397	32918	2108	902	23854	21853	12094	35400	182191
13	3358	47062	75768	9443	48192	23788	10261	129753	92913	186909	28733	8156	-8707	-52459	-40700	-72254	490217
14	942	56842	42233	1991	36154	25689	69316	155278	68337	110469	12472	13529	32457	13948	-7924	85535	717267
15	459	26017	27189	1020	50026	7433	15202	81287	33979	51088	6769	4388	-7550	-877	-1931	36742	331242
16	839	14420	21401	683	55211	18805	47959	131183	41147	67722	14135	3139	17702	-18358	-20658	-52197	343132
Grand Total	7711	218771	275016	23960	245977	330768	286623	680903	377451	801490	117524	94000	962331	665432	349758	679908	6117622

Figure 6-15: Sector benefits for High Growth 2025 Opening Year (£m)

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						1775	402	-186	50	805	7	23	3278	880	11	551	7595
2		9471	12895	0	2180	10688	31501	12993	4110	17511	1883	4236	51197	78261	82801	47712	367438
3		12070	6895	98	3496	70198	53393	4209	5334	26529	1138	4229	96157	62349	15883	23920	385900
4		-1	-9			7283	5080	-232	-5	344	40	112	3535	2380	472	988	19987
5		1417	3690			7362	14476	22734	14714	77293	7487	8468	77069	114766	56924	142210	548610
6	2337	20118	72458	8173	5348	22610	11375	57206	55575	99659	11570	9206	45383	-17753	-41443	25760	387580
7	285	26135	34410	4361	15795	11153		26486	35498	39198	4067	4512	16674	58870	24025	55156	356626
8	242	13380	7069	27	27577	49153	29204	21576	19807	58573	14737	12979	206844	177778	131508	138573	909027
9	152	3152	3628	32	13358	51692	37730	3512	21426	41286	15777	9045	136770	136852	55890	56154	586455
10	340	17377	-12812	-140	48753	89703	45941	52863	-7646	5500	3283	10332	282125	137182	31828	-5855	698774
11	15	1822	1979	164	4953	7616	5155	29601	24110	26183	1093	-1236	43869	-8594	-1775	-7116	127839
12	43	6066	7455	994	10506	9236	6633	25262	16591	33934	3745	1326	14900	16169	-3448	5223	154634
13	3734	52841	119643	12881	89713	101796	23476	173795	141771	265646	43285	22425	40264	-78197	-42833	1575	971816
14	2543	86192	86241	6983	86723	140271	263374	201999	115845	192174	23438	34743	-13683	25180	-32875	-43651	1175496
15	563	42555	36677	1878	77602	31442	37407	109228	49198	53399	7323	5455	-20155	-7901	-11091	-30643	382936
16	1115	36220	34322	1171	119465	56547	84854	150496	54350	53524	14446	10886	-26741	-106340	-87438	-161877	235000
Grand Total	11369	328815	414541	36619	505469	668525	650001	891542	550726	991557	153317	136743	957488	591882	178438	248678	7315713

Figure 6-16: Sector benefits for High Growth 2040 Opening Year (£m)

6.2.40. As you expect most of the benefits are from Sector 8, Sector 9 and Sector 10 to Sector, 13, Sector 14, Sector 15 and Sector 16 and vice versa given the traffic movements that the Norwich Western Link is accommodating.

Core Growth (Sensitivity) scenario

6.2.41. Figure 6-17 and Figure 6-18 and shows the sector to sector benefits for the 2025 and 2040 respectively for the Core Growth (Sensitivity) scenario.

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						272	132	-369	10	237	1	17	1972	362	134	211	2978
2		3762	2568		419	9016	8452	3125	1118	4727	326	895	43881	60015	59265	15988	213556
3		2201	1700	23	783	36559	16561	-6867	1053	8582	175	1615	55816	33722	15502	15907	183333
4			69			2993	1925	-522	-1	56	5	69	1447	607	257	646	7550
5		2158	943			12558	5390	-1817	2568	23905	1047	2728	51574	43440	24922	40900	210316
6	432	24183	36496	5484	5305	5291	6690	24553	34367	44664	2917	1564	23187	-2265	-12018	-9507	191346
7	72	4074	6311	810	4608	2536		10832	7734	11640	1331	1364	5277	18541	7415	17347	99891
8	379	3578	5794	122	1416	22068	11199	17024	18720	51892	10345	9784	173431	117016	97762	93607	634137
9	37	581	1218	7	202	27642	11207	-21895	3573	15826	2923	3672	121038	88905	46752	33200	334889
10	280	5463	10965	234	14962	37069	18702	55790	17272	53192	13502	17514	206907	92374	55326	137652	737203
11	0	202	508	26	534	2876	3196	17037	3430	9251	509	2323	24000	13960	3069	7301	88223
12	26	744	2060	222	2343	2509	2876	14154	4813	16638	1180	557	9592	7182	7856	19203	91955
13	2244	40074	60989	6069	37796	5080	5565	115813	76418	141020	22167	4183	-7917	-47980	-36416	-85303	339801
14	485	44721	26329	1035	23822	9325	49010	126516	44445	61441	6389	6902	16766	13430	-2071	15754	444299
15	245	19820	18654	525	37637	-1106	9445	66167	22444	25093	3442	1000	5218	4254	-491	6960	219304
16	623	4995	9340	277	29094	10026	25652	91915	16528	14365	5976	-1854	42416	-48164	-30369	-67888	102931
Grand Total	4823	156557	183944	14835	158922	184713	176000	511457	254495	482528	72232	52334	774604	395397	236895	241978	3901712

Figure 6-17: Sector benefits for Core Growth (Sensitivity) Growth 2025 Opening Year (£m)

Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
1						896	323	-185	44	520	4	22	2340	623	-2	246	4832
2		10262	9080	0	1675	9330	20651	11670	4065	16863	1724	3422	40624	63248	63843	39196	295653
3		8674	5836	96	2698	55911	36062	2033	4618	17949	1019	3373	67291	44986	11784	13606	275936
4		1	322			4393	3306	-196	13	206	29	91	2389	1368	135	125	12182
5		3630	2713			7484	9434	16692	13468	75985	7188	6997	62900	96676	45268	127200	475635
6	755	17009	46890	5612	4499	20422	12674	42700	40100	60091	7050	5023	46741	-7206	-24050	-7453	270856
7	195	16990	23088	2840	10389	9144		23570	27715	28953	3425	3822	14201	51855	20016	38602	274805
8	474	11843	7884	53	20693	37378	24536	5926	27348	58831	16352	12813	153777	140481	97598	108695	724683
9	130	2909	3886	24	11168	36407	26238	-449	17479	38042	16419	7924	102730	108884	40461	38125	450376
10	348	15964	-5331	72	51277	56665	31158	56265	11199	6316	11060	8140	190420	90224	12177	-30613	505343
11	10	1554	1327	93	4508	5506	3588	28126	20679	23523	1904	-308	27672	-8817	-1017	-3692	104654
12	62	4845	6142	707	7989	6117	5933	22579	13106	20821	3635	1615	12945	13756	2012	7399	129664
13	2426	39676	74178	8475	66269	67795	18302	119449	87529	143246	25011	9351	15747	-47189	-30519	-66056	533691
14	970	58105	42556	3210	71286	71806	120741	156951	81800	70933	6495	12305	-21151	19954	-23487	-124651	547823
15	182	31230	20023	649	60861	20438	27857	77144	29106	11261	2004	772	-13267	809	-8539	-60647	199885
16	822	31450	23167	622	111592	31010	59791	119358	38872	-12122	9192	3654	-10998	-101881	-76598	-158607	69323
Grand Total	6374	254140	261759	22453	424905	440702	400593	681633	417140	561417	112511	79018	694364	467772	129086	-78525	4875341

Figure 6-18: Sector benefits for Core Growth (Sensitivity) 2040 Opening Year (£m)

6.2.42. As you expect most of the benefits are from Sector 8, Sector 9 and Sector 10 to Sector, 13, Sector 14, Sector 15 and Sector 16 and vice versa given the traffic movements that the Norwich Western Link is accommodating.

6.3 ACCIDENT ASSESSMENT RESULTS

6.3.1. An appraisal of accident savings has been undertaken using the DfT COBALT-LT (V2.0 Beta) spreadsheet tool. This tool applies accident rates to traffic flows extracted from the traffic model to predict the change in the number of accidents with and without the scheme in place. The COBALT network is included in Appendix C.

CORE GROWTH SCENARIO

6.3.2. The number of accidents calculated for the Core Growth scenario over the 60-year appraisal period is shown in Table 6-15.

Table 6-15: Total Accidents – Core Growth scenario

Scenario	Total Accidents		Number of Accidents saved by scheme
	Without Scheme	With Scheme	
Core Growth	35,433	34,904	529

6.3.3. Based on the number of accidents the number of casualties is then calculated. The total casualties over the 60-year appraisal period are summarised in Table 6-16.

Table 6-16: Total Casualties - Core Growth scenario

Scenario	Casualties						Total Casualties saved by scheme		
	Without Scheme			With Scheme					
	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
Core Growth	381	4,751	42,827	379	4,696	42,211	2	56	616

6.3.4. The total number of casualties that the scheme is predicted to save has been monetised using the TAG 2020 parameters. The total accident benefits are summarised in Table 6-17.

Table 6-17: Total Benefits (£000s) - Core Growth scenario

Scenario	Accident Costs		Accident Benefits saved by scheme
	Without Scheme	With Scheme	
Core Growth	1,531,387	1,512,806	18,582

6.3.5. The COBALT-LT assessment for the Core Growth scenario has predicted that the scheme will generate over £18.582m in accident saving benefits. This benefit will be included within the overall Core Growth scenario Present Value of Benefits (PVB) of the scheme.

LOW GROWTH SCENARIO

6.3.6. The number of accidents calculated for the Low Growth scenario over the 60-year appraisal period is shown in Table 6-18.

Table 6-18: Total Accidents - Low Growth scenario

Scenario	Total Accidents		Number of Accidents saved by scheme
	Without Scheme	With Scheme	
Low Growth	31,549	31,162	386

6.3.7. Based on the number of accidents the number of casualties is then calculated. The total casualties over the 60-year appraisal period are summarised in Table 6-19.

Table 6-19: Total Casualties - Low Growth scenario

Scenario	Casualties						Total Casualties saved by scheme		
	Without Scheme			With Scheme					
	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
Low Growth	339	4,226	38,140	338	4,188	37,690	1	38	451

6.3.8. The total number of casualties that the scheme is predicted to save has been monetised using the TAG 2020 parameters. The total accident benefits are summarised in Table 6-20.

Table 6-20: Total Benefits (£000s) - Low Growth scenario

Scenario	Accident Costs		Accident Benefits saved by scheme
	Without Scheme	With Scheme	
Low Growth	1,366,023	1,353,230	12,793

6.3.9. The COBALT-LT assessment for the Low Growth scenario has predicted that the scheme will generate £12.793m in accident saving benefits. This benefit will be included within the overall Low Growth scenario PVB of the scheme.

HIGH GROWTH SCENARIO

6.3.10. The number of accidents calculated for the High Growth scenario over the 60-year appraisal period is shown in Table 6-21.

Table 6-21: Total Accidents - High Growth scenario

Scenario	Total Accidents		Number of Accidents saved by scheme
	Without Scheme	With Scheme	
High Growth	41,319	40,909	410

6.3.11. Based on the number of accidents the number of casualties is then calculated. The total casualties over the 60-year appraisal period are summarised in Table 6-22.

Table 6-22: Total Casualties - High Growth scenario

Scenario	Casualties						Total Casualties saved by scheme		
	Without Scheme			With Scheme					
	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
High Growth	425	5511	49745	426	5475	49282	0	37	463

6.3.12. The total number of casualties that the scheme is predicted to save has been monetised using the TAG 2020 parameters. The total accident benefits are summarised in Table 6-23.

Table 6-23: Total Benefits (£000s) - High Growth scenario

Scenario	Accident Costs		Accident Benefits saved by scheme
	Without Scheme	With Scheme	
High Growth	1,764,526	1,751,748	12,778

6.3.13. The COBALT-LT assessment for the High Growth scenario has predicted that the scheme will generate £12.778m in accident saving benefits. This benefit will be included within the overall High Growth PVB of the scheme.

CORE GROWTH (SENSITIVITY) SCENARIO

6.3.14. The number of accidents calculated for the Do Minimum and Do Something over the 60-year appraisal period is shown in Table 6-24.

Table 6-24: Total Accidents - Core Growth (Sensitivity) scenario

Scenario	Total Accidents		Number of Accidents saved by scheme
	Without Scheme	With Scheme	
Core Growth (Sensitivity)	35,294	34,862	432

6.3.15. Based on the number of accidents the number of casualties is then calculated. The total casualties over the 60-year appraisal period are summarised in Table 6-25.

Table 6-25: Total Casualties - Core Growth (Sensitivity) scenario

Scenario	Casualties						Total Casualties saved by scheme		
	Without Scheme			With Scheme					
	Fatal	Serious	Slight	Fatal	Serious	Slight	Fatal	Serious	Slight
Core Growth (Sensitivity)	377	4729	42646	377	4687	42148	1	42	498

6.3.16. The total number of casualties that the scheme is predicted to save has been monetised using the TAG 2020 parameters. The total accident benefits are summarised in Table 6-26.

Table 6-26: Total Benefits (£000s) - Core Growth (Sensitivity) scenario

Scenario	Accident Costs		Accident Benefits saved by scheme
	Without Scheme	With Scheme	
Core Growth (Sensitivity)	1,295,015	1,283,519	11,496

6.3.17. The COBALT-LT assessment for the Core Growth (Sensitivity) scenario has predicted that the scheme will generate £11.496m in accident saving benefits. This benefit will be included within the overall present value benefits of the scheme.

SUMMARY

6.3.18. Table 6-27 summarises the accident benefits saved by the Norwich Western Link scheme.

Table 6-27: Summary of COBALT benefits (£m)

Scenario	Accident Benefits saved by scheme
Core Growth	18.582
Low Growth	12.793
High Growth	12.778
Core Growth (Sensitivity)	11.496

6.4 DELAYS DURING CONSTRUCTION

6.4.1. Construction plans are still to be produced however most of the Norwich Western Link scheme will be built off-line i.e. connection to the Highways England A47 North Tuddenham to Easton scheme at the southern end as shown in Figure 1-3. There will have to be traffic management when the connection between the Norwich Western Link scheme and the A1067 Fakenham Road however it is felt that this would not affect the Benefit to Cost Ratio (BCR) in a meaningful way.

6.5 PHYSICAL ACTIVITY

6.5.1. Physical activity is concerned with whether the intervention is likely to generate significant additional numbers of walking or cycling trips. The assessment has been undertaken in line with the following guidance:

- TAG Unit A5.1 Active Mode Appraisal
- TAG Unit A5.5 Highway Appraisal
- Design Manual for Roads and Bridges (DMRB) LA 112.

6.5.2. The methodology for monetising the scheme impacts has focused on estimating the increase in the amount of cycling and walking associated with implementing the scheme. The method considers:

- Mode shift
- Changes to health
- Changes to journey quality

6.5.3. DfT's Active Mode Appraisal Toolkit (AMAT), has been utilised to understand the likely impact of the scheme. The tool monetised costs and benefits for the following impacts:

- Congestion benefit
- Infrastructure
- Accidents
- Local Air Quality
- Noise
- Greenhouse Gases (GHG)
- Reduced risk of premature death
- Absenteeism
- Journey Ambience
- Indirect Taxation.

6.5.4. The active mode appraisal has been conducted over a 20-year appraisal period, in line with TAG Unit A5.1. The benefits have been discounted and reported in present values using the schedule of discount rates provided in the TAG data book (July 2020). Again, in line with TAG, the values have included real growth in line with forecast GDP per capita. The assumptions used within the appraisal are based on scheme data, Travel-to-Work Census data and default TAG values from the AMAT.

6.5.5. A sustainable transport strategy has been developed through public and key stakeholder consultation, seeking to maximise opportunities for transferring shorter distance band trips to non-motorised modes of travel such as walking and cycling where possible. The Sustainable Transport Strategy is three-fold - it includes a Non-Motorised User Strategy, wider interventions for creating 'cycle friendly' strategic routes and a bus strategy.

6.5.6. To inform the development of Non-Motorised User interventions, a Walking, Cycling and Horse-Riding Assessment (WCHRA) has been undertaken as part of the scheme design process. This has been used to identify the routes used by pedestrians and others and the community facilities which are likely to be affected by the scheme.

6.5.7. The Non-Motorised User (NMU) Strategy element predominantly consists of Public Rights of Way diversions and extension of the PRoW network in the immediate vicinity of the Norwich Western Link highway works, which also helps to mitigate severance issues caused by the road, where existing routes that cross the scheme are to be closed. The proposed NMU strategy also assists with joining up what was found through the WCHAR process to be an existing but fragmented local PRoW network with limited coverage and in some cases poor connectivity to existing settlements.

6.5.8. Eight potential sustainable transport measures across the wider area were consulted on. Following the consultation four of the eight measures were identified to be delivered as part of the Norwich Western Link scheme.

6.5.9. The impacts on Physical Activity have been assessed with DfT's AMAT for three of the four shortlisted options. Based on the AMAT results as included in Appendix D, the Norwich Western Link is forecast to have a beneficial impact of £8.9 million.

6.6 AIR QUALITY

6.6.1. The appraisal has been undertaken following TAG Unit A3 on Air Quality Impacts with the Air Quality worksheet included as Appendix E.1.

6.6.2. With the Norwich Western Link there are modest improvements in local air quality in terms of NO_2 and $PM_{2.5}$ at locations with relevant human exposure. The overall monetary valuation takes into account ecosystem damage costs. No Air Quality Management Areas are included in the air quality study area. The Norwich Western Link links map onto Pollution Climate Mapping links which are all compliant with the NO_2 limit value both with and without the scheme. No exceedances of air quality standards are predicted.

NO_2

6.6.3. In 2025 there are there are 7,860 properties with improvement, 35 properties with no change, and 2,180 properties with deterioration. In 2040 there are 7,733 properties with improvement, 32 properties with no change, and 2,310 properties with deterioration.

6.6.4. The Net Present Value (NPV) of change for NO_2 over the 60-year appraisal period (2025-2084 inclusive) is a benefit of £9,803.

$PM_{2.5}$

6.6.5. In 2025 there are 8,002 properties with improvement, 6 properties with no change, and 2,067 properties with deterioration. In 2040 there are 7,747 properties with improvement, 282 properties with no change, and 2,046 properties with deterioration.

6.6.6. The NPV of change for $PM_{2.5}$ over the 60-year appraisal period (2025-2084 inclusive) is a benefit of £62,165.

6.7 GREENHOUSE GASES

6.7.1. The greenhouse gases appraisal for road transport emissions has been undertaken in accordance with TAG Unit A3 Greenhouse Gases. The calculations are based on the traffic forecasts for the Do Minimum and Do Something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the NATS 2019 traffic model for the OBC. Non-traded CO_2e emissions (petrol and diesel vehicles) and CO_2e traded emissions (electric vehicles) have been calculated in accordance with DMRB LA 114 'Climate' methodology.

6.7.2. The Norwich Western Link scheme gives rise to lower CO_2e emissions compared to the Do-Minimum situation, with savings (benefits) over the 60-year appraisal period (2025 - 2084 inclusive) of 443,429 tonnes in non-traded carbon associated with conventional (petrol and diesel) vehicles, and 13,005 tonnes from traded carbon associated with electric vehicles (i.e. electrical power generation sources).

6.7.3. The differences are generally associated with lower values of total annual vehicle kilometres in each year that are predicted due to the Norwich Western Link scheme. For 2025, the distance travelled over the simulated road network is predicted to be approximately 4,136 million vehicle kilometres in the Do-Minimum scenario compared to 4,087 million vehicle kilometres in the Do-Something scenario - a reduction of approximately 49 million vehicle kilometres. For 2040, the distance travelled over the simulated road network is predicted to be approximately 4,904 million vehicle kilometres in the Do-Minimum scenario compared to 4,767 million vehicle kilometres in the Do-Something scenario - a reduction of approximately 137 million vehicle kilometres.

6.7.4. Over the 60-year appraisal period, the monitised benefit in terms of carbon savings from the operation of vehicles in the road transport sector due to the Norwich Western Link scheme is estimated at £19,474,620. The Greenhouse Gases worksheet is included as Appendix E.2.

6.8 NOISE

6.8.1. A noise appraisal has been undertaken following the methodology presented in TAG Unit A3, Environmental Impact Appraisal (May 2019).

6.8.2. A 3-dimensional digital acoustic model has been generated based on the guidance contained within Calculation of Road Traffic Noise and the DMRB LA 111.

6.8.3. The affected population has been estimated and the monetary valuation of changes in noise impact has been determined using the TAG Unit A3 Noise Appraisal Workbook.

6.8.4. The overall appraisal indicates that the operation of the Norwich Western Link, without mitigation, is likely to generate a beneficial noise impact, and the 'net present value of change in noise' is calculated to be £38,490. The Noise worksheet is included as Appendix E.3.

6.9 PUBLIC ACCOUNTS

6.9.1. Table 6-28 shows the Public Accounts for the Norwich Western Link scheme with the TAG worksheets included in Appendix F.

Table 6-28: Public Accounts (PA) for the scheme

User	Item	Core Growth (£m)	Core Growth (Sensitivity Assessment) (£m)	Low Growth (£m)	High Growth (£m)
Central government funding	Investment costs	£127.129	£127.129	£127.129	£127.129
Central government: non-funding	Indirect tax revenues	-£53.272	-£39.398	-£46.916	-£59.742
Broad transport budget		**£127.129**	**£127.129**	**£127.129**	**£127.129**
Wider public finances		**-£53.272**	**-£39.398**	**-£46.916**	**-£59.742**

6.9.2. The broad transport budget for the Norwich Western Link scheme is **£127.129m**.

6.10 INITIAL BENEFIT COST RATIO (BCR)

6.10.1. The Benefit to Cost Ratio (BCR) considers the impact to the economy, society, the environment and the public accounts. It offers an estimate of the value of benefit generated for every £1 of public expenditure. Therefore, any BCR above one shows a value for money for every £1 of invested cost. The Value for Money (VfM) category is defined by the BCR, these are:

- BCR <0.0 Very Poor
- BCR between 0.0 and 1.0 Poor
- BCR between 1.0 and 1.5 Low
- BCR between 1.5 and 2.0 Medium
- BCR between 2.0 and 4.0 High
- BCR > 4.0 Very High.

6.10.2. The initial BCR includes the monetised impacts associated with Economy for business users and providers, Environment for Greenhouse Gases, Air Quality, Noise, Social for non-business users, physical activity and safety, and Public Accounts for the cost to the broad transport budget and indirect tax.

6.11 ANALYSIS OF MONETISED COSTS AND BENEFITS (AMCB)

6.11.1. Table 6-29 outlines a summary of the results from TUBA for each scheme, providing the Analysis of Monetised Costs and Benefits (AMCB) for the proposed Norwich Western Link scheme. Values are rounded to the nearest million.

Table 6-29: Analysis of Monetised Costs and Benefits (AMCB)

Item	Core Growth (£m)	Core Growth (Sensitivity Assessment) (£m)	Low Growth (£m)	High Growth (£m)
Noise	£0.038	-	-	-
Air Quality	£0.072	-	-	-
Greenhouse Gases (Environmental assessment)	£19.475	-	£17.445	-
Physical Activity	£8.876	£8.876	£8.876	£8.876
Accidents	£18.582	£11.496	£12.793	£12.778
Economic Efficiency: Consumer Users (Commuting)	£58.488	£43.158	£52.234	£84.319
Economic Efficiency: Consumer Users (Other)	£167.804	£140.112	£142.272	£208.363
Economic Efficiency: Business Users and Providers	£88.569	£69.491	£70.836	£116.071
Wider Public Finances (Indirect Tax Revenues)	-£53.272	-£39.398	-£46.916	-£59.742
Present Value of Benefits (PVB)	**£308.632**	**£233.735**	**£257.540**	**£370.665**
Present Value of Costs (PVC)	**£127.129**	**£127.129**	**£127.129**	**£127.129**
OVERALL IMPACTS				
Net Present Value (NPV)	**£181.503**	**£106.606**	**£130.411**	**£243.536**
Initial Benefit to Cost Ratio (BCR)	**2.43**	**1.84**	**2.03**	**2.92**

Note: This is not a direct comparison as only the Core Growth scenario includes impacts for Noise, Air Quality and Greenhouse Gases. The Low Growth scenario includes Greenhouse Gases impacts.

6.11.2. Therefore, based on the scheme impacts and costs the scheme has an initial Value for Money (VfM) category of High for the Core Growth scenario.

6.11.3. Considering the other scenario tests the initial VfM category is in the range of Medium for the Core Growth (Sensitivity Assessment) scenario and High VfM for the Low Growth scenario and High Growth scenario.

6.11.4. The monetised benefits for the scheme range from **£233.735m** for the Core Growth (Sensitivity Assessment) scenario to **£370.665m** for the High Growth scenario.

6.11.5. The Core Growth (Sensitivity Assessment) scenario returns the lowest monetised benefits, followed by the Low Growth scenario and the Core Growth scenario, with the highest monetised benefits returned by the High Growth scenario.

6.11.6. The Analysis of Monitised Costs and Benefits (AMCB) TAG worksheets are included in Appendix G.

6.11.7. With the current present value of costs none of the growth scenarios assessed are in the Low VfM category. For the scheme outputs to sit in a different category the costs of the scheme would need to change.

6.11.8. Looking at the Core Growth scenario, and assuming no change to the monetised benefits, the scheme costs would need to increase by £27.962m (22.00%) for the BCR of the scheme to sit in the next category down i.e. Medium.

6.12 LEVEL 2 IMPACTS

RELIABILITY IMPACTS

6.12.1. Travel time variability (TTV), is defined as variation in journey times that travellers are unable to predict. Journey times vary due to a large number of factors including the time of day, the location of the origin and destination, the distance and the roads along the route.

6.12.2. The standard deviation of travel time (for private travel) has been used as the method to measure travel time variability. The travel distance, time and number of vehicles making the journey have been extracted from the traffic model for each time period for the Do Minimum and Do Something scenario to allow the standard deviation to be calculated for each journey and time period.

6.12.3. Reliability has been assessed in line with TAG Unit A1.3, Section 6.3 (Reliability – urban roads) using the relationships shown in Figure 6-10, based on the calculation of the standard deviation of journey times from journey time and distance for each O-D (origin-destination) pair.

Reliability benefit $= -\sum \Delta\sigma_{ij} \left(\frac{T_{ij2}+T_{ij1}}{2}\right) \times 0.4 \times VOT$

Where: $\Delta = 0.0018\left((t_{ij2})^{2.02} - (t_{ij1})^{2.02}\right) d_{ij}^{-1.41}$

VOT = value of time (£/sec)

t_{ij1} and t_{ij2} = the journey times, before and after the change, from i to j (seconds)

d_{ij} = the journey distance from i to j (km)

Figure 6-19: Reliability impacts

6.12.4. The reliability impacts for the Norwich Western Link over the 60-year appraisal period have been calculated as **£26.291m** (2010 prices discounted to 2010).

WIDER ECONOMIC IMPACTS

6.12.5. As set out in the Economic Narrative, Level 2 wider economic impacts associated with enhanced connectivity due to the Norwich Western Link scheme have been assessed.

6.12.6. WSP's Wider Impacts in Transport Appraisal (WITA) tool has been used. The tool has been approved by the DfT and has been used in the analysis of other projects, including the Trans-Pennine scheme. The tool estimates the following impacts: agglomeration, labour supply and output change in imperfectly competitive markets as described in TAG Unit A2.1 to TAG Unit A2.4:

- Agglomeration - the concentration of economic activity in an area can be improved by transport schemes as accessibility between businesses and workers is improved by reduced journey times, thus generating productivity benefits from the 'closer' proximity
- Changes to tax revenues arising from labour supply impacts - changes in transport costs can incentivise individuals to work, the number choosing to work and thus the amount of labour supplied in the economy. The changes in tax revenues associated with these impacts are not captured within commuter user benefits but are included within the Wider Impacts in Transport Appraisal (WITA) tool
- Output change in imperfectly competitive markets - a reduction in transport costs (for business and freight) allows businesses to profitably increase their output (goods and services) that require the use of transport in their production.

6.12.7. Agglomeration impacts arise from improving accessibility to an area for businesses and workers as they can cluster together and benefit from improved productivity. The Norwich Western Link scheme will improve connectivity between different areas within Greater Norwich and Norwich, the latter a key economic hub for employment and services in East Anglia. The Western Link will bring firms closer together and generate a total increase in GDP, as existing workers become more productive due to connectivity improvements.

6.12.8. With the scheme in place, impacts will also be felt by those making commuting journeys as well as currently unemployed people looking to enter the labour market. If commuting costs fall, then the net returns from working increase. This could influence the trade-off decisions people need to make; whether or not they choose to work or how much they choose to work. The private benefits to these people are captured in transport user benefits. The value of time used for travel time savings does not include exchequer benefits that accrue when people make different decisions about employment as a result of a transport scheme.

6.12.9. Companies will benefit from time savings due to the scheme, which is effectively a reduction in production costs, incentivising firms to increase their output whilst maintaining an attractive profit margin. Firms can pass on these cost savings to consumers, reflecting a net benefit to consumers which is in addition to the transport cost change.

6.12.10. As there is more certainty surrounding these types of wider economic impacts compared to the high-level impacts covered under Level 3, they will be included in the Adjusted BCR for the Norwich Western Link scheme and are thus a key part of the overall economic case for the scheme.

6.12.11. Agglomeration improvements are in scope for the Norwich Western Link scheme as:

- It is located within one of the DfT Functional Urban Regions (FUR)
- The scale of journey time improvements (and other improvements generating a significant decrease in drivers' generalised costs) will mean that agglomeration impacts are likely to be significant.

RESULTS

Agglomeration with Other Modes adjustment

6.12.12. The agglomeration impacts are calculated across the four sectors of the economy within the appraisal guidance. Table 6-30 presents the agglomeration impacts across the Construction, Consumer Services, Manufacturing and Producer Services sectors.

6.12.13. To represent travel by all modes within the average cost calculations, an allowance has been made to account for the impact of the other modes. To account for public transport, walking and cycling, the proportion of car driver trips for each Local Authority District (LAD) examined in the WITA analysis was extracted from the TEMPro database. Adjustment factors were calculated for each WITA zone based on the proportion of car trips compared to total trips. These factors were applied to the WITA agglomeration and labour supply impacts. This is based on data for the year 2020 from the TEMPro database.

Table 6-30: Agglomeration Benefits

Agglomeration Sector	Original Benefits (£m, 2010 prices and values)	Adjusted for other modes (£m, 2010 prices and values)
Manufacturing	18.039	8.784
Construction	16.208	7.929
Consumer Services	51.394	24.616
Producer Services	99.102	47.928
Sub-Total	**184.744**	**89.257**

6.12.14. The agglomeration impacts form the majority of total wider impacts with Producer Services accounting for the largest proportion of agglomeration benefits at 54% of the adjusted total. This is where the scheme will have the largest impacts in terms of reductions in Generalised Travel Costs.

6.12.15. This is closely followed by Consumer Services with Construction capturing the fewest benefits. A breakdown of the agglomeration benefits by Local Authority District is provided in Table 6-31.

Table 6-31: Agglomeration Benefits by Local Authority District

Local Authority	Original Agglomeration Benefits (£m, 2010 prices and values)	Adjusted for other modes (£m, 2010 prices and values)
Breckland	48.562	23.878
Broadland	41.413	21.640
Norwich	27.678	11.133
South Norfolk	11.345	5.986
Great Yarmouth	13.391	5.972
King's Lynn and West Norfolk	27.666	13.579
North Norfolk	14.689	7.070
Total	**184.744**	**89.257**

6.12.16. The greatest agglomeration benefits are in Broadland and Breckland (51% of the adjusted total) as this is where the scheme is located[2] and will have the largest impact in terms of improving accessibility. As stated above, the WITA analysis is only looking at benefits attributed to Zones within the study area (Norfolk only).

6.12.17. The results above are impacted by the fact the Western Link would be located in one of the DfT core Functional Urban Regions (FUR) and has a substantial economic hinterland surrounding Norwich. This means that a significant new infrastructure investment such as the Western Link will generate agglomeration improvements in this relatively urbanised area via the substantial improvements in journey times. Of particular note is the fact that Norwich is the only FUR in the East of England, thus reinforcing the point that the city is a major regional generator of economic activity and will benefit further from the scale of transport connectivity associated with a scheme such as the Western Link.

Output change in imperfectly competitive markets

6.12.18. The total additional benefits arising due to output change in imperfectly competitive markets is approximately **£7.881m** and assumes that benefits would be incurred across all time periods. This shows the extent to which business users benefit from improved accessibility in Norwich as well as the subsequent reductions in congestion brought about by the scheme.

2 The scheme is mostly within Broadland and is on the boundaries with both Breckland and South Norfolk

Labour supply impacts

6.12.19. The total benefits arising due to labour supply impacts over the 60-year appraisal period are approximately **£0.330m**. These impacts are considered to be very minor as the analysis only considers the increased tax revenues associated with changes in the labour supply to be additional at UK level. Calculations for this element are based on the link between the cost of commuting and the increase in labour supply.

SUMMARY

6.12.20. A summary of the wider economic impacts is presented in Table 6-32.

Table 6-32: Summary of Results

Summary of Wider Economic Impact	Benefits (£m, 2010 prices and values)
WI1: Agglomeration impacts	89.257
WI2: Output change in imperfectly competitive markets impacts	7.881
WI3: Tax revenues arising from labour market impacts	0.330
Total Wider Impact Benefits	**97.468**

6.12.21. The WITA analysis shows that the scheme is expected to deliver approximately **£97.468m** of wider economic impacts. The highest contributions come from agglomeration impacts and output change in imperfectly competitive markets impacts. This suggests that businesses will benefit greatly from the enhanced connectivity and consequent congestion reductions brought about by the scheme.

6.12.22. With respect to the scale of these likely agglomeration impacts, it is worth noting that although TAG guidance suggests that these can range between 10% and 30% of user benefits, the agglomeration impacts can be above this threshold. For the Norwich Western Link the agglomeration impacts represent 29% of user benefits. As discussed earlier, agglomeration improvements are expected to be significant for the Norwich Western Link, driven by:

- it is located within the Norwich FUR
- the scale of generalised travel cost savings generated by the scheme.

6.13 ADJUSTED BENEFIT TO COST RATIO

6.13.1. The DfT guidance recommends that this Initial BCR be modified to include additional elements from the AST to create an Adjusted BCR.

6.13.2. The additional impacts which have been monetised are:

- Reliability
- Output change in imperfectly competitive markets impacts
- Agglomeration
- Labour supply impacts.

6.13.3. Following DfT guidance, the monetised values to be extracted from the Appraisal Summary Table (AST) are set out in Table 6-33.

Table 6-33: Adjusted BCR calculation for the Core Growth scenario

Impact	Core Growth (£m)
Initial Present Value of Benefits (PVB)	**£308.632**
Reliability	£26.291
Output Change	£7.881
Agglomeration	£89.257
Labour Supply	£0.330
Adjusted Present Value of Benefits (PVB)	**£432.391**
Present Value of Costs (PVC)	**£127.129**
Net Present Value (NPV)	**£305.262**
Benefit Cost Ratio (BCR)	**3.40**

6.13.4. Following the inclusion of wider economic impacts in appraisal the BCR increases to **3.40** and remains in the High VfM category.

6.14 LEVEL 3 IMPACTS

ENVIRONMENTAL IMPACTS

6.14.1. A qualitative assessment has been undertaken for the following impacts:

- Landscape/Townscape
- Historic Environment
- Biodiversity
- Water Environment

6.14.2. The methods used in undertaking the environmental appraisal followed the principles set out in TAG Unit A3 Environmental Impact Appraisal (December 2015).

6.14.3. The following paragraphs provide a summary of the appraisal and results.

Landscape

6.14.4. The landscape is predominantly gently undulating arable farmland, with plateau to the south, located between two shallow river valleys. River Tud in the south and River Wensum in the north being the larger of the valleys with noticeable difference in character of wet meadow and mosaic of lakes and drainage ditches.

6.14.5. There is some human influence, of note is the overhead line and two wind turbines to the west, with the A47 and A1067 roads noticeable from the plateau. Settlement is sparse, mainly small farmsteads - the biggest settlement is Honingham located to the south.

6.14.6. Land cover is predominately arable fields, contained by clipped hedgerow and infrequent mature trees, with some fields turned to pig rearing. Mixed plantation woodland is common throughout this landscape, often following field boundaries. Roads are generally small lanes, gently curved, and following the field boundaries.

6.14.7. The Norwich Western Link would alter the local landscape character through the introduction of the viaduct, loss of woodland and the width of the new road (dual carriageway). There would be subdivision of fields and sections of embankment and cutting through the landscape which would affect the field pattern and tranquillity locally, however, the viaduct would have a wider impact introducing a new feature into this landscape and will have a significant impact on tranquillity in the north.

6.14.8. The Norwich Western Link would have a **moderate adverse** effect on the Landscape with the TAG worksheet included as Appendix E.4.

6.14.9. **The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**.

Historic Environment

6.14.10. The Norwich Western Link would have a **moderate adverse** effect on the setting (context) of listed buildings located beyond the site boundary. It will adversely affect the appreciation and understanding of the characteristic historic environmental resource. Impacts may be mitigated by design, such as the introduction of screening or an appropriate road lighting scheme.

6.14.11. The Norwich Western Link also would result in a number of **low, moderate** or **major adverse** effects on the undesignated heritage assets recorded on the Historic Environment Records along with any previously unrecorded buried heritage assets. The impacts can be reduced where feasible and warranted, through either mitigation by design, allowing remains to be preserved in-situ, or through preservation by record (i.e. archaeological excavation).

6.14.12. The TAG worksheet is included as Appendix E.5

6.14.13. Further surveys are planned in 2021 which will complete the Archaeological baseline and will feed into the future assessment work for the Norwich Western Link.

6.14.14. **The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**.

Biodiversity

6.14.15. The TAG assessment has concluded that there are **Large Adverse** impacts on the following features:

- Bats (all species) including barbastelle bat.

6.14.16. The Norwich Western Link will result in the loss of foraging habitat for bats including barbastelle bat through the removal of woodland. A compensation strategy for the loss of woodland is currently being developed and will involve the enhancement of existing woodlands to benefit bats and the creation of new woodland areas.

6.14.17. The area for woodland enhancement and creation being targeted is within the 6km Core Sustenance Zone for the known barbastelle bat maternity and pre-maternity roosts.

6.14.18. In line with TAG guidance this compensation strategy cannot be accounted for in the appraisal and therefore the magnitude of impact has been precautionarily assessed as Intermediate Negative, making the Assessment Score Large Adverse.

6.14.19. It should be noted that the assessment of the magnitude of impact on bats of **Intermediate Negative** is based on the important commuting routes being adequately mitigated for through the provision of the following;

- viaduct across the River Wensum and associated floodplain habitat
- three wildlife underpasses - in The Nursery woodland in the north, along Ringland Lane (dual use) and along the stream south of the Foxburrow Plantation in the south
- three green bridges - along the Broadway, in the Foxburrow Plantation and along the hedgerow north of Weston Road
- other mitigation measures are being considered to reduce severance impacts.

6.14.20. The TAG assessment has concluded that there are Moderate Adverse impacts on the following features:

- Wensum Pastures at Morton Hall County Wildlife Site (CWS)
- Land adjoining Foxburrow Plantation CWS
- Broom & Spring Hills CWS
- Primrose Grove CWS
- Fakenham Road Roadside Nature Reserve (RNR)
- Ancient/veteran trees
- Important Hedgerows
- Wet Woodland Habitat of Principal Importance (HPI)
- Lowland mixed deciduous woodland HPI.

6.14.21. A Moderate Adverse impact is expected on the above CWS's due to habitat loss and/or severance which could impact the integrity of the CWS. A compensation strategy will be devised for the loss of habitat, and an underpass will be included to ensure the stream within the Land adjoining Foxburrow Plantation will maintain flow post construction into the River Tud.

6.14.22. The Fakenham Road RNR is designated because of the presence of hoary mullein *Verbascum pulverulentum*. This site will be lost due to the construction of the Norwich Western Link. A compensation strategy will be developed which will aim to recreate the habitat and lead to an increase in hoary mullein within the study area.

6.14.23. Approximately twelve ancient/veteran trees will be removed as a result of the Norwich Western Link scheme. A strategy for ancient/veteran trees is under development which will help to compensate for the loss of the trees however they are regarded as an irreplaceable habitat.

6.14.24. It is anticipated that two hedgerows that met the criteria for 'Important' under the Hedgerows Regulations 1997 will be directly impacted by the scheme. Mitigation will involve creation, enhancement and translocation.

6.14.25. The Norwich Western Link bisects areas of lowland mixed deciduous woodland and wet woodland HPI. The woodland to be lost is not ancient. As part of the compensation strategy new woodland will be planted and existing woodland will be enhanced for biodiversity benefit in the longer term.

6.14.26. The assessment for all other features ranges from slight adverse or neutral impacts based on the adoption of preliminary mitigation and compensation measures.

6.14.27. This assessment is based on the data which has been collected and analysed up to December 2020. It is a provisional impact assessment and has been undertaken before the Ecological Impact Assessment, Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD) assessment have been completed.

6.14.28. The overall assessment score for the Norwich Western Link scheme is a **Large Adverse** Impact due to the loss of woodland foraging habitat for bats including the barbastelle bat. As detailed above, a strategy for woodland creation and enhancement is currently being developed which will help to compensate for the habitat loss.

6.14.29. The TAG worksheet is included as Appendix E.6.

6.14.30. Further surveys are planned in 2021 which will complete the ecological baseline and will feed into the future assessment work for the Norwich Western Link scheme.

6.14.31. **The Environmental Statement will contain more detailed design information and a more thorough impact assessment (in line with CIEEM guidelines) subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**.

Water Environment

6.14.32. The overall Summary Assessment score for the Norwich Western Link is predicted to be **Moderate Adverse.** This is attributable to the high importance to the River Wensum and the **Negligible** impact on the ecological and hydromorphological quality of the River Wensum and the low risk associated with works to the new bridge crossing. A **Moderate Adverse** impact is predicted to the tributary of the River Tud; the River Wensum mapped fluvial floodplain; and the underlying groundwater body (combined superficial and bedrock aquifer). Measures are being developed to further mitigate and compensate for these issues.

6.14.33. A conservative approach to the loss of floodplain has been taken until quantitative analysis of potential effects is undertaken to inform the need for compensatory storage or other mitigation.

6.14.34. The TAG worksheet is included as Appendix E.7.

6.14.35. **The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**.

DISTRIBUTIONAL IMPACTS

6.14.36. Distributional Impacts (DI) across the eight categories (Table 6-34) are reported in full in the Distributional Impacts Report. The appraisal has been undertaken in accordance with TAG Unit A4.2: Distributional Impact Appraisal. The appraisal process consists of three major steps:

- Screening Process (Step 1) - identification of likely impacts for each indicator
- Assessment (Step 2) - identification of impact area, social groups and amenities
- Appraisal of impacts (Step 3) - analysis of impacts, full appraisal and input into Appraisal Summary Table (AST).

6.14.37. The results of the appraisal process are summarised in the following sections.

Screening

6.14.38. Each indicator has been assessed individually using the TAG screening proforma. The output of this assessment determines whether the intervention needs to be assessed further. Consideration has been given to:

- Whether there might be positive or negative impacts on different social groups
- If changes to scheme design can mitigate any potential negative impacts
- How dispersed the impact is likely to be, to understand if the scale of the impact is disproportionate to the potential impact.

6.14.39. A summary of the screening outcomes and decision on whether to progress to the next step is included in Table 6-34.

Table 6-34: Initial Screening

Impact Area	Conclusion	Next Step
User Benefits	There are likely to be beneficial impacts with respect to journey time, based on the SOBC TUBA analysis	Proceed to Step 2
Noise	The SOBC assessment estimated minor impacts both adverse and beneficial with respect to a change in road traffic generated noise levels	Proceed to Step 2
Air Quality	The SOBC assessment indicated adverse impacts for air quality and greenhouse gases emissions	Proceed to Step 2
Accidents	The new link is likely to attract traffic currently using low standard rural routes and congested urban routes. The new link will have reduced number of junctions and will be designed to current standards	Proceed to Step 2
Security	There is no planned change to public transport waiting/interchange facilities with the scheme	Do not proceed to step 2
Severance	The new link is likely to sever existing PRoWs	Proceed to Step 2
Accessibility	There is no planned change to public transport services routing or timings or provision with the scheme	Do not proceed to step 2
Affordability	The scheme will have an impact on car fuel and non-fuel operating costs, only. As a result of rerouting it is expected that there will be changes to these costs. For car fuel and non-fuel operating costs, the outputs from TUBA can be used, and indicate positive benefits. The remaining areas of affordability (parking charges, road user charges, public transport fares and concession availability) are not affected by the scheme	Proceed to Step 2

Assessment

6.14.40. The assessment stage investigated the impacts in more detail to confirm where both spatial impacts will be experienced, and where socio-economic, social and demographic characteristics needed to be considered further.

6.14.41. The area impacted by the Norwich Western Link scheme will vary for each indicator.

6.14.42. Analysis of the characteristics of people in the area likely to be affected has been undertaken by mapping social characteristics at Lower Super Output Area (LSOA) levels. Table 6-35 shows the groups of people that need to be identified in the analysis for each indicator.

Table 6-35: Socio-demographic analysis for DI

Dataset/ Social Group	User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability
Income Distribution	✓	✓	✓				✓	✓
Children: proportion of population aged <16		✓	✓	✓	✓	✓	✓	
Young Adults: proportion of population aged 16-25				✓			✓	
Older People: proportion of population aged 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.							✓	

Source: TAG Unit A4.2 Table 2

6.14.43. The assessment output summary is set out in Table 6-36.

Table 6-36: Assessment (Step 2) Output summary

Social group and amenities indicators			User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability	Local Authority	County	England
Resident population in the impact Area	Income Distribution Quintiles	0-20%	12.3	0	4.9					12.3	12.0%	12..5%	20.1%
		20%-40%	12.8	0	6.7					12.8	12.6%	14.3%	20.0%
		40%-60%	26.6	17.4	19.5					26.6	27.0%	34.2%	20.0%
		60%-80%	31.3	82.6	52.3					31.3	31.6%	26.4%	20.0%
		80%-100%	17.0	0	16.5					17.0	16.9%	12.5%	19.9%
	Children <16			17.8	18.3						16.1%	15.8%	17.6%
	Young People				11.6						12.7%	11.9%	13.2%
	Older People			9.5							13.3%	14.4%	10.9%
	People with a disability										25.7%	27.0%	25.9%
	Black Minority Ethnic										4.2%	3.5%	14.0%
	No Car Households										18.5%	18.8%	25.6%
	Households with dependent children										25.8%	25.3%	29.1%
	Indicator population in the impact area		542,961	7,182	813,552					542,961	511,661	857,888	56,075,912
Am	Schools / Nurseries			✓	✓	✓							

Social group and amenities indicators	User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability	Local Authority	County	England
Playgrounds		✓	✓	✓							
Parks and open Spaces			✓	✓							
Hospitals			✓	✓							
Care homes / Day Centres		✓	✓	✓							
Community Centre		✓	✓	✓							

Appraisal

6.14.44. This step sets out the assessment of the impact of the scheme on each indicator's social groups. This step covers the core analysis of impacts which provides an assessment score for each indicator and each of the social groups. A qualitative assessment has also been undertaken for each relevant indicator which has been summarised in the DI appraisal matrix table and the AST entries.

6.14.45. The DI appraisal is summarised in the Appraisal Matrix shown in Table 6-37 and the AST entry is summarised in Table 6-38.

Table 6-37: Distributional Impact Appraisal Matrix1

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements
	Quintile 1 0-20%	Quintile 2 20%-40%	Quintile 3 40%-60%	Quintile 4 60%-80%	Quintile 5 80%-100%		
User Benefits	✓	✓	✓✓✓	✓✓✓	✓✓✓	No	The distribution across the quintile areas is not even with the majority of impacts favouring those in the least deprived income quintiles. Those in income quintile 4 (second least deprived income quintile) experience a higher than expected proportion of benefits whereas those in the most deprived areas (quintile 1 and to a lesser extent quintile 2) experience a smaller than expected proportion of benefits
Noise			✓	××		No	Noise impacts are experienced by those in the middle income quintiles. Residents living in quintile 4 experience noise disbenefits while residents in quintile 3 experience noise benefits.
Air Quality	✓	✓	✓✓	✓✓	✓	No	Air quality impacts are experienced across all quintiles. Those in quintiles 3 and 4 experience a higher proportion of air quality benefits than would be expected from an even distribution.
Affordability	✓✓✓	✓✓✓	✓	✓	✓	No	The distribution across the quintile areas is not even with the majority of impacts favouring those in the most deprived income quintiles. Those in income quintile 1 (most deprived income quintile) experience a higher than expected proportion of benefits whereas those in the least deprived areas (quintiles 4 and 5) experience a smaller than expected proportion of benefits
Accessibility						N/A	

Table 6-38: AST Entry

Impact	Social Groups						User Groups				Qualitative statement
	Children & Young People	Older People	Carers	Women	Disabled	BME	Pedestrians	Cyclists	Motorcyclists	Young Male Drivers	
Noise	×										Children and young people experience noise disbenefits
Air Quality	✓										Children and young people experience air quality benefits
Accidents	✓	✓					✓	✓	✓	✓	All relevant social groups and user groups experience accident benefits
Security	-	-		-	-	-					
Severance	✓	✓	✓		✓						All relevant social groups and user groups experience severance benefits
Accessibility	-	-	-	-	-	-					n/a

6.15 CORE GROWTH SCENARIO – BENEFIT TO COST RATIO (BCR)

6.15.1. Value for money is determined by considering the relationship between the costs and benefits of a proposal. Where a monetised assessment has been undertaken, the DfT approach to assigning a category starts by considering the appropriate metric (Benefit Cost Ratio or Net Present Public Value).

6.15.2. The Initial BCR and Adjusted BCR for the Core Growth scenario have been calculated as **2.43** and **3.40** respectively demonstrating a High Value for Money. The adjusted Present Value of Benefits (PVB) is **£432.391m** which consists of:

- Transport user benefits: £261.589m
- Environmental benefits: £19.585m
- Accidents benefit: £18.582m
- Physical activity benefits: £8.876m
- Wider economic impact benefits: £97.468m
- Reliability impact benefits: £26.291m.

6.15.3. The Present Value of Costs (PVC) consist of **£127.129m** of scheme costs. Optimism Bias of 15% has been applied, in line with TAG Unit A1.2 for a road scheme at Outline Business Case stage. Table 6-39 shows the Initial BCR and Adjusted BCR.

Table 6-39: Analysis of Monetised Costs and Benefits

Item	Core Growth £m, 2010 prices and values
Noise	£0.038
Local Air Quality	£0.072
Greenhouse Gases	£19.475
Physical Activity (AMAT)	£8.876
Accidents	£18.582
Economic Efficiency: Consumer Users (Commuting)	£58.488
Economic Efficiency: Consumer Users (Other)	£167.804
Economic Efficiency: Business Users and Providers	£88.569
Wider Public Finances (Indirect Taxation Revenues)	-£53.272
Present Value of Benefits (PVB)	**£308.632**
Broad Transport Budget	£127.129
Present Value of Costs (PVC)	**£127.129**
Net Present Value (NPV)	**£181.503**
Initial BCR	**2.43**
Level 2 Benefits	**£123.759**
Adjusted PVB (Level 1 + Level 2)	**£432.391**
PVC (same as above)	**£127.129**
Net Present Value (NPV)	**£305.262**
Adjusted BCR	**3.40**

6.15.4. Overall there will be a **Moderate Adverse** effect on Landscape as there would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a substantial impact on tranquillity in the north.

6.15.5. Overall there will be a **Moderate Adverse** effect on the Historic Environment setting (context) of listed buildings located beyond the site boundary.

6.15.6. Overall there is a **Large Adverse** impact on Biodiversity due to the loss of woodland foraging habitat for bats including the barbastelle bat. A strategy for woodland creation and enhancement is currently being developed which will help to compensate for the habitat loss.

6.15.7. Overall there will be a **Moderate Adverse** on the Water Environment due to the impact on the River Tud and River Wensum.

6.15.8. **The Environmental Statement (ES) will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**.

6.15.9. At this stage it is anticipated that the scheme will deliver significant quantified and non-quantified benefits and provide High Value for Money for public sector expenditure.

6.16 SWITCHING VALUE ANALYSIS – CORE GROWTH SCENARIO

6.16.1. Switching value analysis has been undertaken to determine how a change in costs or benefits would alter the Value for Money category.

6.16.2. Table 6-40 and Table 6-41 provides the changes that would be required, either in scheme costs or benefits, for the scheme to shift from High VfM category (as indicated by its adjusted BCR) to the Medium or Very High categories on either side of its current position.

Table 6-40: Changing the Adjusted BCR to Medium

Factor	Core Growth scenario
Benefits	Benefits would need to decrease by £179.404 or 41.49%
Costs	Costs would need to increase by £90.153m or 70.91%

6.16.3. If the costs were to remain the same, benefits would need to decrease by 41.49% to lower the scheme into the Medium VfM category.

6.16.4. If benefits were to stay the same, costs would need to increase by 70.91% to lower the scheme into the Medium VfM category.

Table 6-41: Changing the Adjusted BCR to Very High

Factor	Core Growth scenario
Benefits	Benefits would need to increase by £76.125m or 17.61%
Costs	Costs would need to decrease by £19.031m or 14.97%

6.16.5. To switch the scheme into the Very High VfM category, if the costs were to remain the same, benefits would need to increase by 17.61%.

6.16.6. If benefits were to stay the same, costs would need to decrease by 14.97% to switch the scheme into the Very High VfM Category.

6.17 OUTPUT OF HIGH CARBON ASSESSMENT

6.17.1. For the High Carbon value sensitivity test, all elements of benefit and cost have been maintained at the same level as the core assessment, with the exception of the values placed on carbon missions. There is no change to the assumed level of emissions, only to their economic value. The result of this assessment is set out in Table 6-42.

Table 6-42: Analysis of Monetised Costs and Benefits

Item	Core Growth	Core Growth (Lower estimate of Carbon)	Core Growth (Higher estimate of Carbon)
	£m, 2010 prices and values		
Noise	£0.038	£0.038	£0.038
Local Air Quality	£0.072	£0.072	£0.072
Greenhouse Gases	**£19.475**	**£8.833**	**£30.127**
Physical Activity (AMAT)	£8.876	£8.876	£8.876
Accidents	£18.582	£18.582	£18.582
Economic Efficiency: Consumer Users (Commuting)	£58.488	£58.488	£58.488
Economic Efficiency: Consumer Users (Other)	£167.804	£167.804	£167.804
Economic Efficiency: Business Users and Providers	£88.569	£88.569	£88.569
Wider Public Finances (Indirect Taxation Revenues)	-£53.272	-£53.272	-£53.272
Present Value of Benefits (PVB)	**£308.632**	**£297.990**	**£319.284**
Broad Transport Budget	£127.129	£127.129	£127.129
Present Value of Costs (PVC)	**£127.129**	**£127.129**	**£127.129**
Net Present Value (NPV)	**£181.503**	**£170.861**	**£192.155**
Initial BCR	**2.43**	**2.34**	**2.51**
Level 2 Benefits	**£123.759**	**£123.759**	**£123.759**
Adjusted PVB (Level 1 + Level 2)	**£432.391**	**£421.749**	**£443.043**
PVC (same as above)	**£127.129**	**£127.129**	**£127.129**
Net Present Value (NPV)	**£305.262**	**£294.620**	**£315.914**
Adjusted BCR	**3.40**	**3.32**	**3.48**

6.17.2. The VfM is not affect and remains in the **High** category for both the Initial and Adjusted BCR.

6.18 APPRAISAL SUMMARY TABLE

6.18.1. The AST presents all the evidence from the economic appraisal a single table. It records all the impacts which have been assessed and described above – economic, fiscal and environmental impacts – assessed using monetised, quantitative or qualitative information as appropriate. The AST for the scheme, in line with TAG requirements, is included in Appendix H.1 for the Core Growth scenario, Appendix H.2 for the Low Growth scenario, Appendix H.3 for the High Growth scenario and Appendix H.4 for the Core Growth (Sensitivity) scenario.

6.19 SUMMARY OF THE ECONOMIC CASE (CORE GROWTH SCENARIO)

6.19.1. The Economic Case identifies and assesses all the impacts of the scheme to determine its overall Value for Money. It takes account of the costs of developing, building, operating and maintaining the scheme, and a full range of its impacts, including those impacts which can be monetised.

6.19.2. The Initial BCR for the Core Growth scenario is **2.43**, indicating **High** Value for Money category according to the DfT Value for Money Framework.

6.19.3. Once the full scheme impacts are included the Adjusted BCR for the Core Growth scenario is **3.40** which strengthens the **High** Value for Money category. The scheme would need to deliver greater than the calculated benefits to reach the Very High Value for Money category.

6.20 SENSITIVITY AND RISK PROFILE

6.20.1. There are key uncertainties which can affect the scheme costs and impacts/benefits, these include changes to the scheme cost which affect the PVC of the scheme and changes to demand and economic growth which can affect the PVB of the scheme.

6.20.2. The cost of the scheme can be influenced by a number of factors, including cost of materials, cost of labour, and delay to programme.

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

- TAG Sensitivity Databook
- High and low traffic growth scenarios
- Alternative levels of Optimism Bias (different stages of the business case)
- Alternative levels of Additionality applied to dependent development impacts.

SENSITIVITY TESTING GROWTH SCENARIO

6.20.4. A Sensitivity Testing Growth scenario has been undertaken using the TAG Sensitivity Databook (V1.14). The Databook reflects changes in economic and population parameters projects provided by the Office for Budget Responsibility (OBR). This Sensitivity Testing Growth scenario is shown in Table 6-43.

Table 6-43: Sensitivity Testing Growth scenario

£m in 2010 prices and values	Values
Initial PVB	£233.735
Wider Economic Impacts & reliability	£90.692
Adjusted Present Value of Benefits (PVB)	**£324.427**
Present Value of Costs (PVC)	**£127.129**
Net Present Value (NPV)	**£197.298**
Adjusted BCR	**2.55**

6.20.5. These results show that the BCR remains above 2 and within the High Value for Money category. This increases the level of certainty in the VfM associated with a reduction in Transport User Benefits and COBALT.

LOW GROWTH SCENARIO AND HIGH GROWTH SCENARIO

6.20.6. Another key uncertainty identified regards demand growth in the vicinity of the proposed scheme. To assess the impact of this uncertainty, sensitivity tests have been devised in line with guidance in TAG Unit M4. These sensitivity tests are provided in Table 6-44.

Table 6-44: Low Growth scenario and High Growth scenario testing

£m in 2010 prices and values	Low Growth	High Growth
Initial PVB	£257.540	£370.665
Wider Economic Impacts & Reliability	£108.767	£126.742
Adjusted Present Value of Benefits (PVB)	**£366.307**	**£497.407**
Present Value of Costs (PVC)	**£127.129**	**£127.129**
Net Present Value (NPV)	**£239.178**	**£370.278**
Adjusted BCR	**2.88**	**3.91**

6.20.7. These results show that the BCR remains above 2 and within the High Value for Money category for the Low Growth scenario. This increases the level of certainty in the VfM associated with a significant reduction in Transport User Benefits. For the High Growth scenario the adjusted BCR is pushed to the top of High Value for Money category.

6.21 VALUE FOR MONEY STATEMENT

6.21.1. In considering overall Value for Money, attention must be paid to the Initial BCR and Adjusted BCR, as well as non-monetised impacts. The Value for Money statement provides a summary of these considerations and is presented in Table 6-45 for the Core Growth scenario, Table 6-46 for the Low Growth scenario, Table 6-47 for the High Growth scenario and Table 6-48 for the Core Growth (Sensitivity) scenario.

Table 6-45: Value for Money Statement for the Core Growth scenario

	Core Growth scenario	Detail
Initial Benefit to Cost Ratio	2.43	Calculated using TAG guidance
Adjusted Benefit to Cost Ratio	3.40	Includes wider impacts
Qualitative Assessment	At this time these are considered to be Adverse	**The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**
Key Risk	There is a risk element of £39.975m	Risk allowance quantified to an appropriate level for this stage of scheme design
Value for Money category	High	Initial BCR and Adjusted BCR are in the High Value for Money category, which is supported by the qualitative assessment

Table 6-46: Value for Money Statement for the Low Growth scenario

	Low Growth scenario	Detail
Initial Benefit to Cost Ratio	2.03	Calculated using TAG guidance
Adjusted Benefit to Cost Ratio	2.88	Includes wider impacts
Qualitative Assessment	At this time these are considered to be Adverse	**The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**
Key Risk	There is a risk element of £39.975m	Risk allowance quantified to an appropriate level for this stage of scheme design
Value for Money category	High	Initial BCR is in the High Value for Money category, which is supported by the qualitative assessment. BCR based on Greenhouse gases, travel time benefits, accident benefits and physical activity

Table 6-47: Value for Money Statement for the High Growth Scenario

	High Growth scenario	Detail
Initial Benefit to Cost Ratio	2.92	Calculated using TAG guidance
Adjusted Benefit to Cost Ratio	3.91	Includes wider impacts
Qualitative Assessment	At this time these are considered to be Adverse	**The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**
Key Risk	There is a risk element of £39.975m	Risk allowance quantified to an appropriate level for this stage of scheme design
Value for Money category	High	Initial BCR is in the High Value for Money category, which is supported by the qualitative assessment. BCR based on travel time benefits, accident benefits and physical activity

Table 6-48: Value for Money Statement for the Core Growth (Sensitivity) scenario

	Core Growth (Sensitivity) scenario	Detail
Initial Benefit to Cost Ratio	1.84	Calculated using TAG guidance
Adjusted Benefit to Cost Ratio	2.55	Includes wider impacts
Qualitative Assessment	At this time these are considered to be Adverse	**The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further**
Key Risk	There is a risk element of £39.975m	Risk allowance quantified to an appropriate level for this stage of scheme design
Value for Money category	Medium	Initial BCR is in the High Value for Money category, which is supported by the qualitative assessment. BCR based on travel time benefits, accident benefits and physical activity

6.21.2. The information presented in the economic case for the Norwich Western Link shows that the Value for Money category for the Core Growth scenario is in the **High** Value for Money category for the Initial BCR and for the Adjusted BCR.

6.21.3. The Value for Money category for the Low Growth scenario and the High Growth scenario are in the **High** VfM category for the Initial BCR and for the Adjusted BCR. The Core Growth (Sensitivity) scenario is in the **Medium** (**1.84**) category for the Initial BCR but in the **High** (**2.55**) for the Adjusted BCR.

7

CONCLUSION

7 CONCLUSION

7.1 INTRODUCTION

7.1.1. This Economic Appraisal Report sets out the assessment of the benefits that the Norwich Western Link scheme is forecast to deliver to society as a whole.

7.2 CORE GROWTH SCENARIO: BENEFITS

7.2.1. The economic appraisal has been quantified in terms of the travel time benefits assessed by TUBA, accident benefits assessed by COBALT, Air Quality benefits and Noise benefits. Over 60 years, the Core Growth scenario for the scheme is expected to generate benefits of:

- Travel time benefits: £314.861m
- Accident benefits: £18.582m
- Indirect Tax Revenues: -£53.272m
- Air Quality benefits: £0.072m
- Greenhouse Gases: £19.475m
- Noise benefits: £0.038m
- Physical Activity benefits: £8.876m
- **Total:** **£308.632m**.

7.2.2. Other assessments undertaken qualitatively include:

- Landscape: Overall there will be a **Moderate Adverse** effect as there would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a substantial impact on tranquillity in the north
- Historic Environment: The Norwich Western Link would have a **moderate adverse** effect on the setting (context) of listed buildings located beyond the site boundary. The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further
- Biodiversity: The overall assessment score for the Norwich Western Link is a **Large Adverse** Impact due to the loss of woodland foraging habitat for bats including the barbastelle bat. The Environmental Statement will contain more detailed design information and a more thorough impact assessment (in line with CIEEM guidelines) subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further
- Water Environment: The overall Summary Assessment score for the NWL is predicted to be **Moderate Adverse**.

7.2.3. **The Environmental Statement will contain more detailed design information and a more thorough impact assessment subsequently providing more site-specific mitigation measures to attempt to reduce impacts and risks further.**

7.3 NORWICH WESTERN LINK: SCHEME COSTS

7.3.1. In line with TAG Unit A1.2 (Scheme Costs), the Present Value of Costs (PVC) only includes investment and operating costs incurred by the public sector. The total discounted Present Value of Costs (PVC) is **£127.129m**.

7.4 CORE GROWTH SCENARIO: BENEFIT TO COST RATIO (BCR)

7.4.1. This information for the Core Growth scenario shows that the Initial Present Value of Benefits (PVB) is **£308.632m** with a Present Value of Costs (PVC) of **£127.129m** which gives a Net Present Value of **£181.503m**. The results shown in Table 6-39 give an Initial Benefit to Cost Ratio (BCR) of the scheme, based on standard monetised values, of **2.43**.

7.4.2. This represents the benefits for the core elements of the scheme and is considered **High** Value for Money according to DfT guidance.

7.4.3. The DfT guidance recommends that this Initial BCR be modified to include additional elements from the AST to create an Adjusted BCR. This means that there is a need to include the assessment of the Wider Impacts which shows a benefit of **£123.759m**.

7.4.4. The Adjusted Present Value of Benefits (PVB) is **£432.391m** with a NPV of **£305.262m** giving an Adjusted BCR of **3.40**.

7.4.5. The information presented in this Economic Appraisal Report indicates that the Norwich Western Link for the Core Growth scenario is considered **High** Value for Money.

SENSITIVITY TESTING

7.4.6. The sensitivity tests applied to the appraisal results confirm the High Value for Money position is not sensitive to cost increases, or a reduction in benefits (as the BCR does not drop into the Medium Value for Money category). This increases the level of certainty that the scheme will deliver High Value for Money. When changes to the TAG Sensitivity Testing Databook (V1.14) and optimism bias have been applied, the scheme delivers an adjusted BCR which still remains **High** Value for Money Category.

Appendix A

DFT COST PRO-FORMA

Appraisal Cost Proforma Summary Sheet

Type of Year ☑

Assumptions:

Price Year Base of Capital Costs	2020/21

Weighted Investment cost optimism bias (%)	15%
Weighted Operating cost optimism bias (%)	0%

QRA / Risk total	39,975	£000s
Design Year Operating Cost (usually 15 years from opening year)	3,070	£000s
Operating Cost (all years total) - outturn	98,087	£000s

COST BREAKDOWN:

All values in £,000's (thousands)

	CAPEX at Base Cost	CAPEX at Real (exc risk)	CAPEX with risk at Real	CAPEX at Real (with OB)	CAPEX - Real, OB, defl, disc, MP of all funding options
Year	Investment Cost (in price year base in cell C3, excluding risk)	Cost including real cost inflation (Base Cost)	Risk adjusted cost	Risk adjusted cost including Optimism Bias	Risk adjusted cost including OB deflated and discounted to 2010 Market Prices
2020/21	2,536	2,536	2,536	2,917	2,051
2021/22	9,264	9,089	12,300	14,145	9,613
2022/23	8,530	8,205	13,030	14,984	9,838
2023/24	27,879	26,222	32,533	37,413	23,734
2024/25	69,849	63,774	81,166	93,341	57,211
2025/26	31,378	28,005	36,241	41,677	24,681
2026/27	0	0	0	0	0
2027/28	0	0	0	0	0
2028/29	0	0	0	0	0
2029/30	0	0	0	0	0

Totals for remaining appraisal years:

	0	0	0	0	0
Totals:	149,438	137,831	177,806	204,477	127,128

Appendix B

TRANSPORT ECONOMIC EFFICIENCY

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	66192		66192			
Vehicle operating costs	-7704		-7704			
User charges	0					
During Construction & Maintenance	0					
COMMUTING	58488	*(1a)*	58488	0	0	0

Non-business: Other	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	83680		83680			
Vehicle operating costs	84124		84124			
User charges	0					
During Construction & Maintenance	0					
NET NON-BUSINESS BENEFITS: OTHER	167804	*(1b)*	167804	0	0	0

Business			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
User benefits								
Travel time	81767		53859	27908				
Vehicle operating costs	6803		6638	165				
User charges	0							
During Construction & Maintenance	0							
Subtotal	88570	*(2)*	60497	28073	0	0	0	0

					Freight	Passengers	
Private sector provider impacts							
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	88570	*(5) = (2) + (3) + (4)*					

TOTAL		
Efficiency Benefits (TEE)	314862	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
values

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	**TOTAL**		**Private Cars and LGVs**	**Passengers**	**Passengers**	
Travel time	58603		58603			
Vehicle operating costs	-6369		-6369			
User charges	0					
During Construction & Maintenance	0					
COMMUTING	52234	*(1a)*	52234	0	0	0

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	**TOTAL**		**Private Cars and LGVs**	**Passengers**	**Passengers**	
Travel time	67572		67572			
Vehicle operating costs	74700		74700			
User charges	0					
During Construction & Maintenance	0					
NET NON-BUSINESS BENEFITS: OTHER	142272	*(1b)*	142272	0	0	0

Business

User benefits			**Goods Vehicles**	**Business Cars & LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	65818		43116	22702				
Vehicle operating costs	5017		4903	114				
User charges	0							
During Construction & Maintenance	0							
Subtotal	70835	*(2)*	48019	22816	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	70835	*(5) = (2) + (3) + (4)*				

TOTAL		
Efficiency Benefits (TEE)	265341	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
values

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	92611		92611			
Vehicle operating costs	-8292		-8292			
User charges	0					
During Construction & Maintenance	0					
COMMUTING	84319	*(1a)*	84319	0	0	0

Non-business: Other	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	115804		115804			
Vehicle operating costs	92559		92559			
User charges	0					
During Construction & Maintenance	0					
NET NON-BUSINESS BENEFITS: OTHER	208363	*(1b)*	208363	0	0	0

Business

User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time	105664		69065	36599				
Vehicle operating costs	10407		9619	788				
User charges	0							
During Construction & Maintenance	0							
Subtotal	116071	*(2)*	78684	37387	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	116071	*(5) = (2) + (3) + (4)*				

TOTAL		
Efficiency Benefits (TEE)	408753	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
values

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	51625		51625			
Vehicle operating costs	-8468		-8468			
User charges	0					
During Construction & Maintenance	0					
COMMUTING	43157	*(1a)*	43157	0	0	0

Non-business: Other	ALL MODES TOTAL		ROAD Private Cars and LGVs	BUS and COACH Passengers	RAIL Passengers	OTHER
User benefits						
Travel time	64540		64540			
Vehicle operating costs	75572		75572			
User charges	0					
During Construction & Maintenance	0					
NET NON-BUSINESS BENEFITS: OTHER	140112	*(1b)*	140112	0	0	0

Business

User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time	64269		42585	21684				
Vehicle operating costs	5222		5172	50				
User charges	0							
During Construction & Maintenance	0							
Subtotal	69491	*(2)*	47757	21734	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	69491	*(5) = (2) + (3) + (4)*				

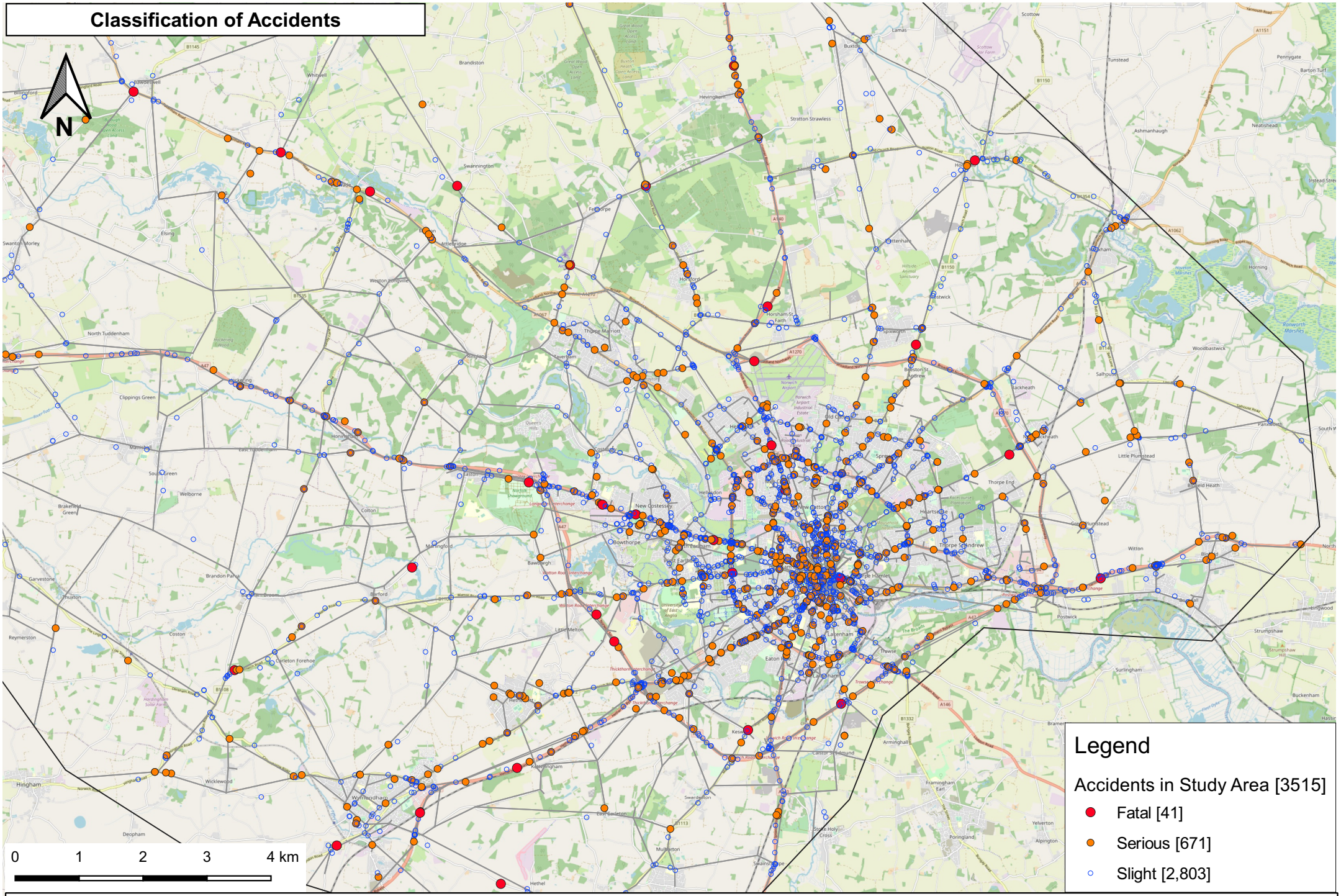
TOTAL		
Efficiency Benefits (TEE)	252760	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
values

Appendix C

COBALT NETWORK

Classification of Accidents

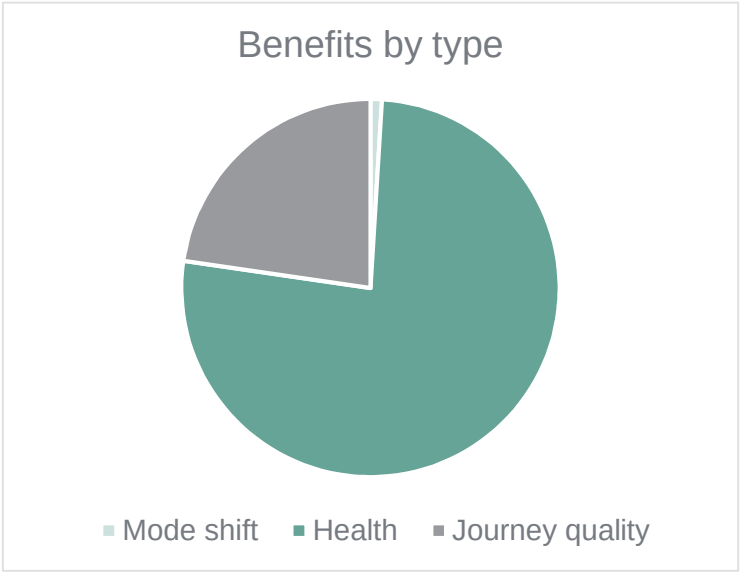


Appendix D

PHYSICAL ACTIVITY

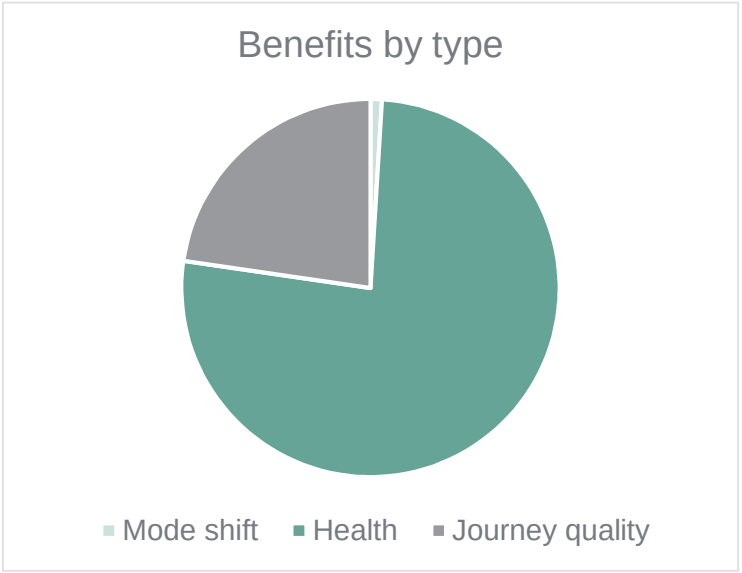
Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	22.18
Infrastructure maintenance	0.49
Accident	3.44
Local air quality	0.54
Noise	0.18
Greenhouse gases	3.01
Reduced risk of premature death	1648.51
Absenteeism	210.20
Journey ambience	552.60
Indirect taxation	-6.47
Government costs	0.00
Private contribution	0.00
PVB	2434.18
PVC	-0.49
BCR	**-4958.63**

Benefits by type:		
Mode shift	23.35	1.0%
Health	1858.72	76.3%
Journey quality	552.60	22.7%



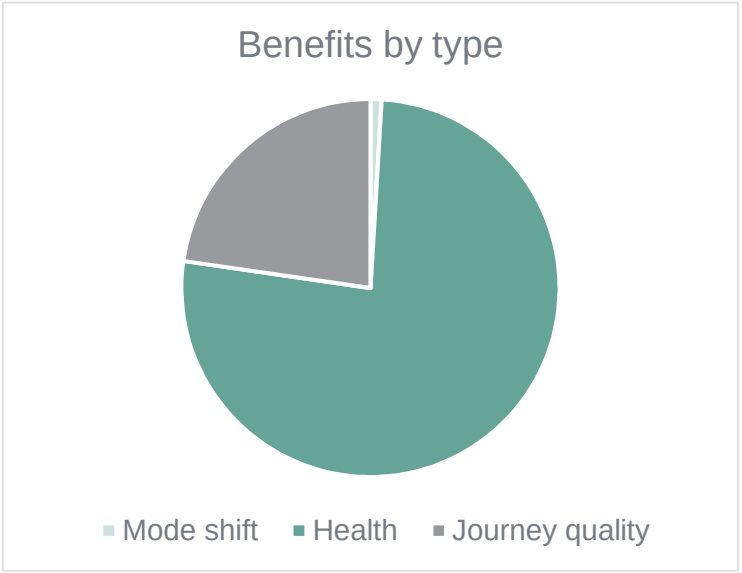
Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	15.92
Infrastructure maintenance	0.35
Accident	2.47
Local air quality	0.38
Noise	0.13
Greenhouse gases	2.16
Reduced risk of premature death	1183.12
Absenteeism	150.86
Journey ambience	396.68
Indirect taxation	-4.64
Government costs	0.00
Private contribution	0.00
PVB	1747.06
PVC	-0.35
BCR	**-4958.87**

Benefits by type:		
Mode shift	16.76	1.0%
Health	1333.98	76.3%
Journey quality	396.68	22.7%



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	42.77
Infrastructure maintenance	0.95
Accident	6.63
Local air quality	1.03
Noise	0.34
Greenhouse gases	5.80
Reduced risk of premature death	3179.28
Absenteeism	405.39
Journey ambience	1066.81
Indirect taxation	-12.48
Government costs	0.00
Private contribution	0.00
PVB	4695.57
PVC	-0.95
BCR	**-4959.77**

Benefits by type:		
Mode shift	45.04	1.0%
Health	3584.67	76.3%
Journey quality	1066.81	22.7%



Appendix E

ENVIRONMENTAL

Appendix E.1

AIR QUALITY

Air Quality Valuation Workbook - Worksheet 3

Scheme Name:	Norwich Western Link
Present Value Base Year	2010
Current Year	2020
Proposal Opening year:	2025
Project (Road/Rail or Road and Rail):	Road Transport (RT)

Overall Assessment Score:

Damage Costs Approach (Emissions)

Present value of change in NOx emissions (£):	£0
Present value of change in PM2.5 emissions (£):	£0
OR	
Present value of change in PM10 emissions (£):	£0

Impact Pathways Approach (Concentrations)

Present value of change in NO2 concentrations (£):	£9,803
Of which:	
Concentration costs:	£69,555
Other impacts:	-£59,752
Present value of change in PM2.5 concentrations (£):	£62,165
Of which:	
Concentration costs:	£62,211
Other impacts:	-£46

Total Change

Total value of change in air quality (£):	£71,968

*positive value reflects a **net benefit** (i.e. air quality improvement)

Quantitative Assessment:

Impact Pathways Approach (Concentrations)

Change in NO2 assessment scores over 60 year appraisal period: (between 'with scheme' and 'without scheme' scenarios)	-10,684.21
Change in PM2.5 assessment scores over 60 year appraisal period: (between 'with scheme' and 'without scheme' scenarios)	-1,172.63

Damage Costs Approach (Emissions)

Change in NOX emissions over 60 year appraisal period (tonnes): (between 'with scheme' and 'without scheme' scenarios)	0
Change in PM2.5 emissions over 60 year appraisal period (tonnes): (between 'with scheme' and 'without scheme' scenarios)	0
OR	
Change in PM10 emissions over 60 year appraisal period (tonnes): (between 'with scheme' and 'without scheme' scenarios)	0

Qualitative Comments:

The air quality impacts appraisal has been undertaken in accordance with TAG Unit A3 methodology. The calculations are based on the traffic forecasts for the do-minimum and do-something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the Norwich Area Transport Strategy (NATS) traffic model for the OBC.

The affected road links map onto PCM links which are all compliant with the NO2 limit value both with and without scheme. The Impact Pathways approach has been applied in valuation. This accounts for impacts in terms of changes in human exposure to ambient concentations of air pollutants, and impacts that do not directly affect households such as ecosystem damages which are determined in terms of changes in emissions.

Comments on assumptions and uncertainties:
1) Impacts in the design year (2040) are based on vehicle emissions factors and background concentrations for 2030 as the last forecast year in Defra's Emissions Factors Toolkit version 10.1 and 2018-based background map dataset. 2030 emissions factors and background concentrations are applied in all years thereafter, up to the end of the 60 year appraisal period (2084). Consequently, any improvements in air quality that may occur after 2030 are not factored into the appraisal. In this respect the appraisal is considered to be conservative.
2) Traffic growth has not been forecast beyond 2040 and so traffic levels are assumed to be the same in all years thereafter, up to the end of the 60 year appraisal period). In this respect the appraisal is considered to be conservative.

Sensitivity Analysis:

Upper estimate net present value of change in air quality (£):	£284,764
Lower estimate net present value of change in air quality (£):	-£6,445

Data Sources:

Traffic data from NATS model output. Emissions from Defra Emissions Factors Toolkit v10.1. Defra 2018-based background pollutant maps. Pollution Climate Mapping model, 2017 reference year (Open Government Licence v3.0). Property counts derived from Ordnance Survey AddressBase data (under contractor licence from NCC).

Appendix E.2

GREENHOUSE GASES

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: Norwich Western Link

Present Value Base Year 2010

Current Year 2020

Proposal Opening year: 2025

Project (Road/Rail or Road and Rail): road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £19,474,620

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): -456,434
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded -13005

Change in carbon dioxide equivalent emissions in opening year (tonnes): -4,292
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): £569,253
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	0	-269.0709127
Non-traded sector	0	0	0	-13371.33319

Qualitative Comments:

The greenhouse gases appraisal for road transport emissions has been undertaken in accordance with TAG Unit A3 methodology. The calculations are based on the traffic forecasts for the do-minimum and do-something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the Norwich Area Transport Strategy (NATS) traffic model for the OBC. Non-traded CO2e emissions (petrol and diesel vehicles) and CO2e traded emissions (electric vehicles) have been calculated in accordance with DMRB LA 114. The substantial differences in the findings compared to those for Scheme 'Option C' those presented in the SOBC are largely attributed to the major updates to the NATS model for the OBC and DMRB methodology (previously HA 207/07) for calculating emissions of greenhouse gases from road traffic.

Comments on assumptions and uncertainty:
1) Emissions have been calculated across the whole of the NATS model simulation area.
2) Emissions have been estimated for scenarios in 2025 and 2040. For each year between the emissions have been determined by linear interpolation. In the absence of any data for the intervening years, this pragmatic approach adds a degree of uncertainty to the TAG calculations for these years.
3) The NATS model future forecast year is 2040. Beyond 2040 no traffic growth has been assumed. In reality some inter-annual variations in traffic levels and emissions can be expected. This factor adds a degree of uncertainty to the appraisal.
4) Emissions have been estimated based on vehicle fleet composition forecasts which were published pre-COVID-19. The likely impact of COVID-19 on fleet composition in future years cannot be predicted with any certainty at this present time.

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £30,126,533

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	£8,833,474

Data Sources:

Traffic data for do-minimum and do-something scenarios in 2025 and 2040 were derived from the NATS model. 'Real-world' link length data used in the calculation of CO2 emissions were derived from Ordnance Survey Open Data and MasterMap base map products. CO2 emissions were calculated using EFT version 10.1.

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NWL (low traffic growth sensitivity test)

Present Value Base Year	2010
Current Year	2020
Proposal Opening year:	2025
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): £17,445,270

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): -410,056
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded -12458

Change in carbon dioxide equivalent emissions in opening year (tonnes): -4,226
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): £545,268
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	0	-258.9681217
Non-traded sector	0	0	0	-13020.77051

Qualitative Comments:

The greenhouse gases appraisal for road transport emissions has been undertaken in accordance with TAG Unit A3 methodology. The calculations are based on the traffic forecasts for the do-minimum and do-something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the Norwich Area Transport Strategy (NATS) traffic model for the OBC, assuming low traffic growth. Non-traded CO2e emissions (petrol and diesel vehicles) and CO2e traded emissions (electric vehicles) have been calculated in accordance with DMRB LA 114. The substantial differences in the findings compared to those for Scheme 'Option C' those presented in the SOBC are largely attributed to the major updates to the NATS model for the OBC and DMRB methodology (previously HA 207/07) for calculating emissions of greenhouse gases from road traffic.

Comments on assumptions and uncertainty:
1) Emissions have been calculated across the whole of the NATS model simulation area.
2) Emissions have been estimated for scenarios in 2025 and 2040. For each year between the emissions have been determined by linear interpolation. In the absence of any data for the intervening years, this pragmatic approach adds a degree of uncertainty to the TAG calculations for these years.
3) The NATS model future forecast year is 2040. Beyond 2040 no traffic growth has been assumed. In reality some inter-annual variations in traffic levels and emissions can be expected. This factor adds a degree of uncertainty to the appraisal.
4) Emissions have been estimated based on vehicle fleet composition forecasts which were published pre-COVID-19. The likely impact of COVID-19 on fleet composition in future years cannot be predicted with any certainty at this present time.

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £26,981,450

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£):	£7,918,856

Data Sources:

Traffic data for do-minimum and do-something scenarios in 2025 and 2040 were derived from the NATS model. 'Real-world' link length data used in the calculation of CO2 emissions were derived from Ordnance Survey Open Data and MasterMap base map products. CO2 emissions were calculated using EFT version 10.1.

Appendix E.3

NOISE

Noise Workbook - Worksheet 1

Proposal Name:	Norwich Western Link
Present Value Base Year	2010
Current Year	2020
Proposal Opening year:	2025
Project (Road, Rail or Aviation):	road

Net present value of change in noise (£):	£38,490

*positive value reflects a **net benefit** (i.e. a reduction in noise)

Net present value of impact on sleep disturbance (£):	£40,071
Net present value of impact on amenity (£):	-£5,219
Net present value of impact on AMI (£):	£7,142
Net present value of impact on stroke (£):	-£1,387
Net present value of impact on dementia (£):	-£2,116

Quantitative results

Households experiencing increased daytime noise in forecast year:	33
Households experiencing reduced daytime noise in forecast year:	10
Households experiencing increased night time noise in forecast year:	3
Households experiencing reduced night time noise in forecast year:	10

Qualitative Comments:

The study area for the assessment has been derived based on guidance within the Design Manual for Roads and Bridges (DMRB), LA 111 Noise and Vibration, May 2020 and is set to a distance of 600m from the kerb of any new roads associated with the scheme. There are 52 residential dwellings within the study area and no additional other sensitive receptors. Generally, within the study area, noise levels are predicted to increase as a result of the scheme, with large increases predicted at isolated receptors towards the centre of the study area where low baseline levels are anticipated. However, some receptors along Wood Lane and Paddy's Lane are predicted to experience noise level reductions as a result of less vehicles using these roads in favour of the scheme.
The Highways England A47 dualling scheme has been included in both the Do-minimum (without scheme) and Do-something (with scheme) scenarios for the purpose of this assessment.

Data Sources:

Norwich Western Link Reference Design
Highways England A47 Dualling Interim Design Fix C Design
OS Mastermap data (from which buildings and roads were extracted)
OS Addressbase Plus Data
2019 LIDAR 1m DTM data
Road traffic flows as provided by project transport consultants

Appendix E.4

LANDSCAPE

TAG Landscape Impacts Worksheet

	Step 2	Step 3				Step 4
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Impact**
Pattern	The landscape to the northern end of the proposed route is a wet lowland shallow valley containing the River Wensum. To the south, the land rises up and gently undulates, becoming a plateau of small to medium regular sized fields contained by hedgerow. The River Tud valley with its associated drainage features is located to the southeast. Irregular blocks of woodland cut through this landscape, reducing the order and regularity of field pattern. There are scattered farmsteads through the landscape, along with small settlements - the most notable being Honingham to the south and Weston Longville to the west. Small lanes also cut through the landscape, generally fairly straight with gentle curves.	Local	Common feature at a local scale	Important at the local and regional level	Easily substitutable, although loss of mature hedgerow trees would take much longer (over 25 years) to re-establish.	**Slight Adverse** The Proposed Scheme would bisect and subdivide fields locally, however the alignment is reflective of the pattern of existing roads within this landscape.
Tranquillity	There is some human influence within this landscape, including scattered farmsteads and small settlements, as well as historic estates such as Morton Hall to the north. Ringland and Weston Longville are notable settlements within this landscape. The wind turbines to the east on the old airfield and overhead line which runs north to south are also notable influences within this landscape. Some arable fields have been turned into pig rearing. Views from the plateau give a wider perception of human influence, particularly of traffic along the A47 and A1067. The eastern and western fringes of the study area have the greatest human influence. Perception/ actual tranquility levels likley to be reduced where large roads are visible or where certain human influences are more visible (pig rearing and wind turbines).	Local	Not rare locally	Important at the local level.	Not easily substitutable in the north, but easier to maintain in the south through replacement hedgerow planting.	**Moderate Adverse** The introduction of the viaduct over the River Wensum will substantially reduce tranquillity in the wider area, and locally to the south due to the road being largely in cutting or at-grade, with short sections on embankment influencing a wider area.
Cultural	The landscape has long been associated with farming. Field patterns are largely intact from 14th century, however there is evidence of larger fields and removal of hedgerows in some areas. There are medieval manors which form 18th-century country house estates such as Morten Hall to the north and Easton Estate to the south.	Local	Not rare locally or regionally	Important at local and regional scale.	Not easily substitutable, although former field boundaries can be readily replaced.	**Slight Adverse** The proposed route would bisect the landscape and alter the pattern of enclosure.
Landcover	Landcover is predominately arable farming throughout this landscape with mixed plantation woodland, although some fields have been turned over to pig rearing. There are small ponds throughout this landscape often regular in shape. The river valley to the north and east following the River Wensum is wet meadow and small lakes. Field are contained by hedgerows and infrequent mature trees.	Predominant landcover common at local to regional scale, others less common.	Not rare locally or regionally	Important at the local level.	Easily substitutable.	**Moderate Adverse** The Proposed Scheme would introduce a new viaduct and large dual carriageway through the landscape, and result in the loss of some of the plantation woodland and arable fields.
Summary of character	The landscape is gently undulating arable farmland, with plateau to the south, located between two shallow river valleys. River Tud in the south and River Wensum in the north being the larger of the valleys with noticeable difference in character of wet meadow and mosaic of lakes and drainage ditches. There is some human influence, of note is the over-head line and two wind turbines to the west, with the A47 and A1067 noticeable from the plateau. Settlement is sparse, mainly small farmsteads - the biggest settlement is Honingham located to the south. Land cover is predominately arable fields, contained by clipped hedgerow and infrequent mature trees, with some fields turned to pig rearing. Mixed plantation woodland is common throughout this landscape, often following field boundaries. Roads are generally small lanes, gently curved, and following the field boundaries.	Common locally	Not rare locally or regionally	Important at the local and regional level	The majority of elements are easily substituitable, although the loss of mature hedgerow trees would take much longer to re-establish. Tranquility is also difficult to substitute. Loss of long views along the river valley is not easily substitutable along with historic elements, which would not be easily replaceable.	**Moderate Adverse** The Proposed Scheme would alter the local landscape character through the introduction of the viaduct, loss of woodland and the width of the new road (dual carriageway). However, it's impact is limited to the immediate surroundings due to the road being largely in cutting or at-grade and the presence of woodland blocks.

Reference Sources

MAGIC, Google Earth, Ordnance Survey Mapping, Natural England - National Character Area 78: Central North Norfolk, Breckland District LCA (2007), South Norfolk Landscape Assessment (2001), Broadland District Council Local Development framework - Landscape Character Assessment SPD (2013)

Step 5 - Summary Assessment Score

Moderate Adverse

Qualitative Comments

There would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a substantial impact on tranquillity in the north. The road will also alter tranquillity locally along its entire length, although more limited than the viaduct due to it largely being at-grade or in cutting. The alignment, which is duelled, is larger than the existing road infrastructure through this landscape and therefore out of character. There will be some loss of woodland and arable farmland altering land cover locally.

Appendix E.5

HISTORIC ENVIRONMENT

TAG Historic Environment Impacts Worksheet

Step 2		Step 3			Step 4
Feature	**Description**	**Scale it matters**	**Significance**	**Rarity**	**Impact**
Form	**Designated heritage assets (physically affected by the scheme)** 1. None. **Designated heritage assets (possible setting impact)** 2. Two Grade I listed buildings. 3. One Grade II* listed building. 4. Fourteen Grade II listed buildings. **Non-designated heritage assets (palaeoenvironmental, prehistoric, Roman and undated/multi-period)** 5. Cropmarks of a possible Roman field system (53485). 6. Post-Roman and undated features and prehistoric finds (63365) 7. Cropmarks of undated and multi-period linear ditches (50605) 8. The findspot of prehistoric flint flakes (18044). 9. Cropmarks of undated and multi-period linear ditches (54356) 10. Cropmarks of possible Iron Age/Roman field boundaries (54357). 11. Cropmarks of possible Iron Age to Roman date enclosures (50610). 12. Cropmarks of possible Iron Age to Roman date enclosures (50615). 13. The cropmarks of undated linear ditches (50619). 14. Cropmarks of undated possible ditches (53625). 15. Cropmarks of undated ditch (53681). 16. **Moderate to high potential** for possible, previously unrecorded remains of these periods 17. **Moderate potential** for palaeoenvironmental remains in the Wensum and Tud valleys. **Non-designated heritage assets (medieval, post-medieval)** 18. World War Two accommodation and training site at Morton Hall (53474). 19. The findspot of of a late Saxon brooch and medieval coin (44454) 20. Cropmarks of field boundaries and trackways of probable post medieval date (50608). 21. Cropmarks of probable post medieval date field boundaries (50609). 22. Cropmarks of probable post medieval former field boundaries (50614). 23. Cropmarks of a linear boundary or trackway of unknown, but possibly later medieval to post medieval date (50616). 24. World War One to Two date military training site (50618). 25. Attlebridge World War Two Airfield (3063). 26. Honingham Park, a post-medieval landscape park (44183). 27. Cropmarks of field boundaries of unknown but possible medieval to post-	1. N/A 2-4. The protection of Listed Buildings is a national concern (*Planning (Listed Buildings and Conservation Areas) Act 1990*). 5. The Roman field system is of regional importance. 6. The undated features and prehistoric finds are of local or regional importance. 7. Theundated and multi-period linear ditches are of regional importance. 8. The findspot of prehistoric flint flakes is of local importance. 9 . The undated and multi-period linear ditches are of regional importance. 10. Iron Age/Roman field boundaries are of regional importance. 11. Iron Age/Roman enclosures are of regional or national importance. 12. Iron Age/Roman enclosures are of regional or national importance. 13. The undated linear ditches are of regional importance. 14. The undated possible ditches are of regional importance. 15. The undated ditch is of regional importance. 16. Previously unrecorded remains are of undetermined importance. 17. Possible palaeoenvironmental remains are of local importance. 18. The World War Two accommodation and training site at Morton Hall are of regional importance. 19. The late Saxon brooch and medieval coin are of local importance. 20. The field boundaries and trackways of probable post medieval date are of local importance. 21. The probable post medieval date field boundaries are of local importance. 22. The probable post medieval former field boundaries are of local importance. 23. The linear boundary or trackway of unknown, but possibly later medieval to post medieval date is of local importance. 24. The World War One to Two date military training site is of regional importance.	1. N/A 2. The Grade I listed buildings are of High significance. 3. The Grade II* listed building is of High significance. 4. The Grade II listed buildings are of Medium significance. 5. The Roman field system is of Medium significance. 6. The undated features and prehistoric finds are of Low or Medium significance. 7. Cropmarks of undated and multi-period linear ditches are of Low or Medium significance. 8. The findspot of prehistoric flint flakes is of Low significance. 9 . The undated and multi-period linear ditches are of Medium significance. 10. Iron Age/Roman field boundaries are of Medium significance. 11. Iron Age/Roman enclosures are of Medium or High significance. 12. Iron Age/Roman enclosures are of Medium or High significance. 13. The undated linear ditches are of Low or Medium significance. 14. The undated possible ditches are of Low or Medium significance. 15. The undated ditch is of Low or Medium significance. 16. Previously unrecorded remains are of undetermined significance. 17. Possible palaeoenvironmental remains are of Low significance. 18. The World War Two accommodation and training site at Morton Hall are of Medium significance. 19. The late Saxon brooch and medieval coin are of Low significance. 20. The field boundaries and trackways of probable post medieval date are of Low significance. 21. The probable post medieval date field boundaries are of Low significance. 22. The probable post medieval former field boundaries are of Low significance. 23. The linear boundary or trackway of unknown, but possibly later medieval to post medieval date is of Low significance.	1. N/A 2. Nationally, 2.5% of listed buildings are Grade I, making them rare and of 'exceptional interest.' 3. Nationally, 5.8% of listed buildings are Grade II*, making them rare and of 'more than special interest.' 4. Nationally, 92% of listed buildings are Grade II, making then less rare but still of national importance. 5. Roman field systems are relatively rare. 6. Post-Roman and undated features and prehistoric finds are relatively common. 7. Cropmarks of undated and multi-period linear ditches are common. 8. Findspots of prehistoric flint flakes are common. 9. The undated and multi-period linear ditches are relatively common. 10. Iron Age/Roman field boundaries are relatively rare. 11. Iron Age/Roman enclosures are relatively rare. 12. Iron Age/Roman enclosures are relatively rare. 13. Undated linear ditches are relatively common. 14. Undated possible ditches are relatively common. 15. Undated ditches are relatively common. 16. The rarity of any unrecorded remains is unknown. 17. Palaeoenvironmental remains are common within alluvial deposits. 18. World War Two accommodation and training sites are relatively rare. 19. Late Saxon brooch and medieval coins are are relatively rare. 20. Field boundaries and trackways of probable post medieval date are common. 21. Post medieval date field boundaries are common. 22. Post medieval former field boundaries are common. 23. Linear boundaries or trackways are common. 24. World War One to World War Two military training sites are relatively rare. 25. World War Two airfields are relatively rare. 26. Landscape parks are relatively rare. 27. The field boundaries of unknown but possible medieval to post medieval date are of Low significance	Moderate Adverse (Built heritage) Low, Moderate or Major Adverse (Archaeology)
Survival	1. N/A. 2-4. The listed buildings are likely to have a good level of survival. Note that the Grade II* listed Church of St Michael is largely a ruin. 5. The level of survival of the Roman field system is unknown. 6. The level of survival of the Post-Roman and undated features and prehistoric finds is unknown. 7. The level of survival of undated and multi-period linear ditches is unknown. 8. No survival, the flint flakes will have been removed. 9. The level of survival of undated and multi-period linear ditches is unknown. 10. The level of survival of Iron Age/Roman field boundaries is unknown. 11. The level of survival of Iron Age/Roman enclosures is unknown. 12. The level of survival of Iron Age/Roman enclosures is unknown. 13. The level of survival of undated linear ditches is unknown. 14. The level of survival of undated possible ditches is unknown. 15. The level of survival of undated ditch is unknown. 16. The level of survival of previously unrecorded remains is unknown.	2-34: The level of survival is not directly relevant to the impacts on heritage assets. 35. N/A.	2-34: The level of survival is not directly relevant to the impacts on heritage assets.	2-34: The level of survival is not directly relevant to the impacts on heritage assets.	N/A
Condition	1. N/A. 2. The condition of the Grade I listed buildings is unknown. 3. The condition of the Grade II* listed building is unknown. 4. The condition of the Grade II listed buildings is unknown. 5. The condition of the Roman field system is unknown. 6. The condition of the Post-Roman and undated features and prehistoric finds is unknown. 7. The condition of the undated and multi-period linear ditches is unknown. 8. The condition of the flint flakes is unknown. 9. The condition of the undated and multi-period linear ditches is unknown. 10. The condition of the Iron Age/Roman field boundaries is unknown. 11. The condition of the Iron Age/Roman enclosures is unknown. 12. The condition of the Iron Age/Roman enclosures is unknown. 13. The condition of the undated linear ditches is unknown. 14. The condition of the undated possible ditches is unknown. 15. The condition of the undated ditch is unknown. 16. The condition of any previously unrecorded remains is unknown. 17. The condition of any palaeoenvironmental remains is unknown. 18. The condition of the World War Two accommodation and training site is unknown. 19. The condition of the late Saxon brooch and medieval coin will have been removed	2-34. The condition is not directly relevant to the impacts on heritage assets. 35. N/A.	2-34. The condition is not directly relevant to the impacts on heritage assets. 35. N/A.	2-34. The condition is not directly relevant to the impacts on heritage assets. 35. N/A.	N/A
Complexity	1. N/A. 2. The complexity of the Grade I listed buildings will include their relationships to other heritage assets and to the wider rural landscape. 3. The complexity of the Grade II* listed building will include its relationship to other heritage assets and to the wider rural landscape. 4. The complexity of the Grade II listed buildings will include their relationships to other heritage assets and to the wider rural landscape. 5. The complexity of the Roman field system is unknown. 6. The complexity of the Post-Roman and undated features and prehistoric finds is unknown. 7. The complexity of the undated and multi-period linear ditches is unknown. 8. The complexity of the flint flakes is unknown. 9. The complexity of the undated and multi-period linear ditches is unknown. 10. The complexity of the Iron Age/Roman field boundaries is unknown. 11. The complexity of the Iron Age/Roman enclosures is unknown. 12. The complexity of the Iron Age/Roman enclosures is unknown. 13. The complexity of the undated linear ditches is unknown. 14. The complexity of the undated possible ditches is unknown. 15. The complexity of the undated ditch is unknown. 16. The complexity of any previously unrecorded remains is unknown. 17. The complexity of any palaeoenvironmental remains is unknown.	2-34. The complexity is not directly relevant to the impacts on heritage assets. 35. N/A.	2-34. The complexity is not directly relevant to the impacts on heritage assets. 35. N/A.	2-34. The complexity is not directly relevant to the impacts on heritage assets. 35. N/A.	N/A
Context	1. N/A. 2. Grade I listed buildings: relationships to assets in Weston Longville and Ringland. Both Grade I listed buildings will have historic and visual relationships to their churchyards and to the immediate rural landscape. Rural. 3. Grade II* listed building: relationship to Grade II listed buildings at or in the vicinity of Morton Hall. Relationship to immediate rural landscape. Rural. 4. Grade II listed buildings: relationships to assets in Weston Longville and Honingham. Relationships to immediate rural landscapes. Rural. 5 - 35. Rural.	2-34. Potential impacts to the context of the listed buildings through changes to their immediate setting. Setting is the way in which an asset is understood and experienced and is not an asset in itself. Changes to setting could include the loss of surrounding rural and agricultural land, impacts from traffic flow and noise, and impacts from road infrastructure, including road lighting. 5-35. The context is not impacted	2-34. Potential impacts to the context of the listed buildings through changes to their immediate setting. Setting is the way in which an asset is understood and experienced and is not an asset in itself. Changes to setting could include the loss of surrounding rural and agricultural land, impacts from traffic flow and noise, and impacts from road infrastructure, including road lighting. 5-35. The context is not impacted	2-34. Potential impacts to the context of the listed buildings through changes to their immediate setting. Setting is the way in which an asset is understood and experienced and is not an asset in itself. Changes to setting could include the loss of surrounding rural and agricultural land, impacts from traffic flow and noise, and impacts from road infrastructure, including road lighting. 5-35. The context is not impacted	N/A
Period	1. N/A. 2. Later medieval. 3. Early and Later medieval. 4. Post-medieval. 5. Roman. 6. Undated/prehistoric. 7. Undated/multi-period. 8. Prehistoric. 9. Undated/multi-period. 10. Iron Age/Roman. 11. Iron Age/Roman. 12. Iron Age/Roman. 13. Undated. 14. Undated. 15. Undated.	2-35. The period is not impacted	2-35. The period is not impacted	2-35. The period is not impacted	N/A

Reference Sources

National Heritage List for England
Norfolk Historic Environment Record
Norwich Western Link Heritage Constraints Report (WSP 2019)

Step 5 - Summary Assessment Score

Moderate Adverse (Built heritage)
Low, Moderate or Major Adverse (Archaeology)

Qualitative Comments

The Proposed Scheme would have a moderate adverse effect on the setting (context) of nearby listed buildings, and will adversely affect the appreciation and understanding of the characteristic historic environmental resource in the area of proposed road construction.
The Proposed Scheme would have a low, moderate or major adverse effect on known non-designated assets. The Proposed Scheme would have a low, moderate or major direct impact on previously unrecorded significant historic environment non-designated assets, resulting in loss of features such that their integrity is substantially compromised. The heritage significance of such assets would depend on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved). The heritage significance will be determined through future assessment, including preliminary site-based archaeological investigations.

Appendix E.6

BIODIVERSITY

TAG Biodiversity Impacts Worksheet

Step 2		Step 3				Step 4	Step 5
Area	**Description of feature/ attribute**	**Scale (at which attribute matters)**	**Importance (of attribute)**	**Trend (in relation to target)**	**Biodiversity and earth heritage value**	**Magnitude of impact**	**Assessment Score**
River Wensum Special Area of Conservation (SAC)	**Biodiversity** Chalk-fed river, designated for: Annex I habitat as a primary reason for selection: - Watercourses of plain to montane levels with a water crowfoot *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. - The Wensum represents sub-type 1 in lowland eastern England. Annex II species as a primary reason for selection: - White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes* Annex II species present as a qualifying feature: - Desmoulin's whorl snail *Vertigo moulinsiana* - Brook lamprey *Lampetra planeri* - Bullhead *Cottus gobio* To date surveys have confirmed the likely absence of white clawed crayfish from the stretch of the River Wensum which was considered relevant to the Proposed Scheme and the presence of: Water crowfoot *Ranunculion fluitantis* , Bullhead, Brook lamprey and Desmoulin's whorl snail either within the Wensum or in the supporting ditches within the floodplain.	**International**	**High** Primary habitat: Sub-type 1 has a limited distribution in the UK, being found only in those areas where chalk is present, and is therefore restricted to southern and eastern England. Primary species: White-clawed crayfish. One of only four watercourses in Norfolk that are known to support white-clawed crayfish. Other qualifying feature: Desmoulins's whorl snail. The site supports one of the largest populations in the UK. Other qualifying feature: Brook lamprey. The Wensum has a healthy population of brook lamprey, with clean water and suitable areas of gravels, silt or sand required for spawning. Other qualifying feature: Bullhead. Sites have been selected to encompass the natural geographical range of the species and to represent the range of ecological situations in which it occurs, e.g. both upland and lowland rivers, and both acidic and base-rich situations.	**Target Feature** Anthropogenic influences have had a dramatic effect on the ecology and hydrology of the River Wensum, in particular at sites up and downstream of mill structures, sites affected by channel modification inc. over-widening and deepening, sites affected by excessive silt ingress, sites that are heavily maintained and sites that lack natural riparian vegetation. The following document has been published that includes specific restoration targets for the qualifying features of the SAC: *European Site Conservation Objectives: Supplementary advice on conserving and restoring site features (Natural England 2019).*	**Very high** Internationally important site with limited potential for substitution.	**Neutral**	**Neutral**
River Wensum Site of Special Scientific Interest (SSSI)	**Biodiversity** Overlaps with River Wensum SAC (see above cell). Notified for: - Flowing waters - Type I: naturally eutrophic lowland rivers with a high base flow. - Flowing waters - Type III: base-rich, low-energy lowland rivers and streams, generally with a stable flow regime - Population of RDB mollusc – Desmoulin's whorl snail. - S25 - Phragmites australis - Eupatorium cannabinum tall-herb fen. - S3 - Carex paniculata swamp. - S4 - Phragmites australis swamp and reed-beds - S5 - Glyceria maxima swamp - S7 - Carex acutiformis swamp - White-clawed crayfish To date, surveys have confirmed the likely absence of white clawed crayfish from the stretch of the River Wensum which was considered relevant to the Scheme and the presence of Desmoulin's whorl snail either within the Wensum or in the supporting ditches within the floodplain.	**National**	**High** The River Wensum is a SSSI of national importance, supporting a diverse range of protected habitats and species.	**Unknown** The trend for the SSSI is currently unknown. No assessments within the last five years. Target species - See above for trends regarding white-clawed crayfish and Desmoulin's whorl snail. Of the 36 SSSI units for this site, 6 were considered to be in 'Favourable' condition in 2010, with the remaining 30 considered to be in 'Unfavourable - Recovering' condition.	**High** Nationally important site with no potential for substitution.	**Neutral**	**Neutral**
River Wensum Pastures, Ringland Estates County Wildlife Site (CWS)	**Biodiversity:** Predominantly an improved cattle-grazed pasture adjacent to the River Wensum, crossed by a network of drains supporting a species-rich flora associated with aquatic habitats.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown -** The Norfolk BAP does not identify a trend in relation to the habitats associated with this CWS.	**Medium** - County value site with potential for substitution.	**Minor negative**	**Slight adverse**
Wensum Pastures at Morton Hall CWS	**Biodiversity:** Predominantly improved cattle-grazed pasture adjacent to River Wensum, crossed by a network of drains supporting a species-rich flora associated with aquatic habitats.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Intermediate negative**	**Moderate adverse**
Land adjoining Foxburrow Plantation CWS	**Biodiversity:** Part of a larger area known collectively as Foxburrow Plantation and The Waterfence. It consists of an extensive area of wet, species-rich grassland situated in the bottom of a spring-fed valley.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Intermediate negative**	**Moderate adverse**
Broom & Spring Hills CWS	**Biodiversity:** Semi-natural deciduous woodland dominated by oak and sycamore.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Intermediate negative**	**Moderate adverse**
Primrose Grove CWS	**Biodiversity:** Structurally varied, predominately consisting of semi-natural broad-leaved and mixed woodland, with some compartments considered to be ancient. Broad-leaved woodland comprised with varying proportions of oak, beech, sycamore and ash. Mixed woodland is represented by Douglas Fir and Scot's Pine.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Intermediate negative**	**Moderate adverse**

Attlebridge Hills CWS	**Biodiversity:** Structurally varied, broad-leaved semi-natural woodland. The canopy is dominated by mature oak, sycamore, sweet chestnut with extensive areas of mixed coppice of hazel, sycamore and sweet chestnut.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown -** The Norfolk BAP does not identify a trend in relation to the habitats associated with this CWS.	**Medium** - County value site with potential for substitution.	**Minor negative**	**Slight adverse**
Gravelpit Plantation and Church Hill CWS	**Biodiversity:** Closed canopy semi-natural broad-leaved and mixed plantation woodland, with some stands considered to be ancient in origin. Canopy dominated to varying degrees by oak, ash and sycamore, and the shrub layer is comprised of hawthorn, hazel and holly.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Minor negative**	**Slight adverse**
Old Covert, Wood Land CWS	**Biodiversity**: A coppice woodland with standards that are not listed on the Ancient Woodland Inventory, although it may have once been part of a larger, Ancient Woodland. The wood is managed as coppice and for shooting.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Minor negative**	**Slight adverse**
Mouse Wood CWS	**Biodiversity:** Citation refers to an ancient, replanted woodland which is now predominantly a commercially-managed conifer plantation surrounded mainly by arable farmland. The extent of the existing ancient woodland is unknown.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Minor negative**	**Slight adverse**
River Tud at Easton and Honingham CWS	**Biodiversity:** Citation refers to a watercourse supporting a spcies-rich aquatic, marginal and emergent riverine flora.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Neutral**	**Neutral**
Church Meadow, Alder Carr, Three Corner Thicket and Nursery Plantation CWS	**Biodiversity:** Citation refers to a site comprising mainly cattle grazed, inimprove wet pasutre, bisected by spring-fed ditches. With ares of wet and dry woodland.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Neutral**	**Neutral**
Taverham Mill CWS	**Biodiversity:** Citation refers to a fishing lake surrounded by marshy and neutral grassland and a mixture of planted and semi-natural woodland on acid soil.	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Neutral**	**Neutral**
Ringland Pits CWS	**Biodiversity:** Citation refers to a flooded disused gravel workings adjacent to the River Wensum .	**County**	**Medium -** Site of county value supporting Habitat of Principal Importance.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this CWS.	**Medium** - County value site with potential for substitution.	**Neutral**	**Neutral**
Fakenham Road Roadside Nature Reserve (RNR)	**Biodiversity:** Species: Hoary mullein V*erbascum pulverentum.* Phase 1 habitat surveys of this area have identified the presence of this species.	**County**	**Medium -** Site of county value, with only one qualifying feature behind the designation.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this species.	**Medium** - County value site with potential for substitution.	**Major negative**	**Moderate adverse**
Ancient Woodland	**Biodiversity**: Ancient Woodland is an irreplacable habitat which is important for many reasons, including its value to wildlife, i.e. bats, birds and fungi. Primrose Grove CWS is also partially designated as Ancient Woodland, as well as other woodland blocks in the local area.	**National**	**High** - Detailed baseline data has not been collected, although the route has potential to impact on ancient woodland. Ancient woodland is considered one of the richest land-based habitats for wildlife.	**Declining** - Ancient woodland is in significant national decline, with a current UK coverage of only 2%.	**High** - National value habitat with no potential for substitution.	**Minor Negative**	**Slight adverse**
Ancient / Veteran Trees and Hedgerows	**Biodiversity:** A number of veteran and ancient trees are present within the Scheme, both as stand-alone features and within hedgerows or other important habitats. Veteran and ancient trees are considered irreplacable habitats, and a BS5837 survey has been completed by Arboriculturists to identify trees which are veteran or ancient. Further assessment works will be completed in 2021 to consider hedgerows.	**County**	**High** - The BS5837 survey has identified a number of veteran and ancient trees within the Scheme. Veteran and ancient trees are considered to be an irreplaceable habitat and are of high value to a range of wildlife.	**Declining** - These habitat are listed as a priority under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk BAP does not identify a trend in relation to these habitat types locally.	**Medium** - County value species with no potential for substitution.	**Major negative**	**Moderate adverse**
Important Hedgerows	**Biodiversity:** Ecologically important hedgerows are recognised as hedgerows that are at least 30 years old which support a mixture of native woody species and other associated features such as mature trees, woodlands, parallel/connecting hedges, and important woodland ground flora as stated in the Hedgerow Regulations 1997. Hedgerow surveys have been completed this year which have identified the presence of a number of important hedgerows along the Scheme. Hedgerows are listed as a target species in the Norfolk Biodiversity Action Plan.	**County**	**High -** Hedgerow surveys have identified a number of important hedgerows within the Scheme, which will be impacted. Hedgerows are an important landscape feature and provide habitat connectivty and high value to a range of wildlife.	**Declining** - The lengths of managed hedgerow decreased by 6.1% between 1998 and 2007. Abundance and distribution of hedgerow trees are declining, as recognised by the Countryside Survey 2000.	**Medium** - County value habitat with limited potential for substitution.	**Intermediate negative**	**Moderate adverse**
HPI - Hedgerows	**Biodiversity:** Hedgerows are a Habitat of Principal Importance (HPI habitat), and is a target habitat as part of the Norfolk Biodiversity Action Plan. This habitat is present within the boundaries of the Proposed Scheme. Hedgerows provide habitat connectivity for a range of species throughout the landscape.	**Local**	**Medium -** Detailed habitat surveys have not yet been undertaken although it is expected that the route will impact hedgerows of county value.	**Declining** - The lengths of managed hedgerow decreased by 6.1% between 1998 and 2007. Abundance and distribution of hedgerow trees are declining, as recognised by the Countryside Survey 2000.	**Medium** - Local value species with potential for substitution.	**Minor negative**	**Minor adverse**
HPI - Floodplain Grazing Marsh	**Biodiversity:** Coastal and Floodplain grazing marsh is a Habitat of Principal Importance (HPI habitat), and is a target habitat as part of the Norfolk Biodiversity Action Plan. This habitat is present within the boundaries of the Proposed Scheme. These habitats are known to support botanical diversity and provide value to a range of invertebrates and breeding and wintering birds.	**Local**	**Medium -** Detailed habitat surveys have not yet been undertaken although it is expected that the route will impact floodplain grazing marshes of county value.	**Declining** - This habitat is listed as priority under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk BAP does not identify a trend in relation to these habitat types locally.	**Medium** - Local value species with potential for substitution.	**Minor negative**	**Minor adverse**
HPI - Arable Field Margins	**Biodiversity:** Arable Field Margins are a Habitat of Principal Importance (HPI habitat), and is a target habitat as part of the Norfolk Biodiversity Action Plan. Further survey work in 2021 will determine the presence / absence within the boundaries of the Proposed Scheme.	**Local**	**Medium -** Detailed habitat surveys have not yet been undertaken although it is expected that the route will impact arable field margins of county value.	**Declining** - This habitat is listed as priority under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk BAP does not identify a trend in relation to these habitat	**Medium** - Local value species with potential for substitution.	**Minor negative**	**Minor adverse**
HPI - Rivers and Streams	**Biodiversity:** The Proposed Scheme will intersect a number of watercourses, including the River Wensum and the River Tudd (a chalk stream), as well as a number of other small watercourses. The River Wensum is internationally designated (see site details above), whilst other watercourses within the boundaries of the Proposed Scheme are considered to be of County value.	**Local**	**High** - More than 85% of all the chalk streams in the world are in England and they are threatened nationally due to impacts from agricultural and urban development. See above for details of River Wensum SAC and SSSI designation. Other watercourses within the Proposed Scheme are also likely to support a range of wildlife and botanical diversity although detailed habitat surveys are yet to be completed.	**Declining -** Increases in population pressure leading to water pumping.	**Medium** - Local value species with potential for substitution.	**Neutral**	**Neutral**

HPI - Lowland Mixed Deciduous Woodland	**Biodiversity**: Lowland mixede deciduous woodland is a Habitat of Principal Importance (HPI). All woodland types are considered ecologically valuable habitat, providing habitat features for a range of species.	**Local**	**Medium -** Detailed habitat surveys have not yet been undertaken although it is expected that the route will impact woodlands of county value.	**Declining** - HPI habitats (such as lowland deciduous woodlands) are listed as a priority under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk	**Medium** - Local value species with potential for substitution.	**Major negative**	**Moderate adverse**
HPI - Wet Woodland	**Biodiversity**: Wet woodland is a Habitat of Principal Importance (HPI). All woodland types are considered ecologically valuable habitat, providing habitat features for a range of species.	**Local**	**Medium -** Detailed habitat surveys have not yet been undertaken although it is expected that the route will impact woodlands of county value.	**Declining** - HPI habitats (such as lowland deciduous woodlands) are listed as a priority under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk BAP does not identify a trend in relation to these habitat types locally.	**Medium** - Local value species with potential for substitution.	**Major negative**	**Moderate adverse**
Habitat listed under the Priority Habitat Inventory (within 200m)	**Biodiversity**: The geographic extent and location of Natural Environment and Rural Communities Act (2006) Section 41 habitats of principal importance.	**Local**	**Medium -** Detailed habitat surveys have not been undertaken although it is expected that the route will impact habitat listed under the Priority Habitat Inventory.	**Declining** - Priority habitats are under the Natural and Rural Communities Act (2006) due to the declining trend nationally. The Norfolk BAP does not identify a trend in relation to these habitat types locally.	**Medium** - Local value species with potential for substitution.	**Minor negative**	**Slight adverse**
Invasive Species	**Biodiversity**: Invasive plant and animal species may be present within the Scheme.	**N/A**	**N/A**	**N/A**	**Negligible**	**N/A**	**N/A**
Vascular and Non-Vascular Plants	**Biodiversity:** The Proposed Scheme supports a diverse range of habitats with the potential to support protected/notable vascular and non-vascular plants. The presence/potential presence of protected and notable flora along the Proposed Scheme have been identifed through Phase 1 habitat surveys and desk-based searches. Further surveys are due to be conducted in 2020 and 2021, and will include a specific NVC survey. Species of vascular and non-vascular plants are listed as Norfolk Biodiversity Action Plan species.	**Local**	**Medium** - detailed baseline survey data has not yet been collected, however it is anticipated that the Proposed Scheme will impact areas of protected and notable vascular and non-vascular plants.	**Unknown** - The Norfolk BAP does not identify a trend in relation to these species locally.	**Medium** - Local value species with potential for substitution.	**Minor negative**	**Slight adverse**
Macrophytes	**Biodiversity:** Macrophyte suveys have identified the water crowfoot species associated with the River Wensum SAC designation.	**International**	**High** - See SAC information above.	**Unknown** - The Norfolk BAP does not identify a trend in relation to these species locally.	**Very high** - Designated features of SAC only.	**Neutral**	**Neutral**
Fungi	**Biodiversity:** The Proposed Scheme supports a diverse range of habitats with the potential to support protected/notable fungi. The presence/potential presence of protected and notable fungi along the Proposed Scheme have been identifed through Phase 1 habitat surveys and desk-based searches. Species of fungi are listed as Norfolk Biodiversity Action Plan species.	**Local**	**Medium** - detailed baseline survey data has not yet been collected, however it is anticipated that the Proposed Scheme will impact areas of protected and notable flora, fungi, bryophyte and lichen surveys.	**Unknown** - The Norfolk BAP does not identify a trend in relation to these species locally.	**Medium** - County value species with potential for substitution.	**Minor negative**	**Slight adverse**
Lichens	**Biodiversity:** The Proposed Scheme supports a diverse range of habitats with the potential to support protected/notable lichens. The presence/potential presence of protected and notable lichens along the Proposed Scheme have been identifed through Phase 1 habitat surveys and desk-based searches.	**Local**	**Medium** - detailed baseline survey data has not yet been collected, however it is anticipated that the Proposed Scheme will impact areas of protected and notable flora, fungi, bryophyte and lichen surveys.	**Unknown** - The Norfolk BAP does not identify a trend in relation to these species locally.	**Medium** - County value species with potential for substitution.	**Minor negative**	**Slight adverse**
Fish	**Biodiversity**: The River Wensum SAC and its tributaries are designated for brook lamprey and bullhead. A fish survey completed in 2020 confirmed the presence of a range of coarse fish on the River Wensum in the vicinity of the scheme which included pike, chub, dace, roach, gudgeon and minnow. It is also highly likely that other species including bullhead and European eel are also present in the River Wensum. A survey of the connected ditches on the floodplain in the vicinity of the scheme highlighted the presence of river/brook lamprey (*Lampetra* spp.), minnow and three-spined stickleback. A survey of the Foxburrow Stream (tributary of the River Tud) resulted in no fish being observed or captured within the survey area.	**International**	**High** - See SAC information above. Additionally the route will cross minor watercourses (including drains), that may support fish. The network of connected ditches on the floodplain adjacent to the River Wensum and the marginal sediment beds within them are a particularly important habitat for lamprey.	**Unknown** - No trend has been identified nationally or locally for the two fish for which the SAC is designated.	**Very high** - Designated features of SAC (bullhead and brook lamprey only).	**Neutral**	**Neutral**
Reptiles (common and widespread species)	**Biodiversity**: Areas of rough grassland and scrub present along the length of the Proposed Scheme are likely to be suitable to support reptiles. Reptile surveys completed in 2019 and 2020 have confirmed the presence of low numbers of reptiles including grass snake and slow worm.	**Local**	**Medium** - widespread species of reptile, including slow worm and grass snake are known to be present in areas of suitable habitat, and the Scheme is ikely to impact reptile populations on a local level.	**Unknown** - The Norfolk BAP does not identify a trend in relation to these species.	**Medium** - reptiles are a species of medium biodiversity value on a national and local level.	**Neutral**	**Neutral**
Great Crested Newt *Triturus cristatus*	**Biodiversity**: Great crested newts are protected under the following legislation: Annexe II and IV of the Habitats Directive Conservation of Habitats and Species Regulations (Schedule 2) Wildlife and Countryside Act (1981) (Schedule 5) Great crested newt habitat suitability and presence/absence surveys in relation to the Proposed Scheme were completed in 2020, where access allowed. These surveys identified the presence of GCN in two ponds, which will be subject to a population class assessment in 2021. A number of ponds were not accessible for survey in 2020 and will therefore be subject to presence/absence and population class survey (where appropriate) in 2021.	**Local**	**High** - the route has potential to affect terrestrial habitat and breeding ponds used by this species.This wil be confirmed by further surveys completed in 2021.	**Target species** - GCN are targeted by the Norfolk BAP due to a major population decline in the Broads. The main objective in Norfolk is to maintain range and viability of the local population.	**High** - GCN are of high biodiversity value on a local and national level.	**Neutral**	**Neutral**
Birds	**Biodiversity**: Habitats present are suitable for use by birds. The arable fields and grasslands provide potential foraging habitat for passage/over-wintering birds such as mixed thrush flocks, skylarks and pipits. Arable fields and areas of grassland could also be used by flocks of migrant/over-wintering bird species such as geese. Wintering bird surveys will be completed in the winter of 2020/2021. The Proposed Scheme also supports extensive and diverse habitat which are likely to support breeding birds typical of these habitats (e.g. farmland, woodland) and confirmed the use of the habitats on-Site by a range of breeding bird speceis, including Barn Owl and king fisher, which are a Schedule 1 species under the Wildlife and Countryside Act (1981).	**Local**	**Medium -** Baseline data collected to-date suggests that the route will impact breeding and wintering birds at a local level.	**Unknown** - The Norfolk BAP identifies a range of bird species in significant decline on a county level.	**Medium** - The site is likely to support a diversity range of breeding and wintering bird species of local importance.	**Minor negative**	**Slight adverse**

Barn Owl	Barn owl *Tyto alba* are a Schedule 1 species under the Wildlife and Countryside Act (1981), and is a Norfolk Biodiversity Action Plan species. Incidental sightings of barn owl were recorded during surveys for other species, and barn owl tree and building roosts were identified during building surveys.	**Local**	**High** - barn owl are a Schedule 1 species and are targeted by the Norfolk Biodiversity Action Plan. The Scheme will result in the severence and/or loss of foraging habitat.	**Declining**- the Norfolk BAP states that barn owl populations crashed in the 20th century in England and Wales. A more recent study in 1997 indicated that, while still declining, the rate of decline was	**High** - Barn owl are of high biodiversity value on a National and Local level.	**Minor negative**	**Slight adverse**
Bats (General)	**Biodiversity**: Habitats present within the Proposed Scheme, including woodlands, hedgerows, mature trees, waterbodies and scrub provide suitable habitat for foraging, commuting and roosting bats. Surveys completed in 2019 and 2020 have confirmed the presence of brown	**County**	**High -** Baseline data collected to date indicates that the route will sever bat commuting routes, and result in the loss of foraging and roosting habitat.	**Target species** - The Norfolk BAP targets four species (including barbastelle) to reduce decline.	**High** - Bats are protected under the Conservation of Habitat and Species Regulations 2017 and	**Intermediate negative**	**Large adverse**
Bats (Barbastelle *Barbastella barbastellus*)	**Biodiversity:** A rare bat species of national importance which is known to roost within the local area. The route is located within the Core Sustenance Zone (CSZ) for barbastelle. Barbastelle are offered specific protection under: Annex II and IV of the Habitats Directive	**National**	**High -** Barbastelle are targeted by the Norfolk Biodiversity Action Plan and are protected under Schedule 5 of the Wildlife and Countryside Act (1981) and Annexe II and IV of the Habitats Directive. Baseline surveys completed to-date	**Target species** - Although a trend in relation to the target species is not known the Norfolk BAP targets barbastelle (as well as three other bat species) to reduce decline.	**Very High** - Bats are protected under the Conservation of Habitat and Species Regulations 2017 and	**Intermediate negative**	**Large adverse**
Badgers *Meles meles*	**Biodiversity**: Badgers are offered protection under the Protection of Badgers Act 1992. Woodlands, hedgerows and grassland provide suitable habitat for foraging badgers, and suitable locations for sett construction. Walkover badger surveys completed in 2019/2020 (as well as observations	**Local**	**High -** Two main badger setts have been identified within the Scheme alignment.	**Unknown** - The Norfolk BAP does not identify a trend in relation to this species, although nationally badgers have shown a significant increase in numbers (c.88% since the 1980s).	**Medium** - badger are a species of medium biodiversity value on a national and local level.	**Minor negative**	**Slight adverse**
Otter *Lutra lutra*	**Biodiversity:** Otter are tareted by the Norfolk Biodiversity Action Plan and are protected under Schedule 5 of the Wildlife and Countryside Act (1981) and the Conservation of Habitats and Species Regulations (2017). In addition to the River Wensum and Tud a series of small watercourses and	**Local**	**Medium** - Otter have been identified as being present in the watercourses to be intersected by the Scheme.	**Target species** - Otter populations are increasing both locally (Norfolk) and nationally.	**High -** Otter are a species of high biodiversity value on a national and local level.	**Neutral**	**Neutral**
Water Vole *Arvicola amphibius*	**Biodiversity:** Water vole are targeted by the Norfolk Biodiversity Action Plan and are protected under Schedule 5 of the Wildlife and Countryside Act (1981). In addition to the River Wensum and Tud a series of small watercourses and drains, in connection with the route may support water vole. Watervole presence has been confirmed in the River Wensum and in other watercourses intersected by the Proposed Scheme.	**Local**	**Medium** - Water vole are targeted by the Norfolk Biodiversity Action Plan and are protected under Schedule 5 of the Wildlife and Countryside Act (1981).	**Target species** - Water vole decline in Norfolk is mainly due to population fragmentation and isolation.	**Medium -** Water vole are a species of medium biodiversity value on a national and local level.	**Neutral**	**Neutral**
SPI - Brown Hare *Erinaceus europaeus*	**Biodiversity** Habitats within the Proposed Scheme include open arable farmland and fields, which offer value to brown hare Lepus europeaus, and many incidental sightings of brown hare hare have been recorded within the Scheme.	**Local**	**Low** - brown hare are not a target species in the Norfolk Biodiversity Action Plan and are relatively widespread within the UK.	**Declining -** brown hare have been in decline for the last 30 years, however recent figures suggest that the species is recovering.	**Low** - brown hare are a species of low biodiversity value on a national and local level.	**Minor negative**	**Slight adverse**
SPI - Hedgehog *Erinaceus europaeus*	**Biodiversity** Habitats within the Proposed Scheme comprise a mosaic of woodland, grassland, wetland and arable, which offers value to hedgehog*Erinaceus europaeus.*	**Local**	**Low** - hedgehog are not a target species in the Norfolk Biodiversity Action Plan and are relatively widespread within the UK.	**Declining -** it is estimated that hedgehog numbers have declined by almost 40% in the past decade.	**Low** - hedgehog are a species of low biodiversity value on a national and local level.	**Minor negative**	**Slight adverse**
SPI - Common Toad *Bufo bufo*	**Biodiversity** Habitats within the Scheme include floodplains, woodlands, the River Wensum and other watercourses, and a number of ponds are present within proximity of the Proposed Scheme. These habitats are likely to support common toads, a UK Biodiversity Action Plan species, and this species has been observed within habitats across the Scheme.	**Local**	**Low** - common toad it not a target species in the Norfolk Biodiversity Action Plan and are relatively widespread within the UK.	**Declining** - recent research by Froglife has identified a decline in toad populations of 68% over the last 30 years, however this is still a widespread species.	**Low** - common toads are a species of low biodiversity value on a national and local level.	**Minor Negative**	**Slight adverse**
Desmoulin's Whorl Snail	**Biodiversity**: Records have been provided of Desmoulin's Whorl Snails in the local area. Surveys conducted in 2019 within suitable habitats to the north of the Proposed Scheme have confirmed the presence of Desmoulin's Whorl Snails. Further surveys are planned in 2020.	**International**	**High** - See SAC information above.	**Target species** - Targeted because of its declining in Norfolk due to destruction of wetlands, habitat degradation, particularly as a result of changes in hydrology and possibly the introduction of grazing.	**Very high** - Primary feature of SAC. Internationally important site with limited potential for substitution.	**Minor Negative**	**Slight adverse**
Aquatic Macroinvertebrates	**Biodiversity**: The watercourses and ponds present within the Proposed Scheme and the local area are likely to support a range of aquatic macroinvertebrates, which may include notable or protected species. Macroinvertebrate surveys were completed in 2020.	**Local**	**High** - The River Wensum SAC and SSSI is designated for white-clawed crayfish and Desmoulin's whorl snail. The scheme will impact upon aquatic macroinvertebrates at a County level.	**Target species** - the only aquatic macroinvertebrate in decline across Norfolk and is targeted by the Norfolk BAP is the Norfolk hawker *Aeshna isoceles* . The local objective is to maintain the current range in Norfolk by preventing loss of freshwater sites and create new habitat with a view to increase the range in Norfolk by 2020.	**Medium** - freshwater habitats may support notable aquatic macroinvertebrate species.	**Minor negative**	**Slight adverse**
Terrestrial Invertebrates	**Biodiversity**: The diverse range of habitats present along the Scheme, including woodland, scrub and grassland are likely to support a range of terrestrial invertebrates. Invertebrate surveys are due to be completed in 2021.	**Local**	**Medium** - Although baseline surveys have not yet been completed, it is expected that the range of habitats along the route will support terrestrial invertebrates that are widespread and common throughout the UK.	**Target species** - The Norfolk BAP identifies a declining trend in certain invertebrate species. Ground beetle, brush-thighed seed-eater beetle, flixweed flea beetle and silver-studded blue butterfly are all target species of the Norfolk BAP. It is unknown whether these species are present in the vicinity of the route option.	**Medium** - The project has the potential to affect terrestrial invertebrate species.	**Minor Negative**	**Slight adverse**

Reference Sources

River Wensum. European Site Conservation Objectives: Supplementary advice on conserving and restoring site features (Natural England 2019).
Norfolk BAP: https://www.norfolkbiodiversity.org/assets/Uploads/Water-vole2.pdf.
Wildlife and Countryside Act 1981 Schedule 1: http://www.legislation.gov.uk/ukpga/1981/69/schedule/1.
Wildlife and Countryside Act 1981 Schedule 5: http://www.legislation.gov.uk/ukpga/1981/69/schedule/5.
NERC Act Section 41 Species of Principal Importance: http://publications.naturalengland.org.uk/publication/4958719460769792.
Froglife: https://www.froglife.org/2018/03/23/amphibian-and-reptile-declines-uk-perspective/
BTO: https://app.bto.org/birdtrends/species.jsp?&s=kingf

Summary Assessment Score

Large Adverse

Qualitative Comments

Overall the Assessment Score is Large Adverse due to the potential impacts on bats, largely associated with the loss of woodland leading to a reduction in available forgaging habitat. Compensation proposals are being developed which will include the enhancement of existing woodlands to benefit bats and the creation of new woodland which, in the long term, will help to compensate for the loss of woodland.

Appendix E.7

WATER

TAG Water Environment Impacts Worksheet

Description of study area/ summary of potential impacts	Key environmental resource	Features	Quality	Scale	Rarity	Substitutability	Importance	Magnitude	Significance
Study area: The study area includes features within 1km of the Red Line Boundary (RLB). **Potential Impacts:** Increased pollution risk to surface water and groundwater Increased sedimentation within watercourses Impacts to the hydromorphological, physio-chemical and ecological quality of watercourses Increased flood risk associated with new structures Impact to groundwater flow pathways	**River Wensum**	**Water supply**	**Medium** - main river, good chemical quality, supports private abstractions.	Regional	Medium	Cannot be substituted	Medium	Negligible	Insignificant
		Biodiversity	**Very High** - channel of the Wensum designated SAC and SSSI.	Regional	High	Cannot be substituted	Very High	Negligible	Low
		Transport and dilution of waste products	**Medium** - large catchment, receives local discharge, WWTW downstream of study area.	Regional	Medium	Limited potential for substitution	Medium	Negligible	Insignificant
		Recreation	**Medium** - flow through urban and public areas	Local	Low	Limited potential for substitution	Medium	Negligible	Insignificant
		Hydromorphology	**Medium** - heavily modified classification but supports good ecological status	Regional	Medium	Cannot be substituted	Very high	Negligible	Low
		Conveyance of flow and material	**High** - main river, large catchment, flows through mix of urban and rural areas	Regional	Medium	Cannot be substituted	High	Negligible	Insignificant
	Floodplain of the River Wensum	**Conveyance of flow and material**	**Medium** - provides local flood flow conveyance route, functional floodplain protecting the local area and downstream Norwich City.	Local	Medium	Cannot be substituted	Medium	Minor Adverse	Insignificant
		Biodiversity	**Very High -** functional floodplain, habitat of principal importance - floodplain grazing marsh.	Local	Medium	Limited potential for substitution	High	Minor Adverse	Low significance
	Tributary of River Tud or Foxburrow Stream	**Water supply**	**Low** - quality unknown, may support agricultural uses although likely to have low flow	Local	Low	Limited potential for substitution	Low	Negligible	Insignificant
		Biodiversity	**Medium** - significantly modified, potential supporting habitat for otter and water vole	Local	Medium	Limited potential for substitution	Medium	Minor Adverse	Insignificant
		Transport and dilution of waste products	**Low** - likely to receive runoff from adjacent land	Local	Low	Limited potential for substitution	Low	Negligible	Insignificant
		Recreation	**Low -** no known recreational or amenity value	Local	Low	Limited potential for substitution	Medium	Negligible	Insignificant
		Hydromorphology	**Low** - heavily modified	Local	Low	Limited potential for substitution	Low	Minor Adverse	Insignificant
		Conveyance of flow and material	**Medium** - provides local flood flow conveyance route	Local	Low	Limited potential for substitution	Medium	Minor Adverse	Insignificant
	Combined Groundwater Aquifers (Secondary and Principal Aquifers)	**Groundwater quality**	**Very High** - Groundwater aquifer (Combined Secondary A, Secondary B and Principal Aquifers), Source Protection Zone 3, Multiple Private Abstractions	Regional	High	Limited potential for substitution	High	Minor Adverse	Low significance
		Groundwater flow (conveyance)	**Very High** - Groundwater aquifer (Combined Secondary A, Secondary B and Principal Aquifers), Source Protection Zone 3, Multiple private abstractions, provides River Wensum baseflow, shallow groundwater in the River Wensum floodplain	Regional	High	Limited potential for substitution	High	Minor Adverse	Low significance
		Water resource	**Very High** - Groundwater aquifer (Combined Secondary A, Secondary B and Principal Aquifers), Source Protection Zone 3, Multiple private abstractions, important baseflow contribution to the River Wensum SSSI & SAC, River Tud	Regional	High	Limited potential for substitution	Very High	Negligible	Low significance

Reference Sources

OS mapping, EA Flood Map for Planning, EA Flood Risk from Surface Water mapping, EA Catchment Data Explorer, Defra MAGIC geographical information portal, Geology of Britain Viewer

Summary Assessment Score

Minor Adverse

Qualitative Comments

No structures are proposed within the channel of the River Wensum or within 10m of the River Wensum. This is expected to minimise impacts to the river flow and channel morphology of the River Wensum.
Proposed Scheme requires the construction of a maintenance access track immediately adjacent to the proposed viaduct to enable inspection of the viaduct over its design life. The track will not require crossing of the River Wensum but will need to be constructed within the floodplain of the River Wensum and cross the land drains located within this area. The access track will be constructed at grade to prevent adverse effect to floodplain storage or flood flow conveyance.
Structures such as culverts into a watercourse can potentially remove natural bed substrate and bank-side habitat, as well as change flow dynamics and sediment transport through the Tributary of the River Tud. Crossings of watercourses and any new watercourse channels are expected to maintain the capacity of the channel, ensure no increased flood risk up to the 1 in 100-year event considering the potential effects of climate change, be designed in accordance with DMRB guidance, and be sensitive to ecological requirements.
The Drainage Strategy at this stage of the assessment indicates that infiltration to ground and discharge to nearby watercourses will be utilised to discharge road runoff. A robust surface water drainage system will be expected to ensure discharge from the Proposed Scheme does not increase flood risk elsewhere up to and including the 1 in 100-year event and allowing for climate change effects and provides sufficient attenuation to restrict the rate and volume of discharge to those agreed with Norfolk County Council as the Lead Local Flood Authority.
Implementation of a Construction Environmental Management Plan (CEMP) and passive treatment incorporated into SuDS should be considered and adhered to during construction and operation of the Proposed Scheme, to reduce the risk of contamination to the water environment.
Mitigation for reduced groundwater recharge due to the introduction of hardstanding should be considered during detail design stage of the scheme.

Appendix F

PUBLIC ACCOUNTS

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Fund						
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Transp						
Revenue	0					
Operating costs	0					
Investment Costs	127129					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	127129	*(8)*				
Central Government Funding: Non-Tr						
Indirect Tax Revenues	53272	*(9)*				
TOTALS						
Broad Transport Budget	127129	*(10) = (7) + (8)*				
Wider Public Finances	53272	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Func						
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Trans						
Revenue	0					
Operating costs	0					
Investment Costs	127129					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	127129	*(8)*				
Central Government Funding: Non-T						
Indirect Tax Revenues	46916	*(9)*				
TOTALS						
Broad Transport Budget	127129	*(10) = (7) + (8)*				
Wider Public Finances	46916	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Func						
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Trans						
Revenue	0					
Operating costs	0					
Investment Costs	127129					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	127129	*(8)*				
Central Government Funding: Non-T						
Indirect Tax Revenues	59742	*(9)*				
TOTALS						
Broad Transport Budget	127129	*(10) = (7) + (8)*				
Wider Public Finances	59742	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Func						
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Trans						
Revenue	0					
Operating costs	0					
Investment Costs	127129					
Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	127129	*(8)*				
Central Government Funding: Non-T						
Indirect Tax Revenues	39398	*(9)*				
TOTALS						
Broad Transport Budget	127129	*(10) = (7) + (8)*				
Wider Public Finances	39398	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

Appendix G

ANALYSIS OF MONITISED COSTS AND BENEFITS

Analysis of Monetised Costs and Benefits

Noise	38	*(12)*
Local Air Quality	72	*(13)*
Greenhouse Gases	19475	*(14)*
Journey Quality	0	*(15)*
Physical Activity	8876	*(16)*
Accidents	18582	*(17)*
Economic Efficiency: Consumer Users (Commuting)	58488	*(1a)*
Economic Efficiency: Consumer Users (Other)	167804	*(1b)*
Economic Efficiency: Business Users and Providers	88569	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-53272	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	308632	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	127129	*(10)*
Present Value of Costs (see notes) (PVC)	127129	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	181503	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	2.43	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.

Analysis of Monetised Costs and Benefits

Noise	0	*(12)*
Local Air Quality	0	*(13)*
Greenhouse Gases	17445	*(14)*
Journey Quality	8876	*(15)*
Physical Activity	0	*(16)*
Accidents	12793	*(17)*
Economic Efficiency: Consumer Users (Commuting)	52234	*(1a)*
Economic Efficiency: Consumer Users (Other)	142272	*(1b)*
Economic Efficiency: Business Users and Providers	70836	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-46916	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	257540	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	127129	*(10)*
Present Value of Costs (see notes) (PVC)	127129	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	130411	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	2.03	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.

Analysis of Monetised Costs and Benefits

Noise	0	*(12)*
Local Air Quality	0	*(13)*
Greenhouse Gases	0	*(14)*
Journey Quality	0	*(15)*
Physical Activity	8876	*(16)*
Accidents	12778	*(17)*
Economic Efficiency: Consumer Users (Commuting)	84319	*(1a)*
Economic Efficiency: Consumer Users (Other)	208363	*(1b)*
Economic Efficiency: Business Users and Providers	116071	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-59742	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	370665	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	127129	*(10)*
Present Value of Costs (see notes) (PVC)	127129	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	243536	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	2.92	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.

Analysis of Monetised Costs and Benefits

Noise	0	*(12)*
Local Air Quality	0	*(13)*
Greenhouse Gases	0	*(14)*
Journey Quality	0	*(15)*
Physical Activity	8876	*(16)*
Accidents	11496	*(17)*
Economic Efficiency: Consumer Users (Commuting)	43158	*(1a)*
Economic Efficiency: Consumer Users (Other)	140112	*(1b)*
Economic Efficiency: Business Users and Providers	69491	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-39398	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	233735	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	127129	*(10)*
Present Value of Costs (see notes) (PVC)	127129	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	106606	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.84	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.

Appendix H

APPRAISAL SUMMARY TABLE

Appendix H.1

AST - CORE GROWTH SCENARIO

Appraisal Summary Table: Core Growth scenario

Date produced:	23-May-21

Contact:	
Name	
Organisation	Norfolk County Council
Role	

Name of scheme:	Norwich Western Link
Description of scheme:	The Norwich Western Link will comprise a new dual carriageway all-purpose road to the west of Norwich, from the A47 to the A1067/A1270, including a new viaduct bridge over the River Wensum and its floodplain. The scheme will provide a direct connection between the Strategic Road Network and the A1270 Broadland Northway through the west of Norwich. This will complete an orbital route around Norwich, which forms part of the Major Road Network.

	Impacts	Summary of key impacts	Assessment: Quantitative	Qualitative	Monetary £(NPV)	Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	The scheme provides business user benefits, with nearly all of the benefits being from journey time savings totalling with £81.766m in user benefits. There are increases in vehicle operating costs, with a benefit of over £6.803m	Value of journey time changes(£): 81,766.000 Net journey time changes (£) 0 to 2min: 37,958 / 2 to 5min: 9,860 / > 5min: 33,950		£88,569,000	
	Reliability impact on Business users	Reliability has been assessed in line with TAG Unit A1.3, Section 6.3 (Reliability – urban roads) based on the calculation of the standard deviation of journey times from journey time and distance for each O-D (origin-destination) pair				
	Regeneration	N/A				
	Wider Impacts	WSP's Wider Impacts in Transport Appraisal (WITA) tool has been used.The tool estimates the following impacts: agglomeration, labour supply and output change in imperfectly competitive markets as described in TAG units A2.1 to unit A2.4:	W1: Agglomeration impacts £89.26m W2: Output change in imperfectly competitive markets impacts £7.88m W3: Tax revenues arising from labour market impacts £0.33m		£97,471,000	
Environmental	Noise	The study area for the assessment has been derived based on guidance within the Design Manual for Roads and Bridges (DMRB), LA 111 Noise and Vibration, May 2020 and is set to a distance of 600m from the kerb of any new roads associated with the scheme. There are 52 residential dwellings within the study area and no additional other sensitive receptors. Generally, within the study area, noise levels are predicted to increase as a result of the scheme, with large increases predicted at isolated receptors towards the centre of the study area where low baseline levels are anticipated. However, some receptors along Wood Lane and Paddy's Lane are predicted to experience noise level reductions as a result of less vehicles using these roads in favour of the scheme. The Highways England A47 duallling scheme has been included in both the Do-minimum (without scheme) and Do-something (with scheme) scenarios for the purpose of this assessment.	Households experiencing increased daytime noise in forecast year: 33 Households experiencing reduced daytime noise in forecast year: 10 Households experiencing increased night time noise in forecast year: 3 Households experiencing reduced night time noise in forecast year: 10	NA	£38,490	
	Air Quality	The appraisal has been undertaken using the Impact Pathways approach. Overall, with the Proposed Scheme there are modest improvements in local air quality in terms of NO2 and PM2.5 at locations with relevant human exposure. The overall monetary valuation takes into account ecosystem damage costs. No Air Quality Management Areas are included in the air quality study area. The Proposed Scheme links map onto PCM links which are all compliant with the NO2 limit value both with and without scheme. No exceedances of air quality standards are predicted.	NO2 Change in NO2 assessment score over 60 year appraisal period: -10,684.21 (between 'with scheme' and 'without scheme' scenarios). In 2025 there are there are 7,860 properties with improvement, 35 properties with no change, and 2,180 properties with deterioration. In 2040 there are 7,733 properties with improvement, 32 properties with no change, and 2,310 properties with deterioration. PM2.5 Change in PM2.5 assessment score over 60 year appraisal period: -1,172.63 (between 'with scheme' and 'without scheme' scenarios). In 2025 there are 8,002 properties with improvement, 6 properties with no change, and 2,067 properties with deterioration. In 2040 there are 7,747 properties with improvement, 282 properties with no change, and 2,046 properties with deterioration.	N/A	NPV of change in NO2: £9,803 NPV of change in PM2.5: £62,165 Total NPV of change in air quality: £71,968	
	Greenhouse gases	The greenhouse gases appraisal for road transport emissions has been undertaken in accordance with TAG Unit A3 methodology. The calculations are based on the traffic forecasts for the do-minimum and do-something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the Norwich Area Transport Strategy (NATS) traffic model for the OBC. Non-traded CO2e emissions (petrol and diesel vehicles) and CO2e traded emissions (electric vehicles) have been calculated in accordance with DMRB LA 114. The substantial differences in the findings compared to those for Scheme 'Option C' those presented in the SOBC are largely attributed to the major updates to the NATS model for the OBC and DMRB methodology (previously HA 207/07) for calculating emissions of greenhouse gases from road traffic. Comments on assumptions and uncertainty: 1) Emissions have been calculated across the whole of the NATS model simulation area. 2) Emissions have been estimated for scenarios in 2025 and 2040. For each year between the emissions have been determined by linear interpolation. In the absence of any data for the intervening years, this pragmatic approach adds a degree of uncertainty to the TAG calculations for these years. 3) The NATS model future forecast year is 2040. Beyond 2040 no traffic growth has been assumed. In reality some inter-annual variations in traffic levels and emissions can be expected. This factor adds a degree of uncertainty to the appraisal. 4) Emissions have been estimated based on vehicle fleet composition forecasts which were published pre-COVID-19. The likely impact of COVID-19 on fleet composition in future years cannot be predicted with any certainty at this present time.	Change in non-traded carbon over 60y (CO2e): -443,429 Change in traded carbon over 60y (CO2e): -13,005	N/A	£19,474,620	
	Landscape	There would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. Field patterns are easily substitutable, although loss of mature hedgerow trees would take much longer to re-establish. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a significant impact on tranquillity in the north. The road will also alter tranquillity locally along its entire length, although more limited than the viaduct due to it largely being at-grade or in cutting. The alignment, which is duelled, is larger than the existing road infrastructure through this landscape and therefore out of character. There will be some loss of woodland and arable farmland altering land cover locally.	N/A	Moderate Adverse	N/A	
	Townscape	Scoped out of WebTAG and AST appraisal.	N/A	N/A	N/A	
	Historic Environment	The Proposed Scheme would have a moderate adverse effect on the setting (context) of nearby listed buildings, and will adversely affect the appreciation and understanding of the characteristic historic environmental resource in the area of proposed road construction. The Proposed Scheme would have a low, moderate or major adverse effect on known non-designated assets. The Proposed Scheme would have a low, moderate or major direct impact on previously unrecorded significant historic environment non-designated assets, resulting in loss of features such that their integrity is substantially compromised. The heritage significance of such assets would depend on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved).	N/A	Moderate adverse (built heritage) Low, moderate or major adverse (buried remains)	N/A	
	Biodiversity	The possible biodiversity impacts include loss of woodland, hedgerows and wetland, degradation of habitats and impacts to protected species through loss of habitat, disturbance, severance of habitat, fragmentation and killing/injury of individuals. Impacts could occur during construction and operation of the Proposed Scheme. Mitigation and compensation strategies are being developed to reduce the identified possible impacts. Mitigation measures include a range of design features such as sensitive timing of construction works and the use of green bridges and underpasses. Compensation measures include planting new areas of woodland and enhancing existing woodlands. The most significant impact which cannot be mitigated for, in the short term, is the loss of woodland which bats use as foraging habitat.	N/A	Large adverse	N/A	
	Water Environment	No structures are proposed within the channel of the River Wensum or within 10m of the River Wensum. This is expected to minimise impacts to the river flow and channel morphology of the River Wensum. The Proposed Scheme requires the construction of a maintenance access track immediately adjacent to the proposed viaduct to enable inspection of the viaduct over its design life. The track will not require crossing of the River Wensum but will need to be constructed within the floodplain of the River Wensum and cross the land drains located within this area. The access track will be constructed at grade to prevent adverse effects to floodplain storage or flood flow conveyance. Structures such as culverts into a watercourse can potentially remove natural bed substrate and bank-side habitat, as well as change flow dynamics and sediment transport through the Tributary of the River Tud. Crossings of watercourses and any new watercourse channels are expected to maintain the capacity of the channel, ensure no increased flood risk up to the 1 in 100-year event considering the potential effects of climate change, be designed in accordance with DMRB guidance, and be sensitive to ecological requirements. The Drainage Strategy at this stage of the assessment indicates that infiltration to ground and discharge to nearby watercourses will be utilised to discharge road runoff. A robust surface water drainage system will be expected to ensure discharge from the Proposed Scheme does not increase flood risk elsewhere up to and including the 1 in 100-year event and allowing for climate change effects and provides sufficient attenuation to restrict the rate and volume of discharge to those agreed with Norfolk County Council (NCC) as the Lead Local Flood Authority (LLFA). A broad range of potential runoff pollutants, such as hydrocarbons (fuel and lubricants), fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving groundwater water bodies. Implementation of a Construction Environmental Management Plan (CEMP) and passive treatment incorporated into sustainable drainage systems (SuDS) should be considered and adhered to during construction and operation of the Proposed Scheme, to reduce the risk of contamination to the water environment. Mitigation for reduced groundwater recharge due to the introduction of hardstanding should be considered during detail design stage of the Proposed Scheme.	N/A	Slight Adverse	N/A	
Social	Commuting and Other users	The scheme provides Commuting and Other user benefits, with most of the benefits being from journey time savings totalling £149.872m in user benefits. This are increases in vehicle operating costs, with a benefit of £76.420m.	Value of journey time changes(£): 149.873 Net journey time changes (£) 0 to 2min: 67,061 / 2 to 5min: 16,721 / > 5min: 66,091		£226,292,000	
	Reliability impact on Commuting and Other users					
	Physical activity	The impacts on Physical Activity has been assessed with DfT's AMAT for three of the four wider walking and cycling interventions. The NWL is forecast to have a beneficial impact of £8.876 million.			£8,876,000	
	Journey quality	Journey Quality has been assessed for traveller care, traveller views and traveller stress. Traveller care impacts have been assessed as moderately beneficial. Traveller views impacts have been assessed as neutral to beneficial, and traveller stress impacts have been assessed as large beneficial.		Moderate Beneficial		
	Accidents	COBALT (COst and Benefit to Accidents – Light Touch) has been used to understand the likely impact of the scheme on accidents in the study area. The impacts on users and road safety (accidents) has been appraised for a period of 60 years from the first year of scheme opening. The results indicate that the scheme will result in a reduction of 529 accidents over the 60 year appraisal period, leading to a reduction of 674 casualties (2 Fatal, 56 Serious and 616 Slight).	The results indicate that the scheme will result in a reduction of 529 accidents over the 60 year appraisal period, leading to a reduction of 674 casualties (2 Fatal, 56 Serious and 616) Slight		£18,582,000	
	Security	Based on the assessment undertaken, the security impacts have been assessed as moderate/large beneficial. This is due to the provision of lighting and illuminated signs on the new link, and the reduction in junctions and stop start traffic.		Moderate Beneficial		
	Access to services	The scheme has not been designed to address accessibility, there is no change in the routes served by the public transport system, although there may be complementary public transport measures considered separately to the NWL at a later time.		Neutral		
	Affordability	The scheme has not been designed to address the affordability of the transport system, there will be no change in fares/travel costs in users apart from those already identified through TUBA via Car Fuel and Non-Fuel operating costs		Neutral		
	Severance	There are more roads forecast to experience decreases in flow rather than increases in flow in the study area; thus, showing a beneficial impact of the scheme on traffic flow, therefore the change in vehicle flows are not anticipated to negatively impact pedestrian movement. Where existing routes are severed, new crossing facilities will be provided, which should mitigate the impact of the new road.		Slight Beneficial		
	Option and non-use values	The scheme will not substantially change the availability of transport services within the study area.		Neutral		
Public	Cost to Broad Transport Budget	The cost to the broad transport budget is £127.129m			£127,128,461	
	Indirect Tax Revenues	The indirect tax revenues are £53.272m			-£53,272,000	

Appendix H.2

AST - LOW GROWTH SCENARIO

Appraisal Summary Table: Low Growth scenario

Date produced:	23-May-21

Contact:	
Name	
Organisation	Norfolk County
Role	

Name of scheme:	Norwich Western Link
Description of scheme:	The Norwich Western Link will comprise a new dual carriageway all-purpose road to the west of Norwich, from the A47 to the A1067/A1270, including a new viaduct bridge over the River Wensum and its floodplain. The scheme will provide a direct connection between the Strategic Road Network and the A1270 Broadland Northway through the west of Norwich. This will complete an orbital route around Norwich, which forms part of the Major Road Network.

	Impacts	Summary of key impacts	Assessment						
			Quantitative				Qualitative	Monetary £(NPV)	Distributio 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	The scheme provides business user benefits, with nearly all of the benefits being from journey time savings totalling with £65.818m in user benefits. There are increases in vehicle operating costs, with a benefit of over £5.018m	Value of journey time changes(£)	65.820				£70,836,000	
			Net journey time changes (£)						
			0 to 2min	2 to 5min	> 5min				
			27.421	9.607	28.792				
	Reliability impact on Business users	Reliability has been assessed in line with TAG Unit A1.3, Section 6.3 (Reliability – urban roads) based on the calculation of the standard deviation of journey times from journey time and distance for each O-D (origin-destination) pair							
	Regeneration	N/A							
	Wider Impacts	WSP's Wider Impacts in Transport Appraisal (WITA) tool has been used.The tool estimates the following impacts: agglomeration, labour supply and output change in imperfectly competitive markets as described in TAG units A2.1 to unit A2.4:	WI1: Agglomeration impacts £89.26m WI2: Output change in imperfectly competitive markets impacts £7.88m WI3: Tax revenues arising from labour market impacts £0.33m					£97,471,000	
Environmental	Noise	Not assessed for the Low Growth Scenario					NA		
	Air Quality	Not assessed for the Low Growth Scenario					N/A		
	Greenhouse gases	The greenhouse gases appraisal for road transport emissions has been undertaken in accordance with TAG Unit A3 methodology. The calculations are based on the traffic forecasts for the do-minimum and do-something model scenarios for 2025 (opening year) and 2040 (design year), as generated by the Norwich Area Transport Strategy (NATS) traffic model for the OBC. Non-traded CO2e emissions (petrol and diesel vehicles) and CO2e traded emissions (electric vehicles) have been calculated in accordance with DMRB LA 114. The substantial differences in the findings compared to those for Scheme 'Option C' those presented in the SOBC are largely attributed to the major updates to the NATS model for the OBC and DMRB methodology (previously HA 207/07) for calculating emissions of greenhouse gases from road traffic. Comments on assumptions and uncertainty: 1) Emissions have been calculated across the whole of the NATS model simulation area. 2) Emissions have been estimated for scenarios in 2025 and 2040. For each year between the emissions have been determined by linear interpolation. In the absence of any data for the intervening years, this pragmatic approach adds a degree of uncertainty to the TAG calculations for these years. 3) The NATS model future forecast year is 2040. Beyond 2040 no traffic growth has been assumed. In reality some inter-annual variations in traffic levels and emissions can be expected. This factor adds a degree of uncertainty to the appraisal. 4) Emissions have been estimated based on vehicle fleet composition forecasts which were published pre-COVID-19. The likely impact of COVID-19 on fleet composition in future years cannot be predicted with any certainty at this present time.	Change in non-traded carbon over 60y (CO2e)	-397,598			N/A	£17,445,270	
			Change in traded carbon over 60y (CO2e)	-12,458					
	Landscape	There would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. Field patterns are easily substitutable, although loss of mature hedgerow trees would take much longer to re-establish. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a significant impact on tranquillity in the north. The road will also alter tranquility locally along its entire length, although more limited than the viaduct due to it largely being at-grade or in cutting. The alignment, which is duelled, is larger than the existing road infrastructure through this landscape and therefore out of character. There will be some loss of woodland and arable farmland altering land cover locally.	N/A				Moderate Adverse	N/A	
	Townscape	Scoped out of WebTAG and AST appraisal.	N/A				N/A	N/A	
	Historic Environment	The Proposed Scheme would have a moderate adverse effect on the setting (context) of nearby listed buildings, and will adversely affect the appreciation and understanding of the characteristic historic environmental resource in the area of proposed road construction. The Proposed Scheme would have a low, moderate or major adverse effect on known non-designated assets. The Proposed Scheme would have a low, moderate or major direct impact on previously unrecorded significant historic environment non-designated assets, resulting in loss of features such that their integrity is substantially compromised. The heritage significance of such assets would depend on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved).	N/A				Moderate adverse (built heritage) Low, moderate or major adverse (buried remains)	N/A	
	Biodiversity	The possible biodiversity impacts include loss of woodland, hedgerows and wetland, degradation of habitats and impacts to protected species through loss of habitat, disturbance, severance of habitat, fragmentation and killing/injury of individuals. Impacts could occur during construction and operation of the Proposed Scheme. Mitigation and compensation strategies are being developed to reduce the identified possible impacts. Mitigation measures include a range of design features such as sensitive timing of construction works and the use of green bridges and underpasses. Compensation measures include planting new areas of woodland and enhancing existing woodlands. The most significant impact which cannot be mitigated for, in the short term, is the loss of woodland which bats use as foraging habitat.	N/A				Large adverse	N/A	
	Water Environment	No structures are proposed within the channel of the River Wensum or within 10m of the River Wensum. This is expected to minimise impacts to the river flow and channel morphology of the River Wensum. The Proposed Scheme requires the construction of a maintenance access track immediately adjacent to the proposed viaduct to enable inspection of the viaduct over its design life. The track will not require crossing of the River Wensum but will need to be constructed within the floodplain of the River Wensum and cross the land drains located within this area. The access track will be constructed at grade to prevent adverse effects to floodplain storage or flood flow conveyance. Structures such as culverts into a watercourse can potentially remove natural bed substrate and bank-side habitat, as well as change flow dynamics and sediment transport through the Tributary of the River Tud. Crossings of watercourses and any new watercourse channels are expected to maintain the capacity of the channel, ensure no increased flood risk up to the 1 in 100-year event considering the potential effects of climate change, be designed in accordance with DMRB guidance, and be sensitive to ecological requirements. The Drainage Strategy at this stage of the assessment indicates that infiltration to ground and discharge to nearby watercourses will be utilised to discharge road runoff. A robust surface water drainage system will be expected to ensure discharge from the Proposed Scheme does not increase flood risk elsewhere up to and including the 1 in 100-year event and allowing for climate change effects and provides sufficient attenuation to restrict the rate and volume of discharge to those agreed with Norfolk County Council (NCC) as the Lead Local Flood Authority (LLFA). A broad range of potential runoff pollutants, such as hydrocarbons (fuel and lubricants), fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving groundwater water bodies. Implementation of a Construction Environmental Management Plan (CEMP) and passive treatment incorporated into sustainable drainage systems (SuDS) should be considered and adhered to during construction and operation of the Proposed Scheme, to reduce the risk of contamination to the water environment. Mitigation for reduced groundwater recharge due to the introduction of hardstanding should be considered during detail design stage of the Proposed Scheme.	N/A				Slight Adverse	N/A	
Social	Commuting and Other users	The scheme provides Commuting and Other user benefits, with most of the benefits being from journey time savings totalling £126.175m in user benefits. This are increases in vehicle operating costs, with a benefit of £68.331m.	Value of journey time changes(£)	126.174				£194,506,000	
			Net journey time changes (£)						
			0 to 2min	2 to 5min	> 5min				
			47.253	21.478	57.433				
	Reliability impact on Commuting and Other users								
	Physical activity	The impacts on Physical Activity has been assessed with DfT's AMAT for three of the four wider walking and cycling interventions. The NWL is forecast to have a beneficial impact of £8.876 million.						£8,876,000	
	Journey quality	Journey Quality has been assessed for traveller care, traveller views and traveller stress. Traveller care impacts have been assessed as moderately beneficial. Traveller views impacts have been assessed as neutral to beneficial, and traveller stress impacts have been assessed as large beneficial.					Moderate Beneficial		
	Accidents	COBALT (COst and Benefit to Accidents – Light Touch) has been used to understand the likely impact of the scheme on accidents in the study area. The impacts on users and road safety (accidents) has been appraised for a period of 60 years from the first year of scheme opening. The results indicate that the scheme will result in a reduction of 386 accidents over the 60 year appraisal period, leading to a reduction of 490 casualties (1 Fatal, 38 Serious and 451 Slight).	The results indicate that the scheme will result in a reduction of 386 accidents over the 60 year appraisal period, leading to a reduction of 490 casualties (1 Fatal, 38 Serious and 451 Slight)					£12,793,000	
	Security	Based on the assessment undertaken, the security impacts have been assessed as moderate/large beneficial. This is due to the provision of lighting and illuminated signs on the new link, and the reduction in junctions and stop start traffic.					Moderate Beneficial		
	Access to services	The scheme has not been designed to address accessibility, there is no change in the routes served by the public transport system, although there may be complementary public transport measures considered separately to the NWL at a later time.					Neutral		
	Affordability	The scheme has not been designed to address the affordability of the transport system, there will be no change in fares/travel costs in users apart from those already identified through TUBA via Car Fuel and Non-Fuel operating costs					Neutral		
	Severance	There are more roads forecast to experience decreases in flow rather than increases in flow in the study area; thus, showing a beneficial impact of the scheme on traffic flow, therefore the change in vehicle flows are not anticipated to negatively impact pedestrian movement. Where existing routes are severed, new crossing facilities will be provided, which should mitigate the impact of the new road.					Slight Beneficial		
	Option and non-use values	The scheme will not substantially change the availability of transport services within the study area.					Neutral		
Public Accounts	Cost to Broad Transport Budget	The cost to the broad transport budget is £127.129m						£127,128,461	
	Indirect Tax Revenues	The indirect tax revenues are £46.916m						-£46,916,000	

Appendix H.3

AST - HIGH GROWTH SCENARIO

Appraisal Summary Table: High Growth scenario

Date produced:	23-May-21

Contact:	
Name	
Organisation	Norfolk County
Role	

Name of scheme:	Norwich Western Link
Description of scheme:	The Norwich Western Link will comprise a new dual carriageway all-purpose road to the west of Norwich, from the A47 to the A1067/A1270, including a new viaduct bridge over the River Wensum and its floodplain. The scheme will provide a direct connection between the Strategic Road Network and the A1270 Broadland Northway through the west of Norwich. This will complete an orbital route around Norwich, which forms part of the Major Road Network.

	Impacts	Summary of key impacts	Assessment			
			Quantitative	Qualitative	Monetary £(NPV)	Distributi 7-pt scale/ vulnerabl e grp
Economy	Business users & transport providers	The scheme provides business user benefits, with nearly all of the benefits being from journey time savings totalling with £105.664m in user benefits. There are increases in vehicle operating costs, with a benefit of over £10.407m	Value of journey time changes(£): 105.620 Net journey time changes (£): 0 to 2min: 47.970; 2 to 5min: 12.416; > 5min: 45.276		£116,071,000	
	Reliability impact on Business users	Reliability has been assessed in line with TAG Unit A1.3, Section 6.3 (Reliability – urban roads) based on the calculation of the standard deviation of journey times from journey time and distance for each O-D (origin-destination) pair				
	Regeneration	N/A				
	Wider Impacts	WSP's Wider Impacts in Transport Appraisal (WITA) tool has been used.The tool estimates the following impacts: agglomeration, labour supply and output change in imperfectly competitive markets as described in TAG units A2.1 to unit A2.4:	WI1: Agglomeration impacts £89.26m WI2: Output change in imperfectly competitive markets impacts £7.88m WI3: Tax revenues arising from labour market impacts £0.33m		£97,471,000	
Environmental	Noise	Not assessed for the High Growth Scenario		NA		
	Air Quality	Not assessed for the High Growth Scenario		N/A		
	Greenhouse gases	Not assessed for the High Growth Scenario	Change in non-traded carbon over 60y (CO2e) Change in traded carbon over 60y (CO2e)	N/A		
	Landscape	There would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. Field patterns are easily substitutable, although loss of mature hedgerow trees would take much longer to re-establish. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a significant impact on tranquillity in the north. The road will also alter tranquillity locally along its entire length, although more limited than the viaduct due to it largely being at-grade or in cutting. The alignment, which is duelled, is larger than the existing road infrastructure through this landscape and therefore out of character. There will be some loss of woodland and arable farmland altering land cover locally.	N/A	Moderate Adverse	N/A	
	Townscape	Scoped out of WebTAG and AST appraisal.	N/A	N/A	N/A	
	Historic Environment	The Proposed Scheme would have a moderate adverse effect on the setting (context) of nearby listed buildings, and will adversely affect the appreciation and understanding of the characteristic historic environmental resource in the area of proposed road construction. The Proposed Scheme would have a low, moderate or major adverse effect on known non-designated assets. The Proposed Scheme would have a low, moderate or major direct impact on previously unrecorded significant historic environment non-designated assets, resulting in loss of features such that their integrity is substantially compromised. The heritage significance of such assets would depend on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved).	N/A	Moderate adverse (built heritage) Low, moderate or major adverse (buried remains)	N/A	
	Biodiversity	The possible biodiversity impacts include loss of woodland, hedgerows and wetland, degradation of habitats and impacts to protected species through loss of habitat, disturbance, severance of habitat, fragmentation and killing/injury of individuals. Impacts could occur during construction and operation of the Proposed Scheme. Mitigation and compensation strategies are being developed to reduce the identified possible impacts. Mitigation measures include a range of design features such as sensitive timing of construction works and the use of green bridges and underpasses. Compensation measures include planting new areas of woodland and enhancing existing woodlands. The most significant impact which cannot be mitigated for, in the short term, is the loss of woodland which bats use as foraging habitat.	N/A	Large adverse	N/A	
	Water Environment	No structures are proposed within the channel of the River Wensum or within 10m of the River Wensum. This is expected to minimise impacts to the river flow and channel morphology of the River Wensum. The Proposed Scheme requires the construction of a maintenance access track immediately adjacent to the proposed viaduct to enable inspection of the viaduct over its design life. The track will not require crossing of the River Wensum but will need to be constructed within the floodplain of the River Wensum and cross the land drains located within this area. The access track will be constructed at grade to prevent adverse effects to floodplain storage or flood flow conveyance. Structures such as culverts into a watercourse can potentially remove natural bed substrate and bank-side habitat, as well as change flow dynamics and sediment transport through the Tributary of the River Tud. Crossings of watercourses and any new watercourse channels are expected to maintain the capacity of the channel, ensure no increased flood risk up to the 1 in 100-year event considering the potential effects of climate change, be designed in accordance with DMRB guidance, and be sensitive to ecological requirements. The Drainage Strategy at this stage of the assessment indicates that infiltration to ground and discharge to nearby watercourses will be utilised to discharge road runoff. A robust surface water drainage system will be expected to ensure discharge from the Proposed Scheme does not increase flood risk elsewhere up to and including the 1 in 100-year event and allowing for climate change effects and provides sufficient attenuation to restrict the rate and volume of discharge to those agreed with Norfolk County Council (NCC) as the Lead Local Flood Authority (LLFA). A broad range of potential runoff pollutants, such as hydrocarbons (fuel and lubricants), fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving groundwater water bodies. Implementation of a Construction Environmental Management Plan (CEMP) and passive treatment incorporated into sustainable drainage systems (SuDS) should be considered and adhered to during construction and operation of the Proposed Scheme, to reduce the risk of contamination to the water environment. Mitigation for reduced groundwater recharge due to the introduction of hardstanding should be considered during detail design stage of the Proposed Scheme.	N/A	Slight Adverse	N/A	
Social	Commuting and Other users	The scheme provides Commuting and Other user benefits, with most of the benefits being from journey time savings totalling £208.415m in user benefits. This are increases in vehicle operating costs, with a benefit of £84.267m.	Value of journey time changes(£): 208.414 Net journey time changes (£): 0 to 2min: 92.593; 2 to 5min: 20.313; > 5min: 95.508		£292,682,000	
	Reliability impact on Commuting and Other users					
	Physical activity	The impacts on Physical Activity has been assessed with DfT's AMAT for three of the four wider walking and cycling interventions. The NWL is forecast to have a beneficial impact of £8.876 million.			£8,876,000	
	Journey quality	Journey Quality has been assessed for traveller care, traveller views and traveller stress. Traveller care impacts have been assessed as moderately beneficial. Traveller views impacts have been assessed as neutral to beneficial, and traveller stress impacts have been assessed as large beneficial.		Moderate Beneficial		
	Accidents	COBALT (COst and Benefit to Accidents – Light Touch) has been used to understand the likely impact of the scheme on accidents in the study area. The impacts on users and road safety (accidents) has been appraised for a period of 60 years from the first year of scheme opening. The results indicate that the scheme will result in a reduction of 410 accidents over the 60 year appraisal period, leading to a reduction of 500 casualties (37 Serious and 463 Slight).	The results indicate that the scheme will result in a reduction of 410 accidents over the 60 year appraisal period, leading to a reduction of 500 casualties (37 Serious and 463 Slight)		£12,778,000	
	Security	Based on the assessment undertaken, the security impacts have been assessed as moderate/large beneficial. This is due to the provision of lighting and illuminated signs on the new link, and the reduction in junctions and stop start traffic.		Moderate Beneficial		
	Access to services	The scheme has not been designed to address accessibility, there is no change in the routes served by the public transport system, although there may be complementary public transport measures considered separately to the NWL at a later time.		Neutral		
	Affordability	The scheme has not been designed to address the affordability of the transport system, there will be no change in fares/travel costs in users apart from those already identified through TUBA via Car Fuel and Non-Fuel operating costs		Neutral		
	Severance	There are more roads forecast to experience decreases in flow rather than increases in flow in the study area; thus, showing a beneficial impact of the scheme on traffic flow, therefore the change in vehicle flows are not anticipated to negatively impact pedestrian movement. Where existing routes are severed, new crossing facilities will be provided, which should mitigate the impact of the new road.		Slight Beneficial		
	Option and non-use values	The scheme will not substantially change the availability of transport services within the study area.		Neutral		
Public	Cost to Broad Transport Budget	The cost to the broad transport budget is £127.129m			£127,128,461	
	Indirect Tax Revenues	The indirect tax revenues are £59.742m			-£59,742	

Appendix H.4

AST - CORE GROWTH (SENSITIVITY) SCENARIO

Appraisal Summary Table: Core Growth (Sensitivity) scenario

Date produced:	23-May-21

Contact:	
Name	
Organisation	Norfolk County Council
Role	

Name of scheme:	Norwich Western Link
Description of scheme:	The Norwich Western Link will comprise a new dual carriageway all-purpose road to the west of Norwich, from the A47 to the A1067/A1270, including a new viaduct bridge over the River Wensum and its floodplain. The scheme will provide a direct connection between the Strategic Road Network and the A1270 Broadland Northway through the west of Norwich. This will complete an orbital route around Norwich, which forms part of the Major Road Network.

Impacts		Summary of key impacts	Assessment: Quantitative	Qualitative	Monetary £(NPV)	Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	The scheme provides business user benefits, with nearly all of the benefits being from journey time savings totalling with £64.269m in user benefits. There are increases in vehicle operating costs, with a benefit of over £5.222m	Value of journey time changes(£): 64.269 Net journey time changes (£): 0 to 2min: 28.558; 2 to 5min: 7.847; > 5min: 27.864		£69,491.000	
	Reliability impact on Business users	Reliability has been assessed in line with TAG Unit A1.3, Section 6.3 (Reliability – urban roads) based on the calculation of the standard deviation of journey times from journey time and distance for each O-D (origin-destination) pair				
	Regeneration	N/A				
	Wider Impacts	WSP's Wider Impacts in Transport Appraisal (WITA) tool has been used.The tool estimates the following impacts: agglomeration, labour supply and output change in imperfectly competitive markets as described in TAG units A2.1 to unit A2.4:	WI1: Agglomeration impacts £89.26m WI2: Output change in imperfectly competitive markets impacts £7.88m WI3: Tax revenues arising from labour market impacts ££0.33m		£97,471,000	
Environmental	Noise	Not assessed for the Core Growth (Sensitivity) Scenario		NA		
	Air Quality	Not assessed for the Core Growth (Sensitivity) Scenario		N/A		
	Greenhouse gases	Not assessed for the Core Growth (Sensitivity) Scenario	Change in non-traded carbon over 60y (CO2e) Change in traded carbon over 60y (CO2e)	N/A		
	Landscape	There would be subdivision of fields, disrupting field patterns locally. There would be sections of embankment and cutting through the landscape which would affect the pattern locally but the viaduct would have a wider impact. Field patterns are easily substitutable, although loss of mature hedgerow trees would take much longer to re-establish. The viaduct across the River Wensum will introduce a new feature into this landscape and will have a significant impact on tranquillity in the north. The road will also alter tranquillity locally along its entire length, although more limited than the viaduct due to it largely being at-grade or in cutting. The alignment, which is duelled, is larger than the existing road infrastructure through this landscape and therefore out of character. There will be some loss of woodland and arable farmland altering land cover locally.	N/A	Moderate Adverse	N/A	
	Townscape	Scoped out of WebTAG and AST appraisal.	N/A	N/A	N/A	
	Historic Environment	The Proposed Scheme would have a moderate adverse effect on the setting (context) of nearby listed buildings, and will adversely affect the appreciation and understanding of the characteristic historic environmental resource in the area of proposed road construction. The Proposed Scheme would have a low, moderate or major adverse effect on known non-designated assets. The Proposed Scheme would have a low, moderate or major direct impact on previously unrecorded significant historic environment non-designated assets, resulting in loss of features such that their integrity is substantially compromised. The heritage significance of such assets would depend on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved).	N/A	Moderate adverse (built heritage) Low, moderate or	N/A	
	Biodiversity	The possible biodiversity impacts include loss of woodland, hedgerows and wetland, degradation of habitats and impacts to protected species through loss of habitat, disturbance, severance of habitat, fragmentation and killing/injury of individuals. Impacts could occur during construction and operation of the Proposed Scheme. Mitigation and compensation strategies are being developed to reduce the identified possible impacts. Mitigation measures include a range of design features such as sensitive timing of construction works and the use of green bridges and underpasses. Compensation measures include planting new areas of woodland and enhancing existing woodlands. The most significant impact which cannot be mitigated for, in the short term, is the loss of woodland which bats use as foraging habitat.	N/A	Large adverse	N/A	
	Water Environment	No structures are proposed within the channel of the River Wensum or within 10m of the River Wensum. This is expected to minimise impacts to the river flow and channel morphology of the River Wensum. The Proposed Scheme requires the construction of a maintenance access track immediately adjacent to the proposed viaduct to enable inspection of the viaduct over its design life. The track will not require crossing of the River Wensum but will need to be constructed within the floodplain of the River Wensum and cross the land drains located within this area. The access track will be constructed at grade to prevent adverse effects to floodplain storage or flood flow conveyance. Structures such as culverts into a watercourse can potentially remove natural bed substrate and bank-side habitat, as well as change flow dynamics and sediment transport through the Tributary of the River Tud. Crossings of watercourses and any new watercourse channels are expected to maintain the capacity of the channel, ensure no increased flood risk up to the 1 in 100-year event considering the potential effects of climate change, be designed in accordance with DMRB guidance, and be sensitive to ecological requirements. The Drainage Strategy at this stage of the assessment indicates that infiltration to ground and discharge to nearby watercourses will be utilised to discharge road runoff. A robust surface water drainage system will be expected to ensure discharge from the Proposed Scheme does not increase flood risk elsewhere up to and including the 1 in 100-year event and allowing for climate change effects and provides sufficient attenuation to restrict the rate and volume of discharge to those agreed with Norfolk County Council (NCC) as the Lead Local Flood Authority (LLFA). A broad range of potential runoff pollutants, such as hydrocarbons (fuel and lubricants), fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving groundwater water bodies. Implementation of a Construction Environmental Management Plan (CEMP) and passive treatment incorporated into sustainable drainage systems (SuDS) should be considered and adhered to during construction and operation of the Proposed Scheme, to reduce the risk of contamination to the water environment. Mitigation for reduced groundwater recharge due to the introduction of hardstanding should be considered during detail design stage of the Proposed Scheme.	N/A	Slight Adverse	N/A	
Social	Commuting and Other users	The scheme provides Commuting and Other user benefits, with most of the benefits being from journey time savings totalling £116.165m in user benefits. This are increases in vehicle operating costs, with a benefit of £67.104m.	Value of journey time changes(£): 116.166 Net journey time changes (£): 0 to 2min: 48.51; 2 to 5min: 13.652; > 5min: 54.004		£183,270,000	
	Reliability impact on Commuting and Other users					
	Physical activity	The impacts on Physical Activity has been assessed with DfT's AMAT for three of the four wider walking and cycling interventions. The NWL is forecast to have a beneficial impact of £8.876 million.			£8,876,000	
	Journey quality	Journey Quality has been assessed for traveller care, traveller views and traveller stress. Traveller care impacts have been assessed as moderately beneficial. Traveller views impacts have been assessed as neutral to beneficial, and traveller stress impacts have been assessed as large beneficial.		Moderate Beneficial		
	Accidents	COBALT (COst and Benefit to Accidents – Light Touch) has been used to understand the likely impact of the scheme on accidents in the study area. The impacts on users and road safety (accidents) has been appraised for a period of 60 years from the first year of scheme opening. The results indicate that the scheme will result in a reduction of 432 accidents over the 60 year appraisal period, leading to a reduction of 541 casualties (1 Fatal, 42 Serious and 498 Slight).	The results indicate that the scheme will result in a reduction of 432 accidents over the 60 year appraisal period, leading to a reduction of 541 casualties (1 Fatal, 42 Serious and 498 Slight)		£11,496,000	
	Security	Based on the assessment undertaken, the security impacts have been assessed as moderate/large beneficial. This is due to the provision of lighting and illuminated signs on the new link, and the reduction in junctions and stop start traffic.		Moderate Beneficial		
	Access to services	The scheme has not been designed to address accessibility, there is no change in the routes served by the public transport system, although there may be complementary public transport measures considered separately to the NWL at a later time.		Neutral		
	Affordability	The scheme has not been designed to address the affordability of the transport system, there will be no change in fares/travel costs in users apart from those already identified through TUBA via Car Fuel and Non-Fuel operating costs		Neutral		
	Severance	There are more roads forecast to experience decreases in flow rather than increases in flow in the study area; thus, showing a beneficial impact of the scheme on traffic flow, therefore the change in vehicle flows are not anticipated to negatively impact pedestrian movement. Where existing routes are severed, new crossing facilities will be provided, which should mitigate the impact of the new road.		Slight Beneficial		
	Option and non-use values	The scheme will not substantially change the availability of transport services within the study area.		Neutral		
Public Accounts	Cost to Broad Transport Budget	The cost to the broad transport budget is £127.129m			£127,128,461	
	Indirect Tax Revenues	The indirect tax revenues are £39.398m			-£39,398,000	

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