A66 Northern Trans-Pennine Project
TR010062

3.8 Combined Modelling and Appraisal Appendix E Stage 3 Economic Appraisal

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A66 Northern Trans-Pennine Project Development Consent Order 202x

3.8 COMBINED MODELLING AND APPRAISAL REPORT – APPENDIX E ECONOMIC APPRAISAL

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1 Introduction

1.1 Project Overview

1.1.1 National Highways (NH) is undertaking the A66 Northern Trans-Pennine Route Project, which looks at options to upgrade the A66 corridor between the M6 at Penrith and the A1(M) at Scotch Corner. The study is at National Highways Project Control Framework (PCF) Stage 3 – Preliminary Design within the 'Development Phase'. The project scope is to widen the remianing single carriageway links, and thereby upgrade the whole A66 to dual carriageway standard. The project also improves the junctions at M6 J40 Skirsgill, A6 Kemplay Bank and A1(M) J53 Scotch Corner, at each end of the route. The aim is to make the A66 a speedier, safer, and more reliable strategic road.

1.1.2 Most of the Preliminary Design is influenced by the transport and travel characteristics which are expected on the route after the A66 improvements are introduced. These characteristics are predicted by using the A66 transport model (A66TM). This approved model was developed from the North Regional Transport Model (NRTM) in PCF Stage 1, further refined in PCF Stage 2, and updated in PCF Stage 3, to produce new traffic forecasts, at 2029, 2044 and 2051. The forecasts are derived from a verified 2019 'base year' model (predating travel disruption in 2020 caused by the COVID-19 pandemic).

1.1.3 HM Government's Department for Transport (DfT) requires that all likely impacts of the A66 improvements are assessed in line with prescribed guidelines, concentrating on economic, social and environmental outcomes and their distribution amongst communities. The aim of the assesment is to determine the project's Benefit to Cost Ratio (BCR), its fitness for purpose, acceptability of outcomes, and achievement of stated objectives. This evidence is required in the application for Development Consent Order (DCO – scheme approvals and powers), in PCF stage 4, during 2022, and for the Project Business Case (for HM Treasury), which is updated in all of the PCF stages.

1.2 Purpose of the Economic Appraisal Package

1.2.1 The Economic Appraisal Package (EAP) is a NH PCF product. It discusses the impact of the A66 NTP project on people's welfare, which is measured in terms of economic, social and environmental outcomes, and the distribution of outcomes amongst communities. An outline of these concepts and methods of assessing outcomes is provided in various guidance sources: DfT Transport Analysis Guidance (TAG, November 2021), the HM Treasury 'Green Book' (Central Government Guidance on Appraisal and Evaluation, November 2020), and the DfT Value for Money Framework (July 2017). The assessment findings will be summarised in the DfT Appraisal Summary Table (AST).

1.2.2 The purpose of the EAP is to describe how the outcomes, benefits and costs of the Recommended Preferred Route, (as amended during Preliminary Design), are derived, and to present the associated results.

The report outlines the principles, tools, data sources, methods, analyses and assumptions used to estimate the appraisal outcomes.

1.2.3 The EAP is a PCF product defined by NH, which broadly aligns with the scope of the DfT / HM Treasury Transport Business Case 'Economic Dimension', and accompanying 'Economic Narrative'.

1.3 Report Structure

1.3.1 The content of the EAP is as follows:

- The remaining sections of Chapter 1 discuss the scope of the appraisal.
- Chapter 2 outlines the background to the project and its evolution.
- Chapter 3 shows the scope of the economic appraisal.
- Chapter 4 describes the methods used to appraise the impacts of the project.
- Chapter 5 provides the appraisal outcomes for the Core Scenario.
- Chapter 6 provides appraisal outcomes for the High and Low Scenarios.
- Chapter 7 draws together some conclusions from the appraisal.
- Appendices A to D contain further details of the various appraisal aspects.

2 Project Background

2.1 Introduction

2.1.1 The A66 Northern Trans-Pennine project is an upgrade of the A66 corridor between the M6 at Penrith and the A1(M) at Scotch Corner. The study is currently at NH PCF Stage 3, Development Phase Preliminary Design.

2.1.2 The project includes upgrading the existing single lane sections of the A66 to dual two-lane all-purpose roads with a speed limit of 70 miles per hour (mph), with the exception of a section of the A66 from the M6 junction 40 through Kemplay Bank which will have a speed limit of 50mph. The project also includes amendments to existing junctions and accesses within these sections. The project has been split into eight schemes as shown in Figure 2-1.

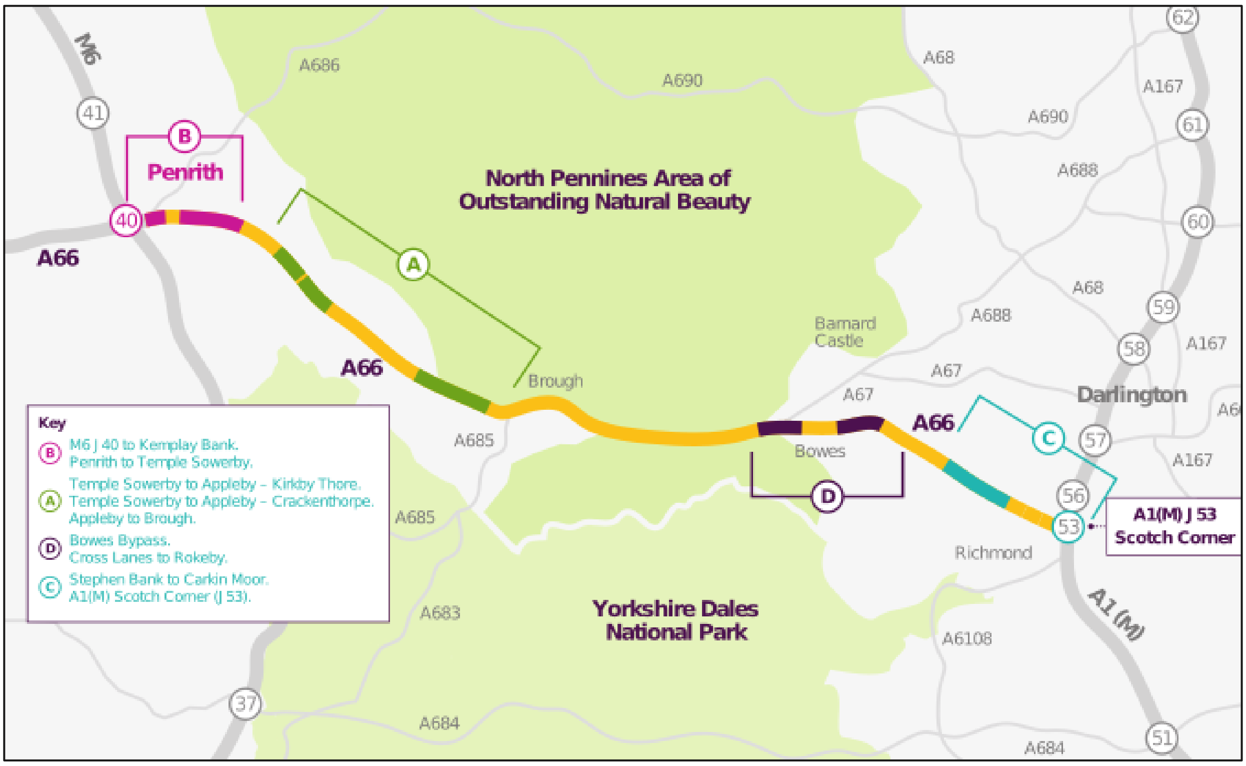


Figure 2-1: A66 Northern Trans-Pennine Project Route Sections

2.1.3 An A66 NTP Preferred Route layout was anounced in May 2020 following PCF stages 1 and 2, in which alternative solutions to identified problems were sifted and refined, during the ‘Options Phase’. The current Preliminary Design has evolved, alongside the background situation, and has now been ‘frozen’ (in February 2022), following further surveys, investigations, analyses, stakeholder discussions, public Statutory Consultation (in September 2021), and additional targeted consultations in early 2021.

2.1.4 It is proposed to start constructing the A66 NTP schemes at the beginning of 2024, in an overlapping programme lasting five years to the end of 2028, with the up-graded route opening for traffic in 2029.

2.2 Objectives of Proposed Project

2.2.1 The strategic objective of the project is to investigate the potential to create a new improved strategic corridor linking the A1(M) with the M6 by upgrading the A66 corridor and making other improvements along its length. Further aims and objectives are to improve strategic, regional and national connectivity, particularly for HGVs, considering a more attractive alternative route to the M62 for some east-west crossing movements, improving journey time reliability on the A66 and promoting economic growth.

2.2.2 The objectives of the A66 Northern Trans-Pennine project are found in Table 2-1: Project Objectives.

Table 2-1: Project Objectives

Option	Description
Economic Growth	Regional: Support the economic growth objectives of the Northern Powerhouse and Government levelling up agenda.
	Ensure the improvement and long-term development of the SRN through providing better national connectivity including freight.
	Maintain and improve access for tourism served by the A66.
	Seek to improve access to services and jobs for local road users and the local community.
Transport	Improve road safety, during construction, operation and maintenance for all, including road users, non-motorised users (NMU), road workers, local businesses and local residents.
	Improve journey time reliability for road users.
	Improve and promote the A66 as a strategic connection for all traffic and users.
	Improve the resilience of the route to the impact of events such as incidents, roadworks and severe weather events.
	Seek to improve NMU provision along the route.
Community	Reduce the impact of the route on severance for local communities.
Environment	Minimise adverse impacts on the environment and where possible optimise environmental improvement opportunities.

2.3 Previous Analysis

2.3.1 During PCF Stages 1 and 2, using an enhanced version of the North Regional Transport Model (NRTM), traffic forecasting and economic appraisal was undertaken to determine the preferred route.

2.3.2 The PCF Stage 1 A66 Transport Model (A66TM) was developed to assess options along the A66 corridor and to inform the option identification process. The NRTM was used as a starting point, with key elements of the model structure retained and the networks, representation of demand, and validation all refined in the area of interest. At PCF Stage 2, the A66TM was further refined to improve assessment of the scheme.

2.3.3 Scheme-specific data was collected to enhance the model, including a traffic survey programme along the A6 corridor between Penrith and A1(M) Scotch Corner during November and early December 2017, as well as additional traffic counts from Cumbria County Council.

2.3.4 Traffic forecasts were prepared to illustrate the sensitivity of transport user benefits to the Core Scenario, as well as traffic growth uncertainties, including local and national uncertainties in traffic growth. As such, in addition to the Core Scenario, two additional growth scenarios, the High Growth Scenario and Low Growth Scenario were assessed.

2.3.5 The PCF Stage 2 economic assessment of the A66 Northern Trans-Pennine Project was undertaken to facilitate the quantification and monetisation of the scheme costs and benefits of the Recommended Preferred Route.The Economic Assessment brings the user benefits and scheme costs together with the accident and environmental impacts, where these can be quantified into the Analysis of Monetised Cost and Benefits (AMCB) tables, which then generate the measures of economic worth, the Net Present value (NPV) and the Benefit-Cost Ratio (BCR) of the scheme. Jounrey time relaibility and wider economic impacts are also assessed.

2.3.6 The results of the PCF Stage 2 economic appraisal were reported in January 2020 and are shown in Table 2-2. The appraisal used standard Department for Transport and Highways England (NH) guidance and procedures, current at May 2019, and transport modelling and appraisal parameters from TAG Data Book v1.12 (May 2019).

Table 2-2: Stage 2 Scheme Appraisal Results (2010 prices discounted to 2010)

PCF Stage 2 Economic Appraisal Package (Final) 23 January 2020 HE565627-ARC-HGN-A66-RP-TR-1076.docx: TAG Data Book V1.12 May 2019 Appraisal Parameters. 7-Year construction programme. Opening Year 2031. Appraisal Period 2031 – 2090.				
	Metric	**Core Scenario(£m)**	**Low Growth Scenario(£m)**	**High Growth Scenario(£m)**
Excluding JTR/ WEB Benefits	Transport User Benefits (Travel Time, VOC and User Charge Savings)	673.47	609.99	825.21
	Construction Impacts	-12.23	-12.23	-12.23
	Accidents	28.70	28.70	28.70
	Wider Public Finances (Indirect Tax Revenue)	80.29	76.33	92.88
	Noise	-4.36	-4.36	-4.36
	Air Quality	-1.08	-1.08	-1.08

PCF Stage 2 Economic Appraisal Package (Final) 23 January 2020 HE565627-ARC-HGN-A66-RP-TR-1076.docx: TAG Data Book V1.12 May 2019 Appraisal Parameters. 7-Year construction programme. Opening Year 2031. Appraisal Period 2031 – 2090.				
	Metric	**Core Scenario(£m)**	**Low Growth Scenario(£m)**	**High Growth Scenario(£m)**
	Greenhouse gases	-141.28	-141.28	-141.28
	Present Value of Benefits (PVB)	**623.51**	**556.08**	**787.85**
	Present value of Cost (PVC)	477.49	477.54	477.82
	Initial Benefit-Cost Ratio (BCR)	**1.31**	**1.16**	**1.65**
Including JTR/ WEB Benefits	Journey Time Reliability Benefits	179.35	179.35	179.35
	Wider Economic Benefits	63.00	57.82	76.64
	Present value of Benefits (PVB)	865.86	793.25	1043.83
	Adjusted Benefit-Cost Ratio (BCR)	**1.81**	**1.66**	**2.18**

2.3.7 The Benefit-Cost Ratios (BCRs) for the scheme for all the growth scenarios are presented in Table 2-2 which includes an initial BCR and adjusted BCR.

2.3.8 The initial BCR has been calculated using the established monetised benefits, which include road user, accident, construction delays, noise, air quality, greenhouse gases and indirect tax revenue.

2.3.9 The adjusted BCR takes into account the evolving monetised benefits, which for the A66 includes wider economic impacts and journey time reliability benefits.

2.3.10 The A66 Project provides an adjusted present value of benefits (PVB) of approximately £865m.

3 Scope of Appraisal

3.1 Introduction

3.1.1 The A66 assessment considers impacts which are associated with the route as a whole, rather than with schemes individually, using quantitative, monetised and qualitative methods. It compares outcomes without the A66 NTP improvement ('do-minimum' – DM) against outcomes with the improvement ('do-something' – DS), to determine the net effect of intervention.

3.1.2 Economic impacts are mainly determined using principles of monetised cost-benefit analysis, since most aspects of transport and travel incur a monetary cost in terms of infrastructure provision and expenditure, vehicle use, time spent by transport users, accident injuries and damage, environment damage and mitigation, and 'externalities' (or costs generated but not wholly born by individuals).

3.1.3 In cost-benefit analysis, all monetised outcomes are assessed over a 60-year appraisal period from scheme opening[1]. For A66, this means the appraisal period is from 2029 to 2088, inclusive. Monetised costs and benefits are also converted back to 2010 present year real market prices and values, by applying an indirect tax correction factor of x1.19, and by discounting[2] from the year of occurrence back to 2010 at a rate of 3.5% per annum for the first 30 years from current year (from 2022 to 2051 inclusive), and 3% per annum for the remaining years of the 60-year appraisal period (from 2052 to 2088 inclusive) as stated in Tag Unit A1.1.

3.1.4 The 60-year appraisal duration, a 2010 present year valuation and specified economic parameters, are all necessary to enable DfT to compare the relative BCRs of different infrastructure investments.

3.1.5 A lower discount rate of 1.5% per annum is applied to certain 'human health' impacts, where monetary valuation is based on 'willingness to pay', specifically air quality, noise, physical activity and human costs of accidents.

3.1.6 Model parameters, which are used in the SATURN traffic model (A66TM) to control the traffic patterns and network performance in the scenarios for appraisal, and appraisal parameters, which are used in the assessment calculations to determine monetised outcomes, are derived from the latest best practice guidance and DfT specifications in TAG Data Book v1.17 (November 2021).

[1] In line with the Principles of Cost Benefit Analysis as set out in *TAG Unit A1.1 Cost Benefit Analysis (Dft July 2021).*

[2] There is significant evidence to show that people prefer to consume goods and services now, rather than in the future. In general, even after adjusting for inflation, people would prefer to have £1 now, rather than £1 in 60 years' time. All monetised costs and benefits arising in the future need to be adjusted to take account of this phenomenon, known as 'social time preference'. The technique used to perform this adjustment is known as 'discounting'

3.1.7 Social and distributional impacts are mainly determined using quantitative and qualitative, non-monetised, assessments, following structured guidance.

3.1.8 Environmental impacts are examined primarily in the the **3.2 Environmental Statement**. However, the findings are also fed into TAG-consistent worksheets for the EAP and the AST.

3.2 Categorisation of Impacts

3.2.1 In the EAP, A66 project outcomes are assessed under four appraisal categories, A, B, C and D. These capture and consolidate the differences and overlap in the guidance sources referred to in section 1.2.1, in terms of how they define types of impact, assessment criteria, and analytical techniques, namely:

- AST –which identifies Economic, Environmental, Social and Public Accounts impacts, assessed using quantitative and qualitative methods.
- BCR – which identifies 'Established' monetised impacts for the initial BCR, 'Evolving' monetised impacts for the adjusted BCR,
- TAG – which retains both the AST (Appraisal Summary Table) and BCR categories above, but which also identifies 'Level 1' monetised impacts for the initial BCR, 'Level 2' monetised impacts for the adjusted BCR, and 'Level 3' indicative monetised and non-monetised impacts for the 'Economic Narrative'.

3.2.2 Not all potential impacts are assessed for the A66 NTP project, because some will be insignificant or irrelevant in the context of the stated objectives, the identified problems and the scope of the proposed improvements. It is therefore dis-proportionate to assess these impacts.

3.2.3 Impacts under category A, include some economic, social and environmental outcomes, because these can be valued with greatest certainty. However, other economic impacts are monetised (with less certainty) under categories B and C, and other social and environmental effects are captured qualitatively in category D. In outline, the aspects of the A66 NTP project which are assessed for PCF Stage 3 (and monetised unless otherwise indicated), are as follows:

- Category A – 'Level 1' (established assessment of direct impacts on road users and providers) –
  - Public expenditure (Construction capital – CAPEX, and operation / maintenance funds – OPEX).
  - Travel time costs, vehicle operating costs, and user charges.
  - Wider public finance and public sector operator revenue.
  - User costs during scheme construction and maintenance.
  - Noise, air quality and greenhouse gases.
  - Safety costs (accidents).
  - Physical activity (not monetised for A66 – assessed under Category D).
  - Journey quality (not monetised for A66 – assessed under Category D).

- Category B – ‘Level 2’ (evolving assessment of transport connectivity impacts) –
  - Journey time reliability.
  - Wider economic impacts under static land use: business output in an imperfect market; release of inactive labour supply, and productivity of businesses through agglomeration and easier interaction with workforce. It should be noted that agglomeration has not been currently included within the A66 appraisal.
- Category C – ‘Level 3’ (indicative assessment of structural economic impacts and other impacts) –
  - Wider economic impacts under dynamic land use
  - Route resilience.
  - Network resilience.
  - Landscape valuation (not assessed for A66).
- Category D – ‘Level 3’ (non-monetised assessment of social and environmental impacts) –
  - Physical activity (not monetised for A66).
  - Journey quality (not monetised for A66).
  - Accessibility.
  - Affordability.
  - Severance.
  - Townscape.
  - Historic environment.
  - Biodiversity.
  - Water environment.

3.2.4 The likely distribution amongst communities of some outcomes listed above is considered in the EAP, in line with the ‘Green Book’ guidance, AST and TAG. Distributional effects are assessed for the following impacts:

- Category A – ‘Level 1’ impacts distribution –
  - User benefits, (travel time costs, vehicle operating costs, and user charges).
  - Noise and air quality.
  - Accident costs.
- Category B – ‘Level 2’ impacts distribution –
  - No distributional assessment.
- Category C – ‘Level 3’ impacts distribution –
  - No distributional assessment.
- Category D – ‘Level 3’ impacts distribution –
  - Security.
  - Accessibility of services and facilities.
  - Affordability.
  - Severance.

3.2.5 Some impacts which are referred to in the guidance are not assessed for the A66 NTP project, because they are not relevant within the scope of the improvements, or they cannot be considered appropriately and proportionally within the scope of the study. These impacts are as follows:

- Category A – ‘Level 1’ established assessment of direct impacts on road users and providers –
  - User costs during scheme maintenance.
  - (These are omitted, because a preliminary pavement engineering report and maintenance plan for the A66 NTP project concludes that the net impact of the improvement on route maintenance requirements, and hence on roadworks delays for users, over 60 years, will be largely neutral; also no maintenance temporary traffic management plans are prepared at PCF3, so the impact on users cannot be accurately modelled or assessed; the new DS route with 352 lane-kms of main carriageway will entail reduced maintenance impacts for the first 30 years after opening, compared with the DM existing route with 264 lane-kms of main carriageway; but the DS route will generate a 12% increase in maintenance impacts in the remaining years; as travel costs during maintenance in later years would be discounted more, to 2010 values and prices, the overall net maintenance cost to users is likely to be slightly positive).
  - Active mode economic and social aspects.
  - (These are not analysed in a monetised assessment, using Active Mode Appraisal Toolkit November 2021, because initial assessment suggests that the project will not have a significant impact on numbers of people walking and cycling; however, provision for existing users is considered in the Walking, Cycling and Horse-riding Assessment and Review. They are assessed qualitatively in terms of physical activity and journey quality impacts).
- Category C – ‘Level 3’ indicative assessment of structural economic impacts and other impacts –
  - Wider economic impacts under dynamic land use change and re-location: (scheme-dependent development with land value uplift and transport external costs; workers’ productivity from moving and changing jobs; and productivity of relocated businesses through agglomeration and easier interaction with workforce).
  - (These are omitted and not considered to be proportional, because the project appraisal does not predict any differential change in land uses or location of homes, jobs and economic activity, between the without-scheme DM and with-scheme DS scenarios; it only predicts changes in the pattern of some trips between the same DM and DS origin and destination land uses).
- Category D – (Level 3) non-monetised assessment of social and environmental impacts –
  - Security.
  - Optional usage / non-usage value.
  - (These are omitted, because the security and optional usage value impacts are usually only applicable for public transport infrastructure and service improvements, and there is no reliable source of evidence regarding the views of non-users of the A66 highway improvement).

4 Appraisal Methods

4.1 Introduction

4.1.1 This chapter describes the methods and tools used to assess the impacts of the A66 NTP project on social welfare. Potential impacts of the A66 NTP project are split into four categories, A, B, C and D, as indicated in Chapter 1. Most impacts for the Do Minimum (DM) and Do Something (DS) situations are predicted using travel patterns and road network performance measurements from the A66 SATURN traffic model (A66TM). Category ‘A’ direct impacts on road users and providers are quantified and monetised. The appraisal method here is recognised and robust and established. User benefits are calculated by subtracting DS outcomes from DM outcomes, to give the net saving in user costs (the Present Value of Benefits, or PVB). Conversely, Public Accounts costs are calculated by subtracting DM expenditure items from DS expenditure items, to give the net increment on expenditure (the Present Value of Costs, or PVC). The Net Present Value of the A66 improvements (NPV) is then derived by subtracting the PVC from the PVB. The ‘initial’ Benefit to Cost Ratio (BCR) is calculated as the ratio of PVB to PVC.

4.1.2 Category ‘B’ transport connectivity impacts are also quantified and monetised. They are assessed from the same traffic model outputs as for Category ‘A’, but the outcomes are handled separately to the initial BCR and are only used to produce an ‘adjusted’ BCR, as there is more uncertainty around the appraisal methods.

4.1.3 Category ‘C’ structural economic and other impacts are quantified and monetised, but the available analytical techniques are even less certain than for ‘B’, so these impacts are indicative only and are not included in either the initial BCR or the adjusted BCR.

4.1.4 Category ‘D’ social and environmental impacts are not monetised. They are largely assessed qualitatively using the DfT seven-point scale (ranging from large, moderate and slight beneficial outcomes, through neutral, to slight, moderate and large adverse outcomes).

4.1.5 The remainder of this chapter outlines the appraisal methods for each impact in categories A, B, C and D, respectively.

4.2 Appraisal Aspects

4.2.1 Table 4-1 gives an overview of how aspects of the A66 NTP project are appraised. The table captures typical impacts of an infrastructure investment which are applicable for the A66.

Table 4-1: A66 NTP Appraisal Aspects and Methods of Assessment

Impact Appraisal Item	Appraisal Summary Table (AST) Aspect	Impact Assessed for A66 NTP				Impact Not Assessed or Relevant for A66 NTP ×
		Monetised ✓			Not Monetised ✓	
		In Initial BCR ✓	In Adjusted BCR Only ✓	In Overall AST Only ✓		
Category A – (Level 1) Established assessment of direct impacts on road users & providers, (which may be monetised)						
Public expenditure: – Costs to public account (PA) for construction, operation & maintenance	Public Accounts	✓				
Transport economic efficiency (TEE): – Costs of travel time & vehicle operation, & user charges, during normal scheme operation	Economic (for business users) Social (for commuter & other users)	✓				
Other transport user impacts: – Wider public finance / indirect fuel tax revenue & public sector operator revenue / road tolls, during normal operation	Economic	✓				
Scheme construction impacts: – Transport economic efficiency (TEE) & other transport user impacts during construction, outside of normal operation	Economic	✓				

Impact Appraisal Item	Appraisal Summary Table (AST) Aspect	Impact Assessed for A66 NTP				Impact Not Assessed or Relevant for A66 NTP ✗
		Monetised ✓			Not Monetised ✓	
		In Initial BCR ✓	In Adjusted BCR Only ✓	In Overall AST Only ✓		
Scheme maintenance impacts: – Transport economic efficiency (TEE) & other transport user impacts during maintenance, outside of normal operation	Economic					✗
Environment: – Noise, air quality & greenhouse gases	Economic	✓				
Safety & Accidents: – Costs of casualties police, insurance, & damage to property	Social	✓				
Physical activity	Social				✓ (Assessed under Category D)	
Journey quality	Social				✓ (Assessed under Category D)	
Active modes: – Monetised economic & social aspects of walking & cycling (using MAT Nov 2021)	Economic (not specified in AST)					✗
<u>Category B – (Level 2) Evolving assessment of transport connectivity impacts, (which may be monetised)</u>						
Journey Time Reliability: – Travel time variability during daily congestion & incidents, plus incident delays <6hrs	Economic (for business users) Social (for commuter & other users)		✓			

Impact Appraisal Item	Appraisal Summary Table (AST) Aspect	Impact Assessed for A66 NTP				Impact Not Assessed or Relevant for A66 NTP ×
		Monetised ✓			Not Monetised ✓	
		In Initial BCR ✓	In Adjusted BCR Only ✓	In Overall AST Only ✓		
Wider Economic Impacts: With improved transport connectivity & static land use: – Business output (welfare equivalent of GDP, under imperfect market competition) – Tax revenue (welfare equivalent of GDP from releasing inactive labour supply)	Economic		✓			
<u>Category C – (Level 3) indicative assessment of structural economic impacts & other impacts, (which may be monetised)</u>						
Route resilience: – Travel time delays during incidents >6hrs on A66	Not in AST (Initiated by NH)			✓		
Network resilience: – Travel time delays during incidents >6hrs on other routes (strategic & local), which are relieved by traffic diversion on to A66	Not in AST (Initiated by NH)			✓		

Impact Appraisal Item	Appraisal Summary Table (AST) Aspect	Impact Assessed for A66 NTP				Impact Not Assessed or Relevant for A66 NTP ×
		Monetised ✓			Not Monetised ✓	
		In Initial BCR ✓	In Adjusted BCR Only ✓	In Overall AST Only ✓		
Wider Economic Impacts: With structural land use change & dynamic re-location of activity: – Scheme-dependent development (Welfare equivalent of land value uplift & transport external costs) – Tax revenue (welfare equivalent of GDP from productivity of workers moving & changing jobs) – Productivity (GDP from dynamic business agglomeration & easier interaction with workforce)	Economic					×
Landscape: – Valuation of changes	Environmental					×
Transport External Costs: – Costs not born by instigator of congestion	Economic (Part of wider impacts)					×
Regeneration: – Obsolete (now captured within WEI)	Economic					×
<u>Category D – (Level 3) non-monetised assessment of social & environmental impacts, (which may be quantified)</u>						
Physical activity	Social				✓ (Moved from Category A)	
Journey quality	Social				✓ (Moved from Category A)	
Security	Social					×

Impact Appraisal Item	Appraisal Summary Table (AST) Aspect	Impact Assessed for A66 NTP				Impact Not Assessed or Relevant for A66 NTP ×
		Monetised ✓			Not Monetised ✓	
		In Initial BCR ✓	In Adjusted BCR Only ✓	In Overall AST Only ✓		
Accessibility (of services & facilities)	Social				✓	
Affordability	Social				✓	
Severance	Social				✓	
Optional usage / non-usage value: – Attributed to the scheme	Social					×
Townscape	Environmental				✓	
Historic Environment	Environmental				✓	
Biodiversity	Environmental				✓	
Water environment	Environmental				✓	

4.2.2 Progressive steps in A66 NTP appraisal process are shown in Figure 4-1.

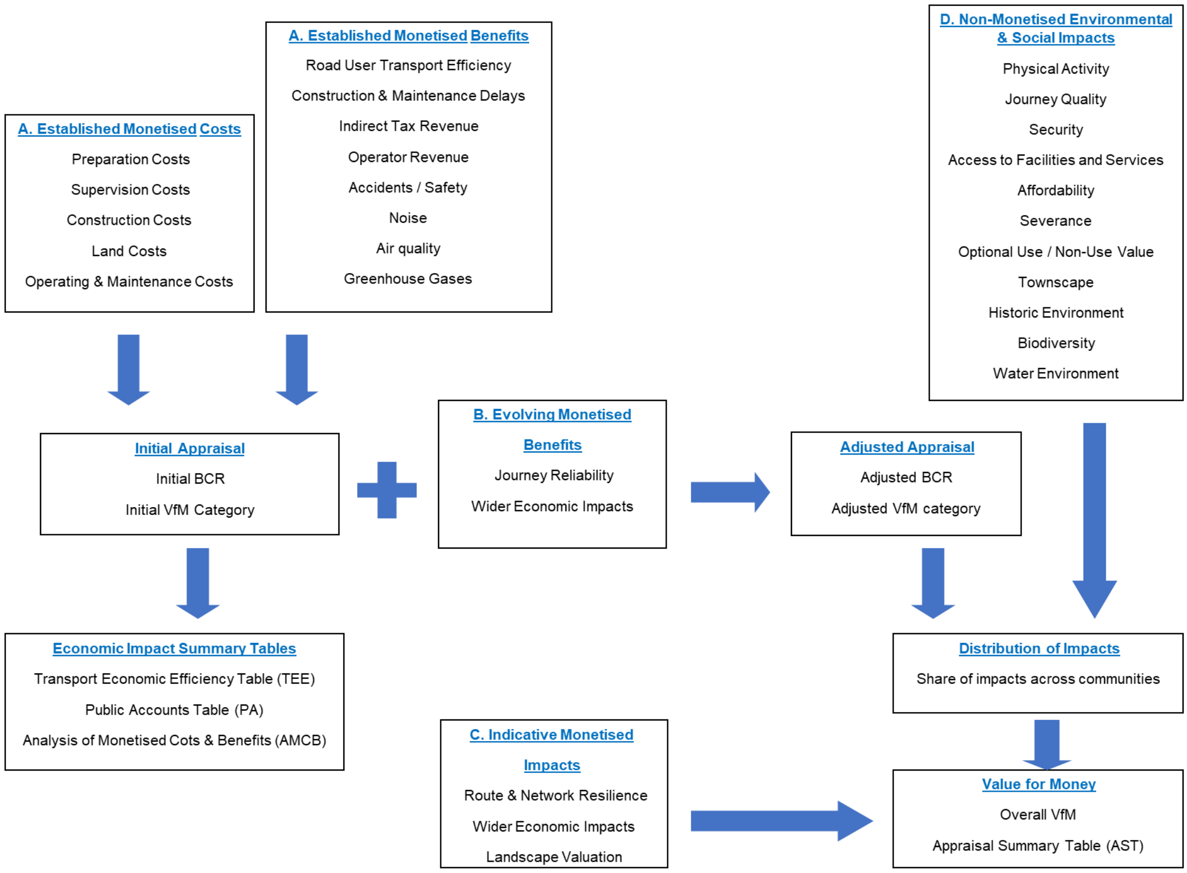


Figure 4-1: A66 NTP Appraisal Process for Impact Categories A, B, C and D

4.3 Appraisal Scenarios and Uncertainty

4.3.1 For A66, a transport appraisal ‘scenario’ represents a combination of several items, namely:

- Assessment period
- Road network configuration.
- Forecast future change in the volume of travel demand and pattern of movement between trip origins and destinations.
- Future economic parameters which determine the monetary valuations of travel cost, social and environmental cost and public expenditure on transport provision.
- Future technological changes which affect the use of transport modes and the impacts of travel.

4.3.2 Many of these items are described in the ‘Appraisal and modelling Strategy – TAG Update Report’ issued by DfT in May 2021. Some are also captured in the current DfT TAG Data Book v1.17 (November 2017).

Core Scenario for Appraisal

4.3.3 A Core scenario outlook is assessed for the A66 project, which represents the most likely project outcomes, and which entails using the following assumptions and parameters in the A66 SATURN traffic model (v11.4.07H) and in the various impact appraisal tools and mechanisms:

- DM road network layout with committed improvements and DS road network with DM changes, plus A66 NTP schemes at preliminary design stage.
- Most likely number and spatial distribution of people, homes and jobs.
- Central case levels of income for individuals and the economy.
- Inclusion of land use developments from the project 'Uncertainty Log' which are either 'Near certain' or 'More Than Likely'.
- Most likely forecast of travel demand trip ends and wider area growth constraints from TEMPro v7.2b database for both DM and DS.
- Central case monetary valuation of travel costs and transport impacts.
- Central case valuation of greenhouse gases (carbon) impacts, and Carbon Dioxide equivalent (CO2e) emissions factors (DfBEIS and DfT 2021).
- Central case appraisal period (60 years) and discount rate (HM Treasury).
- Central case TAG Data Book V1.17 parameters (DfT).
- Project construction from January 2024 (main works) to December 2028.
- Project open to traffic in January 2029.

Uncertainty Scenarios for Appraisal

4.3.4 The sensitivity of the Core Scenario appraisal to uncertainty is assessed in two respects:

- Uncertainty around future traffic and economic growth.
- Uncertainty around public expenditure.

4.3.5 To take account of traffic growth uncertainty, the National Trip End Model database, as contained in TEMPro v7.2b, is used to assemble DM and DS Low Growth and High Growth scenarios in the SATURN A66TM. The Low and High scenarios test the uncertainty and sensitivity around road user benefits (PVB), when compared against the NH Central capital expenditure estimate and Most Likely operation and maintenance expenditure estimate (PVC), and against core scenario outcomes for construction delays, accidents, environment, wider public finances, journey time reliability and wider economic impacts.

4.3.6 To assess public expenditure uncertainty, the NH PCF3 Developing Estimate is used to establish Minimum and Maximum costs for construction (CAPEX) and operation / maintenance (OPEX) within the probability range estimates P0 to P100). The Minimum and Maximum public expenditure scenarios test the uncertainty around public account costs (PVC), when compared against the Core Scenario outcomes for transport economic efficiency, construction delays, accidents, environment, wider public finances, journey time reliability and wider economic impacts (PVB).

4.4 Public Expenditure – Appraisal Method (Category A impact)

4.4.1 Public expenditure is assessed within the initial BCR calculations for the project, in accordance with TAG advice in Unit A1.2 Scheme Costs (November 2021). Public expenditure comprises spending by UK Government on two aspects of the A66 NTP project, which are estimated separately within the overall monetised cost to Public Accounts (PA), namely:

- Capital expenditure on scheme construction.
- Expenditure on route operations and maintenance.

4.4.2 These expenditure items are assessed together for the whole route, including all schemes and existing unchanged sections, for the DM and DS scenarios, using spread sheet calculations, at 2010 present year values and prices, discounted.

4.4.3 Indirect tax revenue and operator revenue impacts are determined separately to the public expenditure items, as outputs from the TUBA (Transport User Benefits Appraisal v1.9.17, December 2021), transport economic efficiency assessment which is based on forecast origin to destination (OD) trips, travel time, journey distance and charges in the DM and DS scenarios, as represented in the A66 Traffic Model.

4.4.4 To calculate overall costs to public accounts in the DM and DS scenarios, the value of indirect tax revenue (fuel tax) and operator revenue (road tolls) for Government is subtracted from the expenditure values for construction, operations and maintenance, to give a total DM and DS scheme cost. The breakdown of these cost items is reported in the TAG Public Accounts table.

4.4.5 However, in the overall TAG Analysis of Monetised Costs and Benefits, the indirect tax component is removed from the PVC calculation and is instead added to the PVB calculation.

4.4.6 The net PVC of implementing the project is derived by subtracting the total of DM expenditure on construction, operations and maintenance, plus operator revenue, from the equivalent DS total.

4.4.7 The yearly profile of capital expenditure on scheme construction is produced by NH Commercial Services Division, in a series of probabilistic range estimates from P0 to P100, for the A66 NTP construction programme. The capital expenditure (CAPEX) cost used in the core scenario appraisal is the NH Central Estimate and the operation and maintenance (OPEX) cost used in the core scenario is the NH. A sensitivity test around public expenditure is undertaken using the Minimum (P2.5) and Maximum (P97.5) CAPEX and OPEX costs.

4.4.8 The construction cost profile covers the period from 2022 to 2034, inclusive. It includes preparation, works, supervision and land, with further allowances for project risk and uncertainty and for portfolio risk. It excludes historic sunk costs prior to 2022 and excludes non-recoverable VAT.

4.4.9 The operation and maintenance cost profile covers the period from 2028 to 2087 inclusive. It also excludes non-recoverable VAT. It represents an incremental cost, calculated by subtracting DM cost from DS cost. It includes annual routine highway maintenance, renewal of new highway assets, new and modified structures, annual routine technology maintenance, renewal of new technology assets, and cost of energy and National Roads Telecommunications System (NRTS), and adjustments for severe weather, incident response and impacts on service delivery.

4.4.10 No specific allowance is made for optimism bias, as this is effectively represented in the risk and uncertainty allowances in the cost estimates.

4.4.11 The NH estimate represents a Base Cost at 2019 Q1 prices, which includes adjustment for real construction cost increases relative to general inflation, at each year of cost occurrence. The Base Cost profile is converted to 2010 prices at factor cost, by applying a central case GDP Deflator from TAG Data Book v1.17 (November 2021).

4.4.12 For the TAG-consistent Core Scenario economic appraisal, the NH central capital expenditure 2010 estimate and most likely operation and maintenance expenditure 2010 estimate are further converted to market prices and then discounted to 2010 values.

4.4.13 The spread sheet PVC calculation is checked by using TUBA to calculate the 2010 valuation of Government expenditure and revenue items described above.

4.5 Travel Time, Vehicle Operation, and User Charges – Appraisal Method (Category A Impact)

4.5.1 Transport Economic Efficiency (TEE) is assessed within the initial BCR calculations for the project, in accordance with TAG advice in Unit A1.1 Cost-Benefit Analysis (July 2021) and in Unit A1.3 User and Provider Impacts (November 2021). TEE impacts are measured in terms of travel time, vehicle operation, user charges, indirect taxes and operator revenue, during normal scheme operation (and separately during scheme construction and maintenenace). This provides a present year 2010 assessment of whole-route user net TEE benefits.

4.5.2 Monetised transport economic efficiency TEE benefits will be derived using the PCF3 SATURN traffic model whole-route assigned Origin to Destination (OD) matrix ‘skims’, which provides inputs to a sectored TUBA v1.9.17.2 assessment in terms of modelled trips (vehicles), travel time (hours), journey distance (kilometres) and charges (pence). The TUBA spatial distribution of 28 TUBA sectors, as derived by aggregating trip origin and destination zones from the SATURN model, is summarised in Table 4-2.

Table 4-2: TUBA Sectors

TUBA Sector Name	TUBA Sector No.
South Cumbria	1
Northwest Cumbria	2
Eden	3
Carlisle	4
Northumberland	5
Tyneside	6
Wearside	7
Durham	8
Cleveland (West)	9
Cleveland (East)	10
Richmond-shire	11
North Yorkshire	12
Yorkshire and The Humber (North)	13
Dumfries & Galloway	14
South & East Ayrshire	15
South Lanarkshire	16
Scottish Borders	17
North Scotland	18
Northwest_(South)	19
Yorkshire and The Humber (Southwest)	20
Yorkshire and The Humber (Southeast)	21
East Midlands	22
West Midlands	23
Wales	24
Southwest	25
Southeast	26
East of England	27
London	28

4.5.3 The TUBA Sectors are shown in Figure 4-2 below.

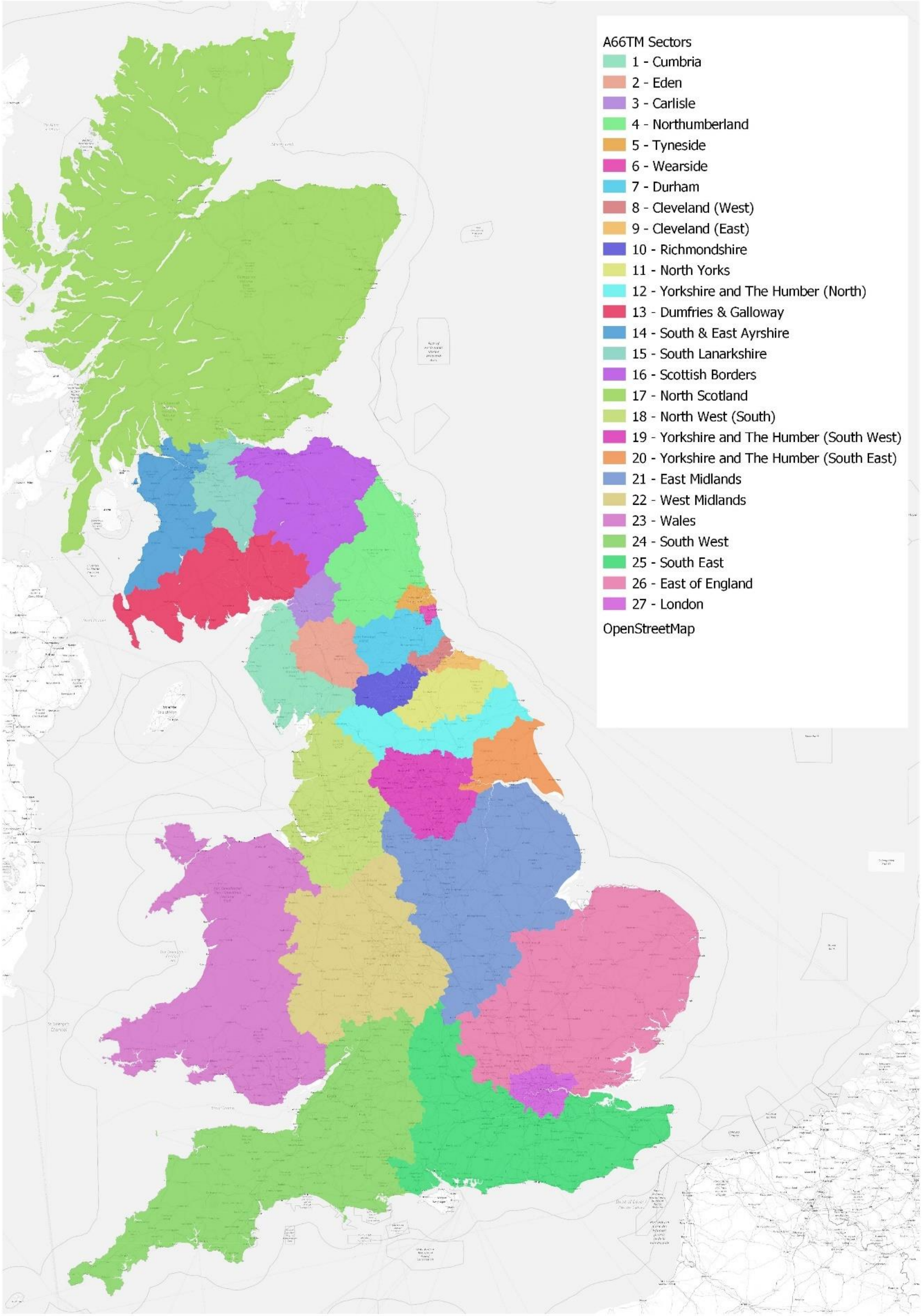


Figure 4-2: TUBA Sectors

4.5.4 The extent of the A66 Transport Model (SATURN) which is used to provide inputs to the TEE appraisal is shown in Figure 4-2 on the following page.

4.5.5 Traffic model March 2019 weekday and weekend day assignment outputs, for DM and DS scenarios, at forecast years 2029, 2044 and 2051, are used in TUBA economic calculations. The model outputs are expanded to a 365-day (8,760-hour) equivalent using annualisation factors appropriate for converting modelled hourly traffic flows at selected times of day and week to a whole year of annual average weekdays, including school holidays, and weekend days plus bank holidays.

4.5.6 In the A66TM, in every forecast year, scheme scenario and time period, road users are categorised into vehicle types: Cars, Light Goods Vehicles – LGV, Heavy Goods Vehicles – HGV (which are split into Other Goods Vehicles OGV1 and OGV2), and into 'User Classes' (UC), which represent permutations of vehicle types and trip purposes (Business, Commute and Other).

4.5.7 For TUBA, these permutations are converted and re-defined as follows:

- x8 input Time Slices (weekday AM shoulder, AM peak, Inter-Peak, PM peak, PM shoulder, Off-Peak, and weekend daytime and night-time).
- x7 input User Classes (Car Business, Car Commute, Car Other, LGV Other, LGV Business, OGV1 Business and OGV2 Business).
- x5 input Vehicle Sub-Modes (Car, LGV Other, LGV Business, OGV1 Business and OGV2 Business).
- x3 input Purposes (Business, Commute and Other).
- x5 output Periods (Weekday AM, PM, Inter Peak, Off Peak and Weekend).

4.5.8 Categorisation of TUBA inputs and outputs, after conversion from the A66TM outputs, is summarised in Table 4-2.

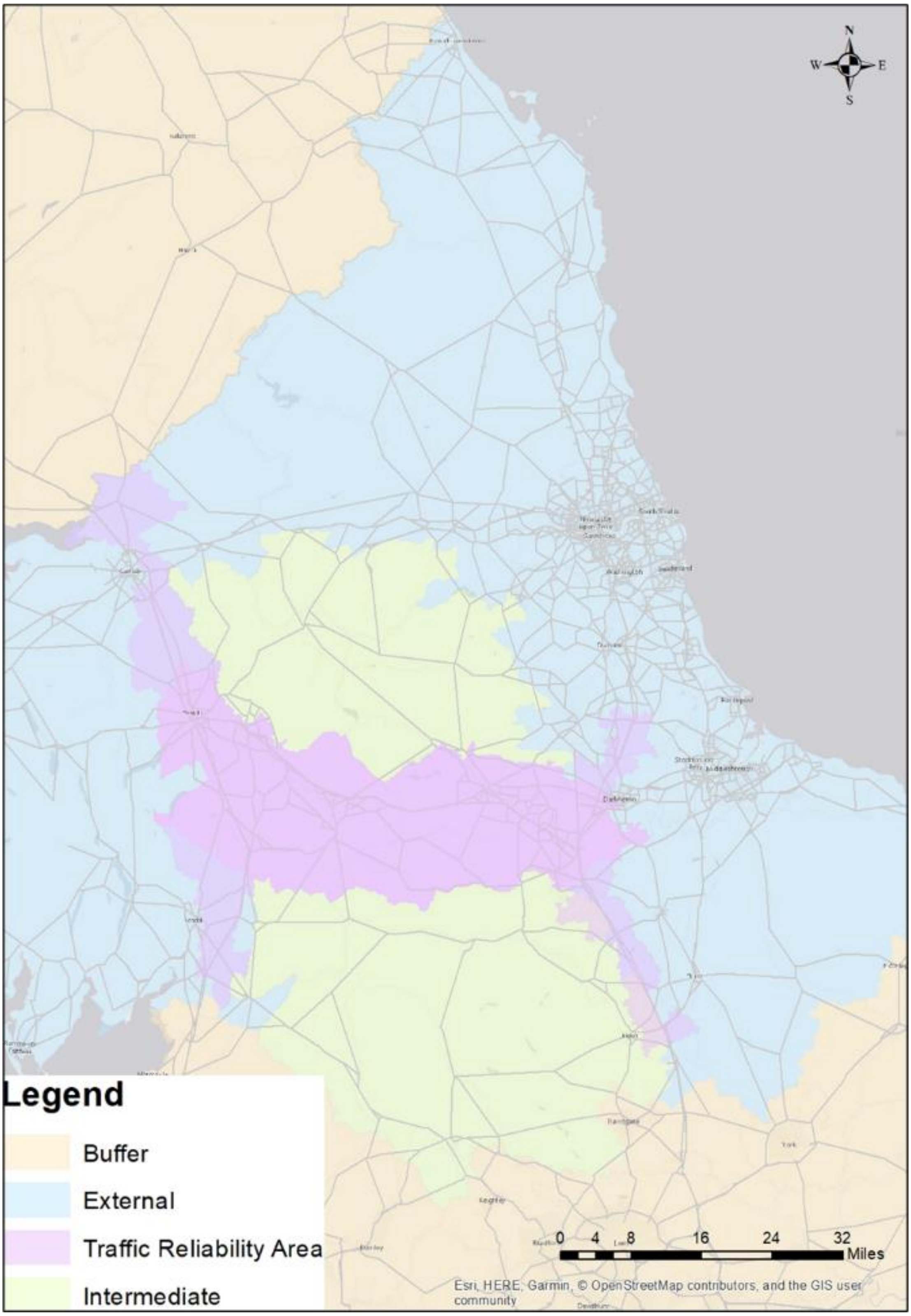


Figure 4-3: A66 Transport Model Network Extent (SATURN)

Table 4-3: A66 TEE Appraisal: SATURN Model Outputs and TUBA Inputs

		Weekday (Mon-Fri)						Weekend (Sat-Sun)	
		AM		Inter Peak	PM		Off Peak	Daytime	Night-time
		1-hr avg. 0700-0800 & 0900-1000	1-hr 0800-0900	1-hr avg. 1000-1600	1-hr avg. 1600-1700 & 1700-1800	1-hr 1800-1900	1-hr avg. 1900-0700	1-hr avg. 1000-1800	1-hr avg. 1800-1000
SATURN Traffic Model: Time Period (TS) and User Class (UC)									
Car	**Business**	TS1 UC1	TS2 UC1	TS3 UC1	TS4 UC1	TS5 UC1	TS6 UC1	TS7 UC1	TS8 UC1
Car	**Commute**	TS1 UC2	TS3 UC2	TS3 UC2	TS4 UC2	TS5 UC2	TS6 UC2	TS7 UC2	TS8 UC2
Car	**Other**	TS1 UC3	TS4 UC3	TS3 UC3	TS4 UC3	TS5 UC3	TS6 UC3	TS7 UC3	TS8 UC3
LGV	**Other**	TS1 UC4	TS5 UC4	TS3 UC4	TS4 UC4	TS5 UC4	TS6 UC4	TS7 UC4	TS8 UC4
LGV	**Business**	TS1 UC4	TS2 UC4	TS3 UC4	TS4 UC4	TS5 UC4	TS6 UC4	TS7 UC4	TS8 UC4
HGV OGV1	**Business**	TS1 UC5	TS2 UC5	TS3 UC5	TS4 UC5	TS5 UC5	TS6 UC5	TS7 UC5	TS8 UC5
HGV OGV2	**Business**	TS1 UC5	TS2 UC5	TS3 UC5	TS4 UC5	TS5 UC5	TS6 UC5	TS7 UC5	TS8 UC5
TUBA Economic Appraisal: Time Slice (TS), User Class (UC), Vehicle Sub-Mode (VSM), Purpose (PPS), and Period (PRD)									
Car	**Business**	TS1 UC1 VSM1 PPS1 PRD1	TS2 UC1 VSM1 PPS1 PRD1	TS3 UC1 VSM1 PPS1 PRD3	TS4 UC1 VSM1 PPS1 PRD2	TS5 UC1 VSM1 PPS1 PRD2	TS6 UC1 VSM1 PPS1 PRD4	TS7 UC1 VSM1 PPS1 PRD5	TS8 UC1 VSM1 PPS1 PRD5
Car	**Commute**	TS1 UC2 VSM1 PPS2 PRD1	TS2 UC2 VSM1 PPS2 PRD1	TS3 UC2 VSM1 PPS2 PRD3	TS4 UC2 VSM1 PPS2 PRD2	TS5 UC2 VSM1 PPS2 PRD2	TS6 UC2 VSM1 PPS2 PRD4	TS7 UC2 VSM1 PPS2 PRD5	TS8 UC2 VSM1 PPS2 PRD5
Car	**Other**	TS1 UC3 VSM1 PPS3 PRD1	TS2 UC3 VSM1 PPS3 PRD1	TS3 UC3 VSM1 PPS3 PRD3	TS4 UC3 VSM1 PPS3 PRD2	TS5 UC3 VSM1 PPS3 PRD2	TS6 UC3 VSM1 PPS3 PRD4	TS7 UC3 VSM1 PPS3 PRD5	TS8 UC3 VSM1 PPS3 PRD5
LGV	**Other**	TS1 UC4 VSM2 PPS3 PRD1	TS2 UC4 VSM2 PPS3 PRD1	TS3 UC4 VSM2 PPS3 PRD3	TS4 UC4 VSM2 PPS3 PRD2	TS5 UC4 VSM2 PPS3 PRD2	TS6 UC4 VSM2 PPS3 PRD4	TS7 UC4 VSM2 PPS3 PRD5	TS8 UC4 VSM2 PPS3 PRD5
LGV	**Business**	TS1 UC5 VSM3 PPS1 PRD1	TS2 UC5 VSM3 PPS1 PRD1	TS3 UC5 VSM3 PPS1 PRD3	TS4 UC5 VSM3 PPS1 PRD2	TS5 UC5 VSM3 PPS1 PRD2	TS6 UC5 VSM3 PPS1 PRD4	TS7 UC5 VSM3 PPS1 PRD5	TS8 UC5 VSM3 PPS1 PRD5
HGV OGV1	**Business**	TS1 UC6 VSM4 PPS1 PRD1	TS2 UC6 VSM4 PPS1 PRD1	TS3 UC6 VSM4 PPS1 PRD3	TS4 UC6 VSM4 PPS1 PRD2	TS5 UC6 VSM4 PPS1 PRD2	TS6 UC6 VSM4 PPS1 PRD4	TS7 UC6 VSM4 PPS1 PRD5	TS8 UC6 VSM4 PPS1 PRD5
HGV OGV2	**Business**	TS1 UC7 VSM5 PPS1 PRD1	TS2 UC7 VSM5 PPS1 PRD1	TS3 UC7 VSM5 PPS1 PRD3	TS4 UC7 VSM5 PPS1 PRD2	TS5 UC7 VSM5 PPS1 PRD2	TS6 UC7 VSM5 PPS1 PRD4	TS7 UC7 VSM5 PPS1 PRD5	TS8 UC7 VSM5 PPS1 PRD5

4.5.9 Annualisation factors for 2019 are applied in TUBA to expand the daily time period outputs from the SATURN A66TM to all hours and all days in the whole year. Factors are derived from 12-month directional traffic counts on the A66 analysed from the WebTRIS database.

4.5.10 Annualisation factors used to convert TUBA inputs (from SATURN) to a whole year of annual average days (365-days, or 8,760-hours) are summarised in Table 4-3. The table shows:

- Conversion from six weekday model 1-hour periods, which represent March 2019, to all-year weekday and school holiday 24-hour periods in 2019.
- Conversion from two weekend model 1-hour periods, which represent an average month in 2019, to all-year weekend and bank holiday 24-hour periods in 2019.

Table 4-4: A66 NTP TUBA Annualisation

Period Name	TUBA 2019 All-Year Time Slice	SATURN 2019 Modelled Hour	2019 Traffic Flow Ratio: All-Months Avg 1hr / Model 1hr [A]	No. Daily Hours per Time Slice [B]	No. Annual Days per Time Slice [C]	Proposed PCF S3 Annualising Factors [A]*[B]*[C] for TUBA
Weekdays (Including School Holidays)						
AMS	TS1 Weekday 07-08 & 09-10	March Weekday Avg 07-08 & 09-10	0.97	2	253	492
AM	TS2 Weekday 08-09	March Weekday 08-09	0.95	1	253	241
IP	TS3 Weekday 10-16	March Weekday Avg 10-16	1.03	6	253	1565
PM	TS4 Weekday 16-18	March Weekday Avg 16-18	0.98	2	253	493
PMS	TS5 Weekday 18-19	March Weekday 18-19	1.00	1	253	253
OP	TS6 Weekday 19-07	March Weekday Avg 07-08 & 09-10	1.01	12	253	3055
Weekend Days & Bank Holidays						
WE Day	TS7 Weekend Day 10-18	All Year Weekend Day Avg 10-18	1.00	8	112	896
WE Night	TS8 Weekend Day 18-10	All Year Weekend Day Avg 18-10	1.00	16	112	1792

4.5.11 The rationale for how various SATURN traffic models are created and their outputs are used in TUBA is summarised below.

- Weekday models for an AM Peak hour (8am-9am), Inter Peak average hour (10am-4pm), and PM Peak average hour (4pm-6pm), are created and validated accurately in the SATURN A66TM, for all user classes (car UC1-3, LGV UC4 and HGV UC5).
  - These assignment outputs are converted to appropriate units and are then input to TUBA, where factors are applied to split UC4 LGV

trips into other and business purposes, and to split HGV trips into OGV1 and OGV2 categories.
- The two unmodelled hours within the AM period, (07:00-08:00 and 09:00-10:00) and a single hour in the PM period (18:00-19:00), are accounted for using the remaining proportion of the AM and PM period demand matrices, together with the skims from these models.

- The weekday model for an Off-Peak average hour (7pm-7am) is derived from the 24-hour PA demand model (Highways England Integrated Demand Interface – HEIDI), whereby the total O-D trips for car, LGV and HGV are matched to A66 March 2019 weekday counts, but the split of O-D car trips amongst UC1, 2 and 3 is approximated.
  - These assignment outputs are converted to appropriate units and are then input to TUBA, where factors are applied to adjust the split of UC1, 2 and 3 car trips amongst business, commute and other purposes, split UC4 LGV trips into other and business purposes, and to split HGV trips into OGV1 and OGV2 categories, in line with TAG Data Book v1.17.
- The weekend models for Day time average hour (10am-6pm) and Night-time average hour (6pm-10am) are derived from the weekday Inter Peak and Off-Peak average hour models respectively, for car, LGV and HGV, and then factored using A66 March weekday and all-year weekend 2019 counts to convert from weekday Inter Peak 6 hours to weekend Day time 8 hours and from weekday Off Peak 12 hours to weekend Night-time 16 hours.
  - These assignment outputs are converted to appropriate units and are then input to TUBA, where factors are applied to adjust the split of UC1, 2 and 3 car trips amongst business, commute and other purposes, split UC4 LGV trips into other and business purposes, and to split HGV trips into OGV1 and OGV2 categories, in line with TAG Data Book v1.17.

4.5.12 LGVs were split into non-work and work and HGVs were split into medium and heavy goods vehicles using the factors shown Table 4-4. The factors for the LGV splits were taken from the TAG Data Book v1.17 (November 2021), table A1.3.4. The factors for the HGV splits are not directly available in TAG and were therefore derived from the NRTM.

Table 4-5: Disaggregation of LGVs and HGVs

Time Period	LGVs		HGVs	
	Non-Work (Commuting and Other)	Work (Freight)	OGV1	OGV2
AM	12%	88%	40%	60%
IP	12%	88%	40%	60%
PM	12%	88%	40%	60%
OP	12%	88%	40%	60%

4.5.13 The SATURN model uses metres and seconds as units of distance and time respectively. However, TAG Unit A1.1 and TAG Data Book (and therefore TUBA) uses kilometres and hours as units. Therefore, a factor of 0.001 was used in the TUBA input file to convert distances from meters to kilometres and a factor of 0.00028 (=1/3600) to convert time from seconds to hours.

4.5.14 The O-D movements between 1,410 traffic model zones, for which trips and travel costs are represented in TUBA, are aggregated to 28 sectors for ease of interpreting the TEE outcomes. Impacts within and between some sectors in TUBA are ‘masked out’, to omit areas from the appraisal where:

- There is simplified network and zoning detail in the SATURN model.
- The magnitude of predicted SATURN and TUBA outcomes is disproportionate to the likely influence of the A66 route improvements.
- The magnitude of predicted TUBA outcomes is disproportionate to the predicted changes in SATURN between the DM and DS scenarios.

4.5.15 The masking approach applied to the TUBA TEE impacts for PCF Stage 3 is shown in Figure 4-3, where sector movements retained in the appraisal are annotated in green (1), and sector movements removed from the appraisal are annotated in red (0). Of the total 784 sector O-D movements (28 x 28), 569 are retained (73%) and 215 are removed (27%). The O-D movements that have been masked out represent model noise from urban movements and/or are remote from the scheme where the model is less detailed.

To Sector		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
From Sector																													
South Cumbria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Northwest	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Eden	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carlisle	4	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1
Northumberland	5	1	1	1	1	1	0	0	1	0	0	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Tyneside	6	1	1	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Wearside	7	1	1	1	1	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
Durham	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cleveland (West)	9	1	1	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cleveland (East)	10	1	1	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Richmond-shire	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
North Yorkshire	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
Yorkshire	13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
Dumfries &	14	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
South & East	15	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
South	16	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Scottish Borders	17	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
North Scotland	18	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Northwest_(South	19	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Yorkshire	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Yorkshire	21	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
East Midlands	22	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
West Midlands	23	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Wales	24	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Southwest	25	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Southeast	26	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
East of England	27	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
London	28	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0

Figure 4-4: TUBA Masking Approach for PCF3 TEE Appraisal

4.5.16 Transport economic efficiency is assessed in TUBA for the Core and Uncertainty scenarios refereed to in section 3.4.

4.5.17 The TUBA method and the traffic model and appraisal periods used in TUBA are consistent with 'TUBA General Guidance' (DfT, Version 1.9.17.2, November 2021).

4.6 Wider Public Finance and Public Sector Operator Revenue – Appraisal Method (Category A Impact)

4.6.1 Wider public finance impacts are assessed within the initial BCR calculations for the project, in accordance with TAG advice in Unit A1.3 User and Provider Impacts (July 2021). The implications of the A66 improvements for wider public finances, in terms of Government fuel tax revenue, and for public sector operator revenue, in terms of Government road toll charges are calculated in TUBA, using the same assessment inputs from the SATURN A66TM as are used to calculate road user benefits.

4.6.2 Indirect tax outcomes are summarised within the initial PVB, whilst operator revenue outcomes are included in the initial PVC.

4.7 User Costs During Scheme Construction – Appraisal Method (Category A Impact)

4.7.1 Impacts on road users during route construction works are assessed within the initial BCR calculations for the project, in accordance with TAG advice in Unit A1.3 User and Provider Impacts (July 2021).

Background

4.7.2 A road improvement can adversely affect economic efficiency of travel for users, during its construction (and maintenance), by restricting carriageway capacity, obstructing free-flow of traffic, slowing vehicle speeds, heightening congestion, worsening route intersection delays, and imposing traffic diversions. These impacts are mainly associated with Temporary Traffic Management (TTM) and control arrangements during roadworks and can increase travel time and distance costs.

4.7.3 However, operational arrangements during construction (and maintenance) are designed to achieve the following:

- TTM with sufficient capacity to accommodate traffic demands.
- Journey times that do not increase significantly from existing conditions.
- Minimal duration, length and frequency of TTM phases, carriageway closures and diversions.
- Advanced warning of roadworks in the calendar and on the road network, to allow drivers to re-route and to minimise traffic disruption.

4.7.4 Construction (and maintenance) effects are a type of economic impact, whereby a monetary value is attributed to changes in users' travel time (or delays during their journeys) caused by roadworks. The value of travel time and delay can vary between users, depending upon their journey purpose, time of travel and type of vehicle.

4.7.5 The impact of construction on road users is assessed when existing traffic movements are disrupted by roadworks while schemes are being built. The effect is measured using the same principles and techniques as are applied to transport economic efficiency for road users during normal route operation (described in section 3.7).

4.7.6 Construction roadworks scenarios are represented in the A66TM. Assignment outputs are then transferred from SATURN into TUBA, to calculate the monetised net impact of roadworks on travel costs for road users. The net impact is valued by subtracting the travel cost of DS roadworks during periods of scheme construction from the travel cost of using the existing A66 during normal operation.

4.7.7 Inclusion of TTM carriageway restrictions in the SATURN model may slightly underestimate true vehicle delays during A66 construction, because the model assumes drivers are fully informed of network conditions, make optimum decisions and can use all available routes to divert around roadworks. In reality, some drivers may be unwilling or unable to avoid travel time delays through the A66 roadworks, or will be signed to follow a longer, but safer strategic diversion route.

Method for Assessing Construction Impacts

4.7.8 Construction impact scenarios are defined according to information provided by the AmeyArup highway design team and specialist TTM sub-contractor Virtus Limited, which comprises:

- Schedule of DS main works construction phase durations for each scheme from Q1 2024 up to Q4 2028.
- Plan of TTM layout phases and lengths of roadworks for building each scheme.
- Schedule of traffic control measures within each TTM phase, by time of day (number and width of lanes, speed limits, contra flow, lane closures, road closures).
- Proposed diversion routes for A66 traffic for each scheme, during significant construction events.

4.7.9 In outline, the method for assessing A66 construction impacts on road users at PCF3 entails the following steps:

- Establish the sequence and layout of TTM phases for each A66 scheme, during construction works.
- Determine details of each TTM phase, including length of TTM restrictions, type of TTM (contra flow with cross-over), number of lanes open to traffic by direction, width of running lanes, speed limits, side road closures, traffic diversion routes, and junction capacity restrictions and movement controls.
- Identify duration of works under each scheme TTM phase and times of day and week when specific TTM components will apply (for example lane closure, road closure, contra flow).

- Capture periods of overlapping roadworks, to determine SATURN / TUBA common construction scenarios, when TTM will occur on multiple existing and completed new scheme sections simultaneously.
- Determine scheme locations and types of TTM on A66 for each construction scenario, and represent TTM in SATURN network coding (for example link speed / flow / capacity and lane allocation characteristics, junction configurations, bans and penalties on link and junction movements), including newly constructed A66 DS dual carriageway sections where these are open in a specific construction scenario.
- Calculate annualising factors to convert modelled 1-hour scheme construction TTM scenario impacts to annual equivalent, taking account of envisaged TTM phase duration.
- Run scheme construction TTM scenarios in SATURN PCF3 forecast opening year 2029 model, (DM without TTM vs DS with TTM), for each time period, using SATURN Full Equilibrium Assignment, for a 1-hour 'Length of Time Period', using LTP parameter, and without 'Warm Start' facility as traffic will have prior warning of A66 roadworks before planning their optimum journey routes.
- Identify potential re-routing away from A66 during construction TTM, using SATURN model scenario assignments.
- Transfer SATURN scenario skim outputs into TUBA v1.9.17.2 using TAG Data Book v1.17 economic parameters.
- Calculate overall annualised and monetised construction disbenefits of traffic delay on A66, aggregated across all TTM scenarios, with some traffic re-routing away from A66.

4.7.10 There are seven sequential construction scenarios which are modelled in SATURN and TUBA to derive the monetised impacts on road users. The overlap of TTM between the A66 schemes and the durations of roadworks in each construction phase is shown in Figure 4-3.

Construction Scenario Assumptions

4.7.11 To assess the user impacts of A66 construction, the following assumptions are made:

- In each construction scenario, the scheme sections which are modelled as being under construction are as follows –
  - Scenario A – Schemes 01, 03, 04, 05, 06, 07, 11.
  - Scenario B – Schemes 01, 03, 04, 05, 06, 07.
  - Scenario C – Schemes 01, 03, 04, 05, 06, 07, 08.
  - Scenario D – Schemes 02, 03, 04, 05, 08, 09.
  - Scenario E – Schemes 02, 03, 09.
  - Scenario F – Schemes 02, 09.
  - Scenario G – Scheme 02.
- In each construction scenario, the sequence of scheme sections which are assumed to be completed and open to traffic is as follows –
  - Scenario A – No schemes.
  - Scenario B – Scheme 11.

- Scenario C – Scheme 11.
- Scenario D – Schemes 11, 01, 06, 07.
- Scenario E – Schemes 11, 01, 06, 07, 04, 05, 08.
- Scenario F – Schemes 11, 01, 06, 07, 04, 05, 08, 03.
- Scenario G – Schemes 11, 01, 06, 07, 04, 05, 08, 03, 09.
- In the final construction Scenario G, only scheme section 2 is still to be completed.

- No construction impact is assessed for scheme 11, at A1(M) J53, as the TTM works here are likely to be unintrusive and are not likely to cause significant delay or diversion to traffic.
- TTM speed limits set, (by changing speed / flow category in SATURN), to 50mph on dual carriageways and 40mph on single carriageways and combined single / dual sections.
- Single lane contraflow TTM on dual carriageways represented by changing to an appropriate link capacity index in SATURN.
- Narrow lane TTM link and turn capacities set at -15% of DM saturation flow, for all relevant single and dual carriageway links and junctions.
- No overnight A66 closures are included in the construction assessment, although they will be required intermittently, because closure details are not yet available.
- Layout restrictions during TTM at the A66 junction with M6 J40 Skirsgill roundabout, Penrith (Scheme 01, Scenarios A, B and C):
  - Reduced approach widths and capacities from 3 lanes to 2 narrow lanes, from A66 eastbound, M6 southbound exit, A592 southbound and A66 westbound, but not on the 2-lane approach from M6 northbound exit, which remains unchanged.
  - Reduced circulatory width and capacity of the circulatory carriageway from 3 lanes to 2 narrow lanes, except on the westbound and eastbound circulatory M6 over-bridges, which remain unchanged.
- Layout restrictions during TTM at the A66 junction with A6/A686 Kemplay Bank roundabout, Penrith (Scheme 02, Scenarios D, E, F and G):
  - Reduced approach widths and capacities from 3 lanes to 2 narrow lanes, from A66 eastbound and A6 southbound, but not on the 2-lane approach from A66 westbound, which remains unchanged.
  - Reduced approach widths and capacities from 3 lanes to 1 narrow lane, from A6 southbound, and from 2 lanes to 1 narrow lane from A6 northbound and A686 southbound.
  - Reduced circulatory width and capacity of the circulatory carriageway from 3 lanes to 2 narrow lanes.

4.7.12 The monetised road user construction impacts, as calculated in TUBA, are neither sectored nor masked, as the effects do not extend beyond the A66 area of focus, where the road network is modelled in detail in SATURN. The assessment does not, therefore, include any distant ‘noise’ where the SATURN model is less accurate.

A66 Schemes & Phases	In Model Scenario	Quarter / No. Days	Year 1 2024				Year 2 2025				Year 3 2026				Year 4 2027				Year 5 2028			
		Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
		No. Days	91	91	92	92	90	91	92	92	90	91	92	92	90	91	92	92	91	91	92	92
Schm01 Phs1	A B C	732																				
Schm02 Phs1	D E F G	365																				
Schm02 Phs2	D E F G	365																				
Schm02 Phs3	D E F G	366																				
Schm03 Phs1	A B C D E	731																				
Schm03 Phs2	A B C D E	365																				
Schm03 Phs3	A B C D E	181																				
Schm04 Phs1	A B C D	731																				
Schm04 Phs2	A B C D	365																				
Schm05 Phs1	A B C D	731																				
Schm05 Phs2	A B C D	365																				
Schm06 Phs1	A B C	366																				
Schm06 Phs2	A B C	365																				
Schm07 Phs1	A B C	182																				
Schm07 Phs2	A B C	184																				
Schm07 Phs3	A B C	365																				
Schm08 Phs1	C D	365																				
Schm08 Phs2	C D	365																				
Schm09 Phs1	D E F	365																				
Schm09 Phs2	D E F	365																				
Schm11 Phs1	A	182																				
Schm11 Phs2	A	0																				
A66TM Construction Scenarios			A		B		C				D				E		F		G			
No. Days			182		184		365				365				181		184		366			

Figure 4-5: A66 NTP Construction Roadworks Assessment Scenarios

Exclusion of Maintenance Impacts

4.7.13 Scheme maintenance refers to the period when existing traffic movements are disrupted, after the scheme is completed and open to traffic, by roadworks which are associated with two main activities, namely:

- Traffic-related maintenance, which usually consists of infrastructure renewal, or major structural repair.
- Non-traffic-related operational maintenance, which generally consists of routine infrastructure management.

4.7.14 Impacts on road users during maintenace are excluded from the PCF3 appraisal. A preliminary pavement engineering report and maintenance plan for the A66 NTP project concludes that the net impact of the improvement on route maintenance requirements, and hence on roadworks delays for users, over 60 years, will be largely neutral. The assessment indicates the following:

- The new DS route, with 352 lane-kms of main carriageway, will require less maintenance and entail reduced user impacts for the first 30 years after opening (2029 – 2058), compared with the DM existing route, with 264 lane-kms of main carriageway, because the DS will comprise a higher proportion of new road pavement.
- The DS route will require 12% more maintenance and cause increased user impacts in the remaining 30 years (2059 – 2088), compared with the DM, because the DS will consist of one third more road pavement to be maintained.
- Although the DS will result in greater travel costs for users during maintenance in later years, the costs will be discounted more, to 2010 values and prices, than in earlier years.

4.7.15 The overall net maintenance cost to users is likely to small, but slightly positive.

4.8 Noise, Air Quality and Greenhouse Gases – Appraisal Method (Category A Impact)

4.8.1 Environmental impacts of the A66 improvements on noise, air quality and greenhouse gases are monetised within the initial BCR calculations for the project, in accordance with TAG advice in Unit A3 Environmental Impact Appraisal (July 2021) and TAG impact-specific workbooks. The appraisal takes inputs from the project’s environment team, using their quantified and monetised assessments of the forecast traffic-related impacts of the A66 improvements. Further details can be found in **3.2 Environmental Statement, Chapter 05 Air Quality, Chapter 07 Climate, and Chapter 12 Noise and Vibration.**

4.8.2 Each aspect is assessed using assigned network flows from the A66TM, for the whole-route, in each modelled time period by vehicle type, at base year 2019 and at forecast years 2029, 2044 and 2051, The modelled network hourly traffic flows are annualised to equivalent 18-

hour AAWT, for noise, and to 24-hour AADT, for air quality and greenhouse gases.

4.8.3 Noise, air quality and greenhouse gases outcomes are calculated during normal scheme operation, for the Core appraisal scenario only.

Noise

4.8.4 Household noise impacts of sleep disturbance, annoyance, heart stress, stroke and dementia are assessed by predicting noise level changes with and without the A66 improvements, for households across the affected road network, based on modelled vehicle flows and composition.

4.8.5 The noise impact appraisal uses the principles outlined in ‘Noise pollution: economic analysis’ guidance (DfEFRA December 2014), and the assessment and valuation tool ‘Transport Noise Marginal Values Model’ (DfEFRA July 2014).

4.8.6 Monetised noise impacts are summarised in the TAG ‘Noise Assessment Workbook’ (November 2021).

Air Quality

4.8.7 Air quality impacts are determined in respect of NOx & PM10 emissions damage. NOx emissions are quantified for ‘areas not in exceedance’, whereas PM10 emissions are predicted across the affected road network. Both impacts are based on modelled vehicle flows, composition and speeds.

4.8.8 The air quality appraisal uses the procedures set out in ‘Air quality appraisal: damage cost’ guidance (DfEFRA March 2021), and the ‘Air quality appraisal: impact pathways approach (DfEFRA March 2021) with ‘Damage Costs Appraisal Toolkit’ (DfEFRA March 2021).

4.8.9 Monetised air quality impacts are summarised in the TAG ‘Air Quality Valuation Workbook’ (November 2021). The TAG ‘Local Air Quality Assessment Workbook’ (May 2019) is used to assess NO2 and PM2.5 concentrations around properties affected by the A66 improvements.

Greenhouse Gases

4.8.10 Changes in emissions of greenhouse gases, CO2, CH4, N2O, HFC, PFC, and SF6, as a result of the project, are assessed by comparing tonnes of carbon dioxide equivalent (tCO2e) across the affected road network, with and without the A66 Project, based on modelled vehicle flows, composition and speeds.

4.8.11 The monetised greenhouse gases impact is calculated in terms of traded and non-traded carbon (tCO2e) using the following guidance and tools:

- ‘Carbon Valuation’ (DfBEIS September 2021).
- ‘Valuation of greenhouse gas emissions: for policy appraisal and evaluation’ (DfBEIS September 2021),

- 'Valuation of energy use and greenhouse gas' (DfBEIS October 2021).
- 'IAG spreadsheet tool for valuing changes in greenhouse gas emissions' (2019).
- 'Data tables 1-19' (DfBEIS June2021).
- 'Template reporting emissions savings' (DfBEIS September 2021).

4.8.12 Quantified and monetised non-traded and traded carbon impacts are summarised in the TAG 'Greenhouse Gases Workbook'. The non-traded carbon impact is fully presented in the initial and adjusted BCR. Traded carbon costs are valued in the initial and adjusted BCR as the difference between the social carbon cost and the permit value.

4.9 Safety – Accident Appraisal Method (Category A Impact)

4.9.1 Impacts on safety of road users are assessed within the initial BCR calculations for the project, in accordance with TAG advice in Unit A4.1 Social Impact Appraisal (July 2021).

Background

4.9.2 The safety appraisal assesses the likely change in the number of road accidents within the area of focus and influence of the A66 route, as a result of the scheme improvements. It also predicts the consequent change in the number and severity of casualties (individuals who are killed or injured), and the change in associated costs to people and organisations, as summarised in Table 4-5 below.

Table 4-6: Costs Associated with Road Accidents

Costs Relating to Number of Casualties	Costs Relating to Number of Accidents
Pain, grief and suffering	Material damage
Lost economic output	Police costs
Medical and healthcare costs	Insurance administration
	Legal and court costs

4.9.3 A monetary value is attached to accidents, casualties and associated impacts, so quantifying the change in impacts in the DS compared with the DM gives a valuation of the prevention of casualties with the proposed A66 improvements.

4.9.4 Accidents are considered as a primary social impact on the human experience of the transport system and therefore contribute to the direct monetised effects of the A66 NTP scheme. They are included in the initial BCR, and the Analysis of Monetised Costs and Benefits (AMCB), net present value (NPV) and benefit to cost ratio (BCR).

4.9.5 Accidents are quantified and monetised using: COBALT (Cost and Benefit to Accidents – Light Touch V2.2, March 2022) alongside the following:

- Assigned network flows and network distances from the SATURN traffic model.

- Generic accident rates per million vehicle kilometres, for links and junctions combined, by road type, in COBALT. A decision was taken to use generic accident rates within this appraisal. This is because a number of safety schemes have been implemented on key sections of the A66 between 2014 and 2019, the last years for which we have data within non Covid impacted operating conditions. Within this data there is insufficient evidence to conclude what the impact of these schemes has been on accident numbers. As such generic accident rates were deemed to be most suitable for use within the economic appraisal.
- TAG parameters from TAG Databook V1.17 (November 2021) for default accident rates by road and junction types, casualty rates per accident, and the monetary value of accidents.
- The discount rate applied to convert forecast future year accident costs over 60 years, back to 2010 values.

4.9.6 The assessment is based on comparison of accidents by severity and associated costs across an identified network area of focus and influence in the DM and DS scenarios, using details of link and junction characteristics, relevant accident rates, accident costs and forecast traffic volumes by link and junction.

4.9.7 For A66, a combined link and junction appraisal is undertaken in COBALT, rather than an assessment of links and junctions separately. The analysis uses differences in junction and link properties, as well as the differences in traffic flows, to calculate the overall impact on accidents as a result of the A66 NTP improvements.

Accident Impact Study Area

4.9.8 The accident analysis study area is determined as the boundary within which traffic flow changes are sufficiently significant for the production of quantifiable future year accident forecasts.

4.9.9 The area of impact selected for accident appraisal in COBALT is consistent with guidance: “the network should extend far enough from the improvement to include all links on which there is a substantial difference in the assigned traffic flows between ‘Without Scheme’ and ‘With Scheme’ networks.” There is no defined magnitude for ‘substantial difference’ in TAG or COBALT advice, so conventional criteria are applied for A66, whereby the included area of focus and influence is where (in the A66TM forecast assignment) there is a predicted change of at least +/-5% in Annual Average Daily Traffic (AADT) flows, and a flow difference of at least +/-50 vehicles per day AADT, in the DS scenario compared with the DM scenario.

4.9.10 The resulting study area for PCF3 accident appraisal is shown in Figure 4-4.

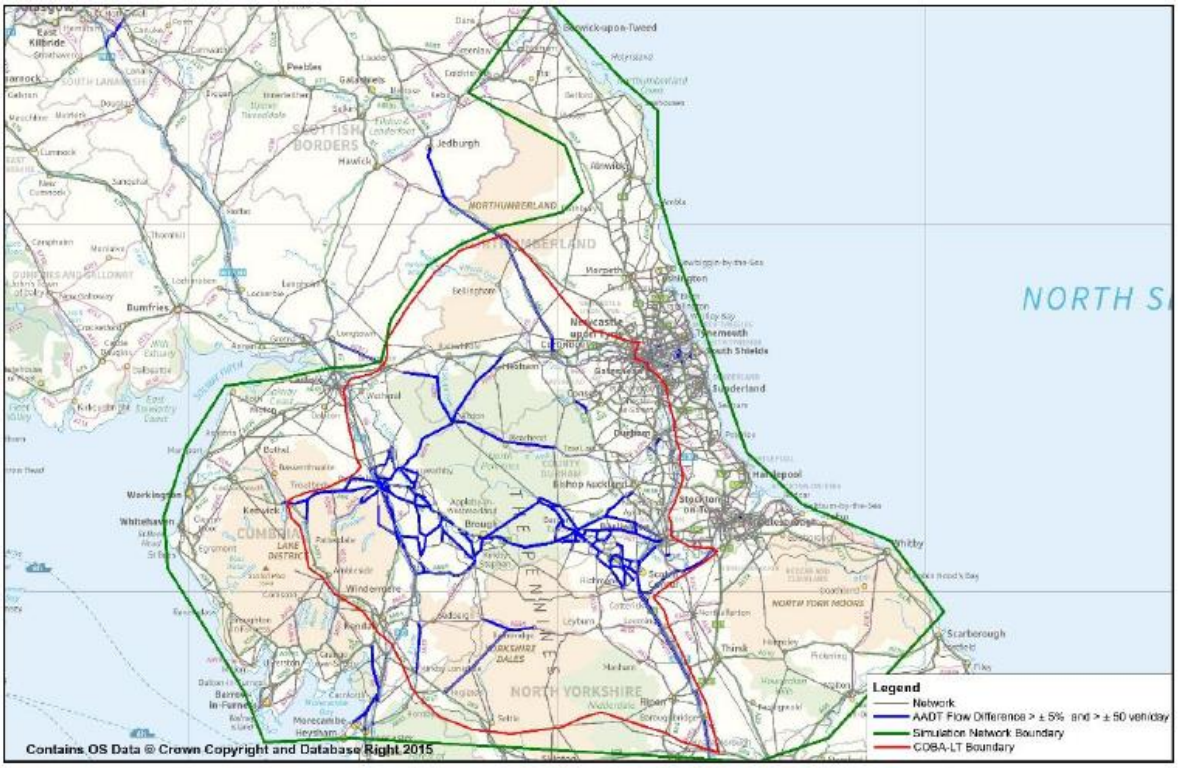


Figure 4-6: A66 NTP PCF3 COBALT Study Area

COBALT Parameters

4.9.11 Classification of DM and DS road types and link speed limits (mph) in the accident appraisal matches the existing local road network inventory and the proposed preliminary design for the A66 Project, and it is consistent with COBALT User Guide Version 2.1 (Section 5.5).

4.9.12 Generic link and junction (combined) accident rates (per million vehicle kilomteres), are applied in COBALT to all roads in the study area, including the A66 corridor, in both the without-scheme scenario (DM) and with-scheme scenario (DS). Generic rates are used because the available sample of locally-recorded accident rates is not statistically reliable, as road safety schemes have been introduced on four single carriageway sections of the A66 since 2015, namely:

- Summer 2016 – A66 S2AP section at Kirkby Thore, speed limit reduction from 60 mph to 40 mph in both directions, between Eden View and the old, dismantled railway line.
- Autumn 2016 – A66 S2AP section at Warcop, speed limit reduction from 60 mph to 50 mph in both directions, between B6259 and D2AP Brough bypass.
- Autumn 2018 – A66 S2AP section at Ravensworth, speed limit reduction from 60 mph to 50 mph both directions, between Browson Bank access and Warrener Lane.

4.9.13 Local accident rates could be calculated for COBALT from the most recent available 5-year accident data (from Stats19) and traffic flow data (from NH WebTRIS). However, the sample size is insufficient after the route was changed with the safety schemes introduced in 2016 and 2018, and once 2020 data are excluded as being non-typical, owing to changes in traffic flows caused by the COVID-19 pandemic.

4.10 Physical Activity and Journey Quality – Appraisal Methods (Category A Impact)

4.10.1 Assessment of the effects of the A66 improvements on physical activity and journey quality of users is not monetised, although a valuation can sometimes be calculated using TAG principles. Here, a qualitative assessment of these social impacts is undertaken using detailed findings from the project's Environment and Human Health teams and from the Walking, Cycling and Horse Riding (WCH) assessment.

4.10.2 Since a qualitative approach is used to examine the A66 physical activity and journey quality effects, this is discussed further in section 4.18, alongside other social, environmental and distributional impact assessments. Outcomes are presented in the TAG 'Physical Activity Impacts Worksheet – Basic' (January 2014), in the TAG 'Journey Quality Impacts Worksheet' (January 2014), and are summarised in the Appraisal Summary Table (AST).

4.11 Overview of Journey Time Reliability and Resilience for Road Users (Category B and C Impacts)

4.11.1 The A66 NTP improvement is assessed in terms of its overall reliability impact, as recognised in TAG, but the project impact here is separated into two aspects:

- Journey time reliability.
- Resilience.

4.11.2 Both aspects reflect unpredictable journey times for road users (and hence travel costs), but they are separated into two categories by NH, because they are differentiated according to:

- Travel time delays shorter than 6 hours ('journey time reliability' on the A66).
- Travel time delays longer than 6 hours ('resilience' to incident closures on the A66 route, on the wider strategic network, and on the local highway network, respectively).

4.11.3 Both journey time reliability and resilience are types of economic impact, whereby a monetary value is attributed to changes in users' travel time (or delays during their journeys). The value of travel time and delay can vary between users, depending upon their journey purpose, time of travel and type of vehicle.

4.11.4 As advised in TAG Unit A1.3 'User and Provider Impacts' (July 2021), neither journey time reliability nor resilience are assessed as Category 'A' established monetised impacts within the initial BCR. However, the evolving approach for assessing journey time reliability is accepted and so this impact is included as a category 'B' outcome in the adjusted

BCR. By contrast, resilience is assessed only as a category 'C' indicative monetised impact, as the method of appraisal is still emerging. Resilience is therefore excluded from both the initial and adjusted BCR, but is included in the overall assessment outcome.

4.11.5 Journey time reliability impacts are included in the Appraisal Summary Table (AST).

4.11.6 Journey time reliability and resilience effects are sub-divided into six strands (a to f) as follows:

- Category B journey time reliability impacts –
  - (a) Travel time variability (TTV) on the A66 during normal operating conditions (daily congestion).
  - (b) Travel time variability (TTV) on the A66 during incidents.
  - (c) Travel time delay on the A66 during carriageway incident constrictions shorter than 6 hours, with some traffic diverting.
- Category C resilience impacts –
  - (d) Travel time delay on the A66 route during carriageway incident closures longer than 6 hours, with all traffic diverting.
  - (e) Travel time delays on the strategic road network, during carriageway incident closures longer than 6 hours, with some traffic diverting to the improved A66.
  - (f) Travel time delays on the local road network, during carriageway incident closures longer than 6 hours, with some traffic diverting to the improved A66.

4.11.7 The approach used to appraise A66 journey time reliability effects (a), (b) and (c) is set out in section 4.14. The A66 route resilience impact (d) and the network resilience outcomes (e) and (f), are described in section 4.16.

4.12 Journey Time Reliability – Appraisal Method (Category B Impact)

Journey Time Reliability Components

4.12.1 The journey time reliability aspect of the A66 NTP improvement comprises items (a), (b) and (c) of the six strands of unpredictable journey time impacts for road users, which are referred to in section 4.13:

- (a) Travel time variability on the A66 during normal operating conditions (daily congestion).
- (b) Travel time variability on the A66 during carriageway incident constrictions.
- (c) Travel time delay on the A66 during carriageway incident constrictions shorter than 6 hours, with some traffic diverting.

Assessment Principles

4.12.2 Journey time reliability refers to the level of unpredictable TTV and fluctuating vehicle speeds associated with item (a) – daily traffic congestion (day-to-day variability), when traffic flow is close to carriageway capacity; and item (b) – incidents which interrupt free-flow of traffic. It also refers to journey delays associated with item (c) – queues and diversions during incidents shorter than a 6-hour duration, which are typically caused by vehicle accidents and breakdowns.

4.12.3 The journey time reliability assessment uses MyRIAD 2021 (Motorway Reliability Incidents and Delays, September 2021), to compare performance of the A66 scenarios, with-scheme and without-scheme, in terms of:

- Travel time variability (TTV) –
  - MyRIAD determines day to day TTV as the variance and standard deviation (SD) of travel times during congestion, by assessing road type, carriageway speed / flow / capacity characteristics (and hence SD of travel time), route length, link speed (and hence travel time), forecast traffic flows, and proportion of HGV.
  - MyRIAD determines incident TTV as the variance and SD of travel times during incidents, using the same parameters as for daily variability, but additionally MyRIAD assesses incident types, durations, rates (per million vehicle kilometres), likelihood, (and hence queue probabilities), and reduced carriageway capacity (lanes closed).
- In terms of incident delays (ID) –
  - MyRIAD determines incident delays using the same parameters as for incident TTV, but additionally MyRIAD assesses mean and maximum queuing delay per vehicle, and hence proportion of diverting traffic.

4.12.4 Net TTV & ID savings (DS – DM) are monetised for economic appraisal, using DfT TAG parameters:

- Value of time.
- Marginal external cost of congestion.

Appraisal Guidelines

4.12.5 Journey reliability is assessed using guidelines set out in ‘MyRIAD 2021 Motorway Reliability Incidents And Delays User Manual’ (Mott MacDonald). References to MyRIAD are also contained in ‘Resilience Technical Annex Valuing a Quick Recovery – Working Draft’ (National Highways, May 2021).

Evidence of Historic Incidents on A66 and Wider Network

4.12.6 To quantify unpredictable travel times and hence journey time reliability on the A66, evidence is needed regarding highway operational characteristics and incident patterns for road types and carriageway layouts which represent the route itself and likely relief routes for traffic diverting off the A66. This evidence data includes the following:

- Vehicle travel time and speed statistics.
- Traffic capacity and speed / flow attributes.
- Incident types – accidents, vehicle breakdowns, other incidents (linked to adverse weather, infrastructure failure).

- Incident frequencies, durations and incident rates (per million vehicle kilometres travelled).
- Amount of reduced carriageway capacity with particular types of incidents.
- Proportion of diverting traffic during incident delays.
- Values of time by vehicle type and trip purpose.
- Route section lengths and directional traffic flows by vehicle types, times of day and days of week, for the A66.

4.12.7 For the journey time reliability appraisal, these details are available within the MyRIAD 2021 spread sheet tool (Motorway Reliability Incidents and Delays), which contains typical nation-wide data for a variety of road types and locations. This data is applicable to the A66. MyRIAD has recently been updated to assess single carriageway roads as well as motorways.

Outline Reliability Appraisal Method

4.12.8 In outline, the MyRIAD appraisal method follows four steps:

- (1) Define simplified DM and DS A66 networks, comprising 14 ‘links’, 105 both-way ‘routes’, and 6 ‘feeders’, for MyRIAD and specify link characteristics (road type, carriageway width, link length and capacity) –
  - A ‘link’ is a directional A66 road section of a specified carriageway type.
  - A ‘route’ is a directional vehicle movement along the A66, between specified corridor entry and exit points, using multiple links.
  - A ‘feeder’ is an aggregation of all strategic roads connecting with the A66 and carrying trips of a specified distance for the upstream and downstream parts of their full journey route outside of the A66 corridor.
- (2) Specify traffic flows, by user class, on A66 carriageway ‘routes’ (by distance band), ‘links’ and ‘feeders’, by using select link analyses and trip length distributions from SATURN.
- (3) Assemble A66 incident diversion routes and MyRIAD inputs from SATURN network characteristics, using most direct available routes.
- (4) Run A66 daily variability / incident variability, and incident delay / diversion delay forecast year scenarios in MyRIAD 2021 model (DS vs DM), with time period annualisation, then interpolate / extrapolate results over 60-year appraisal period 2029 – 2088.

4.12.9 In outline, the method for assessing A66 journey reliability at PCF3 uses the following steps:

- Identify A66 carriageway ‘links’, ‘routes’ and ‘feeders’ for MyRIAD and specify link characteristics (for example link type, length and capacity) –
  - Each MyRIAD ‘link’ represents a directional road section of a defined type within the scheme corridor (for example S2AP / D2AP carriageway).

  - Each MyRIAD 'route' represents a directional vehicle movement along the corridor, between a specified corridor entry point and exit point.
  - Each MyRIAD 'feeder' carries all trips of a particular distance, before and after travelling through the scheme corridor, and represents a notional aggregation of all the strategic roads outside of the modelled scheme corridor, which connect with the A66, and which are used by traffic for the full upstream and downstream parts of their journeys.
  - Pavement widths for single carriageway sections of the A66 route, are measured precisely, by taking the average of as many width measurements as possible along each link section, because the calculation of available traffic capacity during lane closures is sensitive to this width measurement; however the modelled 2-way carriageway width must be at least 7.3m, otherwise the capacity reduction calculated during lane closures is erratic.
  - (Width measurements are not required for dual carriageway sections, because traffic capacity during closures is calculated by lane, not by pavement width).
- Specify traffic flows on A66 carriageway 'routes' and 'links' for MyRIAD –
  - The traffic flow on each MyRIAD 'route' consists of the origin to destination trips which travel along the corridor in the designated direction, between the specified entry and exit points for that route.
  - The traffic flow on each MyRIAD 'link' consists of the summed flows from all of the MyRIAD routes (above) which use that link in the designated journey direction.
  - The traffic flow on each MyRIAD 'feeder' is calculated automatically from the user-specified traffic capacity and ratio of flow to capacity, by time period, on that feeder link.
- Determine SATURN / MyRIAD journey reliability scenarios (whereby each scenario represents a change in carriageway standard from S2AP to D2AP, traffic flow, operational performance, or a combination of these, on all A66 route sections, between Penrith and Scotch Corner).
- Define Origin to Destination (O-D) link flow movements for input to MyRIAD do-minimum and do-something scenarios, incorporating true 'feeder link' distances upstream and downstream of the scheme, by route direction.
- Transfer SATURN scenario assigned 'select link' O-D node to node traffic flows into MyRIAD.
- Assemble A66 incident diversion inputs for MyRIAD (using internal diversion mechanism) and compare against a manual diversion sensitivity test.
- The MyRIAD link and route structure is simplistic, to fit with MyRIAD input constraints (combining some intermediate junctions along the A66), but this is unavoidable as MyRIAD must be run as a full route model (Penrith to Scotch Corner), rather than individual section

models – (the full route is necessary to capture true journey distances).

- As the DM scenario link HGV proportions are inaccurately duplicated on the DS scenario links, calculate average HGV proportions from DM and DS scenarios.
- As the DM scenario link distances are inaccurately duplicated on the DS scenario links, calculate average link distances from DM and DS scenarios, where proposed schemes are offline, (principally, Kirkby Thore, Crackenthorpe and Warcop).
- It is realistic to include both 1-lane and 2-lane incident closures for dual carriageway sections of A66 in MyRIAD, but not 2-lane closures for single carriageway sections of the route (which MyRIAD allows by default, by applying dual carriageway incident characteristics to single carriageways); this is because MyRIAD handles the route assessment correctly in each direction separately for a dual carriageway, in terms of applying 1-way traffic capacity per available lane, but is unrealistic in how it tackles a 2-lane closure for a single carriageway, since it always allows reduced width remaining for traffic to pass in the closure direction, although in reality the road would be closed both ways.
- As MyRIAD applies dual carriageway incident closure characteristics to single carriageways, manually adjust single carriageway incident closure characteristics to align with NH Control Works evidence data for A66 (accidents); this entails replacing dual carriageway default incident parameters, (which are currently applied in MyRIAD to single carriageway roads), with NH recorded A66 single carriageway incident characteristics, incident rates and incident durations; the rationale for this MyRIAD adjustment is that the A66 local data gives a more accurate indication of the reliability performance of the existing route; to date, this step has not been undertaken in the Core Scenario reliability appraisal.
- Run highway speed-flow-DTDV / incident / accident scenarios in MyRIAD 2021 model (DM vs DS).
- Specify annualising factors for converting MyRIAD scenario outcomes to yearly equivalent, based on the TUBA annualisation factors in outlined in section 3.7, but adjusted to match five MyRIAD time periods – (1) Weekday AM Peak, (2) Inter Peak, (3) PM Peak, (4) Off Peak, and (5) Weekend.
- Calculate overall monetised ‘journey reliability’ value of reduced travel time variability (daily congestion and incidents), and incident delays (queues), on A66, Route Resilience Appraisal Method (Category B Impact)

4.13 Wider Economic Impacts – Appraisal Method (Category B Impact)

4.13.1 Wider Economic Impact (WEI) appraisal quantifies the impact on the local, regional and national economy caused by changes in accessibility generated by the A66 Project improvement. WEIs are not always captured by the conventional transport user benefits appraisal undertaken using TUBA. They are not captured in TUBA if there are 'distortions' or market failures that mean the economy is not functioning efficiently, then the additional benefits (or disbenefits) will arise as the impact of transport improvements is transmitted into the wider economy. Positive WEIs arise when there are market failures caused by difficulties for businesses in accessing employees, suppliers and other professional services, and when these market failures are addressed by the proposed transport scheme.

4.13.2 The scope of WEI appraisal at PCF3 is set to provide evidence of whether the project can support the following:

- A66 business case economic objectives –
  - supporting N Powerhouse agenda.
  - Improving A66 as strategic connection.
  - Improving national connectivity including freight.
  - Improving access for tourism, local services and jobs.
- UK Government target of strengthening and re-balancing economic performance (Levelling-up):
  - A66 improves connectivity, (directly on faster A66 and indirectly on relieved SRN), for estimated 25% of 123 category-1 areas (31 districts across Yorkshire and the Humber, Northeast England, East Midlands, Scotland and Lancashire).
- Overcoming market failures and distortions in and around A66 NTP area of focus and influence.
- A66 saving of travel costs for users – which provides improved connectivity and easier interaction between 'core' functional urban regions, and hence wider economic benefits:

Evidence of Market Failure and Distortion

4.13.1 Economic market failures and distortions are likely to exist within the area of influence of the A66 NTP project. Patterns of land use, population structure, household income, employers' business, skills, workers and unemployment have been analysed to identify evidence of such market failures and distortions which could be affected by the A66 project.

4.13.2 The A66 WEI assessment compares DM and DS scenarios for market failures not captured by the TUBA TEE assessment for road users. WEI are monetised within the adjusted BCR calculations for the project, in accordance with TAG advice in Units A2.1, A2.2, A2.3 and A2.4.

4.13.3 The WEI which are captured in the appraisal are as follows:

- Business output change under imperfect market competition.
  - This represents an induced investment impact in TAG Unit A2.2.
  - Whereby reduced travel costs leads to an increase in the market value of output greater than cost of production, due to markups.
- Labour supply change.
  - This represents an employment effect in TAG Unit A2.3.

- Whereby better transport access releases inactive workers into the labour market and provides tax revenue.

4.13.4 Net business output and labour supply impacts are quantified using the TAG Wider Impacts Dataset v3.3 (July 2021), with local authority district (LAD) GDP per worker and jobs, by sector. The impacts are monetised for WEI appraisal, using parameters in DfT TAG Data Book v1.15 (July 2021) and WITA v2.2 2021.

4.13.5 Determinants of WITA calculations (for business output change under imperfect market competition and labour supply change) are as follows:

- O-D trips (from VDM) and change in travel times and distances, from DS and DM SATURN scenarios, by model zone.
- Outputs by model zone, from SATURN, converted to equivalent LAD and WITA zones, (which do not correspond with TUBA sectors).
- Synthesised O-D time and distance, for intra-zonal trips, where O-D time and distance is zero and trips are positive from SATURN.

4.13.6 Net business output and labour supply impacts are calculated as follows:

- Business output change under imperfect market competition:
- Welfare uplift = +10% of level 1 business user Transport Economic Efficiency gains (in TUBA) and +10% of level 2 business user reliability gains (in MyRIAD).
- Labour supply change:
- Welfare (tax revenue) uplift = +40% of GDP gains from workers' output.

4.13.7 WEI are types of economic impact, whereby a monetary valuation is attributed to changes where the full welfare impact of a transport investment may not be reflected in the transport market.

4.13.8 However, none of the WEI outcomes of the scheme can be assessed as primary impacts, and do not contribute to the direct monetised effects of the investment. DfT TAG guidance indicates that WEIs should not be included in the transport economic efficiency (TEE) calculation, analysis of monetised costs and benefits (AMCB), net present value (NPV) and benefit to cost ratio (BCR), but should be included in the appraisal summary table (AST) and adjusted BCR.

4.13.9 The reason for excluding WEIs from the initial economic appraisal is because the methodologies are not as established as those in level 1.

4.13.10 The A66 NTP project, and its focus on enhancing connectivity will directly increase accessibility of businesses to employees, suppliers, customers and compatible professional services. The rationale for how this causes WEI is outlined below.

Increased Output in Imperfectly Competitive Markets

4.13.11 An increase in the production of goods or services due to companies benefitting from time savings due to the A66 NTP scheme. This is effectively a reduction in their production costs which leads to an incentive to increase the output, while still keeping an attractive profit margin. Businesses and consumers would therefore be jointly better off if firms were to increase production.

4.13.12 TAG Unit A2.2 provides examples of market failure and distortions, the presence of which in the A66 area of focus and influence indicates an imperfectly competitive market:

- Product Markets
  - Imperfect competition - Where markets are dominated by a small number of businesses.
  - Tax distortions - When companies adjust efficiency to adjust taxes payable.
  - Positive externalities from product variety - A benefit to consumers and businesses as a result of an increase in the variety of goods and services available.
- Land Markets
  - Imperfect competition - When land is owned by a small number of landowners.
  - Co-ordination failure - When multiple developers each under-invest in local transport improvements.
  - Land rationing - When policies (public or private) artificially limit the area of land available for development.

4.13.13 There are issues which the A66 NTP scheme could help to resolve:

- Reduced competition and increased market deadweight loss, due to imperfect competition and spatial monopolies.
- Employment growth in the Region is increasingly concentrated in the sectors with the highest productivity levels, particularly in knowledge intensive business services.
- Low business start-up rates.
- Transport reported as barriers to investment.
- West Cumbria has an established industrial base, but its potential is constrained by its relative remoteness; the A66 is necessary to provide enhanced connectivity from West Cumbria to other parts of the county and to the M6 and the rest of the UK.
- Businesses and residents have experienced a number of increases in prices over the last few years.
- Businesses have struggled to respond effectively innovative way to reduce costs due to ineffectiveness in local property and labour markets.

4.13.14 Together these market failures and distortions suggest the economy in the area is not functioning efficiently, and in these situations additional benefits are expected to arise when the impact of the A66 NTP is transmitted into the wider economy.

Labour Supply Impacts from More People Working

4.13.15 Transport is most likely to be a barrier to employment when an area has poor connections to employment centres and/or high transport costs relative to incomes. In deciding if they can access suitable employment, and whether or not to work, people will weigh travel costs against the wage rate of available jobs. A change in transport costs is therefore likely to incentivise people to work, and to find employment in a sector most suited to their skills. As a result of the A66 NTP scheme, businesses based in Durham, Darlington, Middlesbrough and Stockton will have access to a widened pool of skilled labour, and inactive workers who travel on the A66 will be able to access appropriate and viable employment.

4.13.16 TAG Unit A2.3 provides examples of market failures and distortions that affect the labour market, the presence of which in the A66 area of focus and influence indicates potential changes in economic acitivity in response to changes in travel costs:

- Taxation - Taxation drives a wedge between the wage a firm is willing to pay and the wage the worker makes their supply decision based on.
- Frictional Unemployment - Occurs when workers lose their current job and are in the process of finding another one.
- Wage Rigidities - The market price for goods and services does not compare to supply and demand in the short term, such that there is high level of unemployment or shortages in supply of labour.
- Monopsony Buyers -The local labour market is dominated by a single employer, who, because their dominant position, can artificially hold the wage rate below the market price, such that employment is below the competitive market outcome.

4.13.17 There are employment issues in the area which the A66 NTP scheme could help to resolve:

- Taxation is important to government but technically construed as a market failure.
- Despite significant improvements over the last five years, unemployment and economic inactivity remain higher in the Northeast than in any other areas.
- Pockets of high unemployment rates and high youth unemployment in Cumbria.
- A barrier to growth, and important characteristic of unemployment in recent years, is that a greater proportion of the unemployed are out of work for 12 months or longer and come to be seen as unemployable, which represents a long-term reduction in the economy’s effective workforce and hence its productive capacity.
- The number of people on low incomes is rising; this is a particular problem in the Northeast because it has lower average wages than other regions.
- By supporting improvements in economic activity in the surrounding area, the A66 NTP has the potential to support additional employment opportunities and depending on the types of firms increasing their activities in the area, there is potential for these jobs to be in higher paid, ‘higher value’ sectors.

- It is expected that reductions in generalised cost of commuting will increase the number of jobs accessible to potential employees and increase the number of potential candidates for vacancies.

Productivity Impacts

4.13.18 The appraisal agglomeration benefits were explored, but ruled out because the scheme does not directly pass through a functional urban region, where agglomeration benefits are considered to be more likely to occur. Work in subsequent PCF stages may be undertaken to further develop the economic narrative of the Project to provide suitable evidence that the improvements can alleviate market failures and therefore provide agglomoration benefits.

Outline Wider Economic Impacts Appraisal Method

4.13.19 WITA software v2.2 is used to assess WEI. Outlined below are the principal steps and assumptions which are applied in the Core Scenario appraisal.

- WITA is run using the latest DfT Wider Impacts Dataset (Version 3.3 - DfT July 2021).
- WEI are assessed for the Core Scenario only (not for low, high, or similar growth sensitivity scenarios).
- WITA v2.2 has been designed to be run in parallel with TUBA, so it uses the same Scheme File, Economics Parameter File and Input matrices as for the Level 1 TUBA v1.9.17.2 assessment (aligned with TAG Data Book v1.17, November 2021), along with supplementary data required for the Wider Impacts calculations; some shared files contain TUBA-specific data parameters and tables, but WITA ignores the surplus information.
- The A66TM DS scenario represents the preliminary design freeze scheme layouts, after Statutory Consultation and it is assessed against the DM.
- The transport model data for the DS and DM scenarios (trips, time and distance matrices) are as prepared for the level 1 TUBA assessment. These are masked to develop various scenarios for input to WITA; and
- Intra-zonal trips are not assigned in the transport model, so do not have time or distance data. Values in WITA have been estimated by ARUP (typically this would be half of the trip time and distance to the nearest zone).
- WITA inputs from the full extent of the A66TM are ‘masked’ to remove impacts outside the A66 area of focus and influence, where the accuracy of appraisal is proportionate, but full-journey generalised costs of travel are less reliable.
- Intra-zonal trips are not assigned in the transport model, so do not have time or distance data. Values will be estimated as half trip time and distance to nearest neighbour.
- Transport data are linearly interpolated between transport model forecast years.

- Economic data and parameters, (which include data on the productivity of labour, and employment numbers in an area) are taken from the latest DfT Wider Impacts Dataset (Version 3.3).
- Cost averaging follows the TAG recommended approach and calculates generalised costs for all purposes.
- Zone Correspondence files are produced to convert inputs between the transport model and WITA zones, and between Local Authority District zones and WITA zones. The WEI analysis will be undertaken at the WITA Zone level.
- The calculation of labour supply impacts requires a production-attraction (PA) matrix for workers that allows the software to distinguish between the home end (production) and workplace end (attraction) of commuting trips.

4.14 Resilience – Appraisal Methods (Category C Impact)

Resilience Components

4.14.1 The ‘resilience’ impact of the A66 NTP improvement is separated into three elements: route resilience on the A66 itself, and strategic route network and local road network resilience, across the wider area of influence. Route resilience comprises item (d) of the six strands of unpredictable journey time impacts for road users, which are referred to in section 4.13, whereas strategic network resilience corresponds with item (e) and local network resilience aligns with item (f):

- (d) Travel time delay on the A66 route during incidents and closures longer than 6 hours3, with all traffic diverting.
- (e) Travel time delays on the strategic road network, during carriageway incident closures longer than 6 hours, with some traffic diverting to the improved A66.
- (f) Travel time delays on the local road network, during carriageway incident closures longer than 6 hours, with some traffic diverting to the improved A66.

Resilience Principles

4.14.2 ‘Resilience’ of a road scheme refers to the frequency and duration of incidents, and the magnitude of traffic delays, of 6 hours or longer, along the route being improved, and also on adjacent roads, when compared with a situation without the road scheme. Incidents entail a partial or full carriageway closure, in one or both travel directions, and comprise accidents, vehicle breakdowns, or hazards (such as adverse weather, or infrastructure failure).

4.14.3 Resilience effects, during abnormal travel conditions, are measured separately from:

[3] The dataset behind MyRIAD, removed extreme outlier events to avoid bias within its calculations. The threshold for exclusion was chosen to be 6 hours. Therefore incidents that last for shorter than 6 hours are considered under ‘reliability’ and those major incidents that impact the network for more than 6 hours are considered under ‘resilience’.

The conventional TEE appraisal (which covers travel cost changes under normal scheme operation) – see section 4.7.

The journey time reliability appraisal (which assesses delays during incidents shorter than 6 hours and congested conditions with variable travel times) – see section 4.14.

4.14.4 Each type of resilience assessment uses an additional traffic assignment in the SATURN model (A66TM) weekday Inter Peak 1-hour model, at forecast years 2029 and 2051, to represent the effect on vehicle movements during typical carriageway incident closures on the following roads, respectively:

- On the A66 itself – (this is the route resilience appraisal).
- On adjacent national routes, managed by NH – (this is the strategic network resilience appraisal).
- On nearby primary routes and principal 'A' roads, managed by highway authorities – (this is the local network resilience appraisal).

4.14.5 The traffic effects of carriageway closures, as modelled in SATURN, are subsequently assessed in TUBA to determine the transport effciency impact of the closure on road users.

4.14.6 Incident closure characteristics (one-way or two-way closure), incident locations, durations and frequencies are determined from recorded data, from NH. The known incident locations are used to determine the road closures to be modelled in SATURN. The known frequency and duration of each type of incident closure is used to calculate the number of hours per year by which each modelled 1-hour traffic impact from SATURN is annualised. The modelled incident impact consists of the change in travel costs associated with the incident closure, network delay, and journey re-routing.

4.14.7 The route resilience, strategic network resilience, and local network resilience assessments use TUBA 1.9.17.2 to compare the performance of the A66, under with-scheme and without-scheme incident scenarios, in terms of:

- Changes in travel times, vehicle operating costs, indirect tax revenues and operator revenues, for road users, during carriageway closures for incidents on the A66.
  - This reflects the reduction or elimination of road capacity on the A66, with a carriageway closure, and the consequent re-routing of traffic away from the A66, as predicted through the SATURN traffic model.
- User impacts are calculated for four types of recorded incidents on the A66 (traffic collision / obstruction / weather / flooding).

4.14.8 With-scheme (DS) and without-scheme (DM) incident impacts are determined separately and then compared, to derive a net overall route resilience outcome.

Route Resilience Appraisal Scenarios

4.14.9 To establish A66 route resilience outcomes, two steps are taken in the TUBA appraisal, because the incident closure frequencies and durations on the A66, (and hence the annualisation factors applied in TUBA), vary between the DM and DS scenarios, depending upon the carriageway layout of each route section.

4.14.10 Here, two steps are taken to calculate the net overall economic impact of the project on route resilience, in terms of travel cost savings, as follows:

- Step 1 – Calculate net DS and DM cost of incidents, separately:
  - Net DS cost of incidents:
    [DS without carriageway closure] – [DS with carriageway closure]
  - Net DM cost of incidents:
    [DM without carriageway closure] – [DM with carriageway closure]
- Step 2 – Calculate overall net incident cost saving:
  - Net incident cost saving:
    [Net DS travel cost of incidents] – [Net DM travel cost of incidents]

4.14.11 The route resilience method compares the performance of the A66, with-scheme-and-with-incident, against the situation with-scheme-and-without incident, to establish the net DS with-scheme impact of a road closure. It then compares the performance of the A66 existing route without-scheme-and-with-incident, against the situation without-scheme-and-without-incident, to establish the net DM without-scheme impact. Finally, it subtracts the incident closure net DM travel cost from the net DS travel cost to determine the overall route resilience outcome.

4.14.12 For route resilience, from step 1, the net DS cost and net DM cost of A66 incidents are both negative values, because the travel cost during an incident closure, in terms of additional travel time and distance for diverted traffic, is greater than the travel cost in normal conditions.

Strategic and Local Network Resilience Appraisal Scenarios

4.14.13 To derive wider network resilience impacts (strategic and local) only one step is required in the TUBA appraisal, because the incident closure frequencies and durations on the wider strategic and local roads, (and hence the annualisation factors applied in TUBA), are the same in the DM and DS scenarios. The assessment assumes that the wider network carriageway layout remains unchanged, regardless of the A66 situation.

4.14.14 Here, the net economic effect of the A66 improvement on strategic and local network resilience (DS scenario), compared with the existing situation (DM scenario), is calculated in terms of travel cost savings, as follows:

- Net incident cost saving:
  [A66 DM with wider network closure] – [A66 DS with wider network closure]

4.14.15 The network resilience method compares the performance of the A66, with-scheme-and-with-network-incident (DS), against the situation without-scheme-and-with-network-incident (DM). It then subtracts the incident closure net DS travel cost from the net DM travel cost to determine the overall network resilience outcome for strategic and local roads respectively.

4.14.16 For network resilience, the net DS cost and net DM cost of A66 incidents are both positive values, because the travel cost is only calculated during an incident closure, in terms of additional travel time and distance for diverted traffic.

Resilience valuation

4.14.17 For all aspects of resilience assessment, net incident delay impacts are monetised for economic appraisal, using DfT TAG parameters in SATURN and TUBA:

- Value of time.
- Value of vehicle operation (fuel and non-fuel components).

4.14.18 Both route resilience and network resilience outcomes from TUBA are masked to be consistent with the appraisal of road user transport economic efficiency (TEE benefits), as outlined in section 4.7.

Appraisal Guidelines

4.14.19 Route resilience is assessed using guidelines set out in 'Resilience Technical Annex Valuing a Quick Recovery – Working Draft' (National Highways, May 2021). No specific advice on resilience assessment (separate from reliability appraisal) is available in DfT TAG.

Incident Data on the A66 Route and the Wider Network

4.14.20 The carriageway incident closure scenarios for the A66 route resilience appraisal are determined from recorded incident data on the A66, over a 6-year period from 2014 to 2019, inclusive, as supplied by NH. The A66 dataset includes evidence of incidents and carriageway closures for each of 14 route sections, with details of dates, locations, travel directions, frequencies (incidents per year) and durations (hours). Route resilience scenarios are assessed for the following eight links along the A66:

- Penrith to Temple Sowerby (currently single carriageway).
- Temple Sowerby to Appleby (currently single carriageway).
- Appleby to Brough (currently single carriageway).
- Brough to Bowes (currently dual carriageway).
- Bowes bypass (currently single carriageway).
- Rokeby to Stephen Bank (currently dual carriageway).

- Stephen Bank to Carkin Moor (currently single carriageway).
- Carkin Moor to Scotch Corner (currently dual carriageway).

4.14.21 Incident closure scenarios are assembled likewise for the strategic network resilience appraisal, using the same principles as for route resilience on the A66, but using NH data for the wider network (M6 and M62). Strategic network resilience scenarios are assessed for the following seven route sections:

- M6 between J31 and J32.
- M6 between J32 and J34.
- M6 between J34 and J36.
- M6 between J36 and J37.
- M6 between J37 and J38.
- M6 between J38 and J39.
- M62 between J21 and J27.

4.14.22 By contrast, no incident records are available for the local network resilience appraisal scenarios from the designated highway authorities. Therefore, local incident closure characteristics and rates (per million vehcle kilometres) are derived instead from the MyRIAD 2021 incident database for typical road types. The MyRIAD incident rates are applied to 2019 AADT flows on the local roads which are being assessed, to calculate total incidents frequencies and durations per link type. Local network resilience scenarios are assessed for the following four route sections:

- A688 east of Barnard Castle.
- A67 east of Barnard Castle.
- A67 west of Barnard Castle.
- A685 south of Brough (5 links).

Resilience Annualisation Factors

4.14.23 For each aspect of resilience appraisal, the recorded incident frequencies and durations are used to calculate annualisation factors, which are applied in TUBA. These factors are applied to each 1-hour Inter Peak SATURN model assignment output, with the A66 incident closure in place, to convert hourly vehicle movements, travel times and journey distances to a yearly equivalent.

4.14.24 Resilience scenarios are modelled in SATURN at forecast years 2029 and 2051. The assignment outcomes are input to TUBA, which interpolates and extrapolates the annualised inputs over a 60-year appraisal period from 2029 to 2088, inclusive, and converts monetised results to 2010 present year values and market prices, discounted.

4.14.25 In the A66 route resilience assessment, annualisation factors are different between the DM and DS closure scenarios, to allow for changes in incident severity when a single carriageway section is upgraded to dual carriageway standard. However, for the strategic and local network resilience appraisals the DM and DS annualisation factors are identical in each closure scenario.

Outline Resilience Appraisal Method

4.14.26 In outline, the method for assessing A66 route and wider network resilience at PCF3 entails the following steps:

- Undertake screening assessment, using recorded incident data and indicative SATURN model assignments, to determine road sections for which resilience scenarios will be modelled in detail (in SATURN and TUBA). The screening assessment considered the following roads:
  - Along the A66 for route resilience.
  - On the strategic network, on M6, M62, A1(M), A19, A69.
  - On the local primary and principal road network, on A688 and A67 (Barnard Castle), A685 (Brough), A686 (Penrith), A689 (Alston), A68 (West Auckland).
- Determine SATURN / TUBA route resilience scenarios (location and scope of road closure separately with and without the A66 improvement), on the A66 route.
- Determine SATURN / TUBA strategic and local network resilience scenarios (location and scope of road closure identically with and without the A66 improvement), on the wider network.
- Calculate annualising factors to convert modelled 1-hour incident scenario impacts to annual equivalent, taking account of frequency and duration.
- Run highway incident / closure scenarios in SATURN PCF3 future year Inter Peak model, using SATURN Full Equilibrium Assignment with ‘Warm Start’ (WS) facility, at 2029 and 2051, for a 1-hour ‘Length of Time Period’, using LTP parameter (DM vs DS).
- Identify potential re-routing away from A66, using SATURN model scenario assignments.
- Transfer SATURN scenario skim outputs into TUBA v1.9.17.2, using TAG Data Book v1.17 economic parameters.
- Calculate overall annualised and monetised net travel cost savings for ‘route resilience’ impact, on A66, for ‘strategic network resilience’ impact, on M6 and M62, and for ‘local network resilience’ impact, on A688, A67, and A685.
- Aggregate results across all road sections, with some traffic re-routing away from A66 (under route resilience) and with some traffic re-routing towards A66 (under strategic and local network resilience).

4.14.27 It is noted that using this outline method for the route resilience appraisal, the SATURN model underestimates the overall traffic effect of carriageway incidents on the A66. This is because it captures the extra travel distance associated with all vehicles diverting away from their optimum route on the A66, but it also misses the extra congestion and delay for vehicles which are ‘trapped’ behind the carriageway closure on the A66 and which are unable or unwilling to divert. As this incident delay at the point of closure is greater in the DM single carriageway scenarios than in the DS dual carriageway scenarios, the net saving in travel cost of upgrading the single carriageways is also underestimated.

4.14.28 To moderate this effect, the travel cost skims from DM single carriageway incidents could be manually corrected before input to TUBA, but the accuracy of this adjustment would be hard to verify.

4.15 Social, Environmental and Distributional Impacts Appraisal Method (Category D Impact)

4.15.1 This section outlines the methods used to undertake qualitative and non-monetised assessment of the A66 project against the following three types of impact:

- Social impacts: physical activity, journey quality, security, accessibility (of services and facilities), affordability, severance, and optional usage / non-usage value.
- Environmental impacts: townscape, historic environment, biodiversity, and water environment.
- Distributional impacts: road user benefits, noise, air quality, accidents, security, accessibility (of services and facilities), affordability, and severance.

4.15.2 Determining whether the A66 project has a meaningful effect in terms of each of these areas of impact requires an understanding of four things:

- The form and layout of the A66 route improvements.
- The character and susceptibilities of the surrounding area, in respect of land use, population, travel behaviour, disadvantage, and environment.
- The area of influence of the A66 project, in terms of affecting journey routes and road traffic conditions.
- The magnitude of predicted traffic changes within the project's area of focus (or the Traffic Reliability Area, TRA, in which the traffic model is accurate), in terms of changes in vehicle flows, speeds, and composition which exceed a threshold.

4.15.3 These four factors have been considered against each of the social, environmental and distributional impact areas, (alongside economic impacts) and a decision made as to whether further appraisal is appropriate. Table 4-6 summarises the scope of appraisal undertaken at PCF Stage 3 for each impact.

Table 4-7: Transport User Impacts by purpose during Normal Operation

Project Aspect		Transport Assessment		Environment Assessment		Human Health / Equality Assessment		Walking, Cycling & Horse-Riding Assessment	
Headline	Detail	Impact	Distribution	Impact	Distribution	Impact	Distribution	Impact	Distribution
Economy									
Public Accounts	Capital Expenditure	✓	×	×		×		×	
	Operation & Maintenance Expenditure								
	Operator Revenue								
Transport Users & Providers (& Indirect Tax)	Normal Conditions	✓	✓	×		×		×	
	Variable Conditions (Reliability & Resilience)	✓	×	×		×		×	
	Construction	✓	×	×		×		×	
	Maintenance	×	×	×		×		×	
Wider economy	Business Output, Labour Supply & Business Productivity	✓	×	×		×		×	
Environment									
Noise		✓	✓	✓	×	✓		×	
Air Quality	Local Air Quality	✓	✓	✓	✓	✓		×	
	Air Quality Valuation	✓	×	✓	×	×		×	
Greenhouse Gases	Carbon (CO2) & Carbon Equivalent (tCO2e)	✓	×	✓	×	✓		×	
Landscape Value		✓	×	✓	×	×		×	
Townscape		×	×	✓	×	×		×	
Historic Environment		×	×	✓	×	×		×	
Biodiversity		×	×	✓	×	×		×	
Water Environment		×	×	✓	×	×		×	
Society									
Safety	Accidents	✓	✓	×		✓		×	
Physical Activity		✓	×	×		✓		×	
Journey Quality		✓	×	×		✓		✓	
Security		×	×	×		×		✓	
Affordability		✓		×		×		×	

Project Aspect		Transport Assessment		Environment Assessment		Human Health / Equality Assessment		Walking, Cycling & Horse-Riding Assessment	
Headline	Detail	Impact	Distribution	Impact	Distribution	Impact	Distribution	Impact	Distribution
Severance (& Accessibility of Facilities & Services)		✓		×		✓		✓	
Optional Usage / Non-Usage Value		×	×	×		×		×	

4.15.4 The Traffic Reliability Area is used as the assessment area for all aspects of the A66 social, environmental and distributional impact appraisal, except for:

- Distribution of road user benefits – this uses the full extent of the traffic model area as sectored and masked in TUBA.
- Environmental noise impact and distribution of noise outcomes – this uses only an area along the A66 corridor, between Penrith and Scotch Corner, which extends to a maximum of 2km either side of the road.

4.15.5 The TRA is defined to represent the extent of full detail in the A66 traffic model (SATURN), as shown in Figure 4-5. However, it is extended in the northwest and southwest corners to include affected parts of the M6, and in the northeast and southeast corners to include affected parts of the A1(M).

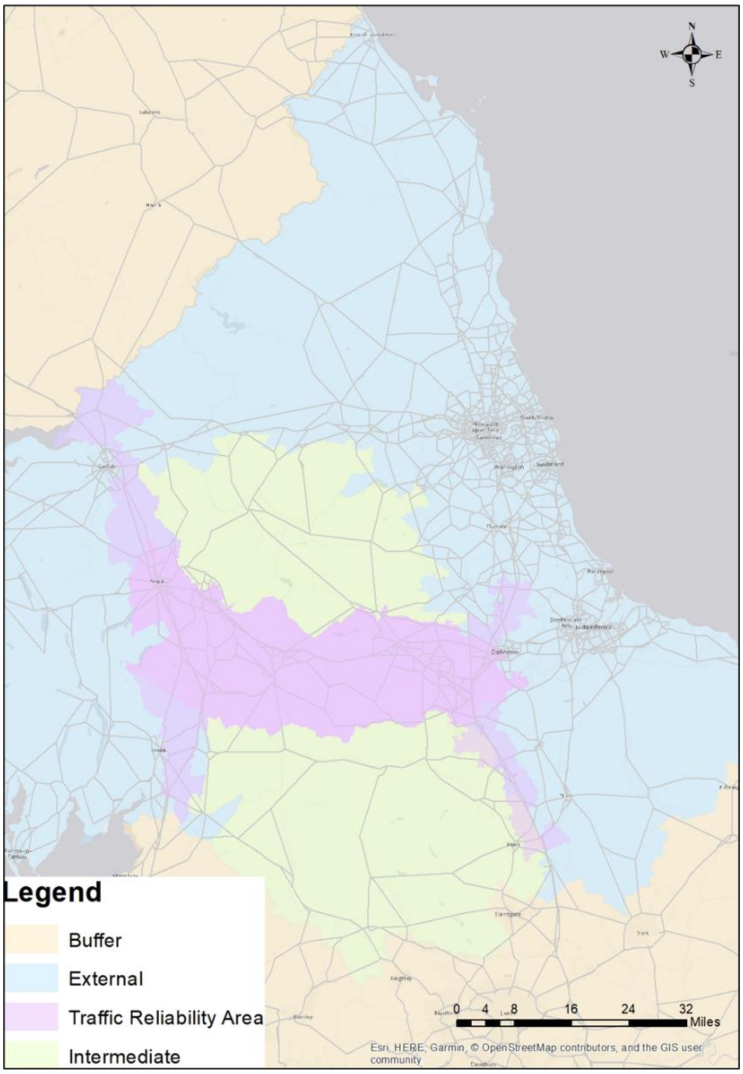


Figure 4-7: PCF3 A66TM Modelled Area (SATURN)

4.15.6 Methods used to assess the relevant A66 impacts in Table 4-6 are outlined in the remainder of this section.

Social Impacts

4.15.7 Social effects of the A66 improvements on local communities are assessed qualitatively and are not monetised. Outcomes are scored according to the TAG seven-point scale (ranging from large, moderate and slight beneficial, through neutral, to slight, moderate and large adverse). Four aspects are appraised:

- physical activity.
- Journey quality.
- Affordability.
- Severance.

4.15.8 The qualitative assessment of these social impacts is undertaken using available local data on land use, population, travel behaviour, and environment, supported by detailed findings from the project's Environment, Human Health, and Walking-Cycling-Horse Riding (WCH) teams.

Physical Activity

4.15.9 Physical activity outcomes are appraised qualitatively from the A66 Human Health assessment. The results are summarised in the TAG 'Physical Activity Impacts Worksheet (Basic)' (January 2014).

Journey Quality

4.15.10 Journey quality impacts are also appraised qualitatively from the A66 Human Health assessment. The results are summarised in the TAG 'Journey Quality Impacts Worksheet' (January 2014).

Security

4.15.11 The project is unlikely to have a meaningful impact on people's security as this impact reflects conditions for public transport users, but the A66 improvement does not have a substantive effect on public transport. The issue is summarised in the TAG 'Security Impacts Worksheet' (January 2014).

Accessibility

4.15.12 Usually, accessibility is framed as a distributional impact and is not assessed separately as a social impact. Also, it focuses on public transport changes in areas with limited opportunity for car travel. However, the A66 project has no relevant or meaningful effects on public transport. For this reason, accessibility of services and facilities is not appraised in social impact terms. The TAG worksheet for 'Distributional Impacts: Accessibility Audit' (January 2014) is not completed for A66.

Affordability

4.15.13 Implications of the A66 project on monetary costs for people less able to afford to travel are examined in the distributional impacts assessment. Affordability is not considered separately as a social impact.

Severance

4.15.14 The severance effect of the project entails hindrance of pedestrian movements to and from important local services, facilities, amenities and activities. This hindrance can reflect changes in traffic volumes and speeds, or dislocation of local access routes by new infrastructure. The social aspect of severance is assessed for A66 in conjunction with the distributional aspect and is not considered separately. Severance outcomes are summarised in the TAG 'Severance Impacts Worksheet' (January 2014).

Optional Usage / Non-Usage Value

4.15.15 The project is unlikely to have a meaningful optional usage / non-usage value. This impact reflects provision of public transport services and facilities, but the A66 improvement does not have a substantive effect on public transport.

Environmental Impacts

4.15.16 Environmental impacts of the A66 improvements on townscape, historic environment, biodiversity and water environment are not monetised in the economic appraisal. They are assessed in accordance with TAG advice in Unit A3 Environmental Impact Appraisal (July 2021) and in TAG impact-specific workbooks, The appraisal takes inputs from the project's environment team, using their quantified and qualitative assessments of the forecast traffic-related and infrastructure-related impacts of the A66 improvements.

Townscape

4.15.17 Townscape outcomes are summarised in the TAG 'Townscape Impacts Worksheet' (January 2014).

Historic Environment

4.15.18 Historic environment outcomes are summarised in the TAG 'Historic Environment Impacts Worksheet' (January 2014).

Biodiversity

4.15.19 Biodiversity outcomes are summarised in the TAG 'Biodiversity Impacts Worksheet' (January 2014).

Water Environment

4.15.20 Water environment outcomes are summarised in the TAG 'Water Environment Impacts Worksheet' (January 2014).

Distributional Impacts

4.15.21 The distributional impact appraisal (DIA) considers the spread of outcomes from the A66 NTP project amongst communities in which there is a significant presence of people in a vulnerable category as defined by several DfT indicators, namely:

- Proportion of affected Lower Super Output Area (LSOA) in each of 5 income deprivation quintiles (decreasing severity from 1 to 5), relative to 20% national average.
- Children aged <16.
- Young adults aged 16-25.
- Older adults aged 70 and over.
- People with a disability.
- People of Black / Minority / Ethnic (BME) origin.
- People without access to car.
- Households with dependent children.

4.15.22 Each LSOA is allocated an Income Deprivation (ID) score from 1 to 10, where the ID score represents % LSOA population which is income deprived. LSOA are ranked by ID score, from highest (rank 1) to lowest (rank 10), whereby the ID score intervals correspond with 10% increments between highest ID score (rank 1) and lowest ID score (rank 10). These LSOA ID scores are further consolidated to 5 intervals, with 20% increments between highest ID score (rank 1) and lowest ID score (rank 5).

4.15.23 Distributional impacts are appraised using TAG principles and worksheets. A 3-step procedure is applied to determine outcomes, where relevant, as follows:

- Step 1 – Screening to retain only meaningful A66 impacts for further appraisal.
- Step 2 – Measuring of criteria against which distributional effects are judged.
- Step 3 – Deriving distributional impact scores from the measured criteria (7-point scale from large / moderate / slight adverse, through neutral, to slight / moderate / large beneficial).

4.15.24 This assessment considers the likely distribution of the following impacts:

- User benefits, (travel time costs, vehicle operating costs, and user charges).
- Noise and air quality.
- Accident costs.
- Security.
- Access to facilities and services.
- Affordability.
- Severance.

Distribution Amongst Communities

4.15.25 An indication of whether the A66 has a significant impact on each of these appraisal aspects and therefore has a distributional dimension, is determined in the TAG ‘Distributional Impact Appraisal Screening Proforma’ (January 2014).

4.15.26 If a significant effect is identified, an appropriate distributional assessment is undertaken and the appropriate TAG worksheet is completed.

4.15.27 Distributional Impacts (DI) have been assessed in line with the guidance in TAG Units A4.1 (Social Impact Appraisal, July 2021) and A4.2 (Distributional Impacts Appraisal, May 2020).

4.15.28 The Distributional Impact (DI) analysis identifies those who would gain or lose from the A66 upgrade and assesses whether it achieves an equitable share of benefits amongst those who are disadvantaged and a fair share of costs for those who are not disadvantaged.

Overview of DI Process

4.15.29 The A66 NTP improvement could affect road users, those living close to the A66 affected by the changes in the structure of the route and those in the wider area affected by rerouting of traffic due to changes in traffic levels. These changes are likely to alter the impact of the route for several of the distributional impact indicators. This report investigates the location and level of these changes and, where possible, how they are distributed among the population.

4.15.30 The DfT guidance ensures that the DI appraisal is proportionate to the scale of the issue and follows a degree of iteration to ascertain whether a full appraisal is necessary. In Table 4-8, the process detailing the key stages of DI appraisal are laid out in three Steps.

Table 4-8: Overview of DI Steps

Step	Description	Output
1	Screening Process: Identification of likely impacts for each indicator	Screening Proforma
2	Assessment: Confirmation of the area impacted by the transport intervention (impacted area); Identification of social groups in the impacted area; and Identification of amenities in the impacted area	DIs social groups statistics and amenities affected within the impacted area
3	Appraisal of Impacts: Core analysis of the impacts Full appraisal of DIs and input into AST	Appraisal worksheets and AST inputs

Initial Screening (Step 1) - Approach

4.15.31 The initial screening assessment considered the likely positive and negative impacts of the eight DI indicators on specific vulnerable groups, including children, older people, people with a disability, black and minority ethnic (BME) communities, people without access to a car and people on low incomes.

4.15.32 A number of key questions were posed in a Proforma, published by the DfT, which were considered during the initial screening. The questions covered the following:

- Is the option being considered likely to have a negative or positive impact on specific groups of people including, children, older people, disabled people, black and minority ethnic (BME) communities, people without access to a car and people on low incomes?
- Can the likely impacts be mitigated through the re-design or amendment?
- Are the impacts significant or concentrated?

Initial Screening (Step 1) – Key Findings

4.15.33 The findings from the initial screening are summarised in Table 4-9 below. The Proforma also contains recommendations, where appropriate, for further analysis through a full appraisal. The full proforma has been provided in the Appendix A.

Table 4-9: Summary of Proforma

Indicator	Likely DI Impact	Recommendations
User Benefits	Yes	Proceed to Step 2
Noise	Yes	Proceed to Step 2
Air Quality	Yes	Proceed to Step 2
Accidents	Yes	Proceed to Step 2
Security	N/A	No further assessment
Severance	Yes	Proceed to Step 2
Accessibility	N/A	No further assessment
Affordability	Yes	Proceed to Step 2

Assessment (Step 2) – Approach

4.15.34 Following Step 1, the steps to complete a full DI are as follows:

Step 2a – Confirmation of impacted area by intervention

4.15.35 The initial screening provides a broad understanding of the areas likely to experience impacts as a result of the scheme. Within Step 2a, a more detailed examination is required to investigate the spatial impacts of the scheme. The area affected is likely to vary depending on the individual DI indicator being appraised.

Step 2b – Identification of the social groups in the impact area

4.15.36 Step 2b requires the analysis of socio-economic, social, and demographic characteristics to develop a profile of:

- The transport users that will experience changes in travel generalised costs resulting from the scheme.
- The people living in those areas identified as likely to be affected by the scheme.
- The people travelling in areas identified as likely to be affected by the intervention.

4.15.37 The analysis uses a common dataset of socio-demographic data and plots the proportions of vulnerable groups within the impacted area.

4.15.38 Table 4-10 sets out the groups of people to be identified in the analysis for each indicator.

Table 4-10: Scope of Socio-Demographic Analysis for DIs (Step 2b)

Social Group	User Benefits	Noise	Air quality	Accidents	Security	Severance	Accessibility	Affordability
Income Distribution	✓	✓	✓				✓	✓
Children: proportion <16		✓	✓	✓	✓	✓	✓	
Young adults: proportion aged 16-25				✓			✓	
Older people: proportion aged 70+				✓	✓	✓	✓	
Proportion of population with a disability					✓	✓	✓	
Proportion of population with a BME origin					✓		✓	
Proportion of households without access to a car						✓	✓	
Carers: proportion of households with dependent children							✓	

Step 2c – Identification of amenities in the impact area

4.15.39 The concentration of social groups is not only based on resident population but also what trip attractors/amenities are within the impact area. Using desktop analysis, the local amenities which are likely to be used by the identified social groups for each DI indicator are identified. Amenity data allows qualitative assessments/statements to be made to add value to the DI appraisal and provides a wider assessment than just that of the resident population.

4.15.40 The outputs of Step 2 are summarised and presented in order to provide evidence for the appraisal of impacts in Step 3.

Appraisal of Impacts (Step 3)

4.15.41 This step examines information collated in the previous steps to assess the potential impacts of the intervention on each indicator's social group.

Step 3a – Core analysis of impacts

4.15.42 An assessment score will be given for each indicator to represent any unevenly distributed impacts and each of the social groups under consideration. The seven-point scoring system follows the standard DfT appraisal measures:

- Large beneficial
- Moderate beneficial
- Slight beneficial
- Neutral
- Slight adverse
- Moderate adverse
- Large adverse

Step 3b – Full appraisal of DIs

4.15.43 The analysis undertaken in Step 3a provides an assessment score for each indicator and each of the social groups under consideration. In addition, a qualitative assessment will be provided for each indicator to describe the key impacts in each case. These are summarised in the DI appraisal matrix.

4.15.44 The scores and qualitative assessment are summarised in the DI appraisal matrix of Social and/or Distributional Impacts with key findings presented in the "key impacts" column.

Socio Economic Profiling

4.15.45 Socio economic profiling data is shown in Appendix B

5 Economic Appraisal Results – Core Scenario

5.1 Introduction

5.1.1 This chapter summarises the outcomes from the A66 NTP appraisal in terms of social welfare, at PCF Stage 3, under the Core scenario assumptions identified in section 3.4. Impacts are split into four categories, A, B, C and D, as follows:

- Category 'A' monetised items represent the initial BCR.
- Category 'B' items inform the incremental adjustment from the initial BCR to the adjusted BCR.
- Category 'C' items have an indicative valuation but are excluded from the adjusted BCR monetised outcomes.
- Category 'D' items are not monetised.

5.2 Public Expenditure (Category A impact)

5.2.1 The costs to public accounts of constructing, operating and maintaining the improved A66 route are estimated by NH and are converted to 2010 present year values and market prices, discounted, for the core scenario initial BCR.

5.2.2 The net impact, (equivalent to DM without-scheme expenditure subtracted from DS with-scheme expenditure), is summed over the 60-year economic appraisal period 2029 – 2088, inclusive.

Capital Expenditure (Construction Cost)

5.2.3 The NH capital expenditure estimate for A66 construction comprises the following cost components:

- Preparation.
- Supervision.
- Construction works.
- Land.

5.2.4 It also includes allowances for risk, uncertainty, unscheduled items, and NH portfolio risk uncertainty. These items together represent the equivalent of Optimism Bias.

5.2.5 The 5-year construction central estimate at 2010 prices is derived from a yearly profile of base costs at Q1 2019 prices (2022 to 2034 inclusive), inflated to outturn costs using NH projected yearly construction related inflation, and then adjusted to 2010 prices using a yearly GDP deflator from TAG Data Book v1.17 (November 2021).

5.2.6 The 2010 cost is adjusted to market prices by applying the TAG indirect tax correction factor of +19%, and is discounted to 2010 values from year of occurrence at a discount rate of 3.5% per annum.

5.2.7 The profile of construction costs at 2010 market prices discounted to 2010 values, split by expenditure item, is shown in Table 5-1.

Table 5-1: A66 Capital Expenditure RDP Central Estimate Construction Cost at 2010 Market Prices and Values, Discounted

Year	Preparation	Supervision	Construction Works	Land	Total
2022	19.264	0	2.073	2.081	23.419
2023	37.36	0	27.043	4.267	68.67
2024	0	2.25	168.403	35.187	205.84
2025	0	5.416	196.528	11.13	213.074
2026	0	4.143	131.601	5.536	141.279
2027	0	1.55	28.233	5.37	35.154
2028	0	1.421	0	1.168	2.589
2029	0	0	0	0.552	0.552
2030	0	0	2.62	0.26	2.88
2031	0	0	0	0.133	0.133
2032	0	0	0	0.091	0.091
2033	0	0	0	0.052	0.052
2034	0	0	0	0.011	0.011
Total	**56.624**	**14.78**	**556.502**	**65.837**	**693.743**

5.2.8 The Central Estimate of the project construction cost, at 2010 prices and values, discounted, amounts to £693.743m.

5.2.9 The proportion of total project cost (Central Estimate) which is contributed by each expenditure item is shown in Table 5-2.

Table 5-2: Percentage Split of Central Estimate Project Costs Amongst Expenditure Items

A66 Capital Expenditure Item	Expenditure Items as % of Project Total
Preparation	8.2%
Supervision	2.1%
Construction Works	80.2%
Land	9.5%
All Expenditure Items	100.0%

5.2.10 The proportion of total project cost (Most Likely Estimate) which is contributed by each A66 scheme is shown in Table 5-3.

Table 5-3: Percentage Split of Most Likely Project Costs Amongst A66 Schemes

A66 Route Section	Scheme Cost as % of Project Total
Temple Sowerby to Appleby	27.1%
Appleby to Brough	23.2%
Penrith to Temple Sowerby	13.2%
Stephen Bank to Carkin Moor	11.6%
Cross Lanes to Rokeby	8.6%
A66/A6/A686 Kemplay Bank	7.2%
Bowes Bypass	6.1%
A66/M6 J40 Skirsgill	2.7%
A66/A1(M) J53 Scotch Corner	0.3%
All Schemes	100.0%

Operation and Maintenance Expenditure

5.2.11 The NH operation and maintenance expenditure estimate for A66 is prepared for both with-project and without-project scenarios. The net incremental impact is derived by subtracting without-project cost from with-project cost.

5.2.12 The operation and maintenance expenditure profile comprises the following cost components:

- Annual routine highway maintenance.
- Renewal of new highway assets.
- New and modified structures.
- Annual routine technology maintenance.
- Renewal of new technology assets.
- Cost of energy and National Roads Telecommunications System (NRTS).
- Adjustments for severe weather, incident response and impacts on service delivery.

5.2.13 The estimate is based upon 'Highways England Asset Delivery Asset Maintenance Requirements' and includes allowances for risk and uncertainty.

5.2.14 The 60-year incremental, most likely, operation and maintenance estimate at 2010 prices is derived from a yearly profile of base costs at Q1 2019 prices (2028 to 2087 inclusive), inflated to outturn costs using NH projected yearly operation and maintenance related inflation, and then adjusted to 2010 prices using a yearly GDP deflator from TAG Data Book v1.17 (November 2021).

5.2.15 The incremental 2010 cost is adjusted to market prices by applying the TAG indirect tax correction factor of +19%, and is discounted to 2010 values from year of occurrence at a discount rate of 3.5% per annum for the first 30 years then 3% thereafter.

5.2.16 A breakdown of the 60-year total incremental most likely operation and maintenance cost, at 2010 market prices discounted to 2010 values, is shown in Table 5-4, split by component scheme and cost item.

Table 5-4: A66 Operation and Maintenance Expenditure 60-Year Most Likely Cost at 2010 Prices and Values, Discounted

A66 NTP Scheme	60-Year Incremental Operation and Maintenance Cost (Most Likely Estimate, £m, at 2010 Market Prices, Discounted)							
	Annual Routine Highway Maintenance	Renewal of New Highway Assets	New and Modified Structures	Annual Routine Technology Maintenance	Renewal of New Technology Assets	Cost of Energy and NRTS	Adjustments for Severe Weather, Incident Response and Impact on Service Delivery	Total
Scheme 01	0.311	-0.408	0.000	0.013	0.043	0.002	0.000	-0.038
Scheme 02	1.030	-0.194	0.520	0.013	0.019	0.002	0.000	1.390
Scheme 03	2.205	3.278	0.307	0.019	0.144	0.014	0.123	6.090
Scheme 04 & 05	3.396	11.441	3.138	0.000	0.000	0.000	0.399	18.374
Scheme 06	3.252	7.080	1.490	0.007	0.100	0.012	0.178	12.120
Scheme 07	0.895	1.946	0.356	0.019	0.144	0.014	0.067	3.441
Scheme 08	1.596	3.832	0.386	0.007	0.100	0.012	0.099	6.032
Scheme 09	2.372	6.595	0.343	0.000	0.000	0.000	0.225	9.536
Scheme 11	0.012	-0.039	0.000	0.000	0.000	0.000	0.000	-0.027
Total (All Schemes)	15.070	33.531	6.541	0.078	0.551	0.056	1.091	56.919

5.2.17 The most likely 60-year operation and maintenance cost of the project at 2010 prices and values, discounted, is £56.919m, equivalent to 8.2% of the project capital expenditure central estimate.

A66 Core Scenario Total Expenditure

5.2.18 Combining the capital expenditure Central Estimate (£693.743m) and the operation and maintenance expenditure Most Likely Estimate (£56.919m), the total public account expenditure in the A66 core scenario amounts to £750.662m.

PA Table

5.2.19 Impacts of the A66 NTP on public finances are summarised in the TAG worksheet 'Public Accounts (PA) Table'. The PA table includes NH cost estimates for capital expenditure (CAPEX) on scheme construction, and operation and maintenance expenditure (O&M) for the route. Also included in the PA Table are the following:

- Indirect tax revenue (the effect on Central Government wider public finances, in respect of fuel tax revenue).
- Operator revenue (the effect on Central Government funding, in respect of revenue from road tolls).

5.2.20 The PA Table is shown in Appendix C.

5.3 Travel Time, Vehicle Operation, and User Charges (Category A Impact)

5.3.1 Transport economic efficiency outcomes for road users, during normal operation of the A66 route, in the Core Scenario, are calculated in TUBA. The net impact, (equivalent to DS with-scheme user costs subtracted from DM without-scheme user costs), is summed over the 60-year economic appraisal period 2029 – 2088, inclusive and is converted to 2010 present year values and market prices, discounted.

5.3.2 As indicated in section 3.7, the TUBA outputs for the full extent of the A66TM are 'masked' to remove impacts outside the A66 area of focus and influence, where the accuracy of appraisal is proportionate but outcomes are less reliable. This procedure results in a more precise assessment, removing both exaggerated scheme benefits and dis-benefits for road users.

Travel Cost Savings by Trip Purpose and Travel Cost Component

5.3.3 One of the scheme objectives is to support the economic growth objectives of the Northern Powerhouse strategy. This can be achieved through saving travel times on the SRN for business and commuter users. The 60-year core scenario TEE outcomes for road users are summarised in Table 5-5, sub-divided by travel cost aspects and trip purposes. Of the overall masked total travel cost savings for road users, which amount to £521m, £478m (92%) are gained by business users, £24m (5%) by commuters, and £19 m(3%) by other users.

Table 5-5: Transport User Impacts by purpose during Normal Operation

Road User Cost Category	Net Valuation (£m, at 2010 Market Prices, Discounted)			
	Travel Time	Vehicle Operation	User Charges	Total
Business Users	476.275	1.345	-0.031	477.589
Commuter Users	49.426	-24.773	-0.014	24.638
Other Users	93.830	-74.844	-0.117	18.870
All Users	619.531	-98.272	-0.162	521.097

5.3.4 All of the masked travel cost saving of £521.097m comprises travel time benefits of £619.531m, a small user charge impact (-£0.162m), and a vehicle operating cost disbenefit of -£98.272m

Travel Cost Savings by Vehicle Type

5.3.5 The TUBA results for road users are analysed further in Table 5-6, split by travel cost aspects and vehicle types (TUBA sub-modes). Of the total masked travel cost savings, £389m (75%) are gained by car users, £42m (8%) by LGV users, and £91m (17%) by HGV users.

Table 5-6: Transport User Impacts by Vehicle Sub-Mode during Normal Operation

Road User Category	Net Valuation (£m, at 2010 Market Prices, Discounted)			
	Travel Time	Vehicle Operation	User Charges	Total
Car Users	488.238	-99.254	-0.161	388.823
LGV Users	52.938	-11.343	-0.002	41.592
HGV Users	78.355	12.326	-0.001	90.681
All Users	619.531	-98.272	-0.162	521.097

Travel Cost Savings by Time Period

5.3.6 The share of road user impacts between weekday and weekend time periods is shown in Table 5-7, split by travel cost aspects. Of the total masked user travel cost savings, £454m (87%) arise during weekdays and £67m (13%) during weekends.

5.3.7 Of the total user benefits which occur on weekdays, £77m (15%) accrue during the 3-hour AM period, £103m (20%) during the 3-hour PM period, £243m (46%) during the 6-hour Inter Peak, and £32m (6%) during the 12-hour Off Peak.

Table 5-7: Transport User Impacts by Time of Day and Week during Normal Operation

Time Period	Net Valuation (£m, at 2010 Market Prices, Discounted)			
	Travel Time	Vehicle Operation	User Charges	Total
Weekday AM	88.045	-11.240	-0.022	76.783
Weekday PM	117.666	-15.095	-0.012	102.560
Weekday Inter Peak	271.023	-28.320	-0.069	242.634
Weekday Off Peak	41.727	-9.971	-0.006	31.750
Weekend	101.070	-33.647	-0.053	67.370
All Users	619.531	-98.272	-0.162	521.097

5.3.8 The concentration of overall user benefits during the weekday inter peak is likely to reflect the higher proportion of business users on the A66 at this time. The increased proportion of benefits in the PM peak, compared with the AM peak, reflects the higher traffic volumes and greater level of congestion on the A66 in the PM.

Road User Travel Cost Impact by Time Band

5.3.9 TUBA gives a breakdown of monetised road user net impacts (comprising travel time, vehicle operating cost and user charge, but excluding operator revenue and indirect tax), by category of time saving, for all sector origin to destination movements. This breakdown includes the small proportion of sectors which are masked out of the definitive A66 TUBA outcome referred to above.

5.3.10 Figure 5-3 shows a graph of net road user impacts by trip purpose and time saving category, for all vehicle types combined.

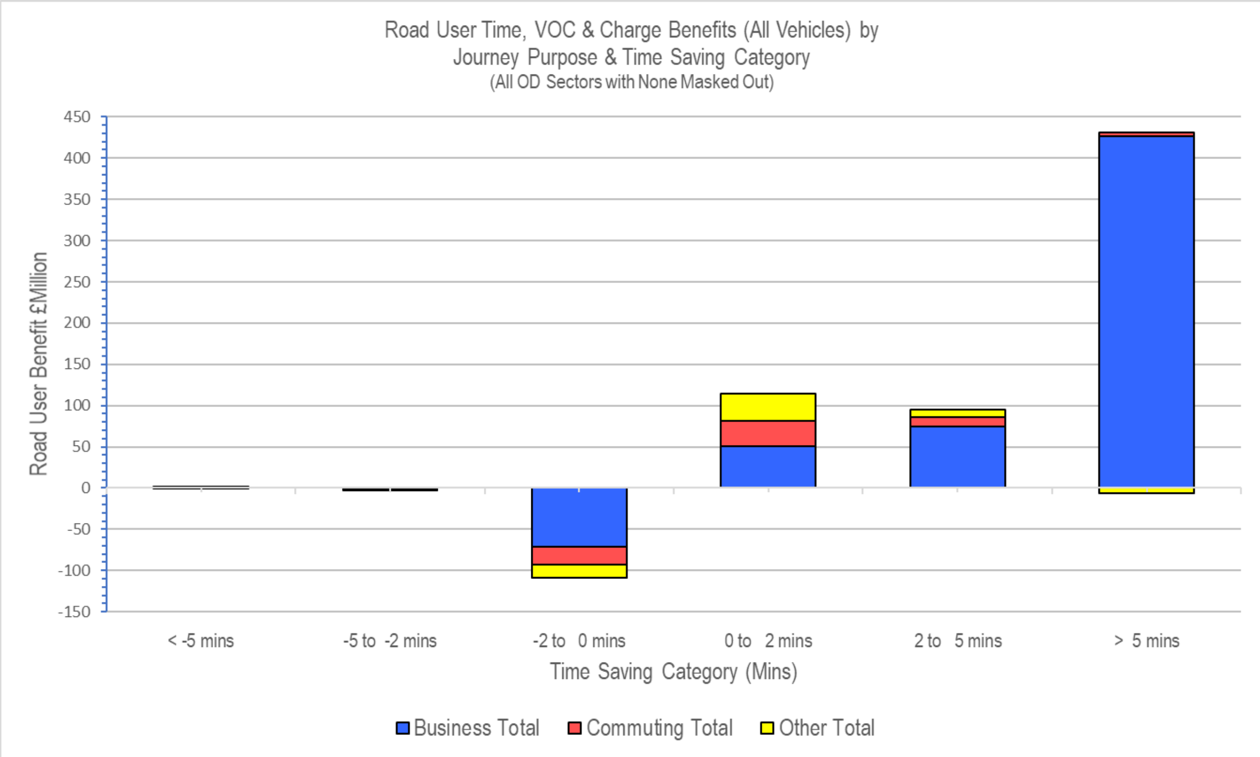


Figure 5-1: A66 Road User Benefits by Journey Purpose and Time Saving

5.3.11 The majority of road user benefits (81%) accrue to business users who make meaningful reductions in there travel time, saving more than 5 minutes on their journey. There are small disbenefits to some users away from the scheme, who could experience small delays caused by traffic increases caused by rerouted or induced traffic itself caused by the scheme.

Road User Travel Cost Impact by Distance Band

5.3.12 Similarly, TUBA gives a breakdown of road user net impacts (comprising travel time, vehicle operating cost and user charge, but excluding operator revenue and indirect tax), by journey distance category, for all sector origin to destination movements. Again, this breakdown includes the small proportion of sectors which are masked out of the definitive A66 TUBA outcome referred to above.

5.3.13 Figure 5-4 shows a graph of net road user impacts by trip purpose and journey distance category, for all vehicle types combined.

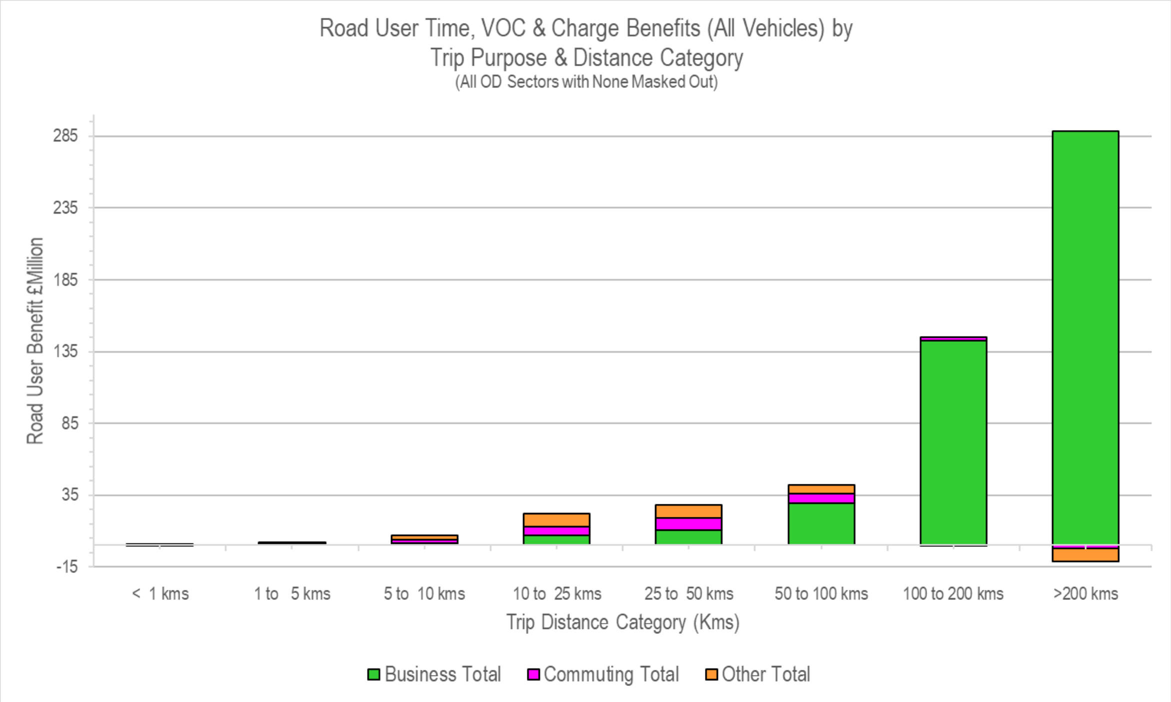


Figure 5-2: A66 Road User Benefits by Trip Purpose and Travel Distance

5.3.14 The majority of road user benefits (82%) are gained by business users making longer distance trips, travelling further than 100km (100km to 200km and more than 200km). These include 53% of benefits which accrue to business users making journeys longer than 200km.

TUBA Impacts Masked out of TEE Outcome

5.3.15 As stated above, the TEE outcome from TUBA is masked to exclude unreliable impacts identified for 215 O-D movements (27% of total 784 O-D movements). The monetised effect of masking out unreliable movements is negligible, as it reduces the overall road user net benefit by £3.463m, or -0.7%.

TEE Table

5.3.16 Impacts of the A66 NTP on road users during normal operation, as calculated in the TUBA assessment, are summarised in the TAG worksheet 'Economic Efficiency of the Transport System (TEE)'. The TEE table also includes impacts on road users during road construction and maintenance (see section 4.5), but excludes all outcomes from TUBA in respect of indirect tax revenue and operator revenue.

5.3.17 The TEE Table is shown in Appendix C.

Road User Travel Cost Savings by Trip Origin and Destination Sectors

5.3.18 The spatial distribution of TEE benefits, combining road user benefits and public accounts impacts, is summarised in section 5.5.

5.4 Wider Public Finance and Public Sector Operator Revenue (Category A Impact)

5.4.1 Other transport economic efficiency impacts in the Core Scenario are also assessed in the masked TUBA appraisal, namely:

- Indirect tax revenue (the effect on Central Government wider public finances, in respect of fuel tax revenue).
- Operator revenue (the effect on Central Government funding, in respect of revenue from road tolls).

5.4.2 These outcomes are quantified separately from the travel cost impacts in section 4.3, because indirect tax and operator revenue are both reported under the Public Accounts aspect, and not under Transport Economic Efficiency. However, the impacts are handled slightly differently within the BCRcalculation:

- Indirect tax revenue is quantified within the overall PVB, so a positive gain recorded in this section represents a hidden addition to the TEE table, but is also reported as a negative reduction to the expenditure costs in the PA table, (conversely, negative indirect tax loss under TEE shows as positive addition to PA cost).
- Private operator revenue (from tolls) reported in TUBA actually accrues to Central Government and is therefore quantified within the overall PVC, so a positive gain recorded in this section is in fact reported as a negative reduction to the PVC and is subtracted from expenditure costs in the PA table, (conversely, negative private operator revenue loss under TEE shows as positive addition to PA cost).

Indirect Tax and Operator Revenue Impacts by Trip Purpose

5.4.3 The 60-year core scenario TEE outcomes for road users are summarised in Table 5-8, sub-divided by wider public finance aspects and by trip purposes. Of the overall masked impact in TUBA, which amounts to £79.241m, 41% is associated with business users, 14% with commuters, and 45% with other users.

Table 5-8: Indirect Tax and Operator Revenue by purpose during Normal Operation (£m, at 2010 Market Prices, Discounted)

Time Period	Operator Revenue (Subtracted from PVC)	Indirect Tax Revenue (Added to PVB)	Total
Business Users	0.000	32.345	32.345
Commuter Users	0.004	11.344	11.348
Other Users	0.108	35.440	35.548
All Users	0.112	79.129	79.241

Indirect Tax and Operator Revenue Outcomes by Time Period

5.4.4 The share of impacts between weekday and weekend time periods is shown in Table 5-9, split by wider public finance aspects. Of the total masked impacts in TUBA, 75% arises during weekdays and 25% during weekends.

5.4.5 Of the 75% of total wider public finance impacts which occur on weekdays, 11% accrue during the 3-hour AM period, 16% during the 3-hour PM period, 39% during the 6-hour Inter Peak, and 9% during the 12-hour Off Peak.

Table 5-9: Indirect Tax and Operator Revenue by Time of Day and Week during Normal Operation (£m, at 2010 Market Prices, Discounted)

Time Period	Operator Revenue	Indirect Tax Revenue	Total
Weekday AM	0.020	8.742	8.762
Weekday PM	0.006	12.650	12.656
Weekday Inter Peak	0.029	31.384	31.413
Weekday Off Peak	0.012	6.768	6.780
Weekend	0.045	19.585	19.630
All Users	0.112	79.129	79.241

PA Table

5.4.6 Impacts of the A66 NTP on public finances, in terms of indirect tax and operator revenue during normal operation, are summarised in the TAG worksheet ‘Public Accounts (PA) Table’, alongside cost estimates for capital expenditure and operation and maintenance expenditure (O&M), and together with indirect tax and operator revenue impacts during construction and maintenance.

5.4.7 The PA Table is shown in Appendix C.

5.5 Combined Road User and Other TEE Impacts (Category A Impact)

Overall Transport Economic Efficiency Impact in TUBA

5.5.1 Taking together the road user benefits of the A66 improvement (£521.097m) and the other impacts on public finances (£79.241m), the overall masked transport economic efficiency impact in TUBA amounts to £600.338m.

5.5.2 To determine the spread of overall TUBA TEE outcomes amongst the 1,410 zones in the A66TM, the zone-to-zone results are first aggregated into 28 trip origin and destination (OD) sectors.

5.5.3 Results from the A66 TUBA assessment, with outcomes combined for both road users (travel time, vehicle operation and charges) and public accounts (indirect tax and operator revenue), are analysed to establish the following:

- 60-year profile of benefits by year.
- Spatial distribution of outcomes between 28 origin and destination sectors.

5.5.4 The total TEE outcome, combining the impact for road users (£521.097m), operator revenues (£0.113m), and indirect taxes (£79.128m), amounts to £600.338m.

60-Year Profile of Road User and Other TEE Benefits

5.5.5 The profile of TEE impacts from TUBA over the 60-year appraisal period, from 2029 to 2088 at 2010 prices and values, is shown in Figure 5-1. The profile includes both road user benefits (travel time, vehicle operating cost and user charges from section 5.3) and other public accounts impacts (indirect tax revenue and operator revenue from section 5.4).

5.5.6 During every year in the appraisal period, the relative proportions of the positive impacts (travel time, indirect tax, operator revenue) and the negative impacts (vehicle operating costs, user charges), which constitute the annual benefit, remain broadly the same. However, the overall amount of benefit in each year reduces steadily through the appraisal period, in line with an increasing annual discount rate factor to 2010 prices and values.

5.5.7 The reducing scale of benefit in every year after opening reflects that travel conditions on the existing route, in the DM scenario, do not worsen rapidly over time, in terms of congestion and delay. Hence, DM travel costs do not increase rapidly over time either. Consequently, although the DS scenario improvement does provide faster vehicle speeds, shorter journey times, and travel cost savings compared with the DM, it does not give an escalating reduction in congestion costs or increase in travel delay saving on the route over time. Hence, the DS benefits are constant, but also reduce in line with discount factors.

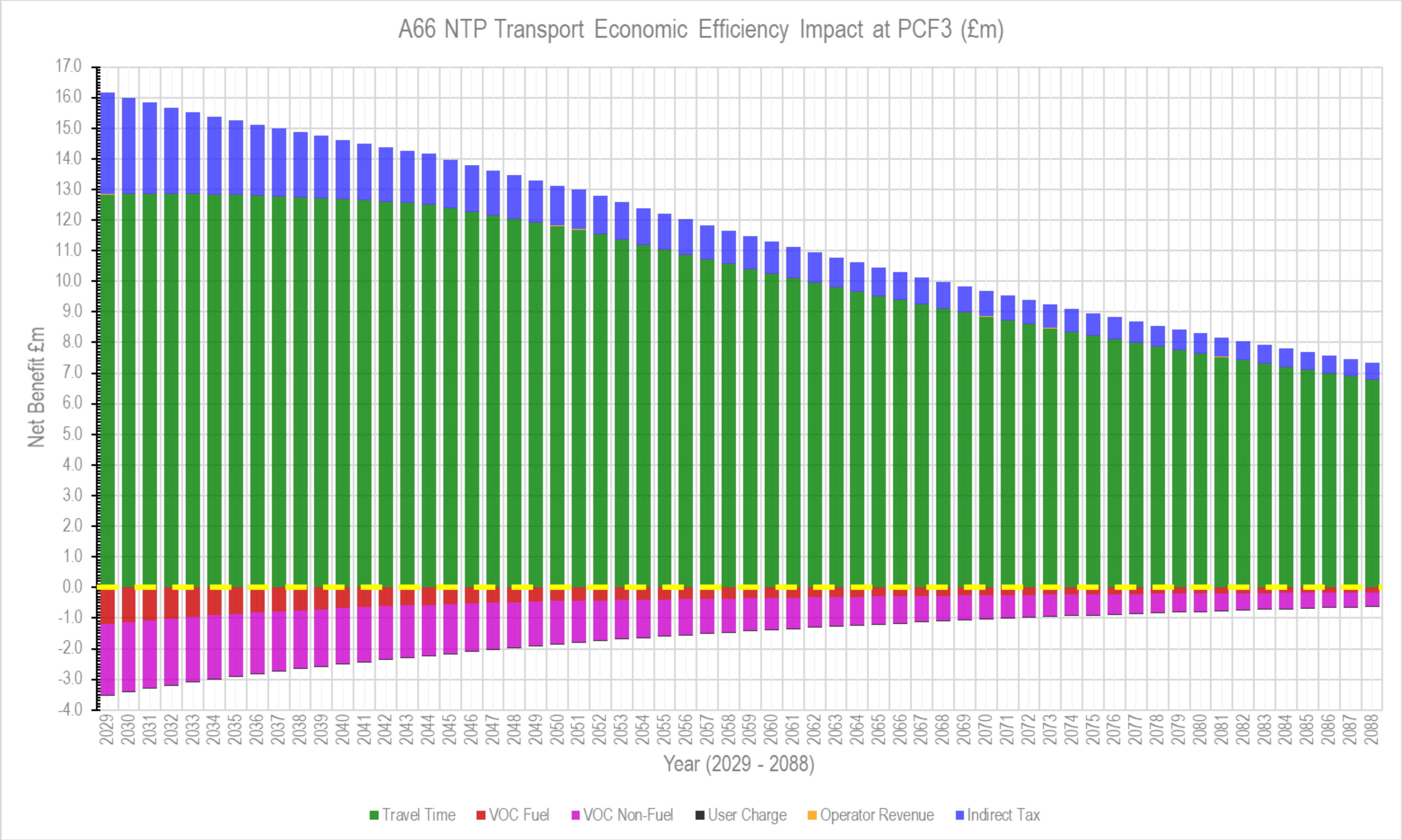


Figure 5-3: A66 NTP 60-Year Profile of TEE Road User and Other Impacts

Spatial Distribution of TUBA Outcomes

5.5.8 Table 5-10 shows that total TEE outcomes are concentrated amongst 15 out of 28 sector origin and destination pairs (2-way travel impacts between a sector-origin and a sector-destination). It is clear that the trip end sectors, for which road users gain the most from the project, lie on a south east / north west orientation, which matches the alignment of the A66 corridor. The 15 OD 2-way movements gaining the most benefit account for £258.071m of travel cost savings, equivalent to 43% of the masked total TEE benefit.

Table 5-10: TUBA OD Movements with Highest Transport Economic Efficiency Impacts

2-Way Origin – Destination Movement				Net TEE Valuation (£m, at 2010 Market Prices, Discounted)
Trip Origin	Trip Destination		TUBA Sector No.	
Eden	Eden	3 – 3	3 – 3	39.330
Eden	Yorkshire & The Humber (Southwest)	3 – 20	20 – 3	29.529
East Midlands	Eden	22 – 3	3 – 22	20.840
South & East Ayrshire	Yorkshire & The Humber (Southwest)	15 – 20	20 – 15	17.879
Dumfries & Galloway	East Midlands	14 – 22	22 – 14	17.474
Northwest Cumbria	Yorkshire & The Humber (Southwest)	2 – 20	20 – 2	15.984
Carlisle	Yorkshire & The Humber (Southwest)	4 – 20	20 – 4	15.705
East of England	South & East Ayrshire	27 – 15	15 – 27	15.356
Dumfries & Galloway	Yorkshire & The Humber (Southwest)	14 – 20	20 – 14	14.555
Durham	Eden	8 – 3	3 – 8	13.741
South Lanarkshire	Yorkshire & The Humber (Southwest)	16 – 20	20 – 16	13.452
East Midlands	South & East Ayrshire	22 – 15	15 – 22	12.863
Yorkshire & The Humber (North)	Eden	13 – 3	3 – 13	12.424
Richmondshire	Eden	11 – 3	3 – 11	12.098
Eden	Carlisle	3 – 4	4 – 3	6.843
All Users				**258.071**

5.5.9 There are 10 sectors where the sum of outgoing (origin) and incoming (destination) travel cost savings are greatest, as shown in order of decreasing value in Table 5-11. Taking these 10 sectors together, their combined trip movements capture 74% of the overall masked total origin plus total destination TEE benefit.

Table 5-11: TUBA OD Movements with Highest Transport Economic Efficiency Impacts

Sector Location	TUBA Sector No.	Combined O&D TEE Benefit as % of Total
Eden	3	21.7%
Yorkshire and The Humber (Southwest)	20	8.6%
East Midlands	22	7.2%
Northwest Cumbria	2	6.6%
South & East Ayrshire	15	6.3%
Carlisle	4	5.9%
Dumfries & Galloway	14	5.1%
South Lanarkshire	16	4.5%
North Scotland	18	4.2%
Durham	8	4.0%
Remaining Sectors	–	25.9%

5.5.10 Road users travelling from and to sector 3, Eden, gain the largest benefits from the A66 improvement, accounting for 22% of the total origin plus total destination benefits across 28 sectors.

5.5.11 Table 5-12 shows the distribution of overall TEE road user and other public finance impacts, from the masked TUBA assessment, amongst origin and destination sectors.

Table 5-12: Sector Distribution of A66 Masked TEE Benefits (Road Users and Public Finances) from TUBA: Travel Time + Vehicle Operating Cost + User Charge + Operator Revenue + Indirect Tax

Total TEE Benefit (£m)	D Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	O Totals	O % of Total OD
O Sector																															
South Cumbria	1	1.220	-0.123	3.728	-0.073	0.033	1.037	0.493	0.829	1.376	0.996	0.542	1.500	1.747	-0.014	-0.012	-0.010	-0.009	-0.007	1.133	0.932	0.543	1.010	0.065	0.020	0.009	0.009	0.295	0.009	17.279	2.9%
Northwest Cumbria	2	0.323	-0.877	4.810	0.264	0.040	0.293	0.562	3.334	4.715	3.097	1.964	2.972	3.370	0.012	0.014	0.017	0.021	0.008	0.475	8.396	1.583	3.809	0.070	0.018	0.008	0.043	0.952	0.032	40.324	6.7%
Eden	3	3.126	5.836	39.330	8.449	0.312	0.984	1.245	6.555	5.990	5.835	5.806	5.089	5.765	0.777	1.009	0.943	0.713	0.960	2.366	12.619	3.286	9.176	0.381	0.101	0.043	0.175	1.897	0.231	128.999	21.5%
Carlisle	4	-0.169	-0.118	-1.607	1.281	0.564	0.509	0.049	1.784	3.516	1.525	1.602	1.909	2.292	0.000	0.000	0.000	-0.020	0.000	0.036	6.857	1.325	5.341	-0.004	0.000	0.000	0.010	1.144	0.063	27.892	4.6%
Northumberland	5	0.099	0.082	0.272	0.793	0.771	0.000	0.000	0.334	0.000	0.000	-0.022	-0.029	-0.064	0.000	0.000	0.000	0.000	0.000	0.156	-0.352	-0.015	-0.303	-0.040	0.009	-0.034	-0.053	-0.088	-0.082	1.433	0.2%
Tyneside	6	1.047	0.424	0.998	0.714	0.000	0.000	0.000	0.314	0.000	0.000	-0.158	-0.227	-0.565	0.000	0.000	0.000	0.000	0.000	1.423	-1.813	-0.074	-1.032	-0.365	-0.042	-0.159	-0.191	-0.317	-0.354	-0.377	-0.1%
Wearside	7	0.479	0.606	1.470	0.048	0.000	0.000	0.000	0.049	0.000	0.000	-0.059	-0.079	-0.148	0.016	0.017	0.017	0.000	0.006	0.415	-0.450	-0.016	-0.250	-0.115	-0.015	-0.017	-0.032	-0.051	-0.052	1.838	0.3%
Durham	8	1.170	3.845	7.186	2.023	0.354	0.236	0.386	4.877	1.665	-0.032	2.100	1.078	-0.008	0.595	0.574	0.558	0.037	0.264	0.822	-0.501	0.093	-0.368	-0.304	-0.043	-0.044	-0.065	-0.101	-0.169	26.230	4.4%
Cleveland (West)	9	1.144	4.643	5.763	3.277	0.000	0.000	0.000	1.668	0.000	0.000	-0.874	-0.515	-0.391	0.995	1.372	1.575	0.013	0.584	1.644	-0.980	-0.058	-0.882	-0.338	-0.029	-0.056	-0.090	-0.187	-0.116	18.161	3.0%
Cleveland (East)	10	1.293	3.177	5.173	1.491	0.000	0.000	0.000	0.007	0.000	0.000	-0.167	-0.176	-0.154	0.792	0.805	0.659	0.001	0.503	0.557	-0.603	-0.023	-0.463	-0.172	-0.039	-0.028	-0.063	-0.097	-0.065	12.408	2.1%
Richmond-shire	11	0.932	2.020	6.292	1.733	-0.010	-0.173	-0.031	1.288	-1.469	-0.544	0.831	0.139	-0.090	1.161	1.106	1.354	0.113	0.726	1.293	-0.275	-0.034	-0.159	-0.027	-0.006	-0.009	-0.012	-0.049	-0.009	16.091	2.7%
North Yorkshire	12	1.570	2.835	5.659	2.119	-0.043	-0.201	-0.069	0.442	-0.789	-0.403	-0.009	-0.359	-0.546	1.172	0.783	1.005	0.037	0.656	0.000	-1.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.845	2.1%
Yorkshire and The Humber (North)	13	2.131	2.933	6.659	2.738	-0.110	-0.640	-0.142	-0.287	-0.336	-0.211	-0.154	-0.522	-0.222	2.527	2.789	2.351	0.085	2.531	0.000	-0.334	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	21.787	3.6%
Dumfries & Galloway	14	-0.054	-0.053	0.418	0.000	0.000	0.000	0.022	0.903	1.457	1.196	1.977	1.516	2.454	0.000	0.000	0.000	0.000	0.000	-0.038	7.712	1.468	8.472	-0.025	-0.006	-0.004	0.037	3.881	0.153	31.487	5.2%
South & East Ayrshire	15	-0.047	-0.013	1.041	0.000	0.000	0.000	0.018	0.939	2.005	0.886	1.883	1.138	3.105	0.000	0.000	0.000	0.000	0.000	0.009	8.678	1.239	6.437	0.008	0.000	0.001	0.389	7.258	2.710	37.683	6.3%
South Lanarkshire	16	-0.040	-0.008	1.018	0.000	0.000	0.000	0.019	0.956	2.138	1.038	2.313	1.191	2.497	0.000	0.000	0.000	0.000	0.000	0.006	6.528	0.762	5.270	0.002	0.000	0.000	0.070	3.268	0.395	27.423	4.6%
Scottish Borders	17	-0.044	-0.003	0.737	-0.022	0.000	0.000	0.000	0.043	0.009	-0.002	0.107	0.056	0.122	0.000	0.000	0.000	0.000	0.000	0.013	0.124	0.006	0.007	-0.005	0.003	0.005	-0.021	-0.088	-0.564	0.482	0.1%
North Scotland	18	-0.040	-0.009	1.175	0.000	0.000	0.000	0.011	0.378	0.820	0.513	1.116	0.983	2.883	0.000	0.000	0.000	0.000	0.000	0.006	4.810	0.995	5.630	0.004	0.001	0.001	0.204	5.341	1.052	25.875	4.3%
Northwest_(South)	19	0.447	-0.265	4.706	-0.022	0.040	1.904	0.583	0.886	2.190	0.754	1.579	0.000	0.000	-0.032	-0.016	-0.018	-0.012	-0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.710	2.1%
Yorkshire and The Humber (Southwest)	20	1.017	7.589	16.910	8.848	-0.527	-2.447	-0.545	-1.301	-1.170	-0.918	-0.479	-1.217	-0.359	6.842	9.201	6.924	0.152	4.903	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	53.424	8.9%
Yorkshire and The Humber (Southeast)	21	0.651	1.757	3.717	2.017	-0.013	-0.060	-0.012	0.033	-0.055	-0.037	-0.071	0.000	0.000	1.797	1.074	0.725	0.004	0.833	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.361	2.1%
East Midlands	22	0.957	4.072	11.665	5.719	-0.415	-1.171	-0.297	-0.761	-0.894	-0.540	-0.313	0.000	0.000	9.003	6.426	5.417	0.154	5.469	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	44.490	7.4%
West Midlands	23	0.042	-0.056	0.922	-0.002	-0.088	-0.558	-0.134	-0.454	-0.363	-0.209	-0.046	0.000	0.000	-0.007	0.005	-0.002	-0.006	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.959	-0.2%
Wales	24	0.011	-0.016	0.222	-0.001	-0.006	-0.099	-0.022	-0.066	-0.049	-0.035	-0.015	0.000	0.000	-0.004	-0.002	-0.003	-0.001	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.087	0.0%
Southwest	25	0.006	-0.004	0.086	0.000	-0.034	-0.176	-0.016	-0.081	-0.057	-0.030	-0.016	0.000	0.000	0.000	0.003	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.317	-0.1%
Southeast	26	0.005	0.028	0.192	0.060	-0.068	-0.242	-0.036	-0.155	-0.095	-0.072	-0.021	0.000	0.000	0.105	0.735	0.157	-0.035	0.495	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.052	0.2%
East of England	27	0.117	1.109	2.248	1.252	-0.124	-0.410	-0.059	-0.234	-0.201	-0.124	-0.107	0.000	0.000	3.456	8.098	3.666	0.027	4.674	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.386	3.9%
London	28	0.005	0.077	0.303	0.145	-0.111	-0.454	-0.056	-0.225	-0.155	-0.074	-0.016	0.000	0.000	0.347	4.251	0.732	-0.333	1.982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.417	1.1%
D Totals		17.398	39.488	131.092	42.848	0.563	-1.669	1.970	22.054	20.249	12.610	19.291	14.448	21.690	29.540	38.232	26.069	0.945	24.566	10.316	50.334	11.083	41.693	-0.864	-0.026	-0.283	0.409	23.057	3.235	600.338	100.0%
D % of Total OD		2.9%	6.6%	21.8%	7.1%	0.1%	-0.3%	0.3%	3.7%	3.4%	2.1%	3.2%	2.4%	3.6%	4.9%	6.4%	4.3%	0.2%	4.1%	1.7%	8.4%	1.8%	6.9%	-0.1%	0.0%	0.0%	0.1%	3.8%	0.5%	100.0%	

Key to Benefits Scale:								
	+£20.00m to +£49.99m	+£10.00m to +£19.99m	+£6.00m to +£9.99m	+£3.00m to +£5.99m	+£0.00m to +£2.99m	-£0.50m to -£0.01m	-£1.00m to -£0.51m	-£10.00m to -£1.01m

5.5.12 The spatial pattern of masked TEE business user benefits from TUBA, by trip origin, amongst 28 OD sectors, is shown in Figure 5-4.

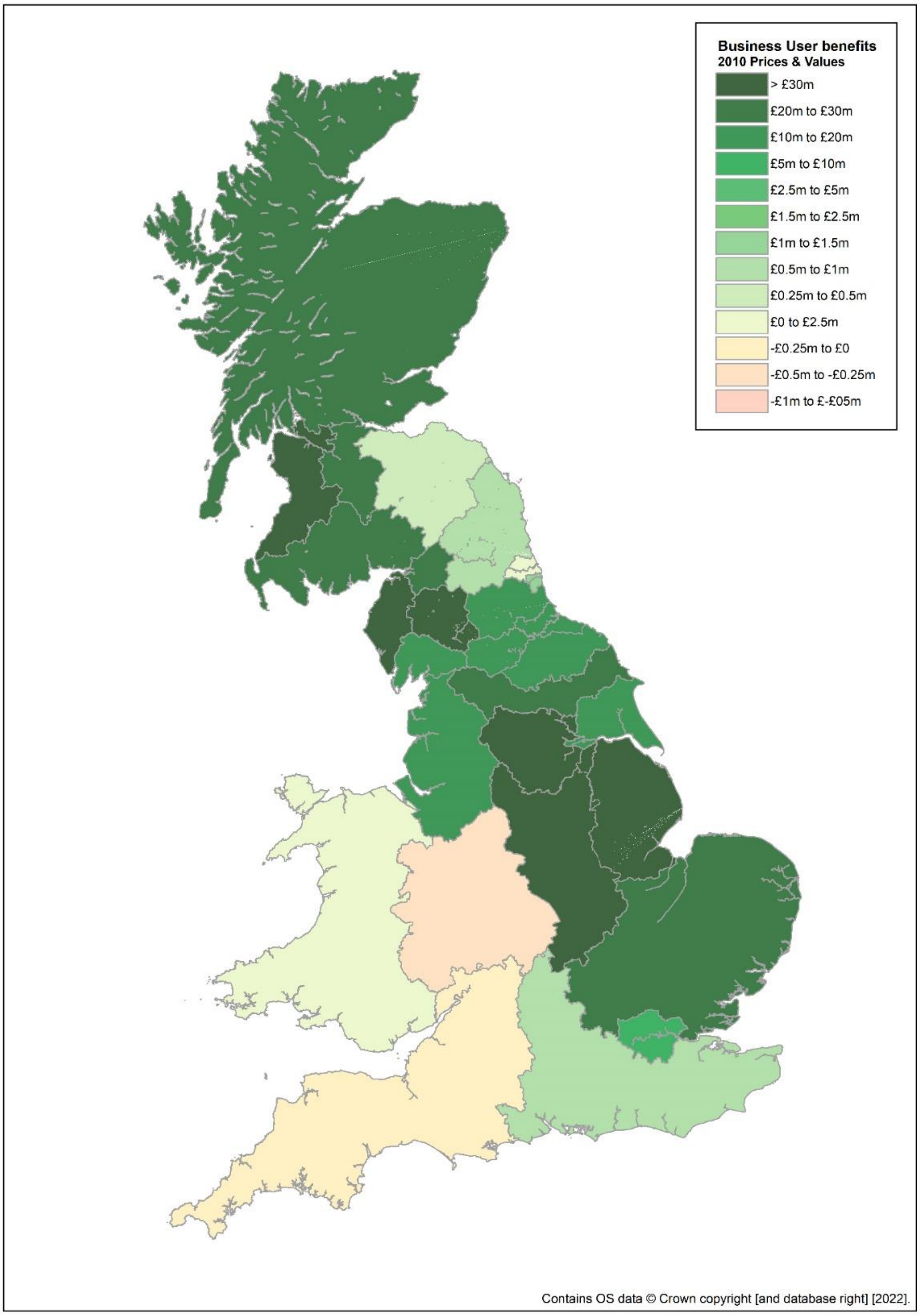


Figure 5-4: Spatial Distribution of Business User Benefits by TUBA Origin Sector

5.5.13 The TUBA business user benefits comprise travel time, vehicle operating cost, and user charge, but exclude indirect tax and operator revenue. The largest benefits are orientated along a northwest / southeast axis, aligning with the A66, for trip movements from Eden, Copeland, Allerdale, Carlisle, southwest Scotland, West and South Yorkshire, East Midlands, and Lincolnshire.

5.6 User Costs During Scheme Construction (Category A Impact)

Construction Scenarios

5.6.1 The schemes which are assessed as being under construction in each SATURN / TUBA model scenario are as follows

- Scenario A – Schemes 01, 03, 04, 05, 06, 07, 11.
- Scenario B – Schemes 01, 03, 04, 05, 06, 07.
- Scenario C – Schemes 01, 03, 04, 05, 06, 07, 08.
- Scenario D – Schemes 02, 03, 04, 05, 08, 09.
- Scenario E – Schemes 02, 03, 09.
- Scenario F – Schemes 02, 09.
- Scenario G – Scheme 02.

5.6.2 However, no construction impact is assessed for scheme 11, at A1(M) J53, as the TTM works here are likely to be unintrusive and are not likely to cause significant delay or diversion to traffic.

5.6.3 Road user travel costs during construction are summarised in Table 5-13, split by travel time, vehicle operation and user charge impacts, and by construction scenario.

Table 5-13: Road User Travel Cost Aspects During Construction (£m, at 2010 Market Prices, Discounted)

Construction Scenario	Travel Time	Vehicle Operation	User Charges	Total
Construction Scenario A	-9.250	-0.440	-0.007	-9.697
Construction Scenario B	-9.349	-0.446	-0.007	-9.802
Construction Scenario C	-22.169	-0.736	-0.015	-22.920
Construction Scenario D	-19.147	-0.475	-0.014	-19.636
Construction Scenario E	-3.505	-0.241	-0.004	-3.750
Construction Scenario F	-0.902	-0.429	-0.001	-1.332
Construction Scenario G	7.607	-1.533	-0.004	6.070
Overall Road User Impact	**-56.715**	**-4.300**	**-0.052**	**-61.067**

5.6.4 The overall travel cost impact for road users during construction amounts to £61.067m, of which 92% is travel time increase, 7% is vehicle operating cost increase and 1% is user charge increase.

5.6.5 Greatest road user costs occur in Scenario C, when seven schemes are constructed concurrently, and no improvements to the A66 single carriageway sections are open to traffic, (only scheme 11 at A1(M) J53 is complete). Conversely, a small road user benefit arises in Scenario G, when only scheme 02 (A66/A6/A686 Kemplay Bank) is still under construction, and when all of the other nine schemes are completed and open to traffic.

Road User Travel Costs by Trip Purpose

5.6.6 A further breakdown of road user travel costs during construction, by trip purpose, is shown in Table 5-14, split by travel time, vehicle operation and user charge impacts, and by construction scenario.

Table 5-14: Road User Travel Costs by Trip Purpose During Construction (£m, at 2010 Market Prices, Discounted)

Construction Scenario	Business Users	Commuter Users	Other Users	Total
Construction Scenario A	-7.503	-1.144	-1.050	-9.697
Construction Scenario B	-7.584	-1.157	-1.061	-9.802
Construction Scenario C	-18.451	-2.290	-2.179	-22.920
Construction Scenario D	-16.033	-1.847	-1.756	-19.636
Construction Scenario E	-2.724	-0.544	-0.482	-3.750
Construction Scenario F	-0.660	-0.363	-0.309	-1.332
Construction Scenario G	6.350	-0.130	-0.150	6.070
Overall Road User Impact	**-46.605**	**-7.475**	**-6.987**	**-61.067**

5.6.7 The share of total road user travel cost during construction (-£61.067m), amongst journey purposes, consists of 76% business, 12% commuting and 12% other.

5.6.8 Figure 5-5 shows a comparison of end-to-end travel time along the A66 from Penrith to Scotch Corner, during each of the seven construction phases, against the situation with and without the A66 improvement.

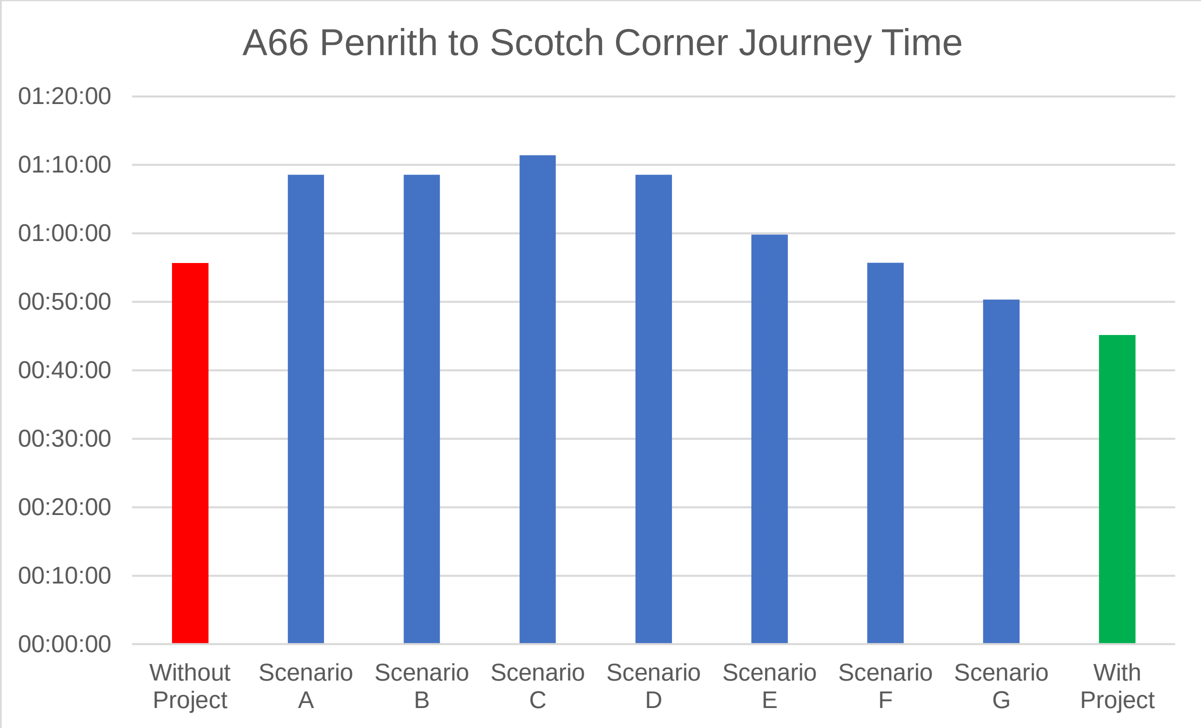


Figure 5-5: A66 Penrith to Scotch Corner Journey Time

Public Finances and Greenhouse Gases During Construction

5.6.9 Transport impacts of construction on public finances, (split between operator revenue and indirect tax), and on estimated greenhouse gases, are set out in Table 5-15, by construction scenario.

Table 5-15: Indirect Tax and Operator Revenue during Construction and Maintenance (£m, at 2010 Market Prices, Discounted)

Scenario	Operator Revenue (Subtracted from PVC)	Indirect Tax Revenue (Added to PVB)	Greenhouse Gases (Added to PVB)	Total
Construction Scenario A	0.007	-0.050	0.044	0.001
Construction Scenario B	0.007	-0.051	0.044	0.000
Construction Scenario C	0.014	-0.221	0.187	-0.020
Construction Scenario D	0.014	-0.232	0.195	-0.023
Construction Scenario E	0.004	0.009	-0.006	0.007
Construction Scenario F	0.001	0.135	-0.113	0.023
Construction Scenario G	0.005	0.716	-0.596	0.125
Overall Public Finance Impact	**0.052**	**0.306**	**-0.245**	**0.113**

5.6.10 Overall, during construction, there is a small positive gain in operator revenue, which translates as a subtraction from public account cost to Government in the PA table. There is also a small positive saving in indirect tax revenue, which also translates as a subtraction from public account cost. The greenhouse gases impact is slightly negative and is subtracted from the PVB. Combining the operator revenue, indirect tax and greenhouse gases impacts gives a net TUBA impact of £0.113m.

5.6.11 The greenhouse gases impact is an approximation derived from TUBA and may be an undersestimate as it is based on a simple average speed between traffic model origin and destination. The tonnage is shown in Table 5-16 below.

Table 5-16: CO^2 Tailpipe Emissions During Construction (tonnes)

Scenario	Untraded	Traded
Construction Scenario A	-493	-3
Construction Scenario B	-499	-3
Construction Scenario C	-1,697	-24
Construction Scenario D	-2,214	-39
Construction Scenario E	-146	-2
Construction Scenario F	785	8
Construction Scenario G	4,845	66
Total	**581**	**3**

Overall Construction Impact in TUBA

5.6.12 Taking together the road user costs during construction (-61.067m) and the other impacts on public finances and greenhouse gases (£0.113m), the overall impact in TUBA amounts to -£60.954m.

TEE Table

5.6.13 Impacts of the A66 NTP on road users during construction and maintenance, as calculated in the TUBA assessment, are summarised in the TAG worksheet 'Economic Efficiency of the Transport System (TEE)'. The TEE table also includes impacts on road users during normal route operation, but excludes all outcomes from TUBA in respect of indirect tax revenue and operator revenue.

5.6.14 The TEE Table is shown in Appendix C.

PA Table

5.6.15 Impacts of the A66 NTP on public finances in terms of indirect tax and operator revenue during construction and maintenance are summarised in the TAG worksheet 'Public Accounts (PA) Table', alongside cost estimates for capital expenditure and operation and maintenance expenditure (O&M), and together with indirect tax and operator revenue impacts during normal operation.

5.6.16 The PA Table is shown in Appendix C.

5.7 Noise, Air Quality and Greenhouse Gases (Category A Impact)

5.7.1 Environmental effects of the project on noise, air quality and greenhouse gases are quantified and monetised for economic appraisal. The net impact, (equivalent to DS with-scheme environment costs subtracted from DM without-scheme environment costs), is summed over the 60-year economic appraisal period 2029 – 2088, inclusive and is converted to 2010 present year values and market prices, discounted.

Noise

5.7.2 Noise impacts resulting from the A66 improvement are assessed as road traffic related changes in A-weighted equivalent continuous sound level (LAeq dB) during daytime and night-time periods, within the area of focus. Variations in noise caused by the project are a consequence of changes in traffic flows, road types, and road speed characteristics.

5.7.3 During daytime, the project causes 1,598 households to experience a noise increase, and 597 households to experience a noise decrease. During night-time, some 788 households experience a noise increase, and 489 households experience a noise decrease.

5.7.4 Despite the there being more households affected by a noise increase than by a noise decrease, overall, the magnitude of noise reductions outweighs that of noise uplifts, giving a net environment benefit. The outcome is caused by the A66 alignment bypassing completely a significant number of properties on the existing route and by the improvement encouraging traffic to divert on to the A66 from some adjacent minor roads.

5.7.5 Taking into acount short term and long term changes in noise which are caused by the project, and also the absolute noise levels, the number of properties with meaningful noise impacts are as summarised in Table 5-17.

Table 5-17: Number of Properties Experiencing Meaningful Noise Impact

Type of Noise Receptor	Category of Impact	
	Adverse	Beneficial
Residential	128	408
Non-Residential	5	46
Total	133	454

5.7.6 Locations where there is a large decrease in noise include Cliburn, Kirkby Thore, Crackenthorpe, Wheat Sheaf Bridge and Turks Head (north of Warcop), Barnard Castle and Ravensworth, and also three other ‘Noise Important Areas’.

5.7.7 The monetary valuation of noise impacts, at 2010 prices and values discounted, is shown in Table 5-18.

Table 5-18: Summary of A66 Noise Impact Valuation (£m, at 2010 Market Prices, Discounted)

Noise Aspect	Noise valuation in Opening Year 2029 (£m)		Noise valuation in Design Year 2044 (£m)		Net 60-Year Noise Valuation
	Households with Net Noise Decrease)	Households with Net Noise Increase	Households with Net Noise Decrease)	Households with Net Noise Increase	
Sleep Disturbance	0.085	-0.031	0.084	-0.050	1.034
Amenity	0.064	-0.041	0.063	-0.065	0.091
Health (Heart Disease / AMI)	0.010	-0.004	0.010	-0.005	0.139
Health (Stroke)	0.008	-0.005	0.008	-0.008	-0.009
Health (Dementia)	0.011	-0.008	0.011	-0.013	-0.015
Overall Impact	0.178	-0.089	0.176	-0.141	1.240

5.7.8 The appraisal shows a slight overall noise reduction with the A66 improvement which gives a small economic benefit of £1.240m. This comprises the following impacts: sleep disturbance £1.034m, Amenity £0.091m, and Health £0.115m (AMI £0.139m, Stroke -£0.009m, and Dementia -£0.015m). Further details of the noise assessment are contained in the A66 Environmental Statement.

Air Quality

5.7.9 Air quality effects of the project are assessed in terms of roadside emissions of oxides of nitrogen (NOx) and particulate matter (PM2.5), associated with the volume, composition and speed of traffic within the area of focus. The net emissions impact (with scheme emissions minus without-scheme emissions) is assessed at Opening Year 2029 and Design Year 2044, then intepolated between and extrapolated beyond, to derive a 60-year outcome. Variations in emissions caused by the project are a consequence of changes in traffic flows, road types, levels of congestion and road speed characteristics.

5.7.10 The appraisal shows net emissions increases of 732 tonnes of NOx and 211 tonnes of PM2.5, over 60 years in the area of focus.

5.7.11 A further assessment is made of net NOx emissions in areas where the Nitrogen Dioxide (NO2) Limit Value is exceeded and in areas where it is not exceeded, in opening year 2029 and in design year 2044. This shows a small net NOx increase of 0.014 tonnes in 2029, but no change in 2044, in areas with exceedance. It also shows more substantial net NOx increases of 9.583 tonnes in 2029, and 12.606 tonnes in 2044, in areas without exceedance.

5.7.12 The monetary valuation of air quality impacts, at 2010 prices and values discounted, is shown in Table 5-19.

Table 5-19: Summary of A66 Air Quality Impact Valuation (£m, at 2010 Market Prices, Discounted)

Air Quality Emission Aspect	Net 60-Year Air Quality Valuation
NOx (Damage Cost)	-2.744
NOx (Abatement Cost)	-0.000
PM2.5 (Damage Cost)	-6.995
Overall Impact	**-9.739**

5.7.13 The project has an overall adverse air quality impact of -£9.739m, comprising NOx damage and abatement cost of -£2.744m, and PM2.5 damage cost of -£6.995m.

Greenhouse Gases

5.7.14 The A66 appraisal includes a full 65-year 'whole-life' carbon assessment for the area of focus (construction period 2024 – 2028, plus operational period 2029 – 2088, inclusive). The conventional road user greenhouse gases impact is only a part of this assessment. The full carbon appraisal includes the following four aspects:

- Construction period non-road user impacts (2024 – 2028), associated with ground treatment and materials.
- Route maintenance and renewal non-road user impacts during the project lifetime (2029 – 2088), associated with transport of materials.
- Road user 'tailpipe' impacts during the project lifetime along the improved A66 (2029 – 2088), consisting of changes in greenhouse gases associated with traffic flows and vehicle speeds, (as measured using DEFRA Emissions Factors Toolkit, EFT v11.0, November 2021).
- Land use changes associated with the A66 NTP design during the construction and operation periods (2024 – 2088), which affect the carbon stock (features which can store and release carbon), whereby adverse impacts are offset by mitigation (sequestration).

5.7.15 The net outcome from the A66 improvement in equivalent tonnes of carbon released (tCO2e) is shown in Table 5-20.

Table 5-20: Tonnes of Carbon A66

Carbon Aspect	(tCO2e 000s, 2024 – 2088)
Construction (ground treatment and materials)	297
Maintenance and Renewal (transport of materials)	122
Road Use (Greenhouse Gas emissions)	2,083
Land Use Change (carbon storage and release)	223
Land Use Mitigation (carbon sequestration)	-146
Overall Impact	**2,578**

5.7.16 The project causes an adverse increase in carbon of 2.578m tCO2e, of which 2.205m tCO2e (85%) is non-traded, and 0.373m tCO2e (15%) is traded.

5.7.17 The monetary valuation of carbon impacts, at 2010 prices and values discounted, is shown in Table 5-21.

Table 5-21: Summary of A66 carbon Impact Valuation (£m, at 2010 Market Prices, Discounted)

	Tailpipe	Construction & Maintenance	Operating	Total
Non-Traded emissions	-147.886	-9.189	-16.837	-173.913
Traded emissions	-1.791	-26.343	-0.00	-28.134
Total value of emissions	-149.678	-35.532	-16.837	-202.047

5.7.18 The project has an overall adverse carbon impact of -£202.047m, of which -£28.134m (14%) is traded carbon and -£173.913m (86%) is non-traded carbon.

5.8 Accidents (Category A Impact)

5.8.1 Implications for the social welfare of users, in terms of road safety and accidents, are appraised using COBALT v2.2 for the project's area of focus and influence in the Core Scenario. The net impact, (equivalent to DS with-scheme accident costs subtracted from DM without-scheme accident costs), is summed over the 60-year economic appraisal period 2029 – 2088, inclusive and is converted to 2010 present year values and market prices, discounted.

5.8.2 Table 5-22 shows the number of accidents saved by introducing the A66 improvements. Over the 60-year appraisal period, the project saves 281 personal injury accidents, of which 7 (3%) are fatal, 58 (21%) are serious, and 216 (76%) are slight. Overall, the project saves 6,975 accidents, of which 281 (4%) involve personal injury and 6,694 (96%) are damage-only.

Table 5-22: Number of Accidents Saved (PIA & Damage-Only)

Accident Severity	Without Scheme (DM)	With Scheme (DS)	No. Accidents Saved
Fatal PIA	619	612	7
Serious PIA	4,912	4,854	58
Slight PIA	73,727	73,511	216
Sub-Total All PIA	79,258	78,977	281
Damage-Only	999,484	992,790	6,694
All Accidents	**1,078,742**	**1,071,767**	**6,975**

5.8.3 Each PIA could have multiple casualties. Therefore, Table 5-23 shows the number of casualties saved over the 60-year period. There is an overall reduction of 530 casualties, of which 3% are fatal, 28% are serious, and 69% are slight.

Table 5-23: Number of Casualties Saved

Casualty Severity	Without Scheme (DM)	With Scheme (DS)	No. Casualties Saved
Fatal Casualties	1,251	1,237	14
Serious Casualties	11,381	11,233	148
Slight Casualties	100,234	99,866	368
All Casualties	**112,866**	**112,336**	**530**

5.8.4 Accident reductions occur across the whole network as the increase flow on the improved A66 also removes traffic from other roads on the surrounding road network (such as rural links with a poorer safety record) therefore in total 14 fatalities, and 148 serious accidents are saved by the Project.

5.8.5 Table 5-24 and Table 5-25 shows a breakdown of the COBALT assessment on each scheme on the A66 corridor, and on each scheme section in terms of accidents and casualties. It should be noted that this analysis considers the impact of implementing the complete Project on each individual scheme section.

Table 5-24: Cobalt Assessment Results – Accidents Saved

Scheme		Personal Injury Accidents Saved	Fatal and Serious Accidents Saved
0102	M6 Junction 40 to Kemplay Bank	17	2
03	Penrith to Temple Sowerby	-1	6
0405	Temple Sowerby to Appleby	142	18
06	Appleby to Brough	86	17
07	Bowes Bypass	-17	1
08	Cross Lanes to Rokeby	-23	2
09	Stephen Bank to Carkin Moor	56	13
11	A1(M) Junction 53 Scotch Corner	-20	-2
All Schemes Total		**240**	**57**

Table 5-25: Cobalt Assessment Results – Casualties Saved

Scheme		Fatal Casualties Saved	Serious Casualties Saved	Slight Casualties Saved
0102	M6 Junction 40 to Kemplay Bank	0	3	23
03	Penrith to Temple Sowerby	2	13	9
0405	Temple Sowerby to Appleby	4	39	184
06	Appleby to Brough	5	36	129
07	Bowes Bypass	0	3	-17
08	Cross Lanes to Rokeby	1	4	-23
09	Stephen Bank to Carkin Moor	4	28	87
11	A1(M) Junction 53 Scotch Corner	0	-2	-25
All Schemes Total		**15**	**123**	**368**

5.8.6 Within the whole study area the Project saves 281 accidents over the 60 year period, resulting in 368 fewer casualties. 15 fatalities and 123 serious casualties are forecast to be saved on the new A66 Project sections.

5.8.7 However, as traffic flows on the whole A66 between Penrith and Scotch Corner also increases due to these improvements (including on the non-improved sections), PIA and casualty numbers on the non-improved sections will increase. This is shown in Table 5-26 and Table 5-27.The accident saving on the improved sections is greater than the increase in accidents on the non-improved sections, therefore a net saving of 9 fatalities and 83 serious injuries is forecast to occur.

Table 5-26: Cobalt Assessment Results – Accidents Saved

Scheme	Fatal and Serious	All Personal Injury
A66 Project Total	57	240
A66 Dual Carriageway Sections	-21	-320
A66 Total	**36**	**-80**

Table 5-27: Cobalt Assessment Results – Casualties Saved

Scheme	Fatal	Serious	Slight
A66 Project Total	15	123	368
A66 Dual Carriageway Sections	-6	-40	-409
A66 Total	**9**	**83**	**41**

Safety Valuation

5.8.8 The monetised valuation of accidents saved by the project is shown in Table 5-28, split by casualty, insurance, Police and property damage costs. Over the 60-year appraisal period, the total accident savings are £29.646m. These savings are derived in the following proportions: 85%

from casualty savings (36% fatal, 41% serious, and 8% slight), and 15% from associated cost savings (1% insurance, 13% property damage, and 1% Police).

Table 5-28: Safety Valuation (£m, at 2010 Market Prices, Discounted)

Cost Component	Without Scheme (DM)	With Scheme (DS)	Saving
Fatal Casualties	927.861	917.180	10.681
Serious Casualties	926.902	914.805	12.097
Slight Casualties	624.161	621.810	2.351
Sub-Total All Casualties	2,478.924	2,453.795	25.129
Insurance	23.550	23.401	0.149
Property Damage	872.287	868.151	4.136
Police	35.806	35.574	0.232
Total Cost	**3,410.567**	**3,380.921**	**29.646**

5.9 Journey Time Reliability (Category B Impact)

Journey Time Reliability Benefits by Time Period

5.9.1 Travel cost savings from the appraisal, by reliability aspect and by time period, are shown in Table 5-29. The overall 60-year total benefit of £272.204m is proportioned between time periods as follows: £25m (9%) in the weekday AM peak, £90m (33%) in the Inter Peak, £33m (12%) in the PM peak, £18m (7%) in the Off Peak, and £106m (39%) during the weekend.

Table 5-29: Reliability Benefits by Time Period (£m, at 2010 Market Prices, Discounted)

Aspect	AM Peak	Inter Peak	PM Peak	Off Peak	Week - end	Total
TTV (Daily Congestion & Incidents)	14.791	45.397	17.327	11.327	62.317	151.159
Incident Delays (A66 Route)	9.689	44.888	15.857	6.547	43.532	120.513
Incident Delays (Diversion Routes)	0.079	0.187	0.037	0.014	0.215	0.532
All Reliability Aspects	**24.559**	**90.472**	**33.221**	**17.889**	**106.064**	**272.204**

5.9.2 Table 5-30 shows the main split of reliability savings between travel time components is incident TTV of £151.057m and incident delay on A66 of £120m.

Table 5-30: Reliability Benefits by Time Period (£m, at 2010 Market Prices, Discounted)

	Daily Congestion	Incidents				Total
		Acci-dents	Break downs	Other	All Incident	
Travel Time Variability	0.102	145.644	1.871	3.542	151.057	151.159
Vehicle Delays (A66 Route)	-	105.304	8.839	6.370	120.513	120.513
Vehicle Delays (Diversion Routes)	-	0.454	0.059	0.019	0.532	0.532
All Travel Time Components	**0.102**	**251.402**	**10.769**	**9.931**	**272.102**	**272.204**

Reliability Benefits by Trip Purpose

5.9.3 The spread of user reliability savings between trip purposes is shown in Table 5-31. The overall 60-year total benefit of £272.204m is proportioned between trip purposes as follows: £125m (46%) amongst business users, and (£147m) 54% amongst commuter and other users.

Table 5-31: Reliability Benefits by Trip Purpose (£m, at 2010 Market Prices, Discounted)

Reliability Aspect	Business Users	Commuter & Other Users	All Users
TTV (Daily Congestion & Incidents)	71.811	79.348	151.159
Incident Delays (A66 Route)	52.697	67.816	120.513
Incident Delays (Diversion Routes)	0.231	0.301	0.532
All Reliability Aspects	**124.739**	**147.465**	**272.204**

5.9.4 The overall journey time reliability outcome is considered to be robust as:

- The MyRIAD width inputs for the DM existing single carriageway link sections are the most accurate available, because they are derived as the average of several, true width measurements along each A66 route section.
- MyRIAD includes adverse impacts of increased traffic and hence incidents (per million vehicle kilometres) on unchanged dual carriageway sections of the A66 and on upstream and downstream 'feeder' links.
- The MyRIAD model interprets single carriageway lane closure details from a dual carriageway road in the MyRIAD incident database (as there are no records for single carriageway incidents); this underestimates the severity of DM single carriageway incidents and their impact on TTV and vehicle delay; (NH data for the A66 shows that most single carriageway incidents entail a 2-way full road closure, which is not reflected in the MyRIAD assessment for single carriageways, because MyRIAD uses a dual carriageway incident database).

5.10 Wider Economic Impacts (Category B Impact)

5.10.1 The implications of improving the A66 for the wider economy are captured using WITA. The net wider economic impact, (equivalent to DM without-scheme welfare and GDP outcomes subtracted from DS with-scheme outcomes), is summed over the 60-year economic appraisal period 2029 – 2088, inclusive and is converted to 2010 present year values and market prices, discounted.

5.10.2 Monetised impacts assessed using WITA comprise the following:

- Business output change under imperfect market competition, (whereby reduced travel costs lead to market value of output greater than cost of production).
- Labour supply change, (whereby better transport access releases inactive workers into the labour market and provides tax revenue).

5.10.3 As indicated in section 3.16, the WITA inputs from the full extent of the A66TM are 'masked' to remove impacts outside the A66 area of focus and influence, where the accuracy of appraisal is proportionate but full-journey generalised costs of travel are less reliable (especially in larger urban areas).

5.10.4 The WITA masking procedure results in a more accurate assessment. It excludes origin to destination travel movements which are wholly outside (external to) the A66 NTP area of focus and influence. It thereby removes both exaggerated wider economic benefits and dis-benefits for road users.

5.10.5 Table 5-32 shows the overall 60-year WEI results, split be type of impact.

Table 5-32: Wider Economic Impact (£m, at 2010 Market Prices, Discounted)

	Road User Cost Item	Net Valuation
Business Output under Imperfect Market Competition	10% Uplift to business user benefit	47.759
	10% uplift to business reliability	12.474
	Total Business Output Change	60.233
	Labour Supply Change (Income Tax Revenue)	1.227
	All Wider Economic Impacts	**61.460**

5.10.6 Of the total A66 WEI benefit of £61.460m, 98.0% is associated with the increased value of business output under imperfect competition, through travel efficiency and reliability cost savings. The remainder of benefits, 2.0%, is derived through tax revenue from releasing inactive labour supply.

5.11 Route Resilience (Category C Impact)

5.11.1 Route resilience assessment for the A66 represents the potential for the road to recover to normal operating conditions and travel times, after an incident blockage and carriageway closure longer than 6 hours. The route resilience effects of the A66 improvement are assessed by testing carriageway closure scenarios in the SATURN traffic model (A66TM) and by monetising the resulting road user economic impacts in TUBA v1.9.17.2.

5.11.2 The carriageway incident closure scenarios are determined from recorded incident characteristics on the A66, over a 6-year period from 2014 to 2019, inclusive.

5.11.3 The net overall economic impact of the project on route resilience (DS scenario), compared with the existing situation (DM scenario), is calculated in terms of travel cost savings, in two steps as follows:

- Step 1 – Calculate net DS and DM cost of incidents:
  - Net DS cost of incidents:
    [DS without carriageway closure] – [DS with carriageway closure]
  - Net DM cost of incidents:
    [DM without carriageway closure] – [DM with carriageway closure]
- Step 2 – Calculate overall net incident cost saving:
  - Net incident cost saving:
    [Net DS travel cost of incidents] – [Net DM travel cost of incidents]

5.11.4 Here, two steps are required in the TUBA appraisal, because the incident closure frequencies and durations on the A66, (and hence the annualisation factors applied in TUBA), vary between the DM and DS scenarios, depending upon the carriageway layout of each route section. Here, the net DS cost and net DM cost of incidents are both negative values, because the travel cost during an incident closure, in terms of additional travel time and distance for diverted traffic, is greater than the travel cost in normal conditions.

5.11.5 The route resilience outcomes from TUBA are masked to be consistent with the appraisal of road user transport economic efficiency (TEE benefits), as outlined in section 4.7.

Route Resilience Benefits by A66 Link Section

5.11.6 The spread of travel cost savings amongst route sections during A66 carriageway incident closures is shown in Table 5-33.

Table 5-33: A66 Route Resilience Valuation (£m, at 2010 Market Prices, Discounted)

Description	With Scheme (DS)	Without Scheme (DM)	Saving
Penrith to Temple Sowerby	-0.189	-0.360	0.171
Temple Sowerby to Appleby	-0.086	-0.188	0.102
Appleby to Brough	-0.480	-1.685	1.206
Brough to Bowes	-9.627	-5.215	-4.413
Bowes Bypass	-0.378	-0.689	0.312
Rokeby to Stephen Bank	-0.122	-0.055	-0.067
Stephen Bank to Carkin Moor	-0.631	-1.481	0.850
Carkin Moor to Scotch Corner	-0.201	-0.101	-0.100
Total	**-9.774**	**-11.714**	**-1.939**

5.11.7 The overall route resilience outcome is -£1.939m over 60 years. The assessment clearly shows a positive travel cost saving, with the A66 improvement, on link sections 04, 06, 08, 10, and 14, associated with upgrading the existing single carriageway to dual carriageway and thereby mitigating, in future, the impact of historic road closures (mostly 2-way closures). On these existing single carriageways, the route resilience benfit amounts to £2.640m.

5.11.8 However, the overall outcome is significantly affected by future incident closures on the unchanged dual carriageway link sections 09, 13 and 15, especially between Brough and Bowes, which handle increased traffic flow in the DS compared with the DM. These unchanged route sections therefore experience a greater incident closure cost in the DS compared with the DM, amounting to -£4.580m.

5.11.9 Using the NH approach to assessing A66 route resilience, the appraisal underestimates likely travel cost savings with the improvement, because the method unrealistically assumes that all traffic can re-route away from the A66 during accidents and breakdowns, and that no vehicles are 'trapped' and delayed in a queue behind a single carriageway 2-way closure. This queue delay effect cannot be replicated in the SATURN traffic model.

5.11.10 In reality, the route resilience effect of the A66 project on travel costs associated with carriageway incident closures longer than 6 hours could be a positive benefit, similar to, but is likely to be less than, the journey time reliability outcome shown in MyRIAD for incidents shorter than 6 hours.

5.12 Network Resilience (Category C Impact)

5.12.1 Wider network resilience assessment for the A66 project represents the potential for other routes on the adjacent strategic and local road network to recover to normal operating conditions and travel times, after an incident blockage and carriageway closure longer than 6 hours. These routes could benefit from improvement of the A66, if the upgraded A66 provides a more dependable diversion route than it does now. The strategic and local network resilience effects of the A66 improvement are assessed separately by testing carriageway closure scenarios in the SATURN traffic model (A66TM) and by monetising the resulting road user economic impacts in TUBA v1.9.17.2.

5.12.2 The carriageway incident closure scenarios on the strategic road network are determined from recorded incident characteristics, over a 6-year period from 2014 to 2019, inclusive. Since no recorded incident data are available on local roads from the relevant highway authorities, the local network incident closure characteristics are derived from the MyRIAD 2021 incident database for typical road types.

5.12.3 Preliminary testing of road closures in the SATURN traffic model shows that there are two roads on the strategic network where the A66 improvement could have a quantifiable impact (more than negligible), namely:

- M6 between J31 Preston (A59) and J39 Shap (B6261).
- M62 between J21 Milnrow (A640) and J27 Gildersome (M621).

5.12.4 The impact of the A66 project on the strategic network resilience of these routes is summarised in section 5.12.6.

5.12.5 Similarly, there are four roads on the local network where the A66 improvement could have a quantifiable impact, namely:

- A688 east of Barnard Castle.
- A67 east of Barnard Castle.
- A67 west of Barnard Castle.
- A685 south of Brough (5 road sections).

5.12.6 The impact of the A66 project on the local network resilience of these roads is summarised in section 5.12.6.

5.12.7 The net economic effect of the A66 improvement on strategic and local network resilience (DS scenario), compared with the existing situation (DM scenario), is calculated in terms of travel cost savings, as follows:

- Net incident cost saving:
  [A66 DM with wider network closure] – [A66 DS with wider network closure]

5.12.8 Here, only one step is required in the TUBA appraisal, because the incident closure frequencies and durations on the wider strategic and local roads, (and hence the annualisation factors applied in TUBA), are the same in the DM and DS scenarios. The assessment assumes that the wider network carriageway layout remains unchanged, regardless of the A66 situation.

5.12.9 The strategic and local network resilience outcomes from TUBA are masked to be consistent with the appraisal of road user transport economic efficiency (TEE benefits), as outlined in section 4.7.

Strategic Network Resilience Benefits on M6 and M62

5.12.10 The share of travel cost savings amongst M6 and M62 strategic route sections, during carriageway incident closures is shown in Table 5-34.

Table 5-34: A66 Strategic Network Resilience Valuation (£m, at 2010 Market Prices, Discounted)

Road Section	Direction	Saving
M6 between Junctions 31 and 32	Northbound	1.004
M6 between Junctions 32 and 34	Two-Way	0.652
M6 between Junctions 32 and 34	Northbound	0.751
M6 between Junctions 32 and 34	Southbound	1.238
M6 between Junctions 34 and 36	Northbound	0.894
M6 between Junctions 34 and 36	Southbound	1.579
M6 between Junctions 36 and 37	Northbound	0.528
M6 between Junctions 36 and 37	Southbound	0.361
M6 between Junctions 37 and 38	Northbound	0.318
M6 between Junctions 37 and 38	Southbound	0.423
M6 between Junctions 38 and 39	Southbound	0.613
M62 Junctions 21 to 27	Two-Way	5.225
M62 Junctions 21 to 27	Eastbound	1.049
M62 Junctions 21 to 27	Westbound	2.877
Total All Route Sections		**17.513**

5.12.11 The overall strategic network resilience outcome is £17.513m over 60 years. Benefits are split evenly between the M6 route sections (47.7%) and the M62 route sections (52.3%). The assessment shows positive travel cost savings, with the A66 improvement, on all M6 and M62 modelled link sections, associated with making the A66 a more efficient and dependable diversion route.

Local Network Resilience Benefits on A688, A67 and A685

5.12.12 The distribution of travel cost savings amongst A688, A67 and A685 local routes, during carriageway incident closures is shown in Table 5-35.

Table 5-35: A66 Local Network Resilience Valuation (£m, at 2010 Market Prices, Discounted)

Description	Direction	Saving
A67 West	One-Way	0.024
A685 section 1	One-Way	0.014
A685 section 2	One-Way	0.095
A685 section 3	One-Way	0.025
A685 section 4	One-Way	0.009
A685 section 5	One-Way	0.047
A67 East	One-Way	0.048
A688	One-Way	0.070
A67 West	Two-Way	0.210
A685 section 1	Two-Way	0.148
A685 section 2	Two-Way	0.992
A685 section 3	Two-Way	0.270
A685 section 4	Two-Way	0.105
A685 section 5	Two-Way	0.541
A67 East	Two-Way	0.526
A688	Two-Way	0.788
Total All Route Sections		**3.911**

5.12.13 The overall local network resilience outcome is £3.911m over 60 years. Benefits are split amongst local roads as follows:

- A688 east of Barnard Castle 21.9%.
- A67 east of Barnard Castle 14.7%
- A67 west of Barnard Castle 6.0%
- A685 south of Brough 57.4%.

5.12.14 The assessment shows small positive travel cost savings, with the A66 improvement, on all local road modelled link sections, associated with making the A66 an easier and more dependable diversion route.

Overall Resilience Outcome

5.12.15 Drawing together the various resilience assessment results for the A66 route (-£1.939m), the strategic network (£17.513m), and the local network (£3.911m), the overall monetised outcome amounts to £19.485m.

5.13 Social, Environmental and Distributional Outcomes: (Category D Impact)

Overview

5.13.1 This section contains an outline summary of findings from the social, environmental and distributional impacts of the A66 NTP project. Where there is overlap in the appraisal aspects handled by different project disciplines, the findings have been drawn together as a single item.

5.13.2 The social outcomes for physical activity and journey quality are examined more fully in the Human Health report strands.

5.13.3 All accessibility effects (social and distributional) are subsumed into the appraisal of severance, which is also handled as a combined social and distributional outcome,

5.13.4 Affordability findings are assessed in distributional terms only,

5.13.5 The project has no meaningful effect on security or optional usage / non-usage values.

5.13.6 Environmental outcomes in respect of townscape, historic environment, biodiversity and water environment, are analysed in detail in the Environmental Assessment Report (alongside noise, air quality, greenhouse gases, and landscape).

5.13.7 Distributional effects are assessed through the TAG 3-step DIA procedure (screening, measuring criteria, deriving impact scores) and are summarised in the TAG DIA Screening Proforma and DIA Matrix.

Social Impacts

5.13.8 Table 5-22 contains a summary of the A66 social impacts for road users and communities.

Physical Activity

5.13.9 Physical activity outcomes are appraised qualitatively from the A66 Population and Human Health assessment. The results are summarised in the TAG ‘Physical Activity Impacts Worksheet (Basic)’ (January 2014), as shown in Table 5-36.

Table 5-36: A66 Physical Activity TAG Worksheet

TAG Physical Activity Impacts Worksheet (Basic)				
	Pedestrians (i)	**Cyclists (ii)**	**Equestrians and Others (iii)**	**Total**
Numbers affected (a)	Not Quantified	Not Quantified	Not Quantified	Not Quantified
Change in journey time in minutes (b)	Not Quantified	Not Quantified	Not Quantified	Not Quantified
Combined impact (c=a*b)	Not Quantified	Not Quantified	Not Quantified	Not Quantified
Reference Source				
A66 PCF Stage 3 Environmental Statement for DCO (Chapter 13 Population and Human Health) No reliable reference data available on movements of walkers, cyclists and horse riders, owing to COVID-19 pandemic impact which disrupted normal activities.				
Summary Assessment Score				
Slight Beneficial				
Qualitative Comments				
Potential slight increase in number of people walking and cycling on new, shared, active travel routes which run alongside the new A66 at Center Parcs (scheme 03), and Rokeby (scheme 08), and which run along the bypassed sections of existing A66, which are retained at Kirkby Thore / Crackenthorpe (schemes 04/05), Warcop / Langrigg (scheme 06), and Ravensworth / W and E Layton (scheme 09). There is no extra hindrance to people crossing the upgraded sections of the A66, because most tunnels or bridges are retained, and most at-grade crossings are substituted with new, safer, and more user-friendly grade-separated or signal-controlled arrangements.				

5.13.10 The overall project impact on physical activity is slight beneficial.

Journey Quality

5.13.11 Journey quality impacts are also appraised qualitatively from the A66 Population and Human Health assessment. The results are summarised in the TAG 'Journey Quality Impacts Worksheet' (January 2014), as shown in Table 5-37.

Table 5-37: A66 Journey Quality TAG Worksheet

TAG Journey Quality Impacts Worksheet				
Factor	**Sub-factor**	**Better**	**Neutral**	**Worse**
Traveller Care	Cleanliness		✓	
	Facilities		✓	
	Information	✓		
	Environment		✓	
Travellers' Views	-	✓		
Traveller Stress	Frustration	✓		
	Fear of potential accidents	✓		
	Route uncertainty	✓		
Reference Source				
A66 PCF Stage 3 Environmental Statement for DCO (Chapter 13 Population and Human Health)				
Summary Assessment Score				
Moderate Beneficial				
Qualitative Comments				
Predicted improvement in journey quality for road users on A66, because the project provides new dual carriageway sections where the layout is faster, safer and enables easier overtaking of heavy vehicles. The improvement offers a more consistent route standard and level of service along the A66 between Penrith and Scotch Corner. The project also provides safer grade-separated junctions for accessing the A66 and better lay-by facilities.				

5.13.12 The overall project impact on journey quality is moderate beneficial.

Security

5.13.13 The A66 improvement does not have a consequential effect on public transport, and so does not change conditions of security for transport users.

Accessibility

5.13.14 As the A66 project has no relevant or meaningful effects on public transport, accessibility to services is considered to be Neutral.

Affordability

5.13.15 The affordability impact of the A66 project is examined in the distributional impacts assessment.

Severance

5.13.16 The severance effects of the project on movements to and from important local services, facilities, amenities and activities are summarised in the TAG 'Severance Impacts Worksheet' (January 2014), as shown in Table 5-23. TAG guidance suggests that the severance appraisal should estimate the number of active road users (pedestrians and cyclists) who are affected in each location where there is a meaningful impact. However, as no reliable data are available on walking and cycling movements (owing to the COVID-19 pandemic impacts on travel patterns), local LSOA population figures have been used instead to estimate volumes of movement. This gives an indication of the difference in magnitude of impact between roads affected adversely and beneficially.

5.13.17 The most significant severance impacts are likely to occur on roads where there are trip attractors and resident populations nearby, which generate pedestrian and cyclist crossing movements, and where the road has a large existing daily traffic flow, which means that the ease and safety of crossing is more sensitive to a given percentage increase or decrease in traffic caused by the A66 improvement.

5.13.18 Severance effects are assessed for road links within the area of focus (where flow change is greater than ±10%), by relating the magnitude of flow change to the existing daily traffic volume and the presence of services, facilities and amenities. Qualitative grading is applied to the outcomes (on a 7-point scale), using the criteria shown in Table 5-38, (which are derived from Social Impact Appraisal guidance in Table 5.1 of TAG Unit 4.1, combined with land use and accessibility guidance in DMRB LA 112 – Population and Human Health).

Table 5-38: Qualitative Severance Impact (7-Point Scale) Relative to Existing Daily Flow and % Flow Change

With-Scheme % Change in Road Link Traffic Flow	**Without-Scheme Daily Traffic Flow (Indicates Road Sensitivity to Flow Change)**			
	Low	**Medium**	**High**	**Very High**
	>1,000 <4,000 AADT	**>4,000 <8,000 AADT**	**>8,000 <16,000 AADT**	**>16,000 AADT**
Substantial Fall (>25% decrease)	Moderate Beneficial	Moderate Beneficial	Large Beneficial	Large Beneficial
Slight Fall (>15% < 25% decrease)	Slight Beneficial	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Neutral (<15% increase or decrease)	Neutral	Neutral	Neutral	Neutral
Slight Rise (>15% <25% increase)	Slight Adverse	Slight Adverse	Moderate Adverse	Moderate Adverse
Substantial Rise (>25% increase)	Moderate Adverse	Moderate Adverse	Large Adverse	Large Adverse

5.13.19 The percentage flow change categories in Table 5-24 are chosen specifically for the A66, to reflect the scale of modelled changes in traffic volumes within the area of focus.

5.13.20 A ‘severance score’ is applied to the 7-point qualitative scale of impact for each road assessed, whereby:

- Large Adverse = [-3].
- Moderate Adverse = [-2].
- Slight Adverse = [-1].
- Neutral = [0].
- Slight Beneficial = [+1].
- Moderate Beneficial = [+2].
- Large Beneficial = [+3].

5.13.21 The ‘severance score’ for each road location is weighted by multiplying the score by the population affected.

5.13.22 Weighted severance scores are then summed across all locations, and then divided by the total affected population, to derive an average overall net severance score per resident (on a 7-point scale between -3, through 0 to +3).

5.13.23 There are no large, moderate, or slight severance effects (adverse or beneficial) on the A66 route, as there are no places where there is substantial change in traffic combined with the presence of nearby facilities and local population generating walking and cycling movements. All effects on the A66 route itself are neutral.

5.13.24 Across the area of focus, there are approximately 9,180 local residents in total, living adjacent to 10 road locations, who may be disadvantaged by a moderate adverse increase in severance. This impact is balanced by approximately 12,405 local residents in total, living adjacent to 10 road locations, who may gain from a moderate beneficial reduction in severance. Weighing these two contrasting impacts, the overall severance outcome for a total of of the project is neutral.

5.13.25 The findings are summarised in Table 5-39 which aligns with the TAG 'Severance Impacts Worksheet'.

Table 5-39: A66 TAG Severance Impacts Worksheet: Number of people affected in Local Population

Road Location	**Large Adv. [-3.0]**	**Mod. Adv. [-2.0]**	**Slight Adv. [-1.0]**	**Neutral [0.0]**	**Slight Bene. [+1.0]**	**Mod. Bene. [+2.0]**	**Large Bene. [+3.0]**
Penrith							
9. A592 Ullswater Road (N of M6J40 Skirsgill)		1917					
10. Clifford Road (E of 592 Ullswater Road)		2120					
11. A6 Bridge Lane (N of A66/A6/A686 Kemplay Bank)						3531	
14. Moor Lane (N of Clifton Dykes)						471	
Sub Total		4037				4002	
Temple Sowerby							
16. Wetheriggs (through Clfton Dykes)						1106	
22. B6412 Station Road (S of Culgaith)		452					
24. B6412 (E of A66 junction)		230					
Sub Total		682				1106	
Kirkby Thore							
28. Main Street (N of A66)						239	
29. Priest Lane (W of Kirkby Thore)						398	
Sub Total		0				637	
Brough & Kirkby Stephen							
38. Christian Head (W of Kirkby Stephen)						1329	
42. A685 (S of Church Brough)		1070					
Sub Total		1070				1329	
Bowes & Barnard Castle							
45. B6277 (S of Middleton In Teesdale)		1409					

Road Location	Large Adv. [-3.0]	Mod. Adv. [-2.0]	Slight Adv. [-1.0]	Neutral [0.0]	Slight Bene. [+1.0]	Mod. Bene. [+2.0]	Large Bene. [+3.0]
47. Road connecting Bowes with A67 (N of The St)		331					
48. The Street (through Bowes)						284	
50. B6277 (S of Barnard Castle)		1337					
Sub Total		3077				284	
Ravensworth & Melsonby							
56. Low Lane (N of Dalton)						382	
58. New Lane (N of Ravensworth)		48					
60. Stonygate Bank (S of Washton)						3463	
62. B6274 Forcett Lane (S of A66)		144					
69. B6274 (through Forcett)						1202	
Sub Total		192				5047	
Middleton Tyas							
74. Scotch Corner Roundabout (A66 / A1M J53)		122					
Sub Total		122				0	
All Roads		**9180**				**12405**	
Reference Source							
Census 2011 demographic data. Open Street Map locations of services, facilities and amenities.							
Summary Assessment Score							
Net Severance Score = [(9180 x -2.0) + (12405 x +2.0)] / 21585 = +0.3 = Neutral							
Qualitative Assessment							
There are no roads in the area of focus where the A66 severance impact is large adverse or large beneficial. There are 9,180 local residents, adjacent to 11 road links, who are disadvantaged by a moderate adverse increase in severance. They are balanced by 12,405 local residents, adjacent to 10 road links, who gain from a moderate beneficial decrease in severance. The overall severance outcome for a total of 21,585 residents is Neutral.							

5.13.26 Across 75 road locations within the area of focus, with a traffic flow change greater than ±10%, the total weighted net severance score is 5,246, (within a range between a possible maximum and minimum score of ±179,910, if every road location had a large-beneficial [+3], or large-adverse [-3], impact). Given the total affected population is 59,970, this gives an overall net severance score for the A66 area of focus of 0.09 per resident, which represents a neutral impact.

5.13.27 Across 75 affected road locations, 60% experience neutral impact, 19% slight or moderate adverse impact, and 21% slight or moderate beneficial impact.

5.13.28 Across 59,970 affected residents, 52% experience neutral impact, 22% slight or moderate adverse impact, and 26% slight or moderate beneficial impact.

Optional Usage / Non-Usage Value

5.13.29 The A66 improvement does not have a consequential effect on public transport, and so does not present any change to optional usage / non-usage value for transport users.

Social Impact Summary

5.13.30 The overall social impact of the project is summarised in Table 5-40.

Table 5-40: A66 Social Impact Assessment – Appraisal Summary Table (AST) Entry

Social Impact Aspect	Summary of A66 Outcomes	Quantitative Assessment	Qualitative Score (7-Point Scale)
Physical Activity	Potential slight increase in number of people walking and cycling on new, shared, active travel routes which run alongside the new A66 at Center Parcs (scheme 03), and Rokeby (scheme 08), and which run along the bypassed sections of existing A66, which are retained at Kirkby Thore / Crackenthorpe (schemes 04/05), Warcop / Langrigg (scheme 06), and Ravensworth / W and E Layton (scheme 09). There is no extra hindrance to people crossing the upgraded sections of the A66, because most tunnels or bridges are retained, and most at-grade crossings are substituted with new, safer, and more user-friendly grade-separated or signal-controlled arrangements.	Total distance of 33.1km of new dedicated walking, cycling and horse-riding routes along and across most of the new A66 sections, comprising: - 6.0km in Scheme 03. - 9.5km in Scheme 04/05. - 8.5km in Scheme 06. - 4.0km in Scheme 08. - 5.1km in Scheme 09.	Slight Beneficial
Journey Quality	Predicted improvement in journey quality for road users on A66, because the project provides new dual carriageway sections where the layout is faster, safer and enables easier overtaking of heavy vehicles. The improvement offers a more consistent route standard and level of service along the A66 between Penrith and Scotch Corner.	Not Applicable	Moderate Beneficial

Social Impact Aspect	Summary of A66 Outcomes	Quantitative Assessment	Qualitative Score (7-Point Scale)
	The project also provides safer grade-separated junctions for accessing the A66 and better lay-by facilities.		
Security	The project has no meaningful impact on public transport provision or use, and so it has no effect on the security of passengers.	Not Applicable	Neutral
Accessibility	The project has no meaningful impact on public transport provision or use, and so has not impact on access to services.	Not Applicable	Neutral.
Affordability	Overall, the road user expenditure impact of the A66 project (vehicle operating cost and toll charges), as assessed in TUBA, is strongly negative, representing a net road user disbenefit. However, this additional expense impact on affordability is only slight, as it is heavily outweighed by road user travel time savings by a factor of 6. VOC disbenefits are shared fairly evenly, amongst 5 income deprivation categories (quintiles) of LSOA, in the region of focus. As the disbenefits are shared fairly evenly, and while users may see the monetary cost, it is on the whole worth the additional expense due to the amount of time saved.	Masked total VOC and toll disbenefits are - £98.434m.	Slight Adverse
Severance	The TAG severance appraisal has considered those using non-motorised modes only. The severity of severance effects of the project are measured on roads in the area of focus where daily traffic flow changes exceed 10%, and they are scaled in terms of: – The existing daily traffic volume range. – The presence of nearby services, facilities, amenities and resident population, which generate pedestrian crossing movements. The severity of impact on each road (7-point scale from -3 through 0 to +3) is weighted by the size of local LSOA population to give a severance score. The overall weighted severance score across 75 road locations is 0.09 per resident, representing a neutral impact (> -1.0, < +1.0).	No roads have large adverse or large beneficial severance impacts. In terms of moderate adverse / beneficial outcomes: – Total 9,180 local residents, living near to 11 road locations, are disadvantaged by a moderate adverse severance increase. – Total of 12,405 local residents, living near to 10 road locations, gain from a moderate beneficial severance decrease.	Neutral
Optional Usage / Non-Usage Value	The project has no meaningful impact on public transport provision or use, and so it has no effect on people's perception of option value.	Not Applicable	Neutral

Environmental Impacts

5.13.31 Effects of the A66 project on the surrounding environment are analysed in a separate PCF Stage 3 Environmental Assessment Report and the accompanying TAG worksheets.

5.13.32 Table 5-41 provides a summary of the A66 environmental outcomes. It should be noted that current guidance from DfT is that the monetary valuation recorded within the AST table against greenhouse gases reflects the non-traded tailpipe emissions, therefore a value of -£147.886m is recorded within the AST, as oppossed to the 'whole-life' carbon assessment discussed in 5.7.14.

Table 5-41: A66 Environmental Impact Assessment: Appraisal Summary Table (AST) Entry

Aspect	Summary of A66 Outcomes	Quantitative Assessment Qualitative Score (7-Point Scale)
Noise	There are four residential properties that are predicted to exceed the criteria to be eligible for noise insulation under the Noise Insulation Regulations 1975. These are listed below: • Skirsgill Lodge, Redhills Lane, Redhills CA11 0DT • Cross Lanes Farm, Cross Lanes, Barnard Castle DL12 9RT • The Grove, Road Leading to The Grove, Rokeby DL12 9SA • Tack Room Cottage, Road Leading to The Grove, Rokeby DL12 9SA There are 10 significant beneficial effects predicted on noise sensitive non-residential receptors. These are listed below: • Brougham Institute (Community Facility), Brougham CA10 2AE • Kirkby Thore School, Priest Lane, Kirkby Thore CA10 1UU • St Michaels Church, Cross End, Kirkby Thore CA10 1UR • Methodist Church, Chapel Lane, Kirkby Thore CA10 1UH • Memorial Hall, Cross End, Kirkby Thore CA10 1XW • Play Area, Main Street, Kirkby Thore CA10 1XN • Disused Chapel, Crackenthorpe CA16 6AF • The Parish Hall, Newgate, Barnard Castle DL12 8NQ • St Marys Church, The Street, Rokeby DL12 9RY • The Old School (Community Facility), The Street, Rokeby DL12 9RY There are no significant adverse effects on noise sensitive non-residential receptors.	1,598 households are likely to experience an increase in daytime noise in the forecast year 597 households are likely to experience a decrease in daytime noise in the forecast year It is noted that the overall magnitude of noise reductions outweighs noise uplifts, giving a net environment benefit. This is caused by the A66 project bypassing properties on the existing route and encouraging traffic to divert on to the A66 from adjacent minor roads. Total NPV: £1.240m
Air Quality	There is an overall adverse impact on regional NOx and PM2.5 emissions as a result of the Proposed Scheme. This is due to an increase in capacity of the network and a	NOx damage and abatement cost -£2.744m.

Aspect	Summary of A66 Outcomes	Quantitative Assessment Qualitative Score (7-Point Scale)
	reduction in congestion as a result of the Proposed Scheme via carriageway widening, realignments and junction improvements. This makes the route more derisible over time and therefore increases the volume of traffic in the area. In relation to local air quality the significance of the construction phase and operational phase effects are both predicted to be not significant. Therefore, it is predicted the effects on air quality at human and ecological receptors would be not significant. More detail on the local air quality assessment can be found in the ES Chapter 5. No properties are being demolished as a result of this scheme. There are no AQMAs which are predicted to be affected by the Project There are no predicted exceedances of the annual mean NO2 objective with or without the Project in 2029 as NO2 concentrations are well below 40ug/m3. Local authority monitoring showed that roadside concentrations of annual mean NO2 in the Penrith area has exceeded the AQO between 2017-2019. This is predicted to be reduced below the AQO by 2029.	PM2.5 damage cost -£6.995m. Overall air quality cost -£9.739m

Greenhouse Gases (Whole-Life Carbon)	Due to predicted increase in traffic flows, the Project is estimated to cause an increase in 2,048,360 tCO_2e in non-traded emissions and an increase in 34,661 tCO_2e in traded emissions over 60 years. The Project opening year is 2029. Due to this, the emissions across relevant carbon budgets are as follows:
	- 5th Carbon Budget (1,725 $MtCO_2e$ over 2028-2032):
	  - Non-traded: 153,105 tCO_2e
	  - Traded: 1,808 tCO_2e
	- 6th Carbon Budget (965 $MtCO_2e$ over 2033-2038):
	  - Non-traded: 183,287 tCO_2e
	Traded: 2,504 tCO_2e
		-£147.886

Landscape	In the west, the character of the Eden valley is influenced by the last Ice age with its distinct glacial drumlin and esker features. The central area is typified by the character of the upland moor landscape within the North Pennines AONB and the moorland fringes and foothills are defined by its geology. To the east, the character is rural arable farming. Tranquillity is an important characteristic of the Eden Valley although tempered by the existing A66. Tranquillity and dark night skies are an important characteristic of the AONB, although this is affected in close proximity to the A66. The landscape has a strong cultural association with a Roman communication link and the Scotland and England border disputes. Landcover varies from the more intimate and settled fertile landscapes within the Eden Valley to the west and the settled mixed farmland in the east. These	Moderate Adverse

Aspect	Summary of A66 Outcomes	Quantitative Assessment Qualitative Score (7-Point Scale)
	landscapes contrast with the central remote open moorland landscape within the AONB. The project would result in incremental encroachment into the landscape of the North Pennines AONB and its setting. The widening of the A66 and off line options would potentially have a direct effect on the pattern, tranquillity, cultural and landcover aspects of the landscape. As a result of the scheme at year 15 there would be adverse permanent significant effects experienced by 10 visual receptors. The appraisal on landscape impacts measures residual impacts beyond year 15. The project would potentially result in moderate adverse change to the pattern, cultural and landcover aspects of the landscape within and in the setting to the North Pennines AONB, including the important Eden Valley to the west. The modification and new road infrastructure would form additional new elements impacting directly and indirectly on national, regional and locally valued features. Mitigation measures have been considered which look to avoid or reduce the negative effects of the project options on the landscape and or townscape resource and on the visual amenity of the study area.	
Townscape	The A66 Project has no meaningful impact on townscape.	Neutral
Historic Environment	Impacts on four types of heritage in the historic environment are assessed: scheduled monuments, listed buildings, registered park and garden (Rokeby), and non-designated heritage. The effects on each type of heritage are measured in respect of six aspects: form, survival, condition, complexity, context and period. The impacts on each type of heritage are appraised both inside and outside the A66 project boundary, with the following results: Inside A66 boundary (order limits)– Scheduled monuments - Moderate Adverse Listed Buildings - Neutral Registered park and garden - Neutral Non-designated heritage - Moderate Adverse Outside A66 boundary (within area of focus) – All heritage types - Neutral Overall Impact (inside and outside A66 boundary) - Slight Adverse	Moderate Adverse
Biodiversity	Several designated sites are located, in part or wholly, within the Order Limits of the Project. Important biodiversity features identified within the Order Limits included, but were not limited to, habitats of principal importance, 'important' hedgerows, bat roosts, otter holts and barn owl breeding sites.	Slight Adverse

Aspect	Summary of A66 Outcomes	Quantitative Assessment Qualitative Score (7-Point Scale)
	The construction phase will result in the permanent or temporary loss of all semi-natural habitats affected by construction. The largest areas of habitat removal will be of improved grassland, poor semi-improved grassland, arable land and woodland. Approximately 648ha of replacement habitats will be provided during the construction phase to mitigate for baseline habitat losses. The residual impact on habitats or principle important are slight adverse, with the exception of swamp habitat within the Stephen Bank to Carkin Moor scheme, where a significant adverse effect on swamp habitat is likely as a result of construction of the Project and the loss of this habitat cannot be fully mitigated through habitat creation. The majority of potential impacts affecting protected species/species of principal importance will arise during the construction phase, comprising habitat loss, fragmentation of habitats and populations, disturbance to species, habitat degradation and species injury and mortality. All species are subject to a slight adverse of neutral impact as a result of the Project, with the exception of barn owl, where there is a moderate adverse impact as obstacle planting is unable to be guaranteed to mitigate the increased collision risk. Operational impacts of the Project on biodiversity features will largely be limited to species injury and mortality and permanent fragmentation. Overall impact on Biodiversity is slight Adverse	
Water Environment	The assessment considers the Project's impacts upon the quality and quantity of surface watercourses, ponds, groundwater, groundwater to surface water interactions, abstractions and changes in flood risk and road drainage within the Order Limits and a 1km buffer of the Order Limits. The construction phase of the Project may result in permanent and temporary losses of quality and quantity of surface watercourses, groundwater and ponds, groundwater terrestrial ecosystems (GWDTEs) or changes to flood risk. With appropriate mitigation measures in place to prevent pollution from construction sources (including hydrocarbons, concrete and sediment) in normal and flood conditions, and embedded mitigation to manage surface water and dewatering activities, the residual impacts upon the water environment are slight adverse. During the operational phase of the Project, permanent losses to the quality or quantity of surface watercourses, groundwater and ponds, GWDTEs or changes to flood risk may occur. With embedded mitigation such as the design and installation of open span watercourse crossings or viaducts, design and installation of a drainage system and flood risk management measures (such as flood compensatory storage) and the avoiding of sensitive	Slight Adverse

Aspect	Summary of A66 Outcomes	Quantitative Assessment Qualitative Score (7-Point Scale)
	GWDTE habitats, residual impacts upon the water environment are slight adverse. Overall impact is slight adverse.	

Distributional Impacts

5.13.33 The share of A66 project outcomes amongst deprived and vulnerable groups in the area of focus, and the scale of these impacts, is analysed in a separate PCF Stage 3 Distributional Impacts Appraisal Report.

5.13.34 Table 5-42 and Table 5-43 provide a summary of the A66 distributional impact outcomes.

Table 5-42: A66 Distributional Impact Assessment

Distributional Indicator	Summary of Key impacts	7-Point Scale Impact
User Benefits	Road user travel cost impacts (travel time, VOC and user charges) are measured within the area of focus captured in the masked TUBA appraisal. The costs and savings are allocated to 5 income deprivation categories of LSOA in the region of focus (20% quintiles from 1, most deprived, to 5, least deprived). (Where LSOA are ranked from 1, with the highest % of income-deprived people, through to 5, with the lowest %) Overall, the travel cost impact of the A66 project is strongly positive, providing net road user benefits. Both road user benefits and disbenefits are shared similarly, and fairly evenly, amongst 5 income deprivation categories of LSOA in the region of focus. 50-60% of both benefits and disbenefits are in least deprived categories 4 and 5, and 25-35% of both are in most deprived categories 1 and 2. The proportion of disbenefits in categories 1 and 2 is slightly higher than the proportion of benefits. The converse is true in categories 4 and 5. The impact in categories 1 and 2 is amplified by these quintiles representing a higher-than-average proportion of the affected population (49% in total). However, a higher-than-average proportion of road user disbenefits (51%) are experienced by the least income deprived LSOA (categories 4 and 5). The distribution of qualitative net road user benefits score (2010) amongst income deprivation quintiles Q1 - Q5 is as follows: Q1 Slight Beneficial, Q2 Slight Beneficial, Q3 Moderate Beneficial, Q4 Large Beneficial, Q5 Moderate Beneficial.	Slight Beneficial
Noise	Severity of noise impact is gauged on a scale of dB increases and decreases, within the A66 corridor perimeter captured in the environmental assessment. There are no meaningful residential noise impacts for the most income deprived LSOA in the study area (category 1). There are day and night residential noise increases in income deprivation quintiles 2, 4 and 5, but decreases in quintile 3. Most noise disbenefit (96%) is experienced by the least income deprived LSOA (4 and 5). Noise impacts are therefore unevenly distributed but overall quite small. During both daytime and night-time, the distribution of qualitative noise impact scores amongst income deprivation quintiles Q1 – Q5 are: Q1 Neutral, Q2 Slight Adverse, Q3 Moderate Beneficial, Q4 Large Adverse, Q5 Moderate Adverse. There are minimal non-residential noise changes at locations used by vulnerable community members. Around 90% of facilities have negligible noise change. Of the remaining 10% of affected locations, about 8% experience noise decreases and 2% noise increases.	Moderate Adverse

Distributional Indicator	Summary of Key impacts	7-Point Scale Impact
Air Quality	Severity of air quality impact is measured on a scale of significant changes in NO_2 concentration (> +0.4ug/m^3, < -0.4ug/m^3) within the area of focus analysed in the environmental assessment. There are no meaningful air quality impacts for receptors in the most income deprived LSOA in the study area (category 1). There are NO_2 concentration increases for receptors in income deprivation quintiles 3, 4 and 5, but decreases in quintile 2. Most air quality disbenefit (93%) is experienced by receptors in the least income deprived LSOA (3, 4 and 5). Some 33% of air quality benefit is experienced by receptors in quintile 2. The distribution of qualitative air quality impact scores amongst income deprivation quintiles Q1 – Q5 are: Q1 Neutral, Q2 Large Beneficial, Q3 Large Adverse, Q4 Large Adverse, Q5 Large Adverse. There are 3 schools in Penrith, out of 18 schools in the study area, where a receptor within 200m distance shows a decline in air quality..	Moderate Adverse
Accidents	Accident impacts are measured for roads in the area of focus captured in the COBALT appraisal, where daily traffic flows change by >5% and by >50 vehicles per day. Overall, the accident impact of the A66 project is slightly positive, representing a net road user benefit. Amongst 6 vulnerable groups of road users and communities, the overall weighted score of positive accident impacts (52% on A66 and 56% in area of focus) balances that for negative impacts (48% on A66 and 44% in area of focus), giving a neutral outcome. The weighted scores for both beneficial and adverse accident impacts are evenly distributed amongst 6 vulnerable groups of road users and local communities, in both the A66 corridor and in the wider area of focus. There is no over-representation of accidents in any vulnerable group. For both the A66 corridor and the wider area of focus there is Neutral impact throughout for children <16, Young males 16-25, Older age 66+, Pedestrians, Cyclists, Motorcyclists.	Neutral
Personal Security	Initial screening indicates that the project has no meaningful impact on personal security.	Not Applicable
Accessibility	Initial screening indicates that the project has no meaningful impact on personal accessibility.	Not Applicable
Affordability	Affordability impacts are measured in terms of changes in distance-related vehicle operating costs within the area of focus captured in the masked TUBA appraisal. The VOC are allocated to 5 income deprivation categories of LSOA in the region of focus (20% quintiles from 1, most deprived, to 5, least deprived). Overall, the VOC impact of the A66 project is strongly negative, representing a net road user disbenefit. VOC disbenefits are shared fairly evenly, amongst 5 income deprivation categories of LSOA in the region of focus. 46% of disbenefits are in least deprived categories 4 and 5, and 39% are in most deprived categories 1 and 2. The disbenefit in categories 1 and 2 is amplified by these quintiles representing a higher-than-average proportion of the affected population (49% in total). The distribution of qualitative affordability score (2010) amongst income deprivation quintiles Q1 - Q5 is as follows: Q1 Slight Adverse, Q2 Moderate Adverse, Q3 Moderate Adverse, Q4 Large Adverse, Q5 Moderate Adverse.	Slight Adverse

Distributional Indicator	Summary of Key impacts	7-Point Scale Impact
Severance	Severance impacts are measured in terms of severity, for road links within the area of focus where daily traffic flow change is >10%, by relating the flow change to the existing daily traffic volume and the presence of nearby facilities and resident population, which generate pedestrian crossing movements. Weighted impact scores are calculated by factoring the 7-point severity score (-3, through 0, to +3) by the number of people in vulnerable groups (4 categories). There are no road links which experience a large beneficial or adverse severance effect for vulnerable groups. Moderate impacts are measured in 7 road locations: Penrith, Temple Sowerby, Kirkby Thore, Brough / Kirkby Stephen, Bowes / Barnard Castle, Ravensworth / W and E Layton, and Middleton Tyas. Across all locations in the area of focus, the weighted severance score by location, divided by the number of residents in each vulnerable group by location, summed, is small positive (> -1.0, < +1.0), amounting to: 0.09 per resident, for people aged <16 (neutral impact). 0.08 per resident, for people aged >70 (neutral impact). 0.07 per resident, for people with disabilities (neutral impact). 0.05 per resident, for people without a car (neutral impact). Overall, negative and positive severance effects are insubstantial and are balanced, giving a neutral outcome. Across 75 affected road locations, the spread of impacts is 19% slight or moderate adverse, 60% neutral, 21% slight or moderate beneficial. Across 59,970 affected residents, the spread of impacts is 22% slight or moderate adverse, 52% neutral, 26% slight or moderate beneficial.	Neutral

Table 5-43: A66 Distributional Impact Assessment Detail

Social group and amenities indicators			User benefits	Noise	Air quality	Accidents	Security	Severance	Accessibility	Affordability	Local Authority	England
Resident population in the impact area	Income Distribution quintiles	0-20%	29%	0%	0%				N/A	29%	20%	20%
		20-40%	20%	14%	10%				N/A	20%	20%	20%
		40-60%	15%	7%	2%				N/A	15%	20%	20%
		60-80%	17%	67%	58%				N/A	17%	20%	20%
		80-100%	18%	12%	29%				N/A	18%	20%	20%
	Children (<16)					19%	N/A		N/A		19%	20%
	Young people (16-25)					11%			N/A		11%	12%
	Older people (70+)					16%	N/A		N/A		16%	14%
	People with a disability						N/A		N/A		21%	18%
	Black Minority Ethnic						N/A		N/A		-	14%
	No car households								N/A		-	26%
	Households with dependent children								N/A		-	43%
	Indicator population		3,688,254	14,062	14,062	3,688,254	N/A		N/A	3,688,254	3,688,254	59,719,72
Amenities present within the impacted area	Schools/nurseries			18	18	N/A	N/A	□	N/A	N/A	-	-
	Playgrounds			13	13	N/A	N/A	-	N/A	N/A	-	-
	Parks and open spaces			10	10	N/A	N/A	□	N/A	N/A	-	-
	Hospitals			7	7	N/A	N/A	□	N/A	N/A	-	-
	Care homes/day centres			0	0	N/A	N/A	-	N/A	N/A	-	-
	Community centre			22	22	N/A	N/A	□	N/A	N/A	-	-

	Distributional impact of income Deprivation					Are the impacts evenly distributed?	Key Impacts – Qualitative Statements
	0-20%	20-40%	40-60%	60-80%	80-100%		
User Benefits	✓	✓	✓✓	✓✓✓	✓✓	No	There are overall net benefits for the scheme across all quintiles. The most deprived quintiles receive benefits that are below the predicted amount given the population by over 5%
Noise	-	×××	✓✓	×××	×××	No	Noise disbenefits from the intervention are experienced in all the quintiles in the study area except the third quintile. The largest impact is expected at the second most and least deprived income quintiles.
Air Quality (NO_2)	-	✓✓✓	×××	×××	×××	No	Air quality disbenefits from the intervention are experienced in all the quintiles in the study area except the second quintile. The largest adverse impact is expected at the three least deprived income quintiles.
Affordability	×	××	××	×××	××	No	Vehicle operating cost disbenefits are experienced in all quintiles in the study area. Disbenefits for the most deprived quintiles are over 5% less than what would be expected give the population
Accessibility	N/A	N/A	N/A	N/A	N/A	N/A	Scoped out of appraisal

AST entry

Impact	**Social Groups**							**User Groups**			Qualitative statement (including any impact on residential population AND identified amenities)
	Children and young people	Older people	Carers	Women	Disabled	BME	Pedestrians	Cyclists	Motorcyclists	Young males	
Noise	Neutral	Neutral									Distributional impacts from noise on children expected to be at schools, community centres, playgrounds and open areas are neutral as the majority of noise changes for these locations are classified as negligible and

											hence this is a neutral impact. The distributional impacts for the elderly in the study area at hospitals, care homes and community centres are also neutral although there are a number of locations with beneficial noise changes.
Air Quality	Neutral										Distributional impacts from air quality (NO2) on children expected to be at schools, community centres, playgrounds and open areas are neutral as the majority of air quality changes for these locations are classified as negligible and hence this is a neutral impact. The distributional impacts for the elderly in the study area at hospitals, care homes and community centres are also neutral although there are a number of locations with beneficial air quality changes.
Accidents	Neutral	Neutral					Neutral	Neutral	Neutral	Neutral	Proportions of accidents involving vulnerable groups is lower in each demographic than the national average, except for older people which is only marginally above the national average. The

											distributional impact on vulnerable user groups is expected to be
Security	N/A	N/A		N/A	N/A	N/A					Scoped out of appraisal
Severance	Neutral	Neutral	Neutral		Neutral						The increases and relief of severance across the vulnerable groups broadly balance outs and with a very slightly positive outcome in the impact areas overall, however, this is only marginally above zero.
Accessibility	N/A	N/A	N/A	N/A	N/A	N/A					Scoped out of appraisal

5.14 Summary of Monetised Economic Impacts – Core Scenario

5.14.1 Table 5-44 contains an overall summary of the economic impacts of the project in the Core Scenario. Economic outcomes are assessed at 2010 present year values and market prices, discounted.

Table 5-44: A66 NTP Core Scenario Economic Impact Summary (£m, at 2010 Market Prices, Discounted)

	Items	Sub-Totals	Totals
CATEGORY 'A' IMPACTS (Established Assessment)			
Transport Economic Efficiency			
Road Users (Travel Time, VOC, Charges)	521.097		
Public Finances (Indirect Tax)	79.129		
		600.226	
Construction			
Road Users (Travel Time, VOC, Charges)	-61.067		
Public Finances (Indirect Tax) & Greenhouse Gases	0.061		
		-61.006	
Safety			
Accidents	29.646		
		29.646	
Environment			
Noise	1.240		
Air Quality	-9.739		
Greenhouse Gases	-202.047		
		-210.546.	
Present Value of Benefits (PVB)			**358.320**
Public Accounts			
Capital Expenditure (Construction)	693.743		
Capital Expenditure (Operation & Maintenance)	56.919		
		750.662	
Operator Revenue (Normal Operation)	-0.112		
Operator Revenue (Construction)	-0.052		

	Items	Sub-Totals	Totals
		-0.164	
Present Value of Costs (PVC)			**750.498**
Net Present Value (PVB – PVC)			**-392.178**
Benefit to Cost Ratio (PVB / PVC)			**0.48**

	Items	Sub-Totals	Totals
CATEGORY 'B' IMPACTS (Evolving Assessment)			
Journey Time Reliability			
Road Users (Travel Time Variability)	151.159		
Road Users (Incident Delay)	121.045		
		272.204	
Wider Economic Impacts			
Business Output in Imperfectly Competitive Market - TUBA	47.759		
Business Output in Imperfectly Competitive Market - MyRIAD	12.474		
Labour Supply (Income Tax Revenue)	1.227		
		61.460	
Adjusted Present Value of Benefits (PVB)			**691.984**
Adjusted Net Present Value (PVB – PVC)			**-58.514**
Adjusted Benefit to Cost Ratio (PVB / PVC)			**0.92**

	Sub-Totals	Sub-Totals	Totals
CATEGORY 'C' IMPACTS (Indicative Assessment)			
Resilience (Road User Travel Time, VOC, Charges, Operator Revenue, Indirect Tax & Greenhouse Gases)			
A66 Route Resilience	-1.939		
Strategic Network Resilience	17.513		
Local Network Resilience	3.911		
		19.485	

Overall Core Scenario Economic Outcome

5.14.2 Combining the core scenario economic appraisal outcomes in the category ‘A’ established assessment, gives an initial PVB of £358.320m. This is offset by a PVC of £750.498m, giving a NPV of -£392.178m and an inital BCR of 0.48. When further outcomes are included from the Category ‘B’ evolving assessment, the adjusted PVB amounts to £791.984m. Offsetting this against the PVC of £750.498m, gives an adjusted NPV of -£58.514m and an adjusted BCR of 0.92.

6 Economic Appraisal Sensitivity Tests

6.1 Introduction

6.1.1 Sensitivity of the A66 NTP core scenario economic appraisal to changes in the underpinning assumptions is assessed in terms of the following aspects:

- Impact on road user benefits of changing from the Core Scenario future year forecast travel patterns in the SATURN traffic model, to Low and High growth scenarios, holding constant all other scheme benefits and dis-benefits.
- Impact on public accounts cost of changing from the Most Likely capital expenditure, within the probability distribution of the range estimate, to Minimum and Maximum costs.

6.1.2 The test for sensitivity to road user benefits (PVB), uses only the Most Likely project cost (PVC).

6.1.3 The test for sensitivity to public account cost (PVC), uses only the Core scenario benefit (PVB) outcome.

6.2 PVB Sensitivity to Forecast Traffic Growth

6.2.1 The present value of benefit (PVB), in terms of road user transport economic efficiency, is sensitive to the future year traffic growth which is assumed in the Core scenario. Potential variation to the PVB is therefore assessed for Low and High traffic growth forecasts as represented in the A66 transport model.

6.2.2 Predicted Low and High PVB outcomes by journey purpose, compared against the Core scenario (Most Likely PVB), are shown in Table 6-1. Outcomes are for the 60-year appraisal period 2029 – 2088, at 2010 market prices and values, discounted.

Table 6-1: Road User Economic Efficiency Low / High Sensitivity by Journey Purpose during Normal Operation (£m, at 2010 Market Prices, Discounted)

	Core Scenario	Low Scenario	High Scenario
Business Users	477.589	399.161	518.731
Commuter Users	24.638	18.192	28.576
Other Users	18.870	-0.808	19.243
All Users	521.097	416.545	566.550

6.2.3 Road user outcomes by user class are shown similarly in Table 6-2.

Table 6-2: Road User Economic Efficiency Low / High Sensitivity by Vehicle Class during Normal Operation (£m, at 2010 Market Prices, Discounted)

Vehicle Type	Core Scenario	Low Scenario	High Scenario
Car Users	388.823	311.358	412.474
LGV Users	41.592	33.958	48.431
HGV Users	90.681	71.230	105.645
All Users	521.097	416.545	566.550

6.2.4 The road user benefit sensitivity results in Tables 6.1 and 6.2 indicate that the core scenario outcome reduces by 20.1% with Low traffic growth and increases by 8.7% with High traffic growth. The asymmetric result is caused by network congestion on some of the routes leading to the A66 within the high scenario limiting the ability of the Project to be used efficiently by the additional traffic. These routes are used by traffic accessing the scheme, therefore the some disbenefit will arise within the high scenario of congestion on these routes caused by additional A66 traffic.

6.2.5 Sensitivity of wider public finances to forecast traffic growth (operator revenue and indirect tax revenue) is summarised in Table 6-3.

Table 6-3: Wider Public Finance Low / High Sensitivity by Journey Purpose during Normal Operation (£m, at 2010 Market Prices, Discounted)

Journey Purpose	Core Scenario	Low Scenario	High Scenario
Business Users	32.345	29.079	34.464
Commuter Users	11.344	10.211	11.953
Other Users	35.440	38.016	37.393
All Users	79.129	77.306	83.810

6.2.6 The TEE wider public finance sensitivity results in Table 6.3 show that the core scenario impact reduces by 2.3% with Low traffic growth and increases by 5.9% with High traffic growth.

Summary of Monetised Economic Impacts – Low and High Traffic Growth

6.2.7 Table 6-4 contains an overall summary of the comparative economic impacts of the A66 NTP project, under Core, Low and High PVB sensitivity scenarios, assuming a Most Likely PVC (central estimate capital expenditure with most likely operation and maintenance expenditure).

Table 6-4: A66 NTP Low / High PVB Sensitivity Economic Impact Summary (with Core Scenario PVC)

	Core Scenario	Low Growth Scenario	High Growth Scenario
CATEGORY 'A' IMPACTS (Established Assessment)			
Transport Economic Efficiency			
Road Users (Travel Time, VOC, Charges)	521.097	416.545	566.550
Public Finances (Indirect Tax)	79.129	77.306	83.810
	600.226	493.851	650.360
Construction (Core Scenario)			
Road Users (Travel Time, VOC, Charges)	-61.067	-61.067	-61.067
Public Finances (Indirect Tax) & Greenhouse Gases	0.061	0.061	0.061
	-61.006	-61.006	-61.006
Safety (Core Scenario)			
Accidents	29.646	29.646	29.646
Environment (Core Scenario)			
Noise	1.240	1.240	1.240
Air Quality	-9.739	-9.739	-9.739
Greenhouse Gases	-202.047	-202.047	-202.047
	358.320	251.945	408.454
Present Value of Benefits (PVB)	358.320	251.945	408.454
Public Accounts			
Capital Expenditure (Construction)	693.743	693.743	693.743
Capital Expenditure (Operation & Maintenance Core Scenario)	56.919	56.919	56.919
	750.662	750.662	750.662
Operator Revenue (Normal Operation)	-0.112	-0.128	-0.053
Operator Revenue (Construction Core Scenario)	-0.052	-0.052	-0.052
	-0.164	-0.180	-0.105
Present Value of Costs (PVC)	**750.498**	**750.482**	**750.557**
Net Present Value (PVB – PVC)	-392.178	-498.536	-342.103
Benefit to Cost Ratio (PVB / PVC)	0.48	0.34	0.54

	Core Scenario	Low Growth Scenario	High Growth Scenario
CATEGORY 'B' IMPACTS (Evolving Assessment)			
Journey Time Reliability (Core Scenario)			
Road Users (Travel Time Variability)	151.159	151.159	151.159
Road Users (Incident Delay)	121.045	121.045	121.045
	272.204	272.204	272.204
Wider Economic Impacts (Core Scenario)			
Business Output in Imperfectly Competitive Market - TUBA	47.759	39.916	51.873
Business Output in Imperfectly Competitive Market - MyRIAD	12.474	12.474	12.474
Labour Supply (Income Tax Revenue)	1.227	1.227	1.227
	61.460	53.617	65.574
Adjusted Present Value of Benefits (PVB)	691.984	585.609	742.118
Adjusted Net Present Value (PVB – PVC)	-58.514	-164.872	-8.439
Adjusted Benefit to Cost Ratio (PVB / PVC)	0.92	0.78	0.99

6.2.8 Comparison of the Core scenario economic appraisal outcome (initial BCR 0.48 and adjusted BCR 0.92) against the PVB sensitivity scenarios, shows a drop in the initial BCR to 0.34 and the adjusted BCR to 0.78, in the Low scenario, but a rise in the initial BCR to 0.54 and the adjusted BCR to 0.99, in the High scenario.

6.3 PVC Sensitivity to Project Expenditure

6.3.1 The present value of cost (PVC), in terms of public account expenditure, is sensitive to the point estimate (within the cost probability range) which is assumed in the Core scenario (Central Estimate for capital expenditure and Most Likely Estimate for operation and maintenance expenditure). Potential variation to the PVC is therefore assessed for Minimum and Maximum points within the cost probability range as represented in the NH A66 cost estimation model.

6.3.2 Predicted Minimum and Maximum PVC outcomes by expenditture item, for the A66 Project, compared against the Core scenario (Central / Most Likely PVC), are shown in Table 6-5. Outcomes are for the 60-year appraisal period 2029 – 2088, at 2010 market prices and values, discounted.

Table 6-5: Public Account Expenditure Minimum / Maximum Sensitivity by Cost Item during Normal Operation (RDP Central Estimate, £m, at 2010 Market Prices, Discounted)

	Central Estimate	Minimum Estimate	Maximum Estimate
Preparation	56.624	33.626	94.107
Supervision	14.780	7.289	26.199
Construction Works	556.502	386.529	772.375
Land	65.837	34.306	84.080
Operation & Maintenance*	56.919	28.351	85.715
Total Expenditure	**750.662**	**490.101**	**1,062.477**
***** Operation and Maintenance cost is most likely			

6.3.3 The public expenditure sensitivity results indicate that the core scenario expenditure reduces by 34.7% with the minimum cost estimate and increases by 41.5% with the maximum cost estimate.

Summary of Monetised Economic Impacts – Minimum and Maximum Expenditure

6.3.4 Table 6-6 contains an overall summary of the comparative economic impacts of the A66 NTP project, under Core, Minimum and Maximum PVC sensitivity scenarios, assuming a Most Likely PVB (core scenario central case traffic growth).

Table 6-6: A66 NTP Minimum / Maximum PVC Sensitivity Economic Impact Summary (£m, at 2010 Market Prices, Discounted)

	Most Likely Cost	Minimum Cost	Maximum Cost
CATEGORY 'A' IMPACTS (Established Assessment)			
Transport Economic Efficiency (Core Scenario)			
Road Users (Travel Time, VOC, Charges)	521.097	521.097	521.097
Public Finances (Indirect Tax)	79.129	79.129	79.129
	600.226	600.226	600.226
Construction (Core Scenario)			
Road Users (Travel Time, VOC, Charges)	-61.067	-61.067	-61.067
Public Finances (Indirect Tax) & Greenhouse Gases	0.061	0.061	0.061
	-61.006	-61.006	-61.006
Safety (Core Scenario)			
Accidents	29.646	29.646	29.646
Environment (Core Scenario)			
Noise	1.240	1.240	1.240
Air Quality	-9.739	-9.739	-9.739
Greenhouse Gases	-202.047	-202.047	-202.047
Present Value of Benefits (PVB Core Scenario)	358.320	358.320	358.320
Public Accounts			
Capital Expenditure (Construction)	693.743	461.750	976.761
Capital Expenditure (Operation & Maintenance Core Scenario)	56.919	28.351	85.715
	750.662	490.101	1,062.477
Operator Revenue (Normal Operation)	-0.112	-0.112	-0.112
Operator Revenue (Construction Core Scenario)	-0.052	-0.052	-0.052
	-0.164	-0.164	-0.164
Present Value of Costs (PVC)	**750.498**	**489.937**	**1,062.313**
Net Present Value (PVB – PVC)	-392.178	-131.617	-703.992
Benefit to Cost Ratio (PVB / PVC)	0.48	0.73	0.34

	Most Likely Cost	Minimum Cost	Maximum Cost
CATEGORY 'B' IMPACTS (Evolving Assessment)			
Journey Time Reliability (Core Scenario)			
Road Users (Travel Time Variability)	151.159	151.159	151.159
Road Users (Incident Delay)	121.045	121.045	121.045
	272.204	272.204	272.204
Wider Economic Impacts (Core Scenario)			
Business Output in Imperfectly Competitive Market - TUBA	47.759	47.759	47.759
Business Output in Imperfectly Competitive Market - MyRIAD	12.474	12.474	12.474
Labour Supply (Income Tax Revenue)	1.227	1.227	1.227
	61.460	61.460	61.460
Adjusted Present Value of Benefits (PVB)	691.984	691.984	691.984
Adjusted Net Present Value (PVB – PVC)	-58.514	202.047	-370.328
Adjusted Benefit to Cost Ratio (PVB / PVC)	**0.92**	**1.41**	**0.65**

6.3.5 Comparison of the Core scenario economic appraisal outcome (initial BCR 0.48 and adjusted BCR 0.92) against the PVC sensitivity scenarios, shows a rise in the initial BCR to 0.73 and the adjusted BCR to 1.41, in the Minimum cost scenario, but a drop in the initial BCR to 0.34 and the adjusted BCR to 0.65, in the Maximum cost scenario.

7 Summary and Conclusion

7.1.1 The economic appraisal of the A66 NTP project, at NH PCF Stage 3, is undertaken in line with best-practice guidance from HM Government (DfT TAG, and Treasury Green Book). It provides analysis of the most likely traffic conditions and economic outcomes associated with this highway project, and its component schemes, (in a Core scenario appraisal). It presents economic, social and environmental impacts in an appropriate hierarchy of monetised, quantitative, and qualitative outcomes, whereby most weight is attributed to the most robust and established strands of the appraisal.

7.1.2 Results from the economic assessment over 60 years, from 2029 (project opening) to 2088, at 2010 prices and values, discounted, show that (when compared to a situation without the investment) the project will provide substantial and worthwhile welfare benefits (£629.872m) to road users and wider public finances, in terms of:

- £521.097m of economic efficiency gains (through easier and faster journeys).
- £29.646m of safety gains (through reduced accident costs).
- £79.190m of indirect tax revenue uplift for public accounts.

7.1.3 These benefits are offset by considerable disbenefits to the environment and to road users during project construction (-£252.701m), in terms of:

- -£210.546m of environmental costs (principally whole-life carbon impact).
- - £61.067m of economic efficiency losses (through slower journeys during roadworks).

7.1.4 They are also compared to the large additional capital, operation and maintenance expenditure requirements from public finances (-£750.498m), which are exaggerated by the proposed earlier implementation of the A66 improvements (‘Project Speed’), in terms of:

- -£693.743m of capital costs (central estimate).
- -£56.919m of operation and maintenance costs (most likely estimate).
- Offset by £0.164m of increased toll operator revenue for Government.

7.1.5 These economic impacts give an initial Benefit to Cost Ratio (BCR) of 0.48 (PVB £358.320m / PVC £750.498m).

7.1.6 Adjustments are made to the initial BCR appraisal to take account of other evolving monetised impact assessments. These additional assessments show considerable further welfare benefits to road users and the wider economy (£333.664m), in terms of:

- £272.204m of journey time reliability gains (through more predictable and less variable travel times during congestion and incidents).
- £61.460m of business output and labour supply gains in the wider economy (through overcoming market failures and distortions by improving transport connectivity).

7.1.7 These economic impacts give an uplifted adjusted Benefit to Cost Ratio (BCR) of 0.92 (PVB £691.984m / PVC £750.498m).

7.1.8 Although the adjusted BCR is less than 1 it is compensated by the following:

- Moderate beneficial improvement in journey quality (through a more consistent A66 route standard and better level of service).
- Slight beneficial improvement in physical activity (through providing 33.1km of new walking and cycling facilities).
- Neutral severance impact (and traffic relief for other strategic roads), despite significant increases in traffic volumes along the A66.
- £19.485m of potential extra road user benefits from improved resilience to adverse incident impacts on the A66 route, and on the wider strategic and local road network.

7.1.9 The monetised economic outcomes are set alongside qualitative assessments of other social, environmental, and distributional impacts, which mainly consist of:

- Neutral effect on personal security, as the project causes no meaningful changes to public transport provision or use, but does provide an additional 4 CCTV installations and 18 emergency roadside telephones along the A66.
- Slight adverse effect on affordability, because the project worsens vehicle operating costs for road users by -£98.272m.
- Slight beneficial noise impact for households within the A66 assessment boundary (valued at £1.240m).
- Moderate adverse air quality impact (valued at -£9.739m).

7.1.10 The distribution of A66 project outcomes amongst vulnerable and deprived people in the community is not large with no appraisal aspects showing a large adverse or large beneficial distributional impact. The outcomes are summarised as follows:

- Slight beneficial distribution of road user benefits.
- Moderate adverse distribution of noise impacts.
- Moderate adverse distribution of air quality impacts.
- Neutral distribution of accident impacts.
- Slight adverse distribution of affordability impacts.
- Neutral distribution of severance impacts.

7.1.11 The core scenario appraisal findings are sensitive to changes in predicted future traffic growth and to changes public expenditure estimates for project construction, operation and maintenance, in particular:

- The core scenario adjusted BCR (0.92) falls to 0.78 with Low traffic growth, and rises to 0.99 with High traffic growth.

The core scenario adjusted BCR (0.92) rises to 1.41 with Minimum estimated expenditure, and falls to 0.65 with Maximum estimated expenditure.

A Distributional Analysis Screening Proforma

Distributional Impact Appraisal Screening Proforma

Scheme description:
A66 Northern Trans-Pennine Project - [PCF Stage 3 Preliminary Design for DCO Application].
This National Highways project improves the A66 corridor between the M6 (J40) at Penrith and the A1(M) (J53) at Scotch Corner, by upgrading the remaining six sections of A66 single carriageway to dual carriageway standard, and enhancing the junctions at M6 J40 Skirsgill / A6 Kemplay Bank and A1(M) J53 Scotch Corner, at each end of the route.
The A66 NTP project improves highway capacity and traffic speeds, reliability of the strategic network, road safety, and ease of movement for vehicles and active road users, with managed impact on the environment. The project objectives are:
- Supporting economic growth, by assisting the Northern Powerhouse agenda, and by improving national connectivity including freight, access for tourism, and access for local services and jobs.
- Improving transport in terms of: road safety, journey time reliability for road users, promoting A66 as a strategic connection for all traffic, resilience of the route to the impact of events such as incidents, roadworks and severe weather events, and NMU provision along the route.
- Benefiting local communities by reducing the impact of the route on severance.
- Maintaining the environment by minimising adverse impacts and where possible optimising environmental improvement opportunities.

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
User benefits	The TUBA user benefit analysis software or an equivalent process has been used in the appraisal; and/or the value of user benefits Transport Economic Efficiency (TEE) table is non-zero.	TUBA outputs give positive TEE impacts, and indicate a net user benefit, but some areas may experience disbenefit. Bus/coach benefits require further assessment.	User benefits are spread over a wide geographic area and many socio-economic groups.	Yes.
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Changes in traffic flows indicate there may be potential noise impacts.	Outputs for environmental assessment will not be available to be included in this report and assessment has been undertaken at the previous stage.	Yes.
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV content: • Change in 24 hour AADT of 1000 vehicles or more • Change in 24 hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or more • Change in peak hour speed of 20kph or more • Change in road alignment of 5m or more	Changes in traffic flows indicate there may be potential air quality impacts.	Outputs for environmental assessment will not be available to be included in this report and assessment has been undertaken at the previous stage.	Yes. A detailed DI assessment should be carried out across a refined study area.
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	CONBALT outputs give positive safety impacts, and indicate a net user benefit, but some roads in the area of focus may experience disbenefit.	User benefits are spread across the area of focus and many vulnerable groups.	Yes. A detailed DI assessment should be carried out across the area of focus.
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	No.	The proposed scheme does not include any changes to public transport waiting or interchange facilities.	No.
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	Changes in traffic flows indicate there could be potential severance impacts.	No severance effects are expected following the implementation of the proposed scheme. All existing facilities (such as foot bridges) will be retained. Increased flow on some assessment links	Yes. Core analysis should be carried out across a refined study area.
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & re-location of a school).	No.	The proposed scheme does not affect the provision or location of transport facilities and hence access to transport is unaffected.	No.
Affordability	In cases where the following charges would occur; Parking charges (including where changes in the allocation of free or reduced fee spaces may occur); Car fuel and non-fuel operating costs (where, for example, rerouting or changes in journey speeds and congestion occur resulting in changes in costs); Road user charges (including discounts and exemptions for different groups of travellers); Public transport fare changes (where, for example premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or Public transport concession availability (where, for example concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority[1]).	Vehicle operating costs and user charges have been identified as having a potential impact on personal affordability	Vehicle operating costs and user charges are spread over a wide geographic area and many socio-economic groups	Yes. A detailed assessment should be carried out across a refined study area.

B Socio Economic Profiling

B.1 Socio Economic Profiling

7.1.12 Figure 7-1 to Figure 7-9 show population distributions mapped in GIS covering the study region of focus. Mapping is based on Lower Super Output Area (LSOA) level disaggregation of 2011 Census and other National Statistics data. For the purposes of comparison, LSOA data values are compared against the corresponding region of focus value, with the exception of income domain, in which ranking is based on the national profile.

7.1.13 The figures include:

- Figure 7-1: Proportion of Children (aged under 16 years) compared to the RoF average (2020).
- Figure 7-2: Proportion of Young People (aged 16-25) compared to the RoF average (2020).
- Figure 7-3: Proportion of Young Males (aged 16-24) in comparison to the RoF average (2020).
- Figure 7-4: Proportion of Older People (aged 70 and over) in comparison to the RoF average (2020).
- Figure 7-5: Proportion of Black Minority Ethnic Population in comparison to Local Authority average – Census 2011.
- Figure 7-6: Proportion of Non-Car Households in comparison to Local Authority average – Census 2011.
- Figure 7-7: Proportion of Households with a Disabled Person – Census 2011.
- Figure 7-8: Proportion of Households with Dependent Children – Census 2011.
- Figure 7-9: Income Deprivation by LSOA (Indices of Deprivation 2019).

Figure 7-1: Proportion of Children (aged under 16 years) compared to the RoF average (2020)

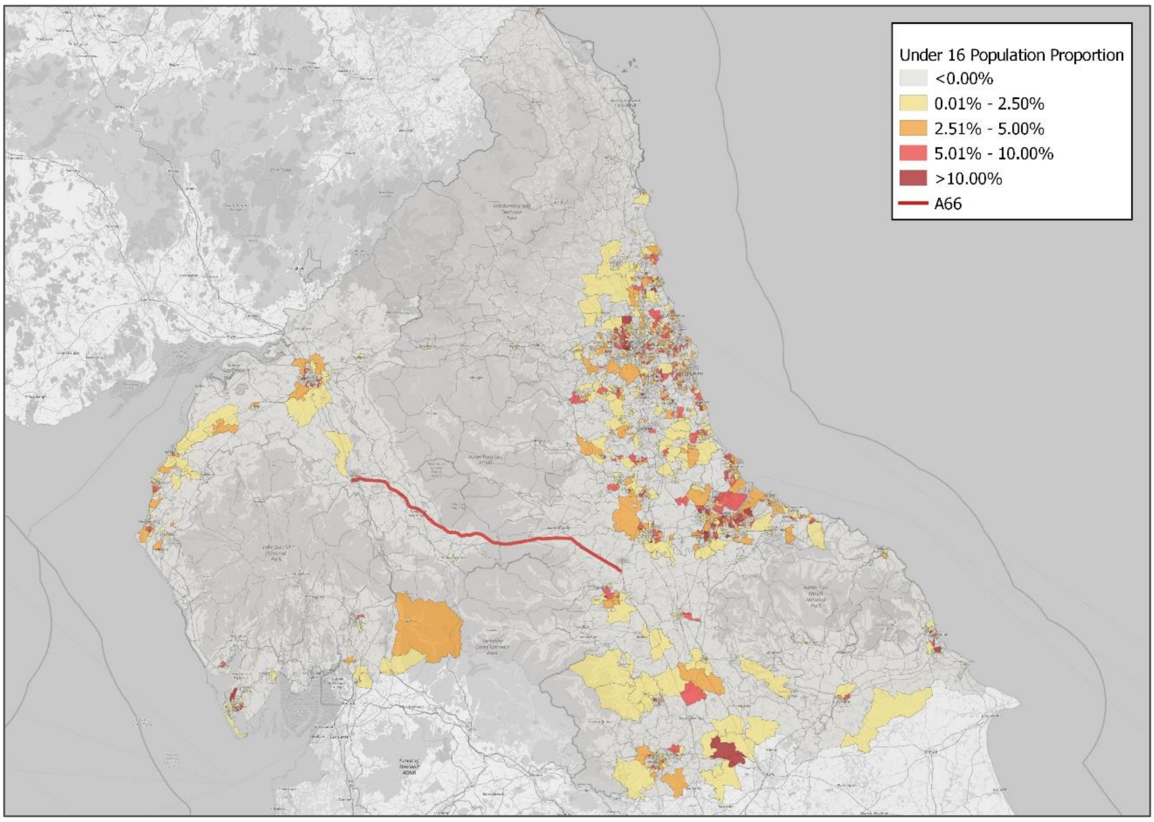


Figure 7-2: Proportion of Young People (aged 16-25) compared to the RoF average (2020)

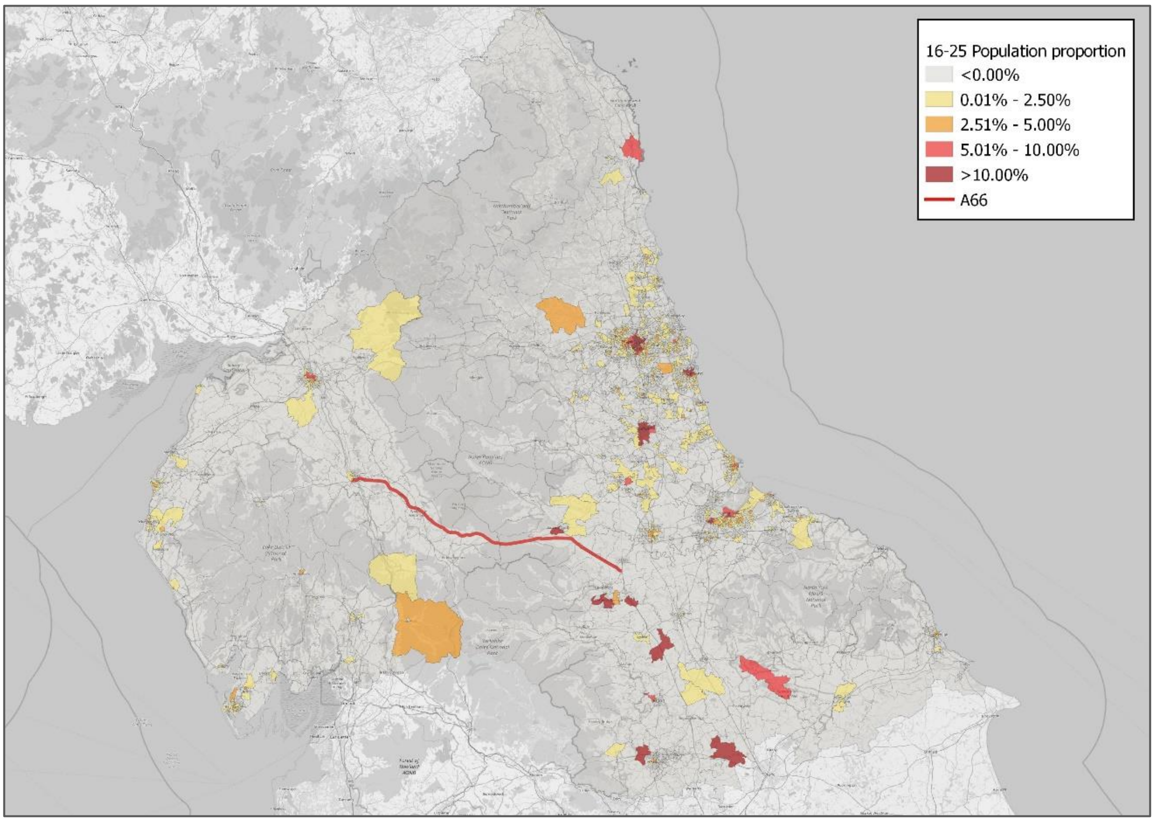


Figure 7-3: Proportion of Young Males (aged 16-24) in comparison to the RoF average (2020)

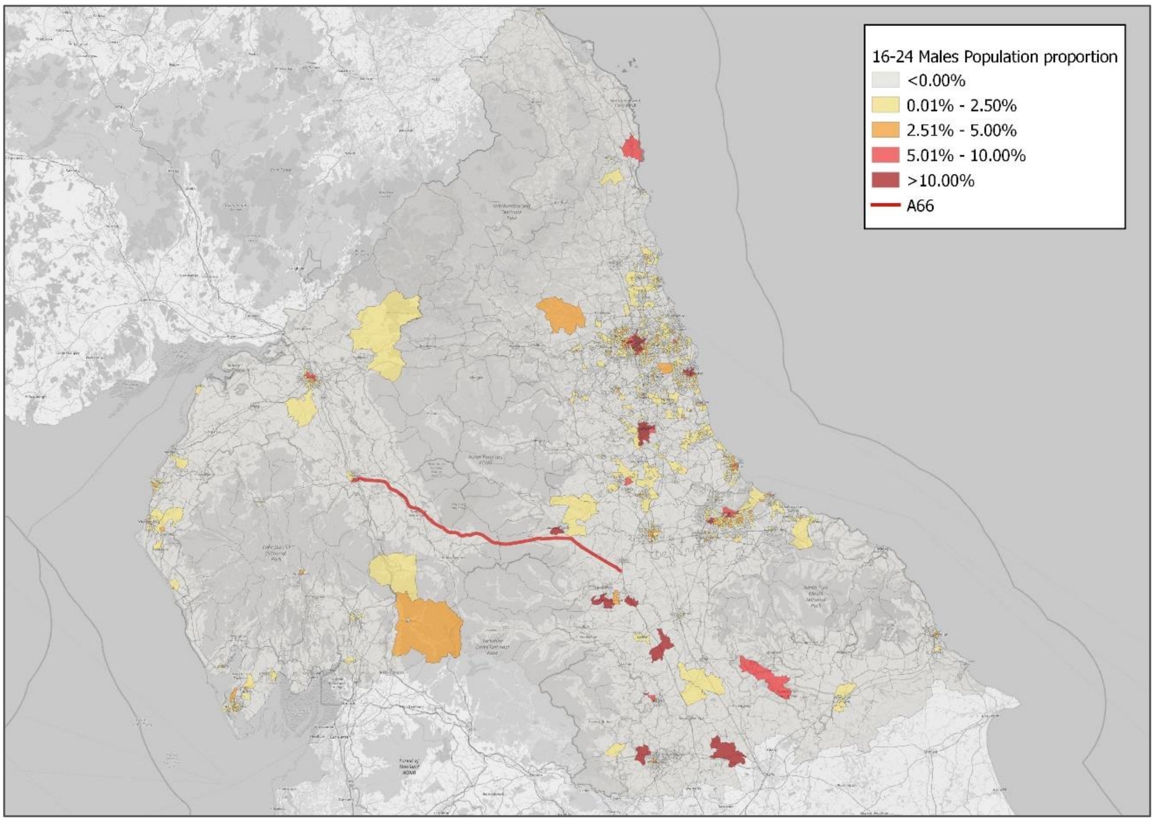


Figure 7-4: Proportion of Older People (aged 70 and over) in comparison to the RoF average (2020)

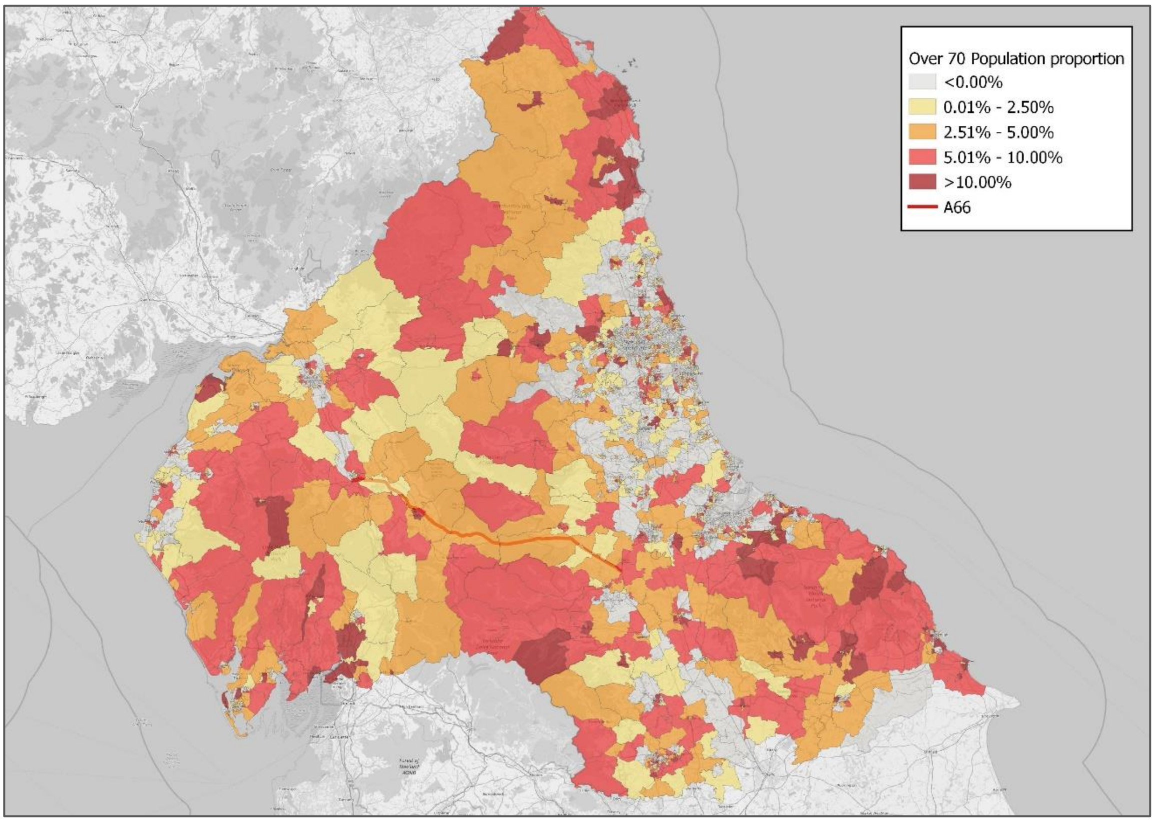


Figure 7-5: Proportion of Black Minority Ethnic Population in comparison to Local Authority average – Census 2011

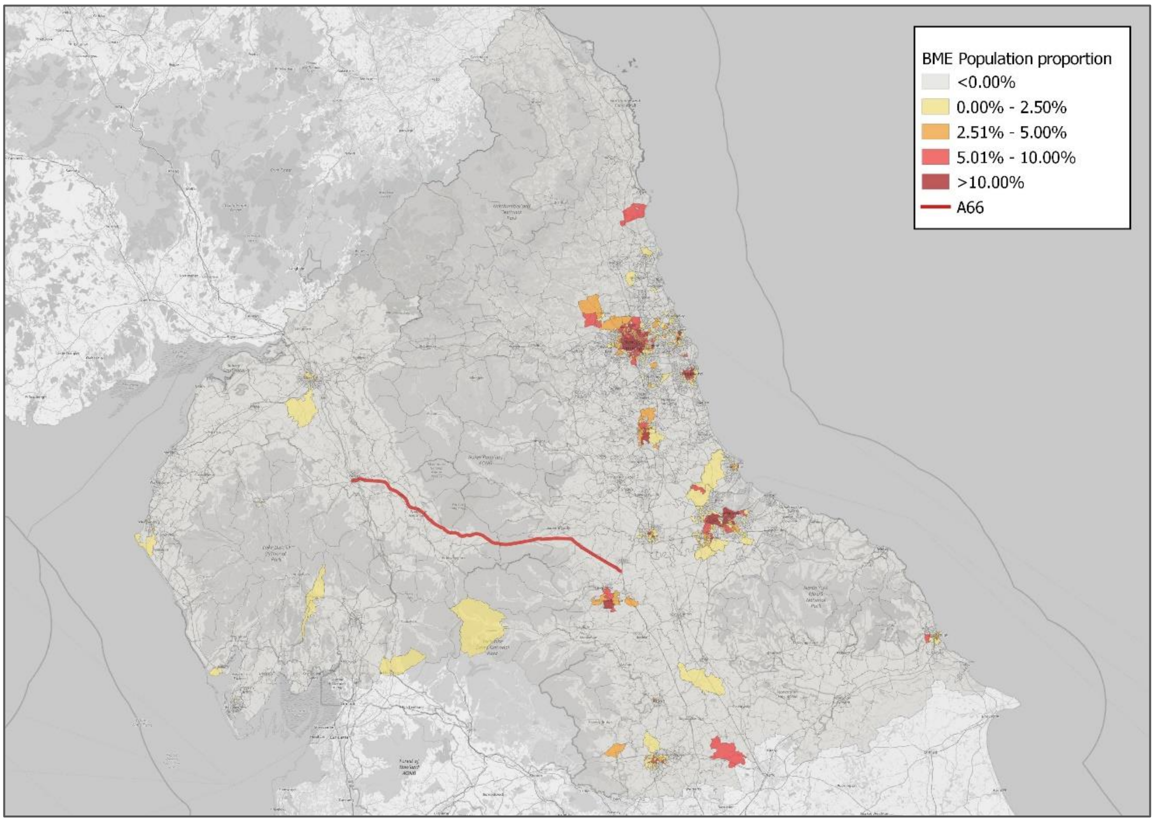


Figure 7-6: Proportion of Non-Car Households in comparison to Local Authority average – Census 2011

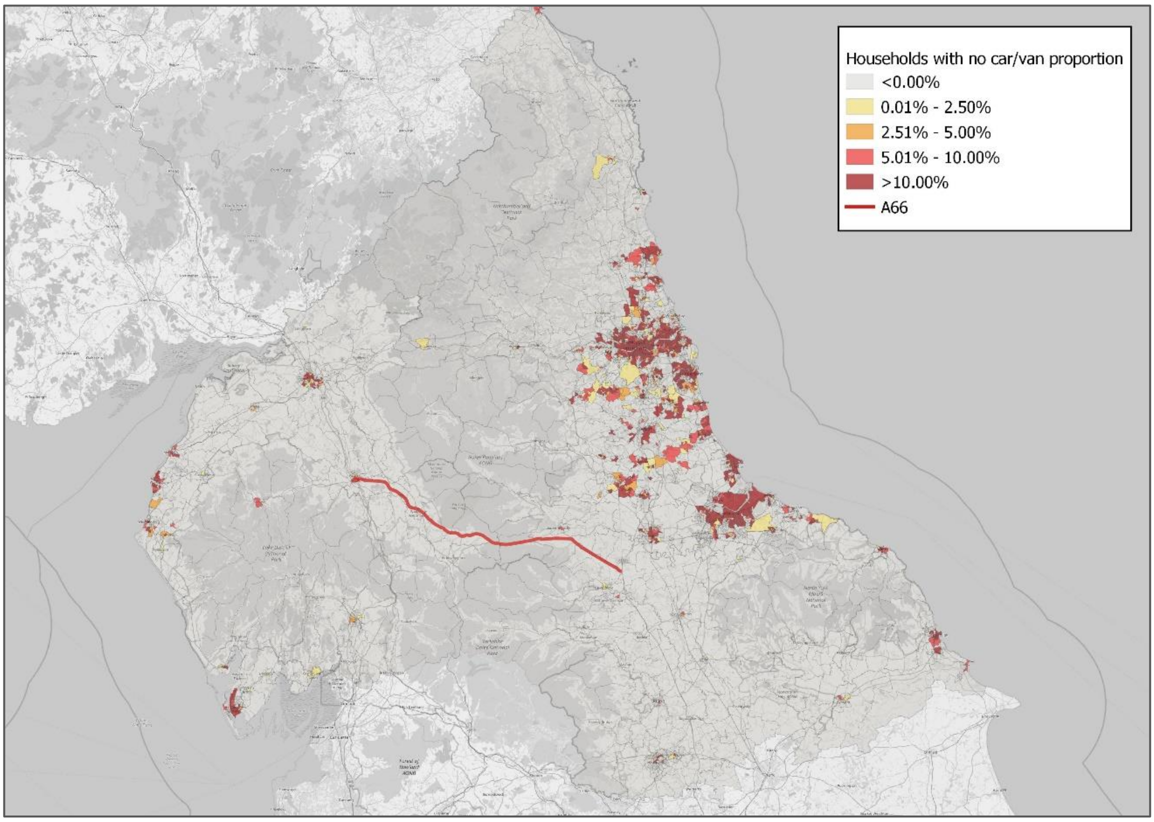


Figure 7-7: Proportion of Households with a Disabled Person – Census 2011

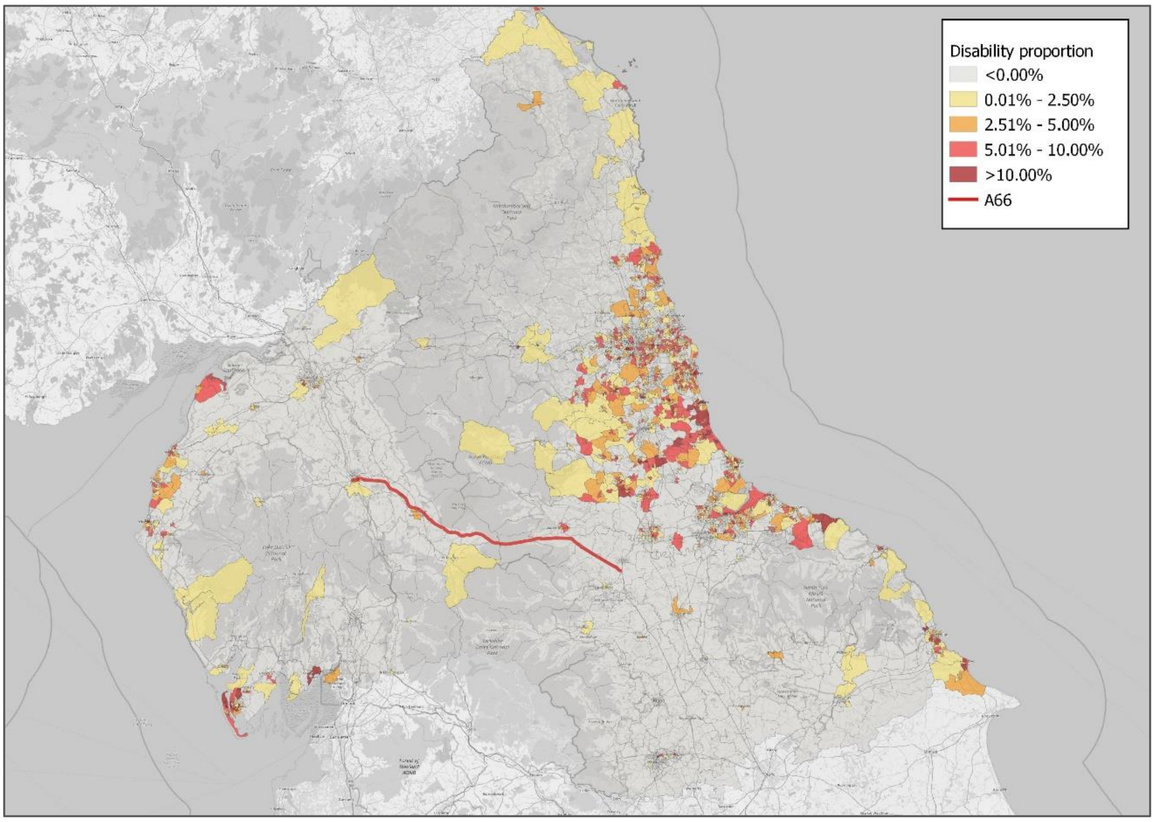


Figure 7-8: Proportion of Households with Dependent Children – Census 2011

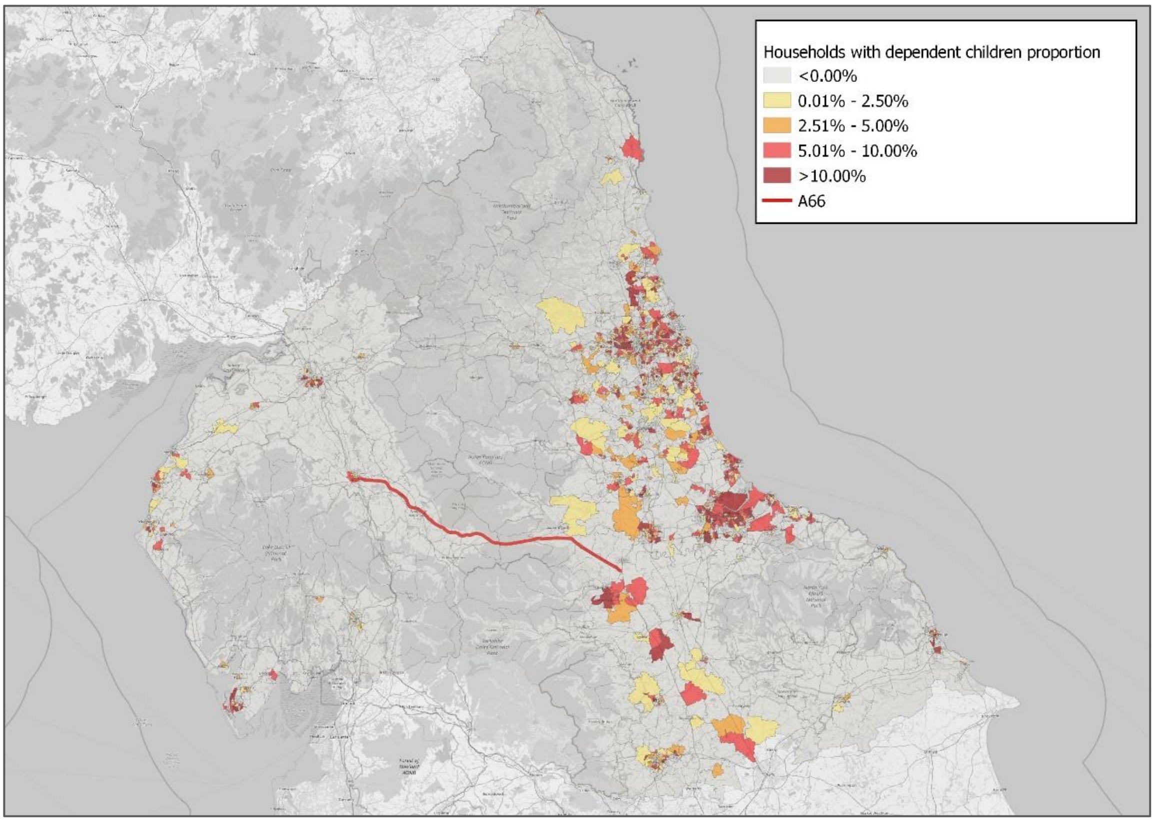
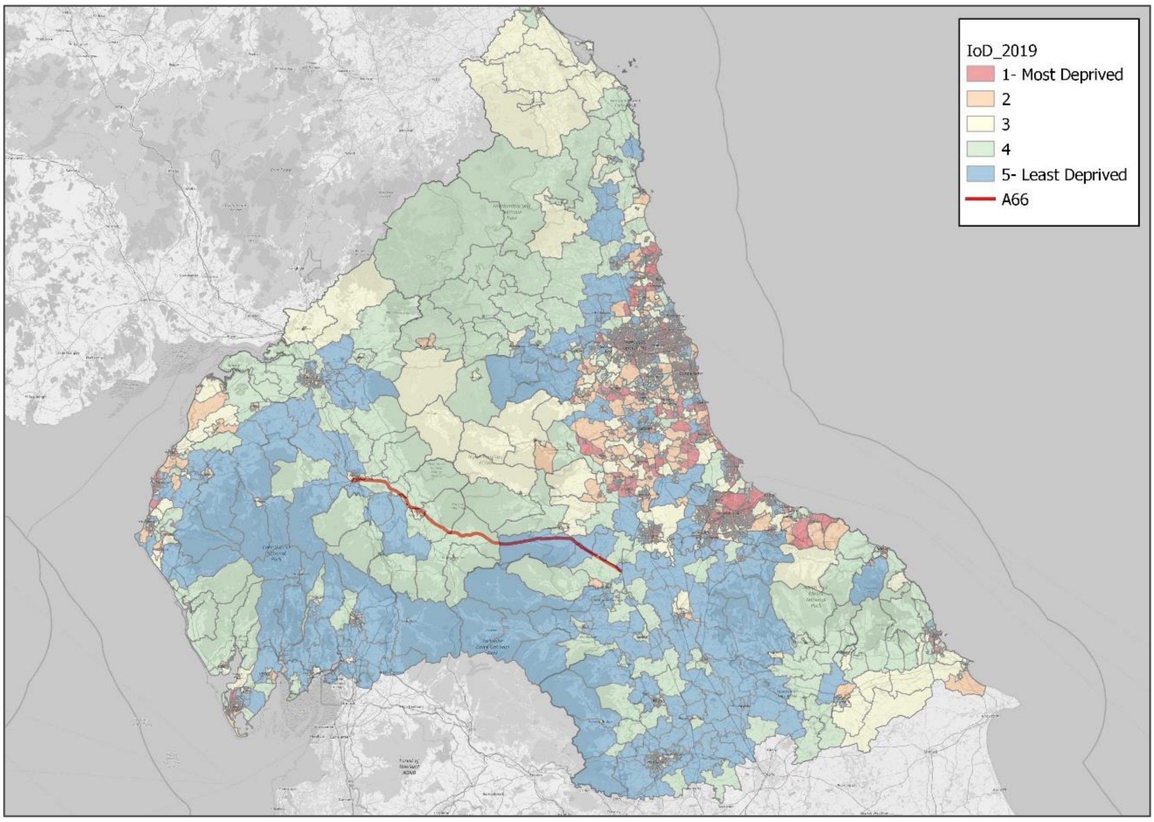


Figure 7-9: Income Deprivation by LSOA (Indices of Deprivation 2019)



C Core Scenario PA AMCB and TEE Tables

Analysis of Monetised Costs and Benefits

Noise	£1,240,323	*(12)*
Local Air Quality	-£9,739,356	*(13)*
Greenhouse Gases	-£202,046,983	*(14)*
Journey Quality	-	*(15)*
Physical Activity	-	*(16)*
Accidents	£29,646,307	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£17,162,257	*(1a)*
Economic Efficiency: Consumer Users (Other)	£11,883,142	*(1b)*
Economic Efficiency: Business Users and Providers	£430,984,628	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	£79,189,441	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£358,319,759	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	£750,497,808	*(10)*
Present Value of Costs (see notes) (PVC)	£750,497,808	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	-£392,178,049	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	0.48	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.

Public Accounts (PA) Table

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Funding						
Revenue	-		-			-
Operating Costs	-		-			-
Investment Costs	-		-			-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	-	*(7)*	-	-	-	-
Central Government Funding: Transport						
Revenue	-£164,121		-£164,121			-
Operating costs	£56,918,558		£56,918,558			-
Investment Costs	£693,742,929		£693,742,929			-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	£750,497,366	*(8)*	£750,497,366	-	-	-
Central Government Funding: Non-Transport						
Indirect Tax Revenues	-£79,189,441	*(9)*	-£79,189,441	-	-	-
TOTALS						
Broad Transport Budget	£750,497,366	*(10) = (7) + (8)*				
Wider Public Finances	£671,307,925					

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.

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	£49,426,257		£49,426,257					
Vehicle operating costs	-£24,773,516		-£24,773,516					
User charges	-£14,483		-£14,483					
During Construction & Maintenance	-£7,476,000		-£7,476,000					
COMMUTING	£17,162,257	*(1a)*	£17,162,257					
Non-business: Other	**ALL MODES**		**ROAD**		**BUS and COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**		**Passengers**	**Passengers**		
Travel time	£93,830,477		£93,830,477					
Vehicle operating costs	-£74,843,772		-£74,843,772					
User charges	-£116,562		-£116,562					
During Construction & Maintenance	-£6,987,000		-£6,987,000					
NET NON-BUSINESS BENEFITS: OTHER	£11,883,142	*(1b)*	£11,883,142					
Business								
User benefits			**Goods Vehicles**	**Business Cars & LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	£476,274,759		£128,076,804	£348,197,955				
Vehicle operating costs	£1,345,135		£2,474,668	-£1,129,533				
User charges	-£31,256		-£1,275	-£29,982				
During Construction & Maintenance	-£46,604,000		-£10,812,128	-£35,791,872				
Subtotal	£430,984,638	*(2)*	£119,738,070	£311,246,568				
Private sector provider impacts						**Freight**	**Passengers**	
Revenue	-							
Operating costs	-							
Investment costs	-							
Grant/subsidy	-							
Subtotal	-	*(3)*						
Other business impacts								
Developer contributions	-	*(4)*						
NET BUSINESS IMPACT	£430,984,638	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	£460,030,037	*(6) = (1a) + (1b) + (5)*						

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