SCENARIO PLANNING PROCESS REPORT

FINAL REPORT

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1. INTRODUCTION

1.1 SYSTRA Commission

1.1.1 In supporting the National Transport Strategy Review (NTS2) and the second Strategic Transport Projects Review (STPR2), Transport Scotland commissioned SYSTRA in October 2017 to develop a Scenario Planning Process with a Scenario Planning Tool embedded within it. The purpose of this is to understand different future scenarios of transport and land-use in Scotland.

1.1.2 Based on the needs identified, the high-level objectives for the Scenario Planning Tool (sitting within the described Scenario Planning Process) are:

- To provide robust evidence of the impact of wide ranging transport and land-use policies and trends;
- Works on readily available (commercial or open-source) software; and
- Outputs can be readily used by GIS and spreadsheet software to produce maps, charts and tables.

1.1.3 The first version of the Scenario Planning Tool has been developed to consider uncertainty over the next 20 years and allow policies to be assessed against uncertain futures.

1.2 Purpose of Report

1.2.1 This report is the Scenario Planning Tool Development Report and sets out the approach that has been taken to developing the tool, as well an outline of the tool itself. This report explains the Stakeholder-Led development of the Outputs and the Plausible Futures.

1.3 Background

Context of the Land use and Transport Integration in Scotland (LATIS) Service

1.3.1 The purpose of Transport Scotland's Land-use And Transport Integration in Scotland (LATIS) service is to provide a robust, quantified evidence base that will assist in the planning, modelling and appraisal of transport policies, programmes and interventions. The LATIS service supports Strategic Transport Planning and Governance as set out in Transport Scotland's Corporate Plan. To this end, Transport Scotland have developed a linked hierarchy of transport models, national and regional models, and a land use model which, applied together, provides a full Land-use and Transport Interaction (LUTI) modelling capability.

1.3.2 The national transport model, Transport Model for Scotland (TMfS) offers a generalised, multi-modal representation of travel demands and infrastructure supply for a base (2014) and future forecast years.

1.3.3 The national land-use model, TELMoS (Transport and Economic Land-use Model of Scotland), provides independent demographic, planning and economic forecasts from a 2014 base which form the basis for future travel demands.

1.3.4 Established forecasting and planning methods assume relative stability in key factors and how they influence travel demand. Some degree of confidence in how these key factors may change over time leads to published demand forecasts (incorporating sensitivity to uncertainty) that underpin policy/investment decisions. Increasingly though, people's travel behaviour patterns and available/new choices are more complex and influenced by various economic, demographic, technological, environmental and social factors. There is growing recognition that the level of future uncertainty continues to increase too. We therefore need to adapt our transport planning toolset to respond to this expansion of possible future travel behaviour trajectories, by such means as the development of a Scenario Planning function / capability.

1.3.5 TMfS and TELMoS can be used for Scenario Planning, but as tools designed to deliver sufficient detail for intervention appraisal, they are unsuitable for the high-level Scenario Planning Process needs of the National Transport Strategy Review; circa four weeks is needed for a full Land-use Transport Interaction analysis across the full 20+ year future horizon. Transport Scotland need a product which can assess the impact of future scenarios on transport and land-use, but operating much faster. The Scenario Planning Tool has a significantly shorter run-time than the current TMfS.

1.3.6 Whilst the Scenario Planning Tool is much simpler than the full TMfS / TELMoS system, it is recognised that this brings its own challenges. Thus, it has been embedded in a framework i.e. the Scenario Planning Process, for interpretation of both inputs and outputs.

1.3.7 Ensuring the application of the Scenario Planning Process is consistent with existing LATIS models and practices, the training of users and the supply of training materials along with documentation is available.

1.3.8 The Scenario Planning Tool will have an ongoing role for quickly exploring the anticipated effects of new policies and mobility ideas; however, it is not intended for use as the sole model for Scheme Appraisal or for Business Case development. The Scenario Planning Tool does not supplant or succeed the TMfS / TELMoS suite of models. It is intended to complement and operate alongside these and, if necessary, other sub-national transport models. It is expected that a set or sub-set of scenarios developed through the Scenario Planning Process go on to be run through the full TMfS / TELMoS Land-use Transport Interaction.

The National Transport Strategy Review, and the Strategic Transport Projects Review Update

1.3.9 The National Transport Strategy (NTS2) sets the long-term vision and direction for transport policy in Scotland. This performs a pivotal role within the wider NTS2 policy framework, which brings together a range of Scottish Government national policies, plans and strategies that drive the decision-making process regarding how we develop our national infrastructure. The NTS review was announced in 2016 and is currently being prepared.

1.3.10 Transport Scotland is committed to aligning the NTS2 with the emerging policy and legislative landscape in Scotland including the outcomes from the independent planning

review, Climate Change Plan, local government review, Enterprise and Skills review, City and Region Growth Deals and the Transport Bill.

1.3.11 Transport Scotland will take into account the impact of these emerging policy and legislative developments on the transport landscape by ensuring that key areas of work within the NTS2, including Transport Governance, complement these developments whilst also delivering the desired outcomes for Transport.

1.3.12 The Scottish Government`s planning review consultation confirmed that the NTS2's work on roles and responsibilities will encompass 'Empowering Planning to Deliver Great Places' recommendations on a review of transport governance, and responses on the consultation will help inform this work under NTS2. The Regional Economic Partnerships report was published in June 2017 as part of the Enterprise and Skills review. The report also recounts the Government's commitment to review Transport Governance.

1.3.13 The approach to National Planning Framework Four (NPF4) will be shaped by the wider programme of planning reform discussed in the planning consultation and the position statement published in June 2017. The outcome of this will determine the timescales and format for NPF4 so it can be taken forward in alignment with NTS2 and STPR2.

1.3.14 A key component in delivering NTS2 is the Strategic Transport Projects Review (STPR), last undertaken in 2008 but scheduled for imminent update (STPR2). The STPR sets out the Scottish Government's transport investment priorities identified as being most effective in delivering the Government's strategic transport objectives. STPR2 will therefore be informed and heavily influenced by the themes and outcomes defined in the NTS review.

1.3.15 It is stated that the NTS2 will define "an updated vision for what kind of transport system we want for the whole of Scotland over the next 20 years or so and how we plan to get there". This concept of planning for the preferred, rather than 'most likely' future (while also accounting for uncertainty) clearly underpins the need to develop the Scenario Planning Process and Tool in this commission.

1.3.16 Figure 1 is the latest NTS2 Strategic Framework.

Our Vision

We will have a sustainable, inclusive and accessible transport system, helping deliver a healthier, fairer and more prosperous Scotland for communities, businesses and visitors.

FIGURE 1. NTS2 Draft Strategic Framework

2. SCENARIO PLANNING APPROACH

2.1 Scenario Planning Principles

2.1.1 The high level requirement of the Scenario Planning Process and Tool is to provide a robust and data-based means by which the impacts of potential transport / land-use policies, measures or actions in Scotland can be gauged within the context of various plausible futures.

2.1.2 The parameters of the Tool – i.e. the make-up of the plausible futures, and the uncertainty drivers acting upon them - were defined and agreed in advance by relevant stakeholders.

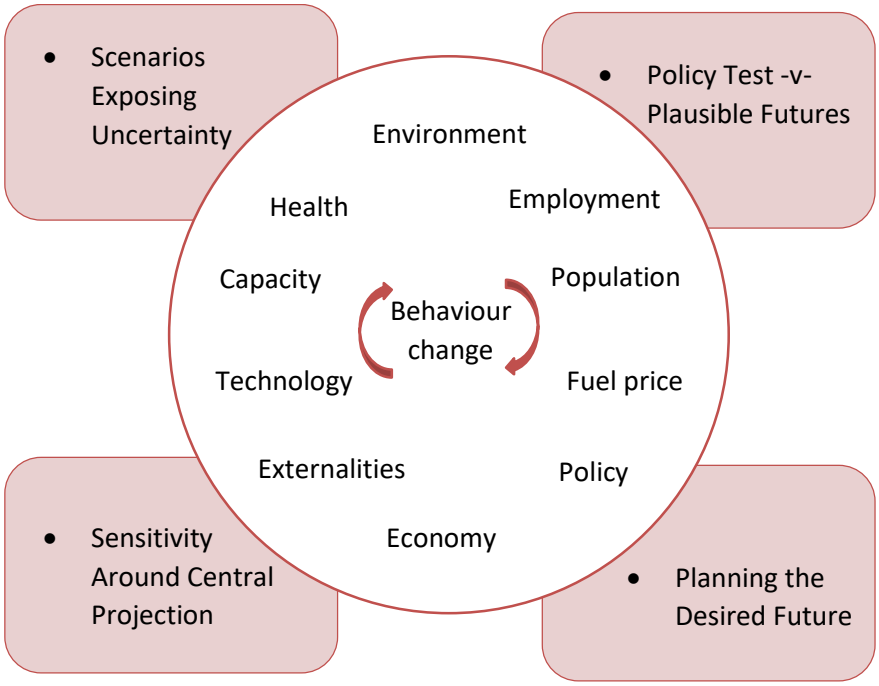
2.1.3 The Tool functions by selectively extracting and using data from complex models, such as TMfS and TELMoS, to predict how well (or otherwise) the outputs of a potential 'Enabler' might align with those sought by the Government, through its strategic objectives.

2.1.4 It should be recognised that the Process and Tool attempts to use existing quantitative data to predict answers to qualitative, future-facing questions.

2.1.5 The high-level requirements of the Scenario Planning Process and Tool are to assess impacts of different future transport/land-use scenarios in Scotland and provide robust evidence of the impact of wide-ranging transport and land-use policies and trends. It is recognised that different sorts of questions may need to be addressed by the Process and Tool, including:

- What happens to the transport system and its use if:
  - the world changes in certain ways?
  - we apply particular policies and investment decisions?
- What different plausible ways could a desirable future state be achieved?

2.1.6 As illustrated below, there are **different possible approaches** that could influence how a Scenario Planning Process and Tool is developed.

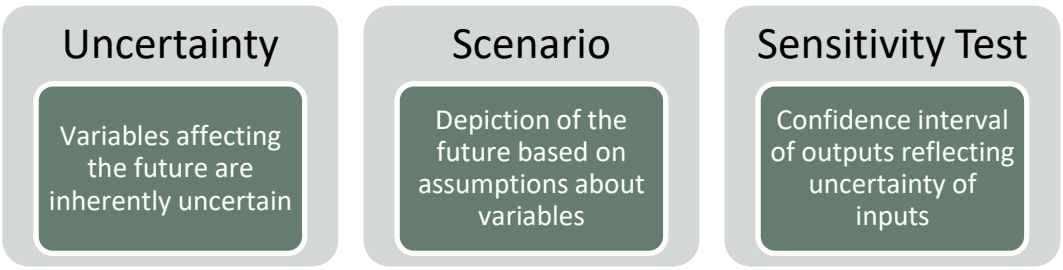


2.1.7 Determining which approach best satisfied the requirements and objectives was a key element of developing the Process and Tool. We needed to consider and understand the **many complex inter-dependencies, actions and uncertainties** (illustrated above) that the decision-maker may face. This is non-trivial but we recognised the importance of making the Process and Tool accessible, usable and ultimately effective.

2.1.8 While certain requirements and expectations were known from an early stage, it was recognised that the required Scenario Planning Process and Tool was (and still is) an evolving process. Therefore, pro-active Stakeholder Engagement was (and still is) essential to defining and refining a detailed scope for the Process/Tool.

Solid Foundations

2.1.9 From the outset, the intention has been to bring clarity and definition to the process, ensuring that stakeholders fully understood the meaning of the language involved. Indeed, the terminology has continue to evolve throughout the development of the process.



2.1.10 We clarified key terminology to explore uncertainty in more detail and understand how different scenarios and sensitivity tests can contribute to planning for the future. Planning in the face of uncertainty is a well-established concept and transport planning can exploit

good practice from other industries (e.g. meteorology, finance, energy, sales/advertising etc.).

Exploring Uncertainty

2.1.11 The diagram below illustrates the four main levels of uncertainty with respect to our future, and describe the uncertainty 'space' within which we need to forecast[1]:

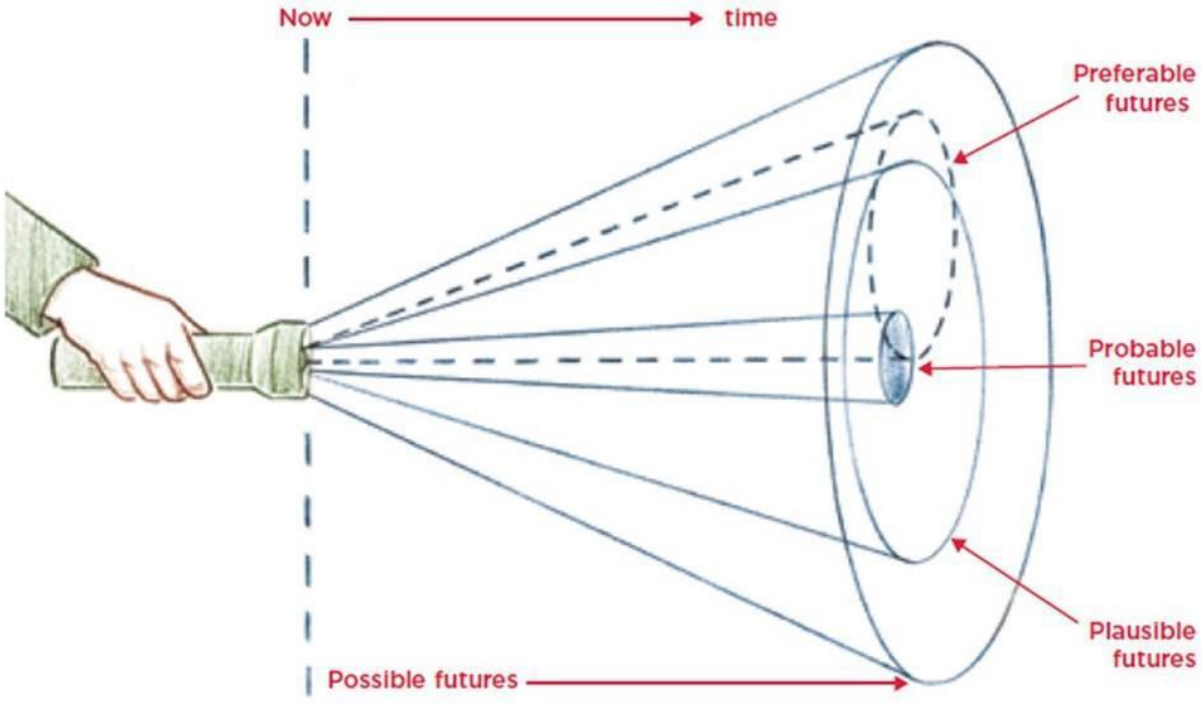
1. Clear Enough	2. Probable Alternatives	3. Plausible Alternatives	4. Unknown
•Not possible/worth measuring uncertainty •Sensitivity test single point estimate	•Multiple estimates distributed with confidence interval •Probability attached to distributed values	•Multiplicity of plausible futures •Limited knowledge of variables & relationships •Difficult to value alternatives	•"Deep Uncertainty" •We only know that we don't know

2.1.12 Many level 1 and 2 uncertainties can be well managed through improved data gathering, using stochastic processes and statistical analysis to reduce uncertainty. However, the technological, social, political and other changes emerging in the 21st century mean that many historic and current trends/relationships cannot reliably be extrapolated into the future. The future impacts of these changes on people's accessibility and travel choices, particularly car travel, cannot be better understood through improved data gathering and are in a period of deep uncertainty.

Understanding Scenarios

[1] Walker, W.E., Marchau, V.A.W.J., Swanson, D., 2010. Addressing deep uncertainty using adaptive policies: introduction to Section 2. Technol. Forecast. Soc. Chang., 77, 917–923.

2.1.13 Allied to understating uncertainty is the need to appreciate the **different types of future scenario** that can be considered and where Scenario Planning flourishes (illustrated below).



2.1.14 Metaphorically, forecasting is like shining a light into the darkness of the future[2], within which lie various:

Probable Futures	Plausible Futures	Preferable Futures	Possible Futures
•Easiest to see & define •Extrapolation from current trends	•Less clearly defined •Plausible based on current understanding of variables & relationships	•How we want the future to look •Perceived to be value-laden	•Hardest to see & define, yet possible •May rely on technology or knowledge that doesn't yet exist

2.1.15 Transport planning has typically created future projections based on 'best available evidence' of key drivers of future travel demand (e.g. population, GDP, fuel cost). Sensitivity testing (e.g. high/low permutations on a central forecast) recognises uncertainty but this simplified view of the *'probable future'* assumes consistency/stability in the main drivers of change and their relationship with demand. In a period of deep uncertainty this may not hold true as the drivers of change themselves and the relationships between these drivers and travel demand may vary. This moves us to towards the wider concept of *'plausible futures'*.

[2] Image reproduced from https://www.nesta.org.uk/sites/default/files/dont_stop_thinking_about_tomorrow.pdf

2.1.16 This is where Scenario Planning can be effectively applied through stakeholder and expert engagement to explore, qualitatively and sometimes quantitatively, the deep(er) uncertainty and changing importance of different drivers of change. Dealing with uncertainty is not an exact science but through good Scenario Planning we can interpret the level of uncertainty being faced and adopt the right mindset and approaches to deal with it. In this way, we open the possibility of controlling where we 'shine the light' to plan for the future we want.

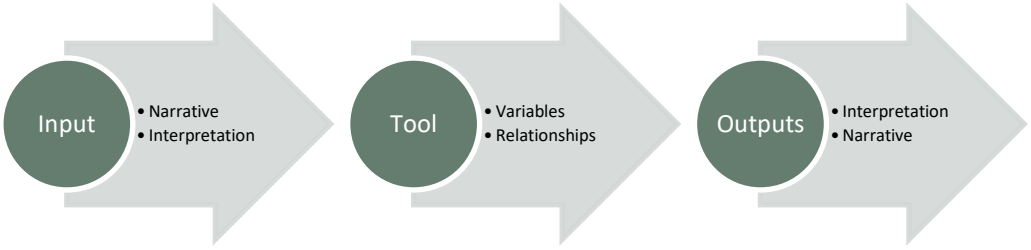
2.1.17 The NTS2's themes and outcomes point towards a *'preferred future'*. Scenario Planning can allow for the identification of those *probable*, *plausible* or *possible futures* which overlap with the *'preferred future'*.

2.2 Scenario Planning Process and Tool

Scenario Planning Process

2.2.1 The development of the Scenario Planning Process allows us to take a scenario or enabler, identify and translate it into a range of inputs (whether quantitative or qualitative) for the Scenario Planning Tool. The Scenario Planning Tool quantifies the impact of the scenario or enabler and the metrics from the Scenario Planning Tool are then translated back into an output narrative to complement the input narrative.

2.2.2 The process starts by using pro-forma Enabler Assessment Templates which can be completed by any relevant groups. This template describes the problem or opportunity



they are trying to affect, the enabler itself and the principal outcomes this enabler is intended to achieve.

2.2.3 The process provides an opportunity to think through:

- Who will be impacted on by the proposed enabler and how will they be affected;
- Which of the outcomes in the draft NTS2 Strategic Framework the proposed enabler will support
- Whether the proposed enabler likely presents any tensions/negative impacts on the draft NTS2 Strategic Framework outcomes.

2.2.4 The process includes an opportunity to document any evidence to support the conclusion that this enabler will have an impact on the agreed outcomes in the manner intended.

2.2.5 The Scenario Planning Tool is a simple transport model, in spreadsheet form that is capable of linking the inputs and metrics in relational terms. The model is transparent about its internal construct and related assumptions and has a user interface suitable for the user to stipulate the input values and see the resulting output scenario results.

2.2.6 As stated in Section 1.3, the Scenario Planning Tool is designed to complement the existing suite of LATIS models e.g. TMfS/TELMoS. The relationship between the Tool and the models depend on the Tool's inputs and outputs. Depending on the questions being answered, the Tool does not include spatial disaggregation; however it may be more detailed in helping inform a small number of specific questions so would not be as expansive and flexible as TMfS/TELMOS.

2.2.7 The initial NTS2/STPR2 focus has informed the development of this first version of the Tool. In addition to the User Manual there is a:

- LATIS-compatible version control system
- Issues log - user and developer input
- Developer's Manual - key assumptions, mechanics of the Process/Tool

3. SCENARIO PLANNING TOOL SCOPING

3.1 Stakeholder Consultation

3.1.1 As part of the Scenario Planning Process project, a workshop was held with stakeholders from Transport Scotland, NTS2 Thematic Group representatives and the LATIS Framework Consultants. Stakeholders considered current NTS2 themes and outcomes in the workshop, the purpose of which was to:

- Determine candidate output metrics relevant to NTS2.
- Identify and prioritise input drivers which influence travel demand.
- Have a degree of consensus on the above sufficient to enable the tool development work to be commenced.

3.1.2 This workshop identified a set of output metrics, using the NTS2 outcomes as a starting point. This did lack a degree of detail on what the actual measurement units would be so further work was undertaken using known publications and data sources e.g. Scottish Transport Statistics and TMfS analyses which have already been collated, and which quantified each of the outputs. This additional information along with internal project team and Transport Scotland input was collated and used to sift the outputs to a manageable number. The outcome of this exercise is to provide a list of metrics for inclusion within the Scenario Planning Tool.

3.1.3 The workshop identified a list of important and uncertain drivers of travel demand which were used to inform the creation of the Plausible Futures which will be used to understand the success of the enablers tested within the Scenario Planning Process.

3.1.4 It was agreed with Transport Scotland that the Tool would only consider the personal travel demand. It does not apply to either freight or non-travel demand aspects of the transport system.

3.1.5 This section documents the metrics that have been processed to date and how the input drivers have been used to inform that development of the Scenario Planning Tool, and how the important and uncertain drivers of travel demand informed the Without Futures.

3.2 Structure

3.2.1 The structure of the Tool comprises three core elements:

- Inputs
- Elasticities
- Metrics

3.2.2 The application of the Tool uses these elements to form a more comprehensive structure:

- Plausible Future Inputs
- Plausible Future Metrics
- Enabler Inputs
- Enabler Metrics compared against each Plausible Future

3.3 Scenarios

3.3.1 In the context of the Scenario Planning Tool, a scenario (or Plausible Future) is a different view of possible future travel demand. This is achieved through defining input values for future population, trip rates and travel costs, which are the key inputs to the Tool.

3.3.2 An enabler is any intervention, e.g. a strategy, policy or measure, that could mitigate, enhance or in some way alter a defined scenario by impacting on the input values which influence travel demand. When choosing Input values for any scenario or enabler professional judgment is required to understand why a particular future has been defined in this context.

3.4 Metrics

3.4.1 A list of 41 metrics that align with NTS2 Outcomes and Themes were developed in collaboration with representatives from the NTS2 thematic groups at a workshop held in March 2018. These metrics are calculated following population of specific Inputs into the Tool whether it be plausible futures or policies. 41 metrics are currently within the tool which are listed below as output (units) by NTS2 Theme.

Economy

- Congestion delays experienced by bus passengers (% of congested bus network)
- Driver journeys delayed due to traffic congestion (% of congested road network)
- Bus Journey Time Reliability on Roads (Punctuality % of Bus Journeys)
- Car Journey Time Reliability (Percentage of Delayed Journey Stages)
- Rail Journey Time Reliability (Rail Punctuality %)
- Active Modes Journey Time Reliability (Active Travel % Reliability)
- Level of Bus overcrowding relative to capacity (Increasing or Reducing)
- Level of Rail overcrowding relative to capacity (Increasing or Reducing)
- LGV km (million veh/km)
- HGV km (million veh/km)
- Car Veh kms/person (population) (million veh/km/person)
- Bus passenger kms/person (passenger kms)
- Rail passenger kms/person (passenger kms)
- Accessibility by Bus to labour market (Public Service Buses per 1000 of population)
- Accessibility by Car to labour market (Time by Car to Travel to Work (minutes))
- Corporate emissions (tCO_2e), split by source (CO_2 (thousand tonnes))

Heath

- Road traffic accidents (Total Injury Accidents)
- Proportion of trips by walking/cycling (Proportion of Walking/Cycling Trips)
- Proportion of public transport/park and ride trips (Prop. of trips made by PT, P&R)
- Proportion of pupil trips made by car (Proportion of pupil trips made by car)
- Active Travel Mode share of all journeys/travel to work/school (increase/decrease)
- Safety – accidents (increase/decrease)
- NO_x/PM_{10}/Noise (NO_x & PM_{10} Annual Emissions thousand kg/yr)

Climate

- Car Veh kms/person population (million veh/km/person)
- Driver journeys delayed due to congestion (% of congested road network)
- Corporate emissions (tCO_2e), split by source (CO_2 thousand tonnes)
- Driver journeys delayed due to congestion (% of congested road network)
- Emissions of air pollutants (PM_{10}) (PM10 Annual Emissions thousand kg/yr)
- Emissions of greenhouse gases (CO_2) (CO_2 thousand tonnes)
- Proportion of trips made solely by car (Proportion of trips made solely by car)

Equality

- Bus Speed Average Bus Speed km/hr
- Car Speed Average Car Speed km/hr
- Proportion of journeys to work made by Bus (%)
- Proportion of journeys to work made by Car (%)
- Proportion of journeys to work made by Rail (%)
- Proportion of journeys to work made by Active Travel (%)
- Number of concessionary card/Young Scot card journeys made (increase/decrease)
- Generalised cost for Bus (increase/decrease)
- Generalised cost for Car (increase/decrease)

3.4.2 Each metric is calculated using elasticities calculated from a combination of research using published statistics, analysis of the Transport Model for Scotland and professional judgement.

3.4.3 Within the Tool the user must consider each metric and decide if it changes, is that a positive or negative impact relative to the NTS2 outcome. For example an increase in the Proportion of Trips made by Walking/Cycling is a positive outcome with respect to the Enables Us To Make Healthy Travel Choices outcome but an increase in Emissions (CO_2) is a negative outcome for the Promotes Greener Cleaner Choices outcome. This is known as the polarity and this parameter is included in the tool and can be manipulated if required.

3.4.4 The cumulative effect of the metrics is calculated within the tool and to facilitate this each of the metrics is associated with an NTS2 theme and outcome for example Vehicle kilometres is associated with the theme 'Helps our economy prosper' and the outcome 'Gets us to where we need to get to'. This relationship is flexible and can be altered as required in the future.

3.5 Drivers of Travel Demand

3.5.1 The overall purpose of the process and Tool is to be able to consider candidate enablers in the face of uncertainty in order to support robust decision making that can set a direction of travel towards achieving the NTS2 outcomes. The tool addresses uncertainty by allowing the anticipated travel demand impact of these candidate enablers to be modelled upon a range of scenarios, or plausible futures. To do this, it was necessary to first determine the important and uncertain drivers of travel demand that would underpin the narrative of each plausible future.

3.5.2 Following a workshop with representatives from the NTS2 thematic working groups, Transport Scotland and consultants from the LATIS Framework, a series of important and uncertain drivers of transport demand was established. The selection of these drivers followed a process of 'opening out' uncertainty. This allowed the extent of uncertainty being faced to be embraced and reflected in a wide range of drivers considered. This wide range of drivers was then prioritised by determining those which ranked the highest in terms of both importance and uncertainty.

3.5.3 The eight drivers that emerged from this process were:

- Popularity of walking and cycling
- Demand for personal travel
- Capabilities and affordability of digital technologies
- Change in share of manually controlled motor vehicles
- GDP / (disposable) income
- Share of knowledge work within economy
- Energy supply capacity relative to demand
- Degree of economic instability

4. SCENARIO PLANNING TOOL

4.1 Introduction

4.1.1 An important aspect of the tool is that there is has to be a level of judgment when populating inputs and interpreting the outputs. The tool is designed to inform the likely Enabler outcomes, not precisely measure the impact of an Enabler.

4.1.2 It is a requirement that the Scenario Planning Tool can operate on commercially available or open-source software. In the same vein, outputs must be suitable for taking into MS Excel for the creation of charts, tables, figures, maps, etc. The tool has been tested in advance of active use to ensure it is producing intuitive results which are credible, coherent and comprehensible.

4.1.3 Throughout its development, the ongoing maintenance and application of the product has been considered as has its accessibility to all users and portability or passing between successive developers in the future.

4.1.4 As discussed previously, the structure of the tool comprises three core elements:

- Inputs;
- Elasticities; and
- Metrics.

4.1.5 Again, the application of the Tool uses these elments to form a more comprehensive structure:

- Plausible Future Inputs;
- Plausible Future Assessment;
- Enabler Inputs; and
- Enablers Future Assessment.

4.2 Inputs

4.2.1 The inputs are populated with default values which are 2018 values. All inputs applied as index values where 100 = no change i.e. a 5% increase is 105 and a 5% decrease in input as 95. Any change pivots off 2018 values, not an alternative forecast from a specific future scenario.

4.2.2 A sense-check of all the inputs should be undertaken to ensure the overall representation of a scenario is representative of what is envisaged. During the verification checks, various recommended ranges for the input values were identified and are contained within the tool.

Population

4.2.3 The input population is split into working and the remaining (non-working) population. In the context of this Tool, non-working comprises both those not in work seeking paid employment (i.e. unemployed) and those not seeking paid employment (e.g. retired, children, stay-at-home parents). The working population is the primary indicator for the performance of the economy e.g. a buoyant economy = larger working population. This can be expressed as a shift from non-working to working population, or a net increase in population through increased migration.

4.2.4 The Population Inputs are not linked; i.e. a decrease in working population has no impact on the number of non-working population.

Trip Rates

4.2.5 The trips rate inputs capture the general propensity to travel by each mode. Inputs are available for **Car**, **Bus**, **Rail** and **Active Travel**. The trip rate can be expressed as a shift in trip rates between modes, for example Car to Bus/Rail or a general increase or decrease in overall trip making.

4.2.6 The Trip Inputs are not linked; i.e. a decrease in car trips has no impact on the number of PT or active travel trips. Such a change requires manual input.

Travel Cost

4.2.7 The travel costs inputs are **Car**, **Bus**, **Rail** and **Active** travel costs. The travel cost inputs do have a 'ripple' effect on direct and indirect outputs, which should be considered when changing the inputs. For example, if the car generalised cost increases this will impact upon any specific output which is influenced by the number of cars on the network. In addition, the tool will impact upon any metrics which are rail, bus and active travel based, to account for the change in mode due to the change in travel cost. This also applies if you decrease the generalised cost and the same principle is applied for Bus, Rail and Active Travel.

4.2.8 The **Car** travel costs include travel time, vehicle operating costs including fuel price as set out in WebTAG. Research undertaken using the Transport Model for Scotland has concluded that over time the generalised cost of car travel changes marginally over time so the tolerances for manipulating this value within the tool is very small (+/- 2% 98-102) as the tool is very sensitive to a change in Car generalised cost.

4.2.9 **Bus** and **Rail** travel costs are assumed to include travel time including waiting time, transit time and fares. Bus travel times are also influenced by an increase in car trips. From research using the Transport Model for Scotland and other available research the Bus and Rail generalised costs increase by much greater margins over time compared to the Car and the tolerances reflect this (+30%/-10% 90-130).

4.2.10 **Active Travel** costs is made up of the travel time and an element of knowledge of the network. The rational is that although the actual travel time may not reduce, the

perceived travel cost of active travel may change if for example, there is a culture change with respect to health benefits. This input has the same tolerances as the Bus and Rail generalised cost (+30%/-10% 90-130).

4.3 Elasticities of Change

4.3.1 As discussed earlier in this report the inputs to the Scenario Planning Tool have been identified, as have the metrics which align with the NTS2 Themes and Outcomes. The elasticities are the relationship between the inputs and metrics. These elasticities have been calculated using the following:

e = (log(%DI)/(log(%DM)),

where %DI is the percentage change in the Input and %DM is the percentage change in the Metrics.

4.3.2 Research and analysis has been undertaken to understand the changes to the inputs - population, trip rates and trip cost over time and each of the tool metrics listed in Section 3.1. The sources of research into each elasticity calculation is contained with Appendix B.

4.3.3 There are no cross-elasticities applied in the tool.

4.4 Verification Checks

4.4.1 Throughout the development of the tool various verification checks were undertaken. The tool is intended to consider uncertainty over the next 20 years and allow policies to be assessed against uncertain futures. A sense check of the elasticities was undertaken using the inputs from the 2037 forecast TMfS scenarios. This provided a baseline forecast to understand how the tool reacts to variation in the inputs.

4.4.2 In some cases, the initial elasticity calculations using the time and data available produced very large elasticities which made the tool very sensitive to the Inputs. The elasticities were subsequently refined to produce more intuitive results using the given tolerances of the Inputs.

4.5 Plausible Futures

4.5.1 With the key important and uncertain drivers of travel demand determined, different futures are described numerically in terms of their effect on travel demand.

4.5.2 A total of 30 Plausible Futures were created with a descriptive narrative and a corresponding set of input parameter values for each. The 30 Plausible Futures were fed into the Scenario Planning Tool to confirm the logical nature of their metrics, thereafter eight final Plausible Futures of varying preferability were selected and retained in the tool. Any With-Enabler scenario can then be compared with its corresponding Plausible Future, to understand the predicted impact of that enabler, in that scenario.

4.5.3 Each of the eight pre-defined Plausible Futures have been run through the tool in preparation for testing enablers.

4.5.4 The descriptive narrative for the eight pre-defined Plausible Futures are provided in Appendix B. The eight Plausible Futures are named:

- Healthy and Wealthy
- Mindful Travellers
- Cyber-Ecos
- Top Gear
- Straitened Stay-homers
- White-collar Connectors
- Multi-modal Movers
- Cyber-Boomers

4.6 With-Enabler Assessment

4.6.1 The Scenario Planning Tool explores uncertainty by testing an Enabler against a number of Plausible Future scenarios to understand its impact against each of the future scenarios. The eight Plausible Futures selected and retained in the Scenario Planning Tool are used for comparison with future With-Enabler scenarios.

4.6.2 The tool assesses an Enabler against a number of Plausible Future scenarios. This comparison is undertaken against the 2018 scenario and the 20 year Plausible Futures.

4.6.3 The information which is input into the tool is the predicted change in population, trip rates and trip costs which is explained further in Section 4. The assessment of the impact of the Enabler can be undertaken using the output metrics from the tool, which are:

- Specific Metric Values
- Metric Polarity
- RWB Assessment (Red/White/Blue)
- Graphical Representation

Specific Metric Values

Whilst specific metric values are tabulated within the tool, there is a considerable level of uncertainty associated with the precision of the elasticity values and the absence of cross-elasticity relationships. Any use of quantitative metrics from the tool should be agreed with Transport Scotland LATIS team.

Metric Polarity

4.6.4 The polarity, as discussed in Section 3.4, is defined to consider each metric and understand if it changes as a result of changing the population, trip rate and journey cost inputs, is the aggregate score a positive or negative outcome relative to its associated NTS2 Outcome. This is known as the polarity and this parameter is included in the tool and can be manipulated if required.

RWB Assessment

4.6.5 The RWB assessment is a visualisation of the With-Enabler assessment against the Plausible Futures for each of the NTS2 Outcomes. This assessment is an aggregation of the metrics grouped by NTS2 Outcome and is presented in two forms:

- A comparison against the current year, 2018; and
- Comparison against the Plausible Future

4.6.6 The comparison against the current year is a comparison between the 2018 Base conditions and the 2038 forecast Year With-Enabler Future, illustrated in Figure 2 and Figure 3 respectively.

Ensure sustainable labour market accessibility to employment locations

NTS Outcome	Healthy & Wealthy	Mindful travellers	Cyber-Ecos	Top Gear	Straightened stay-homers	White-collar Connectors	Multi-modal movers	Cyber-boomers	User Defined 1	User Defined 2
Will be reliable, efficient and high quality	5	-74	55	-69	27	14	-171	-45	10	10
Will get us where we need to get to	16	11	6	19	14	17	14	9	3	3
Will use beneficial innovation	93	97	102	96	100	96	92	94	99	99
Will be safe and secure for all	17	-16	36	-8	33	24	-20	-11	6	6
Will enable us to make healthy travel choices	210	45	39	18	95	36	72	37	11	11
Will help make our communities great places to live	88	41	37	14	40	4	11	21	29	29
Will adapt to the effects of climate change	11	-85	88	-88	63	6	-69	-118	25	25
Will help deliver our net-zero target	62	62	97	52	80	59	47	35	78	78
Will promote greener, cleaner choices	44	51	84	42	64	41	27	33	66	66
Will provide fair access to services we need	0	-11	18	-12	17	5	-14	-10	2	2
Will be easy to use for all	-3	-2	-4	-14	2	-32	-8	-17	-3	-3
Will be affordable for all	13	-43	28	-14	25	23	-1	-60	13	13

Figure 2. RWB Assessment Illustration (compared to 2018 values)

Ensure sustainable labour market accessibility to employment locations

NTS Outcome	Healthy & Wealthy	Mindful travellers	Cyber-Ecos	Top Gear	Straightened stay-homers	White-collar Connectors	Multi-modal movers	Cyber-boomers	User Defined 1	User Defined 2
Is reliable, efficient and high quality	8	12	8	11	10	9	9	17	10	10
Gets us where we need to get to	4	2	4	3	3	4	4	1	3	3
Uses beneficial innovation	-1	0	0	0	-1	0	-1	-1	-1	-1
Is safe and secure for all	6	7	6	6	6	6	6	6	6	6
Enables us to make healthy travel choices	12	8	15	7	10	9	12	4	11	11
Helps make our communities great places to live	-6	0	-4	-1	-6	-7	-7	-1	-4	-4
Adapts to the effects of climate change	21	31	19	32	25	24	21	47	25	25
Helps deliver our net-zero target	0	7	1	8	1	2	0	12	3	3
Promotes greener, cleaner choices	-4	4	-1	4	-3	-3	-5	5	-1	-1
Provides fair access to services we need	2	2	2	2	2	2	2	1	2	2
Is easy to use for all	-1	-5	-2	-5	-3	-1	-1	-7	-3	-3
Is affordable for all	12	21	12	15	12	11	13	25	13	13

Figure 3. RWB Assessment Illustration (compared to Plausible values)

4.6.7 The graphical representation illustrates the cumulative impact of each metric (from left to right) as a result of a specific Enabler within an NTS2 theme, illustrated in Figure 4 to Figure 7. The value on the right hand side is the value used in the RWB assessment.

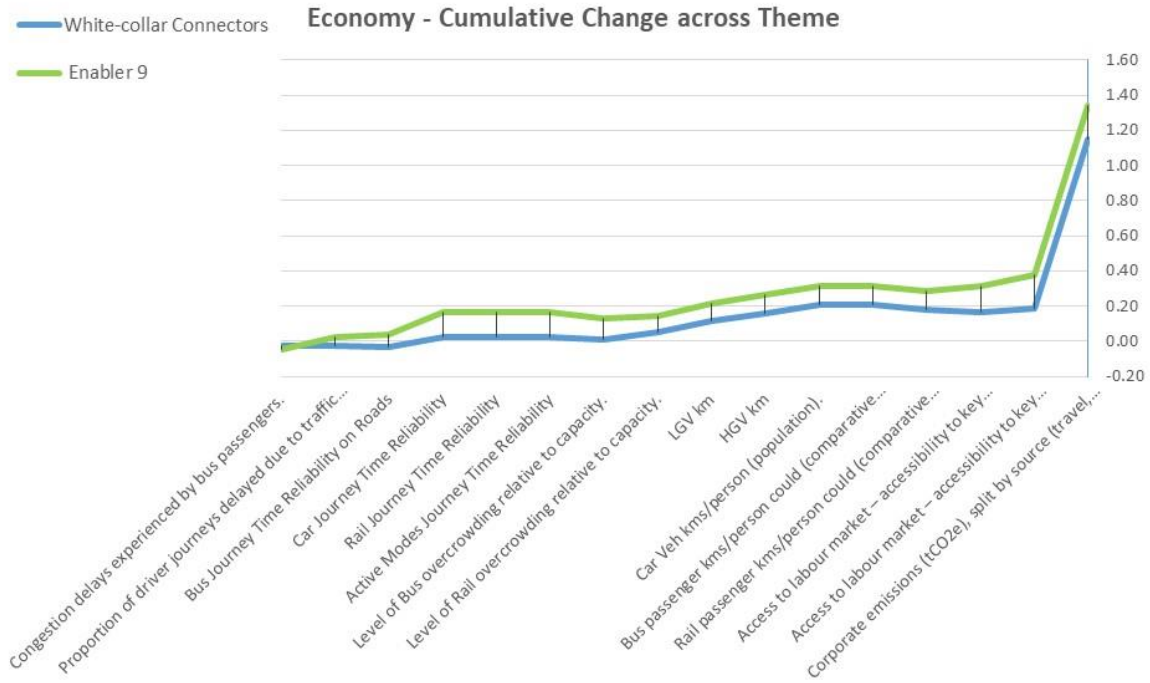


Figure 4. Economy - Cumulative Change across Theme Illustration

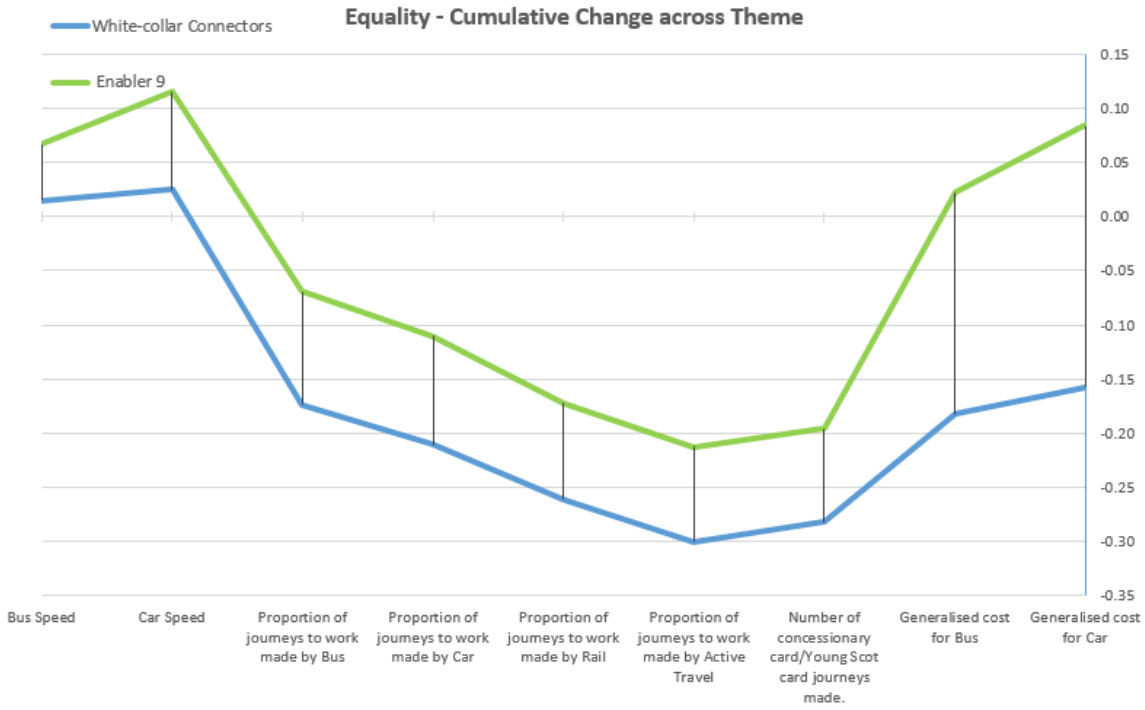


Figure 5. Equality - Cumulative Change across Theme Illustration

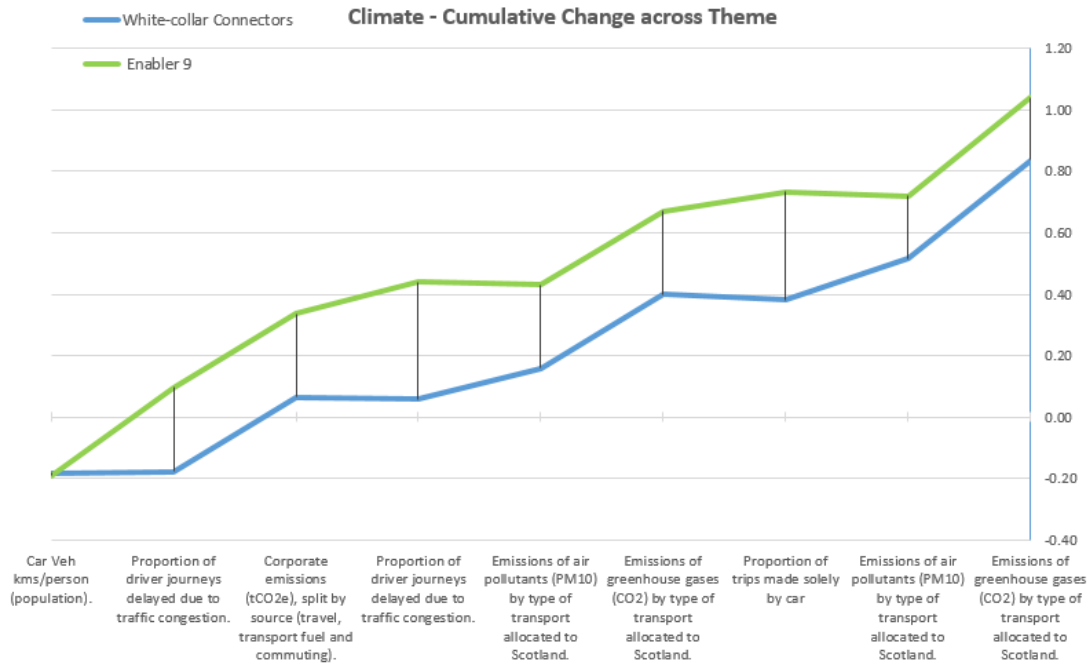


Figure 6. Climate - Cumulative Change across Theme Illustration

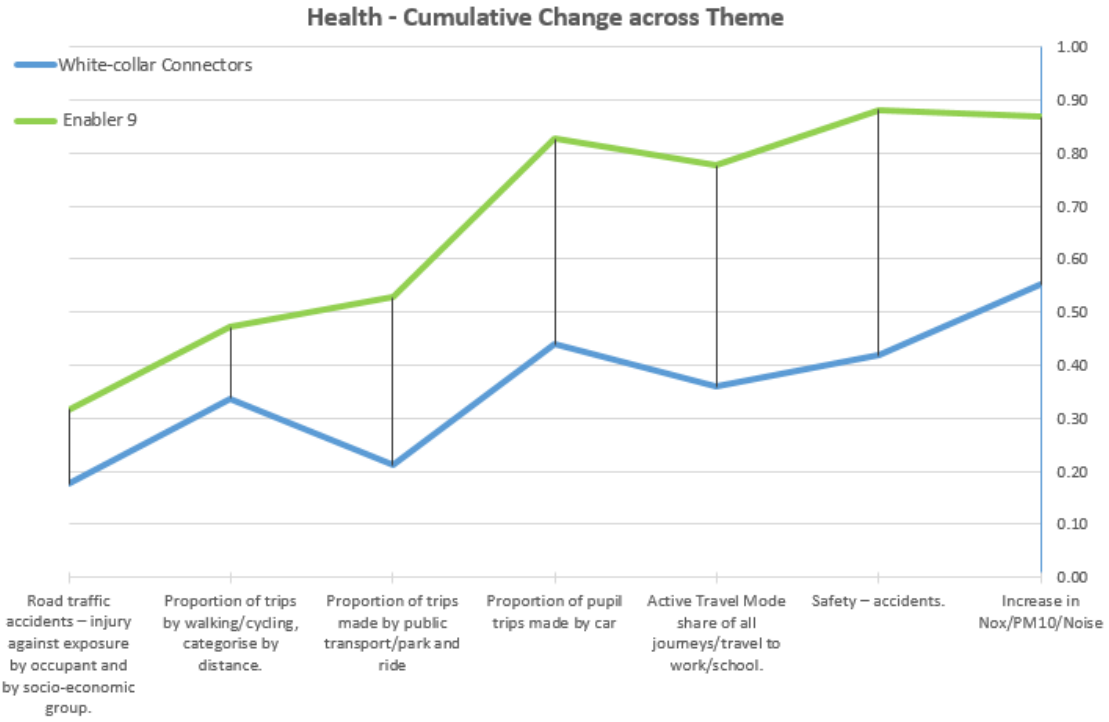


Figure 7. Health - Cumulative Change across Theme Illustration

4.6.8 The specific metrics are aggregated into each of the four NTS2 Themes and illustrated in Figure 8.

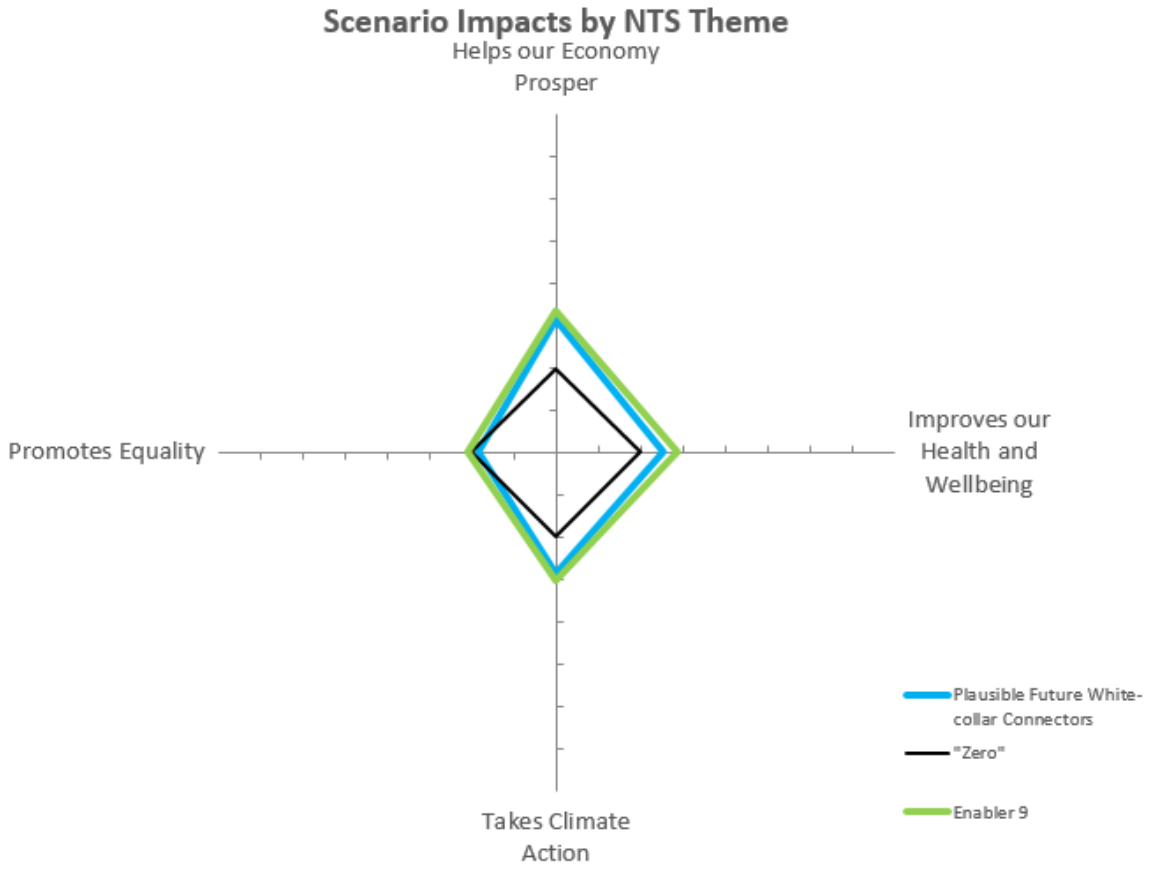


Figure 8. Cumulative Change across NTS2 Themes Illustration

4.6.9 The specific metrics are aggregated into each of the twelve NTS2 Outcomes and illustrated in Figure 9.

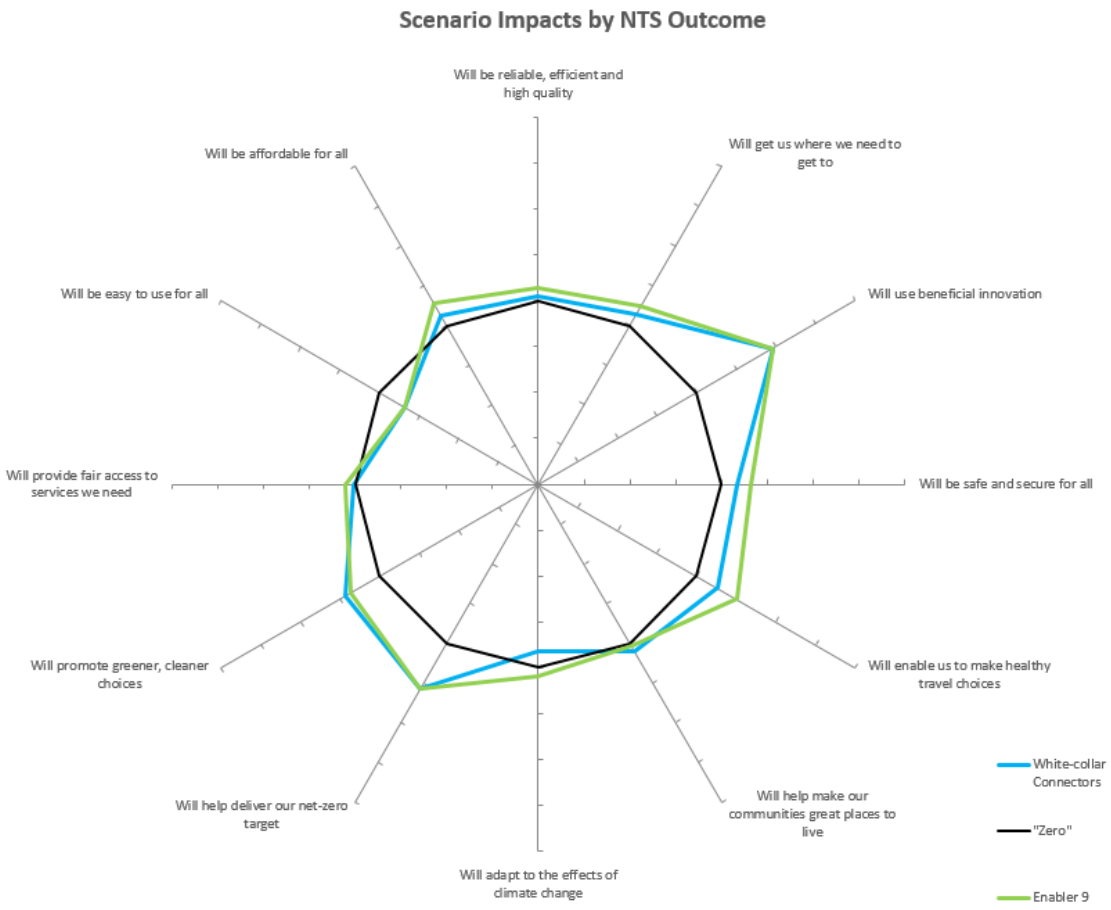


Figure 9. Cumulative Change across NTS2 Outcomes Illustration

4.7 User Manual

4.7.1 The Scenario Planning Tool User Manual is embedded within the Scenario Planning Tool

APPENDIX A - ELASTICITY SOURCES BY OUTPUT

A1 Congestion delays experienced by bus passengers (% of congested bus network)

Input	Congestion delays experienced by bus passengers. (% of congested bus network)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Bus Trips	No elasticity required for bus trips as any increase in passengers does not directly impact on the road network.
Rail Trips	No elasticity required for bus trips as any increase in passengers does not directly impact on the road network.
Active Trips	No elasticity required for bus trips as any increase in passengers does not directly impact on the road network.
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus km of congested bus network from TMfS12 AFS forecasting (2012-2037)

Table 1. **Congestion delays experienced by bus passengers (% of congested bus network)**

A2 Proportion of driver journeys delayed due to traffic congestion. (% of congested road network)

Input	Proportion of driver journeys delayed due to traffic congestion. (% of congested road network)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Bus Trips	No elasticity required for bus trips as any increase in passengers does not directly impact on the road network.
Rail Trips	No elasticity required for rail trips as any increase in passengers does not directly impact on the road network.
Active Trips	No elasticity required for active trips as any increase in walking/cycling does not directly impact on the road network.
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus km of congested network from TMfS12 AFS forecasting (2012-2037)

Table 2. **Proportion of driver journeys delayed due to traffic congestion. (% of congested road network)**

A3 Bus Journey Time Reliability on Roads (Punctuality % of Bus Journeys)

Input	Bus Journey Time Reliability on Roads (Punctuality % of Bus Journeys)
Working Population	Working population for the period 2010 to 2016 obtained from ONS labour market statistics annual population survey (30th June 2018) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Remaining Population	Remaining population for the period 2010 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required of walking/cycling does not affect JT reliability
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values). versus 2010- 2016 Punctuality Percentage, Stagecoach East Scotland Annual Report, 2017. Final elasticity value adjusted using judgement.

Table 3. **Bus Journey Time Reliability on Roads (Punctuality % of Bus Journeys)**

A4 Car Journey Time Reliability (Percentage of Delayed Journey Stages)

Input	Car Journey Time Reliability (Percentage of Delayed Journey Stages)
Working Population	Working population for the period 2010 to 2016 obtained from ONS labour market statistics annual population survey (30th June 2018) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2006-2015. Page 100
Remaining Population	Remaining population for the period 2010 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2006-2015. Page 100
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2006-2016 (%) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2006-2015. Page 100
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required of walking/cycling does not affect JT reliability
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2007-2015. Page 100
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2007-2015. Page 100
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2007-2015. Page 100
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS No.35, 2016 Edition: Percentage of car/van stages delayed by traffic congestion 2007-2015. Page 100. Final elasticity value adjusted using judgement.

Table 4. **Car Journey Time Reliability (Percentage of Delayed Journey Stages)**

A5 Rail Journey Time Reliability (Rail Punctuality %)

Input	Rail Journey Time Reliability (Rail Punctuality %)
Working Population	No elasticity required
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS No.35, 2016 Edition: 2006-2015. Page 120. Rail Punctuality: Public Performance Measure for all services
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	Rail trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2006-2016 (%) versus STS No.35, 2016 Edition: 2006-2015. Page 120. Rail Punctuality: Public Performance Measure for all services
Active Trips	No elasticity required of walking/cycling does not affect JT reliability
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS No.35, 2016 Edition: 2006-2015. Page 120. Rail Punctuality: Public Performance Measure for all services
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS No.35, 2016 Edition: 2006-2015. Page 120. Rail Punctuality: Public Performance Measure for all services
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS No.35, 2016 Edition: 2006-2015. Page 120. Rail Punctuality: Public Performance Measure for all services
Active Generalised Cost (ppk)	No elasticity required

Table 5. **Rail Journey Time Reliability (Rail Punctuality %)**

A6 Active Modes Journey Time Reliability (Active Travel % Reliability)

Input	Active Modes Journey Time Reliability (Active Travel % Reliability)
Working Population	No elasticity required
Remaining Population	No elasticity required
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	Estimated using anecdotal trends and sense checked
Car Generalised Cost (ppk)	No elasticity required
Bus Generalised Cost (ppk)	No elasticity required
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	No elasticity required

Table 6. **Active Modes Journey Time Reliability (Active Travel % Reliability)**

A7 Level of Bus overcrowding relative to capacity. (Increasing or Reducing)

Input	Level of Bus overcrowding relative to capacity. (Increasing or Reducing)
Working Population	Estimated using anecdotal trends and sense checked
Remaining Population	Estimated using anecdotal trends and sense checked
Car Trips	No elasticity required
Bus Trips	Estimated using anecdotal trends and sense checked
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Bus Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Rail Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Active Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked

Table 7. **Level of Bus overcrowding relative to capacity. (Increasing or Reducing)**

A8 Level of Rail overcrowding relative to capacity. (Increasing or Reducing)

Input	Level of Rail overcrowding relative to capacity. (Increasing or Reducing)
Working Population	Estimated using anecdotal trends and sense checked
Remaining Population	Estimated using anecdotal trends and sense checked
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	Estimated using anecdotal trends and sense checked
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Bus Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Rail Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Active Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked

Table 8. **Level of Rail overcrowding relative to capacity. (Increasing or Reducing)**

A9 LGV km (million veh/km)

Input	LGV km (million veh/km)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus LGV Veh km of from TMfS12 AFS forecasting (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus LGV Veh km of from TMfS12 AFS forecasting (2012-2037)
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	No elasticity required
Bus Generalised Cost (ppk)	No elasticity required
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	No elasticity required

Table 9. **LGV km (million veh/km)**

A10 **HGV km (million veh/km)**

Input	HGV km (million veh/km)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus HGV Veh km of from TMfS12 AFS forecasting (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus HGV Veh km of from TMfS12 AFS forecasting (2012-2037)
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	No elasticity required
Bus Generalised Cost (ppk)	No elasticity required
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	No elasticity required

Table 10. **HGV km (million veh/km)**

A11	Car Veh kms/person (population). (million veh/km/person)
Input	**Car Veh kms/person (population). (million veh/km/person)**
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Bus Trips	No elasticity required for bus trips as any increase in passengers does not directly impact on the road network.
Rail Trips	No elasticity required for rail trips as any increase in passengers does not directly impact on the road network.
Active Trips	No elasticity required for active trips as any increase in walking/cycling does not directly impact on the road network.
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population

Table 11. **Car Veh kms/person (population). (million veh/km/person)**

A12 Bus passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)

Input	Bus passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Car Trips	No elasticity required
Bus Trips	Bus trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) Versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS(2017): Vehicle Kilometres on Local Bus Services (2006-2017) / Total Population

Table 12. **Bus passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)**

A13 Rail passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)

Input	Rail passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus STS(2016): ScotRail PKM / Total Population
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS(2016): ScotRail PKM / Total Population
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	Rail trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) Versus STS(2016): ScotRail PKM / Total Population
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS(2016): ScotRail PKM / Total Population
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS(2016): ScotRail PKM / Total Population
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS(2016): ScotRail PKM / Total Population
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS(2016): ScotRail PKM / Total Population

Table 13. **Rail passenger kms/person could (comparative annual rates of how hard the network is working). (passenger kms)**

A14 Access to labour market – accessibility to key activities by Bus and by geography. (Public Service Buses per 1000 of population)

Input	Access to labour market – accessibility to key activities by Bus and by geography. (Public Service Buses per 1000 of population)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Remaining Population	Remaining population for the period 2008 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) Versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Bus Trips	Bus trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) Versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus DfT (2018): Number of Buses Used as Public Service Vehicles (Thousand)

Table 14. **Access to labour market – accessibility to key activities by Bus and by geography. (Public Service Buses per 1000 of population)**

A15 Access to labour market – accessibility to key activities by Car and by geography. (Usual Time Taken by Car to Travel to Usual Place of Work (minutes)

Input	Access to labour market – accessibility to key activities by Car and by geography. (Usual Time Taken by Car to Travel to Usual Place of Work (minutes))
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) STS (2017): Usual Time Taken to Travel to Usual Place of Work
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS (2017): Usual Time Taken to Travel to Usual Place of Work

Table 15. **Access to labour market – accessibility to key activities by Car and by geography. (Usual Time Taken by Car to Travel to Usual Place of Work (minutes))**

A16 Access to labour market – accessibility to key activities by Rail . (not used)

Input	Access to labour market – accessibility to key activities by Rail . (not used)
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 16. **Access to labour market – accessibility to key activities by Rail . (not used)**

A17 Access to labour market – accessibility to key activities by Active Travel. (not used)

Input	Access to labour market – accessibility to key activities by Active Travel. (not used)
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 17. **Access to labour market – accessibility to key activities by Active Travel. (not used)**

A18 Access to labour market – accessibility to key activities by Active Travel. (not used)

Input	Change in the demand for travel (not used)
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 18. **Access to labour market – accessibility to key activities by Active Travel. (not used)**

A19 Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))

Input	Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)

Table 19. **Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))**

A20 Road traffic accidents – injury against exposure by occupant and by socio-economic group. (Total Injury Accidents)

Input	Road traffic accidents – injury against exposure by occupant and by socio-economic group. (Total Injury Accidents)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.

Table 20. **Road traffic accidents – injury against exposure by occupant and by socio-economic group. (Total Injury Accidents)**

A21 Proportion of trips by walking/cycling, categorise by distance. (Proportion of Walking/Cycling Trips)

Input	Proportion of trips by walking/cycling, categorise by distance. (Proportion of Walking/Cycling Trips)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus Walking and Cycling Distance as Percentage of Total (STS, 2016, P202)
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus Walking and Cycling Distance as Percentage of Total (STS, 2016, P202)
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	Estimated using anecdotal trends and sense checked
Car Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Bus Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	Estimated using anecdotal trends and sense checked

Table 21. **Proportion of trips by walking/cycling, categorise by distance. (Proportion of Walking/Cycling Trips)**

A22 Proportion of trips made by public transport/park and ride (Proportion of trips made solely by PT, P&R)

Input	Proportion of trips made by public transport/park and ride (Proportion of trips made solely by PT, P&R)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Car Trips	No elasticity required
Bus Trips	Bus trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Mode Share (Scottish Transport and Travel 2016, w/ Census Data) P202

Table 22. **Proportion of trips made by public transport/park and ride (Proportion of trips made solely by PT, P&R)**

A23 Proportion of pupil trips made by car (Proportion of pupil trips made by car)

Input	Proportion of pupil trips made by car (Proportion of pupil trips made by car)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus % of School Children in private motorised travel(Hands Up Scotland Survey, Statistical News Release 24 May 2018)

Table 23. **Proportion of pupil trips made by car (Proportion of pupil trips made by car)**

A24 Active Travel Mode share of all journeys/travel to work/school. (%)

Input	Active Travel Mode share of all journeys/travel to work/school. (%)
Working Population	Working population for the period 2010 to 2016 obtained from ONS labour market statistics annual population survey (30th June 2018) versus Modal Share of all Journeys (STS: 2016, P195)
Remaining Population	Remaining population for the period 2010 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus Modal Share of all Journeys (STS: 2016, P195)
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	Usual means of travel to usual place of work: STS 2017, P191 versus Modal Share of all Journeys (STS: 2016, P195)
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus Modal Share of all Journeys (STS: 2016, P195)
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus Modal Share of all Journeys (STS: 2016, P195)
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values). versus Modal Share of all Journeys (STS: 2016, P195)

Table 24. **Active Travel Mode share of all journeys/travel to work/school. (%)**

A25 Safety – accidents. (reported accidents)

Input	Safety – accidents. (reported accidents)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Car Trips	Car trips proxied from STS N036 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus STS 2017, P104, Reported accidents by type of road and severity - All severity's.

Table 25. **Safety – accidents. (reported accidents)**

A26 Increase in NOx/PM10/Noise (NOx & PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))

Input	Increase in NOx/PM10/Noise (NOx & PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)

Table 26. **Increase in NOx/PM10/Noise (NOx & PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))**

A27 Car Veh kms/person (population). (million veh/km/person)

Input	Car Veh kms/person (population). (million veh/km/person)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Car Veh km from TMfS12 AFS forecasting (2012-2037) / population

Table 27. **Car Veh kms/person (population). (million veh/km/person)**

A28 Proportion of driver journeys delayed due to traffic congestion. (% of congested road network)

Input	Proportion of driver journeys delayed due to traffic congestion. (% of congested road network)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus km of congested network from TMfS12 AFS forecasting (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus km of congested network from TMfS12 AFS forecasting (2012-2037)

Table 28. **Proportion of driver journeys delayed due to traffic congestion. (% of congested road network**

A29 Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))

Input	Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)

Table 29. **Corporate emissions (tCO2e), split by source (travel, transport fuel and commuting). (Co2 (thousand tonnes))**

A30 Proportion of driver journeys delayed due to traffic congestion. (Proportion of driver journeys delayed due to traffic congestion.)

Input	Proportion of driver journeys delayed due to traffic congestion. (Proportion of driver journeys delayed due to traffic congestion.)
Working Population	Working population obtained ONS labour market statistics annual population survey (30th June 2018) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Remaining Population	Remaining population for the period 2006 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS12 primary forecasts (2012-2037) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Perceived Driver Journeys Delays (Transport and Travel, 2016 + STS, 2010)

Table 30. **Proportion of driver journeys delayed due to traffic congestion. (Proportion of driver journeys delayed due to traffic congestion.)**

A31 Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))

Input	Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)

Table 31. **Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))**

A32 Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))

Input	Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)

Table 32. **Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))**

A33 Proportion of trips made solely by car (Proportion of trips made solely by car)

Input	Proportion of trips made solely by car (Proportion of trips made solely by car)
Working Population	Working population for the period 2010 to 2016 obtained from ONS labour market statistics annual population survey (30th June 2018) versus Modal Share of all Journeys (STS: 2016, P195)
Remaining Population	Remaining population for the period 2010 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus Modal Share of all Journeys (STS: 2016, P195)
Car Trips	Car trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus Modal Share of all Journeys (STS: 2016, P195)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	Usual means of travel to usual place of work: STS 2017, P191 versus Modal Share of all Journeys (STS: 2016, P195)
Car Generalised Cost (ppk)	2001 - 2011 car generalised costs calculated from TAG Unit 3.5.6 Values of Time and Vehicle Operating Costs (2014) versus Modal Share of all Journeys (STS: 2016, P195)
Bus Generalised Cost (ppk)	2010 - 2016 Operating Cost per Passenger Journey (STS, 2017) versus Modal Share of all Journeys (STS: 2016, P195)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Modal Share of all Journeys (STS: 2016, P195)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values). versus Modal Share of all Journeys (STS: 2016, P195)

Table 33. **Proportion of trips made solely by car (Proportion of trips made solely by car)**

A34 Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))

Input	Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus PM10s obtained by application of the emissions factors toolkit (DEFRA)

Table 34. **Emissions of air pollutants (PM10) by type of transport allocated to Scotland. (PM10 (Annual Emissions (kg/yr except CO2 tonnes/yr)(thousands))**

A35 Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))

Input	Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Total CO2 obtained from TMfS12 AFS work (primary forecast) (2012-2037)

Table 35. **Emissions of greenhouse gases (CO2) by type of transport allocated to Scotland. (Co2 (thousand tonnes))**

A36 Bus Speed (Average Bus Speed km/hr)

Input	Bus Speed (Average Bus Speed km/hr)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Journey time per km calculated form TMfS12 AFS (Bus Speed)

Table 36. **Bus Speed (Average Bus Speed km/hr)**

A37 Car Speed (Average Car Speed km/hr)

Input	Car Speed (Average Car Speed km/hr)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Journey time per km calculated form TMfS12 AFS (Car Speed)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Journey time per km calculated form TMfS12 AFS (Car Speed)

Table 37. **Car Speed (Average Car Speed km/hr)**

A38 Journey time per kilometre for Rail

Input	Journey time per kilometre for Rail
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 38. **Journey time per kilometre for Rail ()**

A39 Journey time per kilometre for Active Travel

Input	Journey time per kilometre for Active Travel
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 39. **Journey time per kilometre for Active Travel**

A40 Proportion of journeys to work made by Bus (%)

Input	Proportion of journeys to work made by Bus (%)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Car Trips	No elasticity required
Bus Trips	Number of bus trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037

Table 40. **Proportion of journeys to work made by Bus (%)**

A41 Proportion of journeys to work made by Car (%)

Input	Proportion of journeys to work made by Car (%)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Car Trips	Number of bus trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037

Table 41. **Proportion of journeys to work made by Car (%)**

A42 Proportion of journeys to work made by Rail (%)

Input	Proportion of journeys to work made by Rail (%)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	Estimated using anecdotal trends and sense checked
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037

Table 42. **Proportion of journeys to work made by Rail (%)**

A43 Proportion of journeys to work made by Active Travel (%)

Input	Proportion of journeys to work made by Active Travel (%)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Car Trips	No elasticity required
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	Estimated using anecdotal trends and sense checked
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Commute trip proportions (by mode) extracted from TMfS14 Primary Forecasting 2014 - 2037

Table 43. **Proportion of journeys to work made by Active Travel (%)**

A44	Number of concessionary card/Young Scot card journeys made. (million)
Input	**Number of concessionary card/Young Scot card journeys made. (million)**
Working Population	Working population for the period 2010 to 2016 obtained from ONS labour market statistics annual population survey (30th June 2018) versus DFT Bus Costs-Concessions - Number of Concessionary Journeys Made (million)
Remaining Population	Remaining population for the period 2010 to 2016 obtained from NRS 2017 mid-year population statistics minus ONS labour market statistics annual population survey (30th June 2018) versus DFT Bus Costs-Concessions - Number of Concessionary Journeys Made (million)
Car Trips	No elasticity required
Bus Trips	Bus trips proxied from STS No36 2017 edition, page 191, Usual means of travel to usual place of work (in Autumn) 2010-2016 (%) versus DFT Bus Costs-Concessions - Number of Concessionary Journeys Made (million)
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	No elasticity required
Bus Generalised Cost (ppk)	No elasticity required
Rail Generalised Cost (ppk)	No elasticity required
Active Generalised Cost (ppk)	No elasticity required

Table 44. **Number of concessionary card/Young Scot card journeys made. (million)**

A45 Generalised cost for Bus (ppk)

Input	Generalised cost for Bus (ppk)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Car Trips	No elasticity required
Bus Trips	Number of bus trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)

Table 45. **Generalised cost for Bus (ppk)**

A46 Generalised cost for Car (ppk)

Input	Generalised cost for Car (ppk)
Working Population	Working population obtained from TMfS12 AFS work (primary forecast) (2012-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Remaining Population	The remaining population (all excluding working) obtained from TMfS12 AFS work (2012-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Car Trips	Number of car trips obtained from application of NTEM 6.2 trip rates to TMfS14 primary forecast population input files (2014-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Bus Trips	No elasticity required
Rail Trips	No elasticity required
Active Trips	No elasticity required
Car Generalised Cost (ppk)	Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Bus Generalised Cost (ppk)	Bus generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Rail Generalised Cost (ppk)	Rail generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)
Active Generalised Cost (ppk)	Active generalised cost uses the bus as a proxy (WebTAG has very similar values) versus Car generalised cost obtained from a 12 Hour weighted average cost skim from TMfS14 primary forecasting (2014-2037)

Table 46. **A45 Generalised cost for Car (ppk)**

A47 Generalised cost for Rail (ppk)

Input	Generalised cost for Rail (ppk)
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 47. **Generalised cost for Rail (ppk)**

A48 Generalised cost for Active (ppk)

Input	Generalised cost for Active Travel (ppk)
Working Population	no elasticities calculated due to lack of information available
Remaining Population	no elasticities calculated due to lack of information available
Car Trips	no elasticities calculated due to lack of information available
Bus Trips	no elasticities calculated due to lack of information available
Rail Trips	no elasticities calculated due to lack of information available
Active Trips	no elasticities calculated due to lack of information available
Car Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Bus Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Rail Generalised Cost (ppk)	no elasticities calculated due to lack of information available
Active Generalised Cost (ppk)	no elasticities calculated due to lack of information available

Table 48. **Generalised cost for Active Travel (ppk)**

APPENDIX B – PLAUSIBLE FUTURES

Plausible Future 1: "Healthy & Wealthy"

As a nation, we have taken on board the growing public health concerns surrounding levels of obesity, deteriorating mental health, and the effects of poor air quality, especially on the very young and vulnerable. Reporting in the media, as well as social and political messaging, has prompted us as a society to make healthier travel choices. We are also much more conscious of the need to try to limit further climate change by making our lifestyles more sustainable.

This has resulted in a very large surge in the numbers of people walking and cycling, and a move away from vehicular travel. The way we organise our lives and the way we use our land have changed, making it far easier to move about on foot or by bike.

Scotland has invested in upskilling its workforce: innovation in the economy means that there is less commuting, and less business travel, and more people are working in high skill, high pay jobs that are not location specific. One in four people now walk or cycle to work, and the numbers of people working from home has also increased. Employees are more productive, and sickness absence rates have dropped. Last mile deliveries are undertaken either by cargo-bike, or by drones.

This shift in travel behaviours means that people are much less likely to buy a car, and instead make use of public or car club autonomous vehicles, which are by now almost entirely electric. Our prospering economy has led to investment in a high quality, efficient transport network which allows us to travel round quickly, easily, and at a relatively low cost – while more short journeys are made actively, the shift away from car use has meant the public transport network for journeys over 5 miles is well used. Time lost to congestion has decreased.

This greater affluence, and shift to healthier means of travel has translated into less demand on our health services, even though we still have the challenges that come with an ageing society. The average percentage of disposable income spent on travel and transport has fallen.

The availability of electric bikes help make cycling more accessible, and more mainstream, though people who are old or who have a disability are still less likely to cycle than the general population.

Our towns and cities feel cleaner, and more liveable; air quality is greatly improved on 2018 levels, and the growth in energy consumption has been constrained. We have continued to invest in our renewable energy resources, and have strong and robust energy supply capacities. CO2 emissions have fallen to less than 23 million tonnes.

We understand that much more still needs to be done to arrest the damage being caused by climate change, but we are moving in the right direction, and without any economic harm.

Plausible Future 2: "Mindful travellers"

There have been many changes to the social landscape. The goal of economic growth, while greatly progressed by automation, is now more strongly counter-balanced by an urgent understanding of the need for environmental sustainability.

Greater automation led to a rebalancing of the economy, and after a period of turbulence Scotland has succeeded increasing its productivity to the extent that we enjoy both an increase in our GDP, and a decrease in the average number of hours per week we work. These circumstances, combined with an ageing population, have led to a more leisured society. There has also been a reverse in the trend to conduct so much of our lives online – people prefer face-to-face interaction with their friends and families, and local shops and businesses. These factors have together created an increase in the demand for discretionary personal travel, particularly for short to medium distance journeys.

However, as we are much more aware of the impact our travel decisions have on the environment, we now give more thought to how we travel. We are also conscious of the benefits of active lifestyles for physical and mental well-being. The rise in demand for travel has therefore translated into a surge in walking and cycling. Overall, these attitude shifts have led to a much smaller-than-forecast increase in car ownership.

Greater numbers of people make use of public or car club autonomous vehicles, which by now are almost entirely electric. A large fleet of public autonomous vehicles mean that people who would previously have been excluded from car travel either by income, age or disability can now enjoy the benefits of car use. The rise in the demand for personal travel also extends to public transport – the decline in the number of bus journeys has been reversed, and rail travel is enjoying steady growth. Public autonomous vehicles provide connectivity to the public transport network for those that need it. The demand for travel has driven strong growth in Mobility as a Service.

The surge in levels of walking and cycling, combined with the electrification of the car fleet and transport network, have resulted in great progress towards decarbonising land-based transport in Scotland. Also, with fewer emissions from our travel and transport, urban air quality is much improved. Congestion is still a problem, but in a slower-paced society the value of time receives less focus, and people travelling in AVs are able to work while in traffic. Our towns and cities are more liveable, and feel more connected.

Plausible Future 3: “Cyber-Ecos”

Scotland has embraced digital technology, and the beneficial innovations they bring. Scotland is an innovation leader across a number of sectors. Artificial intelligence and the Internet of Things has altered the shape of our lives: less time is needed for household management, for example, and more people are working a reduced working week, and either working from home, or hotdesking.

There are more opportunities than ever before to access the labour market, though the level of commuter trips has dropped markedly. The pattern of working is more flexible and entrepreneurial, though also less stable. Overall, national economic productivity has increased relative to our neighbours, and we enjoy a good quality of life.

The drop in commuting means that people spend more time (and money) in their own local communities – former commuter belt “dormitory towns” have started transforming, with more amenities appearing for the people who live there. Towns and cities feel cleaner, greener, and more people-friendly – though the numbers of people undertaking more activities online also means that there is a greater risk of social isolation for some. The elderly, in particular, sometimes feel alienated from this technological new world that has changed so much from when they were young; and low

income people can feel excluded from the opportunities offered by the more cutting edge technologies, which remain expensive.

Work, entertainment, shopping and socialising, even remote healthcare, can all be undertaken from the home, to the extent that there has been a drop in journeys made across all modes. Drones are now regularly used for deliveries. The increase in automation, combined with the decrease in walking and cycling even for short journeys, means that Scotland is still tackling the problem of obesity. We lead less active lives, and the trend for increasing life expectancy is beginning to fall back.

Surprisingly, this uptake of new technologies has been less pronounced with regard to autonomous vehicles. Manually controlled vehicles still make up the majority of the private car fleet. Cars are more affordable; and energy is plentiful and cheap, thanks to investments in renewable energy and improvements to the energy transmission network. The in-depth use of data means that Mobility as a Service has really taken off as a concept, and is embedded now in the way we travel. We rely on travel information to help us make efficient route and departure-time choices.

We are now more conscious of the need to limit or reduce the environmental impact of our lifestyles. While automation, superspeed broadband and the Internet of Things consume a lot of energy, this is more than offset by the reduction in travel. Electrification of the car fleet and transport network means that transport-related emissions have fallen very sharply – Low Emissions Zones have been re-drawn to encompass the areas of heavy industry.

Plausible Future 4: "Top Gear"

In this scenario, Scotland has not redressed the imbalance between economic growth and environmental sustainability, with growth still prioritised. In this, we have been successful: we have invested in upskilling our workforce and gained a competitive edge in high-value knowledge sectors. Overall, our economy is growing strongly - though there is now greater inequality between those who work in the creative and knowledge economies, and those who either work in low-skilled jobs, or jobs where humans now have to compete with ever smarter robots.

The uptake of autonomous vehicles has been slower than anticipated, with manually controlled vehicles still predominating, though these are almost all electric. The overall rise in GDP means that more people can fulfil their desires to travel, enjoy more leisure activities, etc. Car ownership has grown more strongly than expected, and the total road traffic volume has increased. Rail travel is also still growing, and the decline in bus patronage has reversed. Most of the transport network is now electrified, and combined with the increased consumption of energy that comes with a thriving economy, our energy grid is struggling to cope with demand. Energy costs have seen above-inflation increases, and vehicle charging speeds slow down noticeably during times of peak demand.

At a local level, transport emissions have been almost totally eradicated, and urban air quality is vastly improved. However, our demand for energy is high (much more than can be met by renewable sources); and the upgrade of the general fleet to electric has created a boom in bus and car production (in the UK?). Even though more flexible working patterns allow periods of peak travel demand to be smoothed out, congestion is nonetheless an acute problem in towns and cities at rush hour, and the transport network has not been developed to adapt to this.

In short, we are a clever, busy society – working hard, playing hard – and while most of us enjoy more prosperous lives, there are some drawbacks.

Plausible Future 5: "Straitened stay-homers"

Scotland has slipped down the international league tables for economic growth and GDP, unemployment has risen, and we have entered into recession. Productivity is lower, and as a society we have struggled to respond to increasing automation in a way that is beneficial for all walks of life.

The faltering economy leads to a reduced demand for travel: there is less commuting, less business travel, fewer movements of goods, fewer discretionary trips. On a positive note, this leads to less congested roads, and less consumption of goods; on a negative note, investment in transport stalls, and the quality of the transport network and transport services gradually deteriorates, leaving the system less reliable, less efficient, and less innovative.

People are less likely to replace their car – electric cars are generally imported, and expensive to buy or lease – but make use of public or car club autonomous vehicles instead. The recession notwithstanding, there is a plentiful energy supply, and electric vehicles are cheap to run, to the extent that people are less likely to walk or cycle when they can take an autonomous car, or bus.

A combination of reducing disposable income, and lower levels of active travel means that there is a slight decline in the health of the general population, and there is less money to invest in preventative public health care, or public health messaging.

Plausible Future 6: "White-collar Connectors"

Due to an institutional and social landscape supportive to innovation, Scotland is an innovation leader across a number of sectors. More of us are working in highly skilled, highly remunerated jobs which require professional knowledge, critical or creative thought, and ready access to information.

This type of work does not require as many people to travel to an office, business centre or industrial site - more of us can work from home or elsewhere. Moveover, the embrace of digital technology eliminates a lot of need for business travel. Many jobs and activities can be automated. More of us are able to fit work into our lives in a way that is more convenient for us, and may not even need to live in or close to the cities where our employers may be based.

The level of commuter miles travelled drops substantially. Peak hour congestion remains manageable. By now, electric vehicles are the norm; this has vastly improved air quality and reduced CO2 emissions. Our cities are cleaner, greener, and more pleasant to visit and live in. There has been a marked reduction in the number of people suffering from respiratory conditions.

The combination of increased homeworking / smartworking, and increased use of artificial intelligence leads to workplaces being smaller. Shops have smaller in-store inventories due to online shopping and the use of data to manage stock control, so retail space also starts to shrink. Together, these factors begin to have a knock-on effect on land-use planning.

With inner cities now cleaner and greener, they have become more attractive places to live, and we see denser levels of residential housing in town and city centres. There is a degree of urban regeneration. This, coupled with a much greater awareness of need to limit the impact of our activities on the environment, means that we see reduced travel demand across all modes, but especially in the demand for car travel.

More of us may decide that we don't need to replace our car (especially when self-driving / car club cars are available), to the extent that car ownership levels do not increase by as much as was anticipated. Autonomous vehicles make up a major share of Scotland's car fleet. The use of digital technology enhances travel for many, though some people who are not tech-savvy do sometimes feel excluded from the range of travel information and services available.

Smart, data-driven energy management systems means that energy demand in Scotland can be efficiently met. Energy is plentiful, and affordable, relative to earlier expectations.

Plausible Future 7: "Multi-modal movers"

There has been an energy revolution in Scotland. Great strides forward have been made in harnessing and storing energy from renewable energy sources. Suppliers have invested in upgrading infrastructure, and there is now a smart, robust energy transmission network.

Our transport network, with the exception of the ferry system, is now almost wholly electrified – cars, buses, trains all run now on electricity. Reduced costs mean that there is now a clear business case for public transport services that were previously unviable or marginal public transport services. We have made great progress in addressing transport inequalities, and more people than before have ready access to opportunities for employment, education and leisure. Previously poorer air quality areas all too often overlapped with areas of social deprivation, and this health equality gap has now been closed. The quality of the air we breathe in our towns and cities has much improved: Low Emission Zones are now largely redundant.

The cheap and plentiful supply of energy, and the resolution of local environmental issues, has unleashed a latent demand for more travel. There has been a growing recognition of the drawbacks of using digital technology to replace physical interactions – increased loneliness, internet addition, cyber security issues, reduced productivity, obesity, etc, so we are now keener to see our friends, family, clients, colleagues, etc, face to face more often. As a society, we are careful to try to harness digital technology to free up more time for meaningful activities IRL, and we understand the importance of leading active lives.

We choose between all modes to transport when we travel – levels of walking, cycling, public transport, and private or shared car use have all grown, with the result that there is an increase in congestion at peak times, and at sensitive junctions.

The uptake of autonomous vehicles has not been as rapid or as widespread as we anticipated, as manual cars are still more affordable, and people are still choosing to buy them for their households.

Plausible Future 8: “Cyber-boomers”

Scotland’s population is growing. Through a combination of rising birth rate, increasing life expectancy, and immigration, there are more people of all ages in our society. More children in school, a larger workforce, a high number of retired people – there are more essential trips across the transport network for education, work, healthcare, etc.

Despite warnings about the need to rein in our energy-hungry lifestyles, we continue to use large amounts of electricity. The government has been struggling to make the shift over to renewable energy, and this is putting strain on the transmission network. Supplier costs rise significantly, and these are passed on to the customer, which means that gas and electricity costs, and public transport fares, rise well above inflation. At times of peak demand, electric vehicle charging times are slower.

This hike in prices impacts on our levels of disposable income, and means that we are making fewer non-essential journeys, but the fact that the population has grown considerably means that there is still strain on the transport network. People, particularly those on lower incomes, find increased transport costs a real strain on the household budget, as travel now eats up a greater percentage of disposable income.

To some degree, the reduction in physical mobility caused by the energy price increase is countered by an increase in the use of digital technology. Developments continue to reduce our need to make physical journeys – more remote working, more use internet shopping, and holography for social and professional interactions.

SYSTRA provides advice on transport, to central, regional and local government, agencies, developers, operators and financiers.

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