# The Speed Limit Appraisal Tool: User Guidance

January 2013

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# Ministerial Foreword

Setting the right local speed limits is vital for road safety, local growth and local health outcomes. It is vital that speed limits are suitable for local conditions and local authorities are best placed to develop solutions that suit their communities, working in conjunction with law enforcement agencies and taking on board the views of the community they serve.

This speed limits appraisal tool will help councils assess the full costs and benefits of any proposed local speed limit schemes. As well as casualties and other traffic effects, we have made particular efforts to build into the tool effects that cannot be monetised, such as those that enhance quality of life.

I am grateful to those local authorities who contributed and provided input, as well as to the members of the Speed Limit Appraisal Tool Steering Group.

**Stephen Hammond**

# Executive summary

1. In the Strategic Framework for Road Safety (DfT, May 2011) the Department for Transport announced that it would update speed limit guidance to help local authorities to improve safety on their roads. It also announced that it would provide a new speed limit appraisal tool, hosted on the DfT website, to help local authorities assess the full costs and benefits of any proposed schemes. These together will help councils make evidence-based decisions to introduce local speeds that reflect the needs of all road users. Following a consultation, the guidance 'Setting Local Speed Limits' has been revised and re-issued as Department for Transport Circular 01/2013.

2. The tool has therefore been designed to enable local highway authority officers and other professionals to:

   - forecast mean and 85th percentile speeds for speed limit changes;

   - forecast changes to: journey times separately for business and personal users; vehicle operating costs including fuel; accidents by severity; $CO_2$ emissions; and $NO_X$ emissions; and

   - appraise changes in speed limits to 20mph, 30mph, 40mph, 50mph, 60mph and, on dual carriageways, 70mph.

3. The tool aims to introduce transparency in the decision making process. It also provides a facility that encourages local highway authorities to adopt a more consistent appraisal process, whilst still allowing the flexibility for the highway authority to take into account local road conditions and the surrounding environment.

4. The User Guidance has been produced to provide:

   - instructions on how to run the appraisal tool, and

   - an informative practical guide to the assessment of a range of aspects that local authorities should consider when planning to introduce a change in speed limits.

5. The User Guidance should be read in conjunction with DfT Circular 01/2013, which sets out our policies on setting local speed limits on single and dual carriageway roads in both urban and rural areas.

6. The Tool has been developed to be straightforward to operate and provide informative outputs that can be flexibly interpreted in the context of the local highway authority's requirements. At its basic level, it does not call for specialist skills such as demand modelling and environmental analysis.

7.  The Guidance describes how the Tool deals with those aspects of speed limit changes that can be quantified, such as accidents, journey time savings and $CO_2$ emissions, and those that presently cannot be quantified because of a lack of evidence, such as journey time reliability, modal shift and impacts on public anxiety.

8.  Reference is made throughout the document to current DfT guidance and relevant WebTAG[1] units to help the user compile the data that is required to run the tool and to guide the user to more detailed information, should this be required.

9.  A section is included on Preparing for an Appraisal. This has been included to provide the user with guidance on preparing the data that would be required for running the tool.

10. The user is then taken through the mechanics of installing and operating the tool, including some of the basic concepts and terminologies, and how to set up directories for storing and retrieving data.

11. The Tool outputs are presented automatically in four Excel table formats that show economic impacts (i.e. Present Value Cost and Present Value Benefits) and other quantifiable impacts (e.g. Before Speeds and After Speeds). Provision exists for non-quantified information also to be presented in both the data entry tables and the output reporting tables.

12. The set of four output spreadsheets should be considered as a starting point for developing the appraisal into a case that can be readily understood and appreciated by a range of people, and which reflects wider considerations than the quantitative values that the Tool provides.

13. Details on how the relationships that are used in the tool were developed are set out in an annex to the document, enabling the reader to gain an understanding of the background calculations that the Tool is performing.

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[1] The Department for Transport's Web-based Transport Analysis Guidance on the conduct of transport studies http://www.dft.gov.uk/webtag/

# 1. Background

**1.2**    The Department for Transport has re-issued guidance on setting local speed limits (DfT Circular 01/2013) with the aim of increasing flexibility for local highway authorities. In conjunction with the release of this revised guidance, it has also provided a speed limit appraisal tool, hosted on the DfT website, that will enable local highway authorities to assess the full costs and benefits of introducing a change in speed limits and make robustly defensible decisions on whether or not to introduce them. The tool has been developed for the Department by Hyder Consulting, in association with John Fearon Consultancy and Minnerva.

**1.3**    The purpose of the tool is to enable local highway authority officers and other professionals to:

- forecast mean and 85th percentile speeds for speed limit changes;

- forecast changes to: journey times separately for business and personal users; vehicle operating costs including fuel; accidents by severity; $CO_2$ emissions; and $NO_X$ emissions[2]; and

- appraise changes in speed limits to 20mph, 30mph, 40mph, 50mph, 60mph and, on dual carriageways, 70mph.

**1.4**    The tool has been developed to be straightforward to operate and provide informative outputs that can be flexibly interpreted in the context of the local highway authority's requirements.

**1.5**    It focuses on the specific issues relating to speed limit change and, at its basic level, does not call for specialist skills such as demand modelling and environmental analysis.

**1.6**    The outputs produced by the tool are quantitative and are presented in four formats:

- Transport Economic Efficient (TEE) tables

- An Appraisal Summary Table (AST)

- An Objective Analysis Table

- A Link Impacts Table

**1.7**    However, the Department recognises that there are many aspects of changing speed limits that cannot currently be quantified by the tool, for

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[2] The economic values of these effects are in accordance with Government valuations current at the time of publication.

example improved ambience and modal shift. This is because there is insufficient evidence at present to develop a supportable relationship.

1.8 The tool has therefore been designed to allow for various 'non-monetised' conditions pre- and post- change of speed limits to be recorded. In this respect, the Department encourages local highway authorities to undertake programmes of data collection and monitoring of these conditions to produce further evidence that may be used to develop more relationships for incorporating into future versions of the Tool. References to Departmental guidance on the appraisal of some of the non-monetised benefits that could be associated with changing speed limits are provided throughout this User Guidance.

1.9 The outputs of the tool are therefore intended as a starting point for developing the appraisal into a case that can be readily understood and appreciated by a range of people, and which reflects wider considerations than the quantitative values that the Tool provides. Users of the Tool are therefore encouraged to apply the economic evaluations produced by the tool, not as a definitive answer as to whether or not the speed limit change should be introduced, but as a means of informing the appraisal process, which should consider both the monetised and non-monetised benefits.

1.10 Local highway authorities therefore still have the flexibility to appraise a potential scheme if it considers local non-monetised benefits to be more important than a possibly adverse monetised benefit. For example, an improvement in the quality of life in a deprived residential area or a depressed high street may outweigh the disbenefit of increasing travel times by slowing and diverting traffic.

1.11 In order to develop the tool, a four-stage process was adopted comprising:

- A review and gathering of relevant information, ranging from Local Authorities in the UK and sources throughout Western Europe and Nordic countries.

- A Call for Evidence inviting contributions from researchers and other organisations working in the field to better understand the state of the existing evidence base on the impacts of speed limit changes, particularly in terms of changes in actual speeds, but also encompassing wider impacts such as traffic diversion/suppression, accidents, emissions, noise, journey time reliability, mode shift, severance and quality of life.

- Based on the findings from 1 and 2 above, the development of relationships between:

    i. speed limit changes and actual speed changes

    ii. actual speeds and $CO_2$ plus $NOX$ emissions

    iii. actual speed changes and accident/casualty rate changes (including by casualty severity).

- <u>Development of the tool</u> using Ruby, which is an open-source programming language that is fully object orientated to support and encourage good programming practices.

**1.12** Further information on the development of the relationships and the calculations performed by the Tool can be found in Annex A.

# 2. Tool Features

## Quantified Effects

**Overview**

2.1 The tool is able to explicitly deal with quantifiable effects for nine speed limit types as follows:

    a. Urban 20 mph with no traffic calming;

    b. Urban 20 mph with traffic calming[3];

    c. Urban 40 to 30 mph;

    d. Village 40 to 30 mph;

    e. Village 60 to 30 mph;

    f. Village 60 to 40 mph;

    g. Rural single carriageway 60 to 50 mph;

    h. Rural single carriageway 60 to 40 mph; and

    i. Rural dual carriageway 70 to 40 mph.

2.2 It is also able to deal explicitly with reversals of all the above speed limit types.

2.3 Other speed limit changes not listed above (e.g. village 20mph) can be appraised using the tool, but it should be noted that there were no observations available for such cases when the forecasting relationships were developed. The program will give a warning in such cases and the Tool will default to using relationships for the most appropriate change for which relationships are available.

2.4 Effects which are quantified in the tool are changes in:

    a. Speed, both for mean and 85th percentile speed;

    b. Traffic flows;

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[3] The change to 20mph would usually be from a 30mph limit, but this is not actually a requirement of the tool.

     c. Accidents;

     d. Travel Time;

     e. Vehicle Operating Costs;

     f. $CO_2$ Emissions; and

     g. NOx Emissions.

**2.5** The tool forecasts speed changes between before and after the imposition of the proposed speed limit. The user is required to forecast any changes in traffic flows on links. All the other changes are estimated based on the calculated changes in mean speed and the traffic flows specified by the user[4]. Based on these changes and using standard WebTAG parameters the annual cost savings due to each type of change are calculated. These costs are then discounted. The tool advises a 10 year scheme appraisal period and hence discounts the costs over the 10 year period to give a Present Value of Benefit (PVB). However, this appraisal period is not mandatory and different appraisal (and associated discounted) period may be used. The maximum future year is 2035.

**2.6** The above calculations are undertaken for individual highway links as defined by the user and for the scheme as a whole.

**2.7** The user needs to input the capital and on-going costs of the scheme. These are discounted over the 10 year scheme appraisal period to give a Present Value of Cost (PVC).

**2.8** The quantification of each of the above is outlined in the following sub-sections.

**Speeds**

**2.9** For each speed limit type, the tool contains relationships that forecast the after mean speed from an observed before mean speed. These relationships and their parameters, which are based on before and after data, are detailed in Annex A.

**2.10** Where the before mean speed is below the proposed speed limit, the imposition of a speed limit may result in the tool forecasting an increase in speed. Conversely, where the speed is low, removal of the limit may result in the tool forecasting a reduction in speed. These effects are based on the observed data used in the development of relationships. To address this issue, the tool has a user-defined option that allows speed changes to be capped such that a speed limit cannot increase mean speeds and the removal of a speed limit cannot reduce them.

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[4] If the user does not specify a change in flows, the tool will assume the same flows in the before and the after.

**2.11** The tool also contains relationships that forecast the after 85th percentile speed based on the before observed 85th percentile speeds. These relationships are also described in Annex A.

## Traffic Flows

**2.12** For each link the user needs to input annual average daily (AADT) traffic flows. This is the annual traffic flow for the scheme base year divided by 365 (days).

**2.13** As a default the tool assumes that the traffic flows are the same before as after the speed limit. However, the user may define a proportion of traffic to be diverted by the speed limit.

**2.14** It is necessary to split the AADT flow by vehicle type (car, LGV, OGV1, OGV2 and PSV). If the user defines the region and area type the tool selects the appropriate vehicle type shares from the Road Traffic Forecasts (RTF). Alternatively the user may define vehicle type shares based on local data. The vehicle type shares are applied equally over all links.

**2.15** Traffic growth will occur between the traffic base year and each scheme year i.e. each year in the appraisal period. If the user defines the region and area type the tool will calculate growth from the RTF forecasts by vehicle type. Alternatively the user may define local growth factors based for example on a local transport model.

**2.16** Although the tool does not calculate the impact of speed changes on modal shift, the user has the option of recording pedestrian and cycling movements for each link in the study.

## Accidents and Casualties

**2.17** Users need to define the annual number of personal injury accidents (PIA) on each link for the traffic base years. If the user defines whether the scheme is urban or rural (for this purpose urban is defined as an area with a population of over 10,000), the road type Road Accident Statistics (RAS) tables will be used by the tool to determine the proportions of PIA by severity (fatal, serious and slight). Alternatively the user may define local proportions by severity but this must be based on statistically significant data i.e. data for a period which is sufficiently long to make the estimates of numbers of accidents by severity reliable.

**2.18** The tool estimates the number of damage only accidents based on relationships used in COBA (COBA Manual Part 2 Table 3/1).

**2.19** Changes in accidents are forecast from the change in speeds between the before and after cases, using functions developed by Rune Elvik[5].

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[5] The Power Model of the Relationship Between Speed and Road Safety, Rune Elvik, TOI Report 1034/2009, Norwegian Institute for Transport Economics

These functions, which are detailed in Annex A, forecast changes in accidents by severity. There are separate functions for urban and rural areas, which are applied based on the speed limit type. For PIAs, the functions predict that the greater the severity of accidents the larger the reduction in relation to reduced speed. For fatal and serious accidents for any given speed changes accident numbers reduce more in rural areas than urban areas. As the functions include the effect of traffic diversion, any user coded traffic diversion will not affect the numbers of accidents.

2.20    PIA accident rates have been reducing over time. To reflect this trend the tool applies accident reduction factors by year over the appraisal period. These are derived from Table 4/1 of Part 2 of the COBA Manual. The user needs to define the COBA Accident Road Type to select the factors to be used. These trends are used with forecast traffic growth to forecast the numbers of accidents by year for each year in the scheme appraisal period.

2.21    Where a speed limit scheme reduces speeds, the tool will always forecast reductions in accidents. Conversely, where speeds increase, accidents are also forecast to increase.

2.22    For economic evaluation, values of the prevention of accidents by severity by urban and rural areas are taken from WebTAG 3.4.1 Table 4a. These costs are assumed to increase in line with the forecast growth in GDP per household as defined in Table 3a of the same document.


**Time Savings**

2.23    Time savings relate to occupants in vehicles which will travel along the links to which speed limits are to be applied. This aspect of appraisal is defined in WebTAG 3.5.6.

2.24    The first stage of defining the time savings is to define the vehicle type split as discussed in paragraph 2.14.

2.25    The shares by trip purpose (work, commuting and other) must be defined for the traffic base year for car, LGV and PSV. Where local values are available for the study area the user may code these. Otherwise shares from Table 7 of WebTAG 3.5.6 are used.

2.26    Vehicle occupants by vehicle type and trip purpose must be defined for the traffic base year. The user may code local values. Otherwise values from Table 4 of WebTAG 3.5.6 are used.

2.27    It should be noted that both the user coded purpose splits and the occupancy values must be annual averages. Reliable data for these is only likely to be available if a strategic transport model has been developed which covers the study area.

2.28    Nationally, car occupancies are forecast to decline. The tool takes account of this by applying the trends from Table 6 of WebTAG 3.5.6.

**2.29** For appraisal, market values of time are used. The tool takes these values from Tables 1 and 2 of WebTAG 3.5.6. These are based on national average values (which, to ensure equity, are applied in the appraisal of major transport schemes). The Tool has a facility to apply a multiplier to the national values of time to reflect local differences, but in general it is recommended to use the national values as these are more robust to scrutiny should the speed limit scheme be challenged.

**2.30** Values of time are assumed to grow as GDP grows. This growth for the appraisal period is taken from Table 3b of WebTAG 3.5.6.

**2.31** Total annual travel time costs 'before' and 'after' are calculated as the product of the values of time and the annual vehicle hours which are calculated from the link length, flow and speed.

**2.32** Where speed limits reduce speeds there will always be travel time disbenefits. Conversely, where removal of a speed limit increases speeds there will always be travel time benefits.

**Vehicle Operating Costs**

**2.33** There are two types of vehicle operating costs:

   a. The cost of fuel; and

   b. Non-fuel costs, e.g. maintenance, depreciation.

**2.34** The methodology for calculating these costs is set out in WebTAG 3.5.6. Vehicle operating costs are calculated by link separately for the before and after cases.

**2.35** The first stage of the calculation of the fuel elements of vehicle operating costs is the calculation of fuel consumption per kilometre. This is done by vehicle using the standard formula in WebTAG 3.5.6 using the parameters in Table 10.

**2.36** To reflect improvements in fuel efficiency, factors are calculated based on Table 13 of WebTAG 3.5.6, which reflects the forecast improvement in efficiency for each of the scheme years.

**2.37** Based on Table 12 of WebTAG 3.5.6, the proportions of vehicles by fuel type (petrol, diesel, electricity) are calculated. Annual vehicle kilometres by vehicle type are calculated from the traffic flow and link length. This is multiplied by the fuel consumption per kilometre to give total annual fuel use.

**2.38** Annual fuel costs for each scheme year are calculated using the market price costs per unit of fuel in Table 11a of WebTAG 3.5.6.

**2.39** Non-fuel elements of vehicle operating cost per kilometre are calculated using the formulation in WebTAG 3.5.6 with the parameters in Table 15. Annual costs are calculated by multiplying these by the annual vehicle kilometres.

**2.40** It will be noted from Figures 1 and 2 of WebTAG 3.5.6 that fuel consumption is at a minimum at around 70 kph (44mph). It rises very steeply at lower speeds and less steeply at higher speeds. Non-fuel costs always increase as speed decreases.

**2.41** In view of the above, for speed limits where vehicle speed is reduced from around 40 mph, vehicle operating costs will always increase after the speed limit reduces, hence there will be a disbenefit. However, where speeds higher than 40 mph are reduced there may be vehicle operating cost benefits.

## $CO_2$ Emissions

**2.42** $CO_2$ emissions by scheme year are calculated by link based on WebTAG 3.3.5D.

**2.43** Annual volumes of fuel used are taken from the vehicle operating cost calculations for both before and after. These are multiplied by the CO2 emissions per unit of fuel as set out in Table 1 of WebTAG 3.3.5D. Costs of these emissions are then calculated by year using the values in Table 2a of WebTAG 3.3.5D.

**2.44** As with vehicle operating costs, $CO_2$ emissions will increase where the speed is reduced from around 40 mph. Conversely, they will decrease where higher speeds are reduced towards 40 mph.

## NOx Emissions

**2.45** WebTAG does not include functions for estimating NOx emissions from fuel consumption. To provide this, relationships were calculated between NOx and $CO_2$ emissions using the emissions model developed by TRL in the DfT 2009 Emissions Factors Study (see Annex A).

**2.46** Using the above, NOx emissions are calculated for before and after based on the $CO_2$ emissions. Annual costs of these for each scheme year are calculated using the damage costs set out in Table 4 of WebTAG 3.3.3.

**2.47** Based on the derived relationships, NOx emissions, like $CO_2$, are estimated to increase where speed is reduced from around 40 mph, and decrease where higher speeds are reduced towards 40 mph. It should be noted that NOx emissions are very much lower than $CO_2$ emissions, with $CO_2$ emissions being typically between 400 and 1000 times higher in tonnes than NOx.

**2.48** It should be noted that the NOx emissions estimates provided by this tool are indicative only. If required, a more detailed assessment of the likely changes in emissions and/or pollutant concentrations could be undertaken using tools such as the Emission Factor Toolkit published by Defra, particularly in areas with existing poor air quality.

**Treatment of Diverted Traffic**

2.49   The tool does not model the explicit routes taken by diverted traffic. In view of this a consumer surplus approach is used to assess changes relating to diverting traffic. This traffic is assumed on average to be subject to half the change in time savings, vehicle operating costs, $CO_2$ emissions and NOx emissions which apply to traffic which is not diverted. Although simplistic, this is a practical approach in the absence of a traffic model to provide more accurate information.

**Scheme Costs**

2.50   The user is required to input the costs of the scheme and the year in which they occur. The estimation and treatment of scheme costs is covered in WebTAG 3.5.9.

2.51   Costs will include the following:

   a.   Investment costs (i.e. capital costs), e.g. traffic management measures, signs, road markings;

   b.   Maintenance costs, the cost of maintaining the capital equipment, e.g. maintaining signs, repainting road markings;

   c.   Preparation costs, e.g. design costs, surveying costs; traffic regulation orders; and

   d.   Enforcement costs, e.g. police costs

   Costs should be based at the 'prices year' advised in WebTAG Unit 3.5.9 (currently this is to 2010 prices). It should be noted that the tool does not automatically re-base the input costs to a specific 'price' year. This must be carried out manually by the user before the costs are entered."

2.52   Costs must include allowances for risk and optimum bias. Costs for future years should be indexed as in WebTAG 3.5.9D.

# Non-Quantified Effects

**Overview**

2.53   Where there is currently insufficient evidence to allow a reliable analysis to be carried out , space is provided in the output sheet to record any such non-quantified effects to keep the full appraisal, including summaries, in a single location. The user is directed towards a computation separately available for noise impacts.

2.54   The following section outlines relevant guidance and highlights areas that may be of particular interest when appraising local speed limit changes.

This section should be read in conjunction with 'Setting Local Speed Limits'. (DfT Circular 01/2013).

## Journey Time Reliability

2.55   Guidance for assessing Reliability impacts is given in WebTAG Unit 3.5.7 Reliability.

2.56   Based on the approach taken in WebTAG, speed limit changes are unlikely to have any impact on Journey Time Reliability, except where they cause significant changes in traffic flows.

2.57   Our review found no evidence that public transport reliability is impacted by speed limit changes. For example, First Bus reported that the 20 mph pilot at Inner South Bristol has not adversely affected Bus Journey Times or Service Reliability.

## Noise

2.58   Noise impacts have not been quantified in the tool, as test calculations show that the noise exposure changes as a result of altering speed limits are likely to be small (see Annex A). However, if a large number of people are likely to be affected by the change in noise exposure, it would be appropriate to carry out a Noise Assessment. Guidance for assessing and monetising noise impacts can be found in WebTAG Unit 3.3.2 The Noise Sub-Objective. Other information can be found in the Design Manual for Roads and Bridges (DMRB) 11.3.7 Noise and Vibration, and Calculation of Road Traffic Noise (DfT 1988).

2.59   When evaluating a proposal, consideration should be given to the impact on any Important Areas (as defined in the relevant Noise Action Plans)[6]. In particular, the opportunity should be taken to integrate the proposal with any measures being considered to assist the management of noise in the Important Areas.

## Effects on Vulnerable Road Users

2.60   Guidance for assessing Social and Distributional Impacts (SDI) can be found in WebTAG Unit 2.13 and 3.17.

2.61   The greatest effects arising from a speed limit change are generally on the numbers of accidents, both those involving personal injuries and those where there is damage only. Therefore, if an SDI Analysis is required, particular attention could be paid to assessing the SDI of accidents. Research has shown that vulnerable groups (in terms of their accident risk) include children and older people, young males and motorcyclists. There is also a strong link between deprivation and road accidents: children from social class V are five times more likely to be

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[6] For more information on noise action plans please see:
http://www.defra.gov.uk/environment/quality/noise/environmental-noise/action-plans/

involved in a fatal road accident than those from social class I (WebTAG Unit 3.4.1).

2.62    User Benefits and Affordability are also likely to form a significant part of the overall impact of a speed limit change. However, calculating these SDI impacts is likely to require a traffic model, which may not be available.

2.63    Our review found no conclusive evidence that speed limit changes in isolation from other measures have an impact on walking and cycling levels (even with 20mph schemes). However, the evidence was limited, and this is not to say that changing speed limits does not influence walking and cycling activity in some cases. Local highway authorities are encouraged to evaluate their speed limit schemes so that data can be fed into future appraisal.

2.64    Guidance on Impacts on Pedestrians, Cyclists and Others can be found in WebTAG Unit 3.5.5.

**Level of Public Anxiety**

2.65    Setting speed limits should be evidence-led and self-explaining. However, the deciding factor for many speed limit changes is the level of public demand for a scheme. The tool provides space, in the Objectives Analysis table, for this important consideration to be recorded.

2.66    Reductions in speed limits are often popular to start with, but can lead to increased anxiety if the limits are unrealistic and not adequately enforced. Enforcement is therefore a crucial element that needs to be considered. If it is to be provided, it should be fully costed for each year of the appraisal period.

**Level of Severance**

2.67    Guidance for assessing Severance impacts can be found in WebTAG Unit 3.6.2 The Severance Sub-Objective and DMRB 11.3.8 Pedestrians and Others and Community Effects.

2.68    In DMRB, changes in Severance can only be caused by the creation or removal of new crossing facilities and/or changes in traffic flows of 30% or more. Changes in vehicle speed alone are considered not to have an impact on severance.

**Visual and Environmental Impact of Signing and Traffic Calming Measures**

2.69    Schemes should be designed in accordance with Departmental guidance and the Traffic Signs, Regulations and General Directions (2002). Further guidance on signs can be found in 'Setting Local Speed Limits'.

# 3. Preparing for an Appraisal

## Overview

**3.1**   This chapter sets out the background to approaching an appraisal for a speed limit scheme. Schemes which can be addressed range from a single link to a large area.

**3.2**   Given the flexibility of the tool, it can be used for initial screening appraisal to assess in broad terms whether speed limits are likely to be appropriate or in more detailed appraisal of specific options.

**3.3**   Issues which need to be addressed in preparing for an appraisal, which are described in the following sections are as follows:

   a.  Defining a network of links;

   b.  Measuring accidents;

   c.  Measuring traffic flows;

   d.  Measuring traffic speeds; and

   e.  Estimating Costs.

## Defining a Network of Links

**3.4**   The roads for which speed limits are to be appraised need to be defined as links. A link is a section of road which differs in characteristics (e.g. road type, flow, speed, accident rate) from adjacent sections of road. There is no restriction on the maximum number of links that can be examined in one run of the tool, but the larger the number of links the more time and cost is required for data collection and preparation.

**3.5**   The first phase of defining the network is to understand its characteristics from a combination of mapping, satellite imagery (e.g. Google Earth) and site visits.

**3.6**   With simple schemes, such as a village speed limit, it will be relatively easy to identify the appropriate links. These may be defined by junctions and also by link characteristics, e.g. at the edges of the village, speeds may be faster than in the centre. The user may wish to consider options on the extent of the speed limit, e.g. whether it applies to the outer areas

of the village. In this case, separate links should be used to allow these options to be assessed.

3.7  With complex schemes, such as a town wide speed limit, the numbers of potential links may be higher than is practical and/or cost effective to handle. In this case it may be necessary to group similar links. For example, if a limit is to be applied to a series of parallel residential streets between distributor roads, it may be possible to group the residential roads if they have similar characteristics, speeds and flows. For example, ten such roads each 0.5 km long could be represented by one link of 5 km long with the average flow for the ten links but with all their accidents.

3.8  A practical issue to be considered in designing a link network is the number of links for which it is feasible to collect flow and speed data.  It may be necessary to combine potential links to keep the costs of data collection at manageable levels.

## Measuring Accidents

3.9  For a preliminary appraisal, the numbers of personal injury accidents (PIA) could be estimated by, for example, using the average link and junction accident rates in COBA.

3.10  For detailed appraisal, PIA data by severity should be extracted from STATS19 data.  For links, this should include all accidents which occur on the link, including those on arms of junctions which are part of the link. To derive robust estimates of the numbers of accidents, these should be based on at least three years of accident data.

3.11  Accident data should be factored to take account of trends in accident rates, severity and traffic flows between the mid year of the period for which the STATS19 data is extracted and the traffic base year.  Trends in accident rates and severity should be based on latest Road Accident Statistics (currently table RAS10002) and the COBA Manual Part 2 Table 4/1.  Trends in traffic growth should be derived either from the DfT Road Traffic Forecasts Table 1 for the relevant region and area type or from a relevant local permanent traffic count site and/or traffic model.

## Measuring Traffic Flows

3.12  For each link the AADT flow in vehicles is required for the traffic base year.

3.13  For a preliminary appraisal an AADT flow may be obtained by factoring up a short period count collected during a site visit, or by factoring up an old count or even on the basis of judgement and local knowledge.

3.14  For more detailed appraisal, more accurate count data should be collected. This should ideally be by means of an automatic traffic counter for at least a one week period. This flow should ideally be factored up to

AADT based on data from a permanent counter which is appropriate to the study area. Ideally counts should be undertaken during neutral month periods and should avoid school holidays. Where counts for years other than the traffic base year are used, these should be factored to the base year using factors for the appropriate region and area type from the DfT Road Traffic Forecasts or from a local traffic model or from local continuous count data.

**3.15** Further information on traffic data collection can be found in DMRB Volume 5.

**3.16** Information on collecting data on journeys made by pedestrians and cyclists (and other non-vehicle trips) can be found in DMRB Volume 11 Section 3 Part 8.

## Measuring Traffic Speeds

**3.17** For a preliminary appraisal, mean traffic speeds may be assessed for a short period using a radar gun during a site visit.

**3.18** For more detailed appraisal, speeds should be measured for a longer period, preferably at least a week. This would ideally be done using the same equipment as is used for traffic counting. This data would allow the calculation of mean and 85th percentile speeds if required.

**3.19** Speeds should be measured at a point which will be representative of the average speed on a link. This would need to be established by local knowledge and a site visit.

## Estimating Costs

**3.20** For a preliminary appraisal, broad estimates of cost may be made based on similar schemes which have been implemented previously.

**3.21** For detailed appraisal it is necessary to carry out preliminary design of the scheme to establish all the costs, e.g. traffic management, signing, road surfacing and marking, enforcement and maintenance. Cost should be prepared in accordance with WebTAG 3.5.9.

# 4. Installing the Speed Limit Appraisal Tool

**4.1** The Speed Limit Appraisal Tool (SLAT) can be downloaded from https://www.gov.uk/government/publications/speed-limit-appraisal-tool

**4.2** The SLAT system is supplied in an installation file called:

- SLAT_Installation_Vx-x-x.exe
- where  x-x-x is the release version number

**4.3** To install the tool, run this file and follow the presented dialogues. You are not expected to need Administrator rights, but this may depend on your local IT rules and regulations. If you experience problems when trying to install the tool, you should refer in the first instance to your IT support.

**4.4** When presented with this dialogue you MUST adopt the option 'Associate program with file type .rbw'. If not, the application will not run.
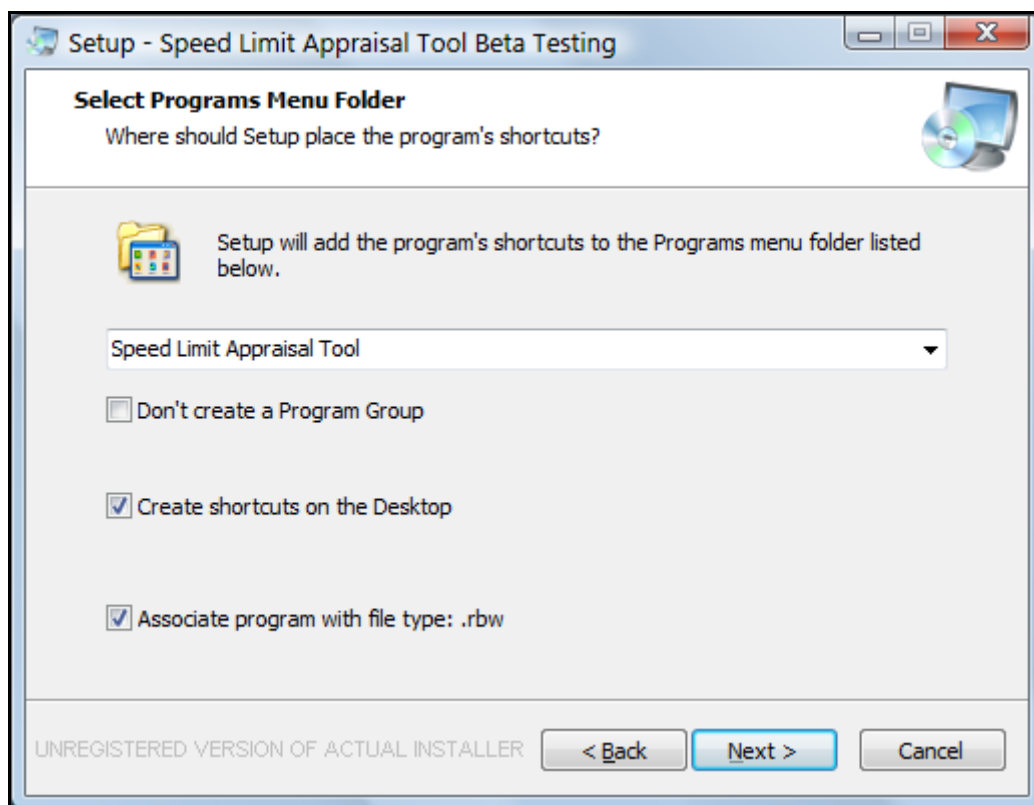
# What is installed on your Computer?

**4.5**    When installing, you are asked where you want to file the installation. By default this is <Program Files>, but you can change this as required.

**4.6**    Where ever you choose to put the installation, the following directories are created:

<Program Files>\Speed Limit Appraisal Tool
                              \Code
                              \WxRuby


**4.7**    A directory is also created in your User\AppData\Roaming directory. This is called 'DfT_SLAT' and it is used to hold the Master set of spreadsheets which are copied to each the 'DfTDataTables' and 'Templates' directories of a Study when created by you using the STUDY>NEW menu option.

# Software Requirements

**4.8**    You will need:

- **Excel** - For the tool to operate you must have MicroSoft Excel installed on your computer. The version should not be relevant, but note that the Excel spreadsheet types are .XLS and NOT .XLSX so that the system is available to users who have older versions of Excel.

# 5. Overview of the Speed Limit Appraisal Tool

## Introduction

**5.1**   This chapter provides an introduction to the basic concepts and procedures for using the tool. Further information and details on using the tool are provided in Chapters 6 to 9.

## Some Basic Concepts and Terminology

**5.2**   Activities within the tool are organised into 'studies' that appraise one or more planned 'schemes' for altering speed limits on a part of a highway authority's road network. The tool does not impose a limit on the size of the network, which is represented by data on a series of road 'links'. Many schemes will have only a relatively small number of links, but others may extend over much broader geographic areas and have a correspondingly larger number of links. For large-scale schemes it may be helpful to draw data from a traffic model; this is possible, but the description here assumes that data is input manually.

**5.3**   The tool provides a series of Excel template spreadsheets for its input and output. It is not necessary to use the input spreadsheets as it is possible to input data directly into the graphical user interface (GUI) that the tool provides, but it will often be convenient for users to use the input spreadsheets, including those cases when data has been derived from a traffic model

**5.4**   The tool outputs its appraisal information in a set of four spreadsheet tables. Three of these correspond to standard DfT WebTAG appraisal tables, namely:

    a.  Appraisal Summary Table (AST)

    b.  Transport Economic Efficiency table (TEE)

    c.  Objectives Analysis table (OA)

**5.5**   The fourth table (Link Impacts table) provides detailed information on each link in the network to provide information on where and to what extent benefits and costs are distributed across the network.

# Data Preparation

**5.6**  The categories of data required by the tool comprise:

- inventory type data describing the road network
- (observed) data on traffic flows, speeds, and road accidents
- scheme network data – mainly revised speed limit values but potentially also information on 'traffic diversion' proportions
- scheme cost data – forecast capital and maintenance costs for each year of the appraisal period

**5.7**  The following describes the key aspects of the data that is required. Further details are provided in both the data input template spreadsheets provided for each set of input data and in the graphical user interface.

### Road Network Description

**5.8**  The minimum data required for the base network description for each link in the network is:

a. a unique (alphanumeric) link identifier

b. link length

c. speed limit

d. descriptors of link type (e.g. single or dual lane) and of area type (urban, village, rural)

**5.9**  The minimum additional information required for speed limit schemes is:

a. speed limits in scheme (and if traffic calming is used with 20mph limits on a link)

b. percentage change in flow from traffic re-routeing effects ('diversion'), which defaults to zero if no entry is made.

### Optional Network Data

**5.10**  The network description data can include optional data that could help identify links (e.g. text descriptions), aid analysis and support the qualitative aspects of the appraisal (e.g. indicating whether traffic flow is encumbered by parked vehicles or whether a link is bordered by sensitive locations such as schools and hospitals).

**5.11**  Apart from the indicator for traffic calming, the optional data does not have an effect on the calculated results, but can be relevant to providing contextual information that supports the qualitative and summary aspects of the final appraisal of schemes. For example, if 'Enforcement' is set to 'Y' (yes) for a link or links, then this can be used to support the case, say, that an appraisal benefit value is likely to be more robust and sustainable

than if enforcement is not provided. It may also serve as a reminder that operational costs (see section below) include some element of enforcement costs.

**Link Data**

5.12    The different components of the appraisal and modelling procedures within the tool come from varied sources, notably relationships between speed change and speed limit developed specifically for the Tool, the COBA relationships used for accident severity trends and the Elvik function used for forecasting accident change in response to speed change. These do not share a consistent classification for describing link types and areas and consequently there is some overlap in the data used to describe types.

5.13    The **Link_Area** descriptor for a link area type (and carriageway) can be designated as:

- Urban
- Village
- Rural Single, or
- Rural Dual.

It is associated with the speed limit changes shown in Table 5.1 (or reversals of these). Other reductions from 60mph for roads classified as Rural Single are permitted, but it should be noted that there were no observations available for such cases when the forecasting relationships were developed. The program will give a warning in such cases and the Tool will default to using relationships for the most appropriate change for which relationships are available

| Table 5.1  Typical Speed Limit Changes |
|---|
| Urban 30 to 20 (no calming) |
| Urban 30 to 20 with calming |
| Urban 40 to 30 |
| Village 40 to 30 |
| Village 60 to 30 |
| Village 60 to 40 |
| Rural Single 60 to 50 |
| Rural Single 60 to 40 |
| Rural Dual 70 to 40 |

**5.14** Changes to (or from) 20mph speed limits are not distinguished by link area or carriageway but, rather, by whether traffic calming measures (of whatever type) are applied. The indicator for traffic calming on a link is separate from that of the **Link_Area**.

**5.15** The **Link_COBA_Type_Accidents** descriptor allows the carriageway of a link to be described using one of 12 descriptors. These are taken from definitions in COBA accident calculations (COBA Manual Part 2 Table 4/1 and supporting text) and are shown in Table 5.2. The column marked 'Input Value' represents the values used by SLAT. Note that 'HS' refers to the one metre wide hard strip provided both sides of the carriageway, and that motorway values are not used. Modern roads are those designed and built to geometric standards relevant to post 1980.

| Table 5.2  COBA Link Descriptors | |
|---|---|
| **Road Type** | **Input Value** |
| Modern S2 Roads | S2 |
| Modern S2 Roads with HS | S2 HS |
| Modern WS2 Roads | WS2 |
| Modern WS2 Roads with HS | WS2 HS |
| Older S2 A Roads | Older S2 A |
| Other S2 Roads | Other S2 |
| Modern D2 Roads | D2 |
| Modern D2 Roads with HS | D2 HS |
| Older D2 Roads | Older D2 |
| Modern D3+ Roads | D3+ |
| Modern D3+ Roads with HS | D3+ HS |
| Older D3+ Roads | Oldr D3+ |

**5.16** The Notes worksheet in the **Input_Link_Data** template spreadsheet and the drop-down menus in the SLAT GUI provide guidance on permitted values. The tool is not applicable to motorways.

**5.17** For the disaggregation of PIA by severity, there is a broad definition as to whether a link is in an urban or rural area. The link descriptor **Urban/Rural** is set according to whether the population in the built up area in which the link is located is greater than 10,000 ('U') or less than

10,000 ('R'). This is only required if accidents are input as PIA values - see next section.

**5.18** Also for the disaggregation of PIA by severity, the link descriptor **Road_Type** is set to either 'A' or 'B' depending on the class of road. Note: any road that is not an A road should be defined as a B road. (This is only required if accidents are input as PIA values -see next section).

## Observed Data

**5.19** Statistically sound observed data should be inserted for each link and should be associated with the user-defined 'Base Year'. Accident data should be averaged over at least a 3-year period.

**5.20** Mean all-vehicle flow (AADT) – observed flows of buses, pedestrians, and cyclist may be supplied as well

**5.21** Mean speed (mph) – (an 85th percentile speed is an optional input)

**5.22** Accidents - these may be supplied either as total annual personal injury accidents (PIA) on each link (which can be classified more explicitly into Fatal, Serious, and Slight). Accident data should be factored to take account of trends in accident rates, severity and traffic flows between the mid year of the period for which the STATS19 data is extracted and the traffic base year. Trends in accident rates and severity should be based on latest DfT Road Accident Statistics and the COBA Manual Part 2 Table 4/1. Trends in traffic growth should be derived either from the DfT Road Traffic Forecasts Table 1 for the relevant region and area type or from a relevant local permanent traffic count site and/or traffic model.

## Cost Data

**5.23** Annual scheme cost data is required under the headings of Capital and Operating. Capital costs should usually arise between the Base Year and the Opening Year, and Operating costs should be provided for each year from the Opening Year to the Final Year of the appraisal period. Costs should be entered in pound sterling.

## Local Data

**5.24** The tool provides the opportunity for the user to supply local values of certain data rather than use WebTAG default values. This data relates to:

**5.25** **Vehicle Type Shares** – average proportions of vehicle types in total traffic flow

**5.26** **Trip Purpose Splits by Vehicle Type** – average proportions of (in-Work, Commuting, and Other) trips by vehicle type (Car, LGV, PSV)

**5.27** **Percentage Changes of Vehicle Types**  -  from 2010 in five-year bands

**5.28** **Vehicle Occupancy** by Vehicle Type and Trip Purpose.

**5.29** A (single) multiplier to adjust WebTAG default Values of Time (VOT) to locally calculated average values can be input by the user.

# The Speed Limit Appraisal Tool Graphical User Interface (SLAT-GUI)

**5.30** The SLAT-GUI comprises several components (see Figure 5.1):

- **The Menu Bar**. This provides access to the various actions required to take a study through the various phases of data import, validation and appraisal run. As a rule, menu categories and the sub-actions associated with them are disabled / enabled given different states of the data environment

- **The Study Status Area**. This is the blue band at the top of the SLAT-GUI used primarily to inform what the 'Current Active' scheme is; this can be the Base or any of the future schemes. The Active Scheme is the scheme that has its Data Tab/Grid showing (described below), available for review or editing. A scheme is made active by either selecting the associated tab, or by clicking on the 'document' icon shown in the Study Scheme Manager (described below). When an Appraisal is initiated, the run is for the active scheme versus the Base Scheme and so a non-base scheme must be active for the appraisal to proceed.

- **The Study Scheme Manager**. This is a 'tree' structure which shows the Base Links scheme, all (future) Links Scheme(s), the available Cost Schedules and their relationship to each (future) Links Scheme(s). The Study Scheme Manager is one of the most important components of the SLAT-GUI as its construction by the user, with the names given to the various data items, defines how all of the input worksheets, if used, must be labelled.

- **The Data Tab Area**. This contains a series of data tabs; one per defined Links Scheme and one per defined Cost Schedule. The Base Links Scheme is a special case; there can be only one of these and it must be defined before any future Links Schemes are created. Each Data Tab is generated automatically as each Scheme is generated in the Study Scheme Manager. The data grids are populated by either importing the appropriate spreadsheet/worksheet or by entering the data manually. Note that the menu item **SCHEME LINK DATA>COPY FROM THE BASE** allows appropriate data to be copied from the Base Links Scheme Data Tab to the Active (future) Links Scheme Data Tab.

- **The Run Output and Messages Area.** This pane is used to report on actions undertaken by the software; specifically to report on the validation of data as it is undertaken. The contents of this area can be saved in a data file using the **REPORT>SAVE LOG FILE** option.

**Figure 5.1 Initial Screen - Component Elements of the SLAT-GUI**
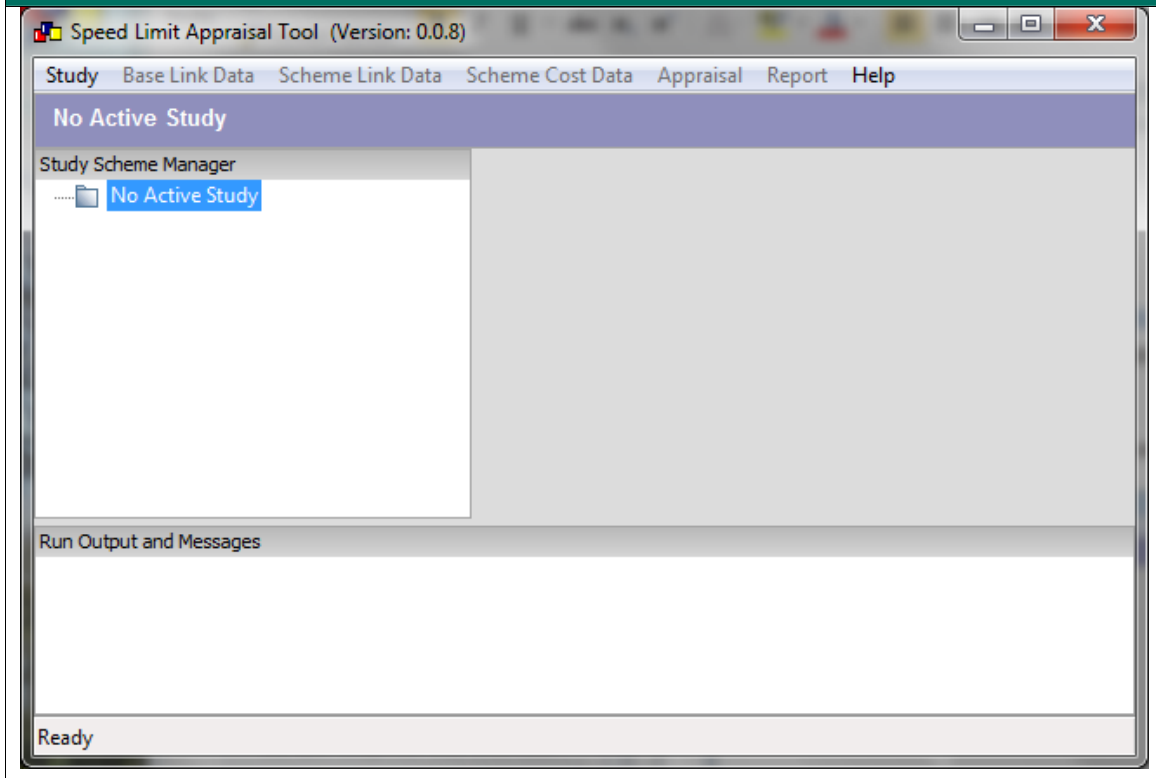


## The Flow of Data through the Tool

**5.31** Figure 5.2 shows how data flows through the tool.

**Figure 5.2  Overview of SLAT Data Flow**



Flow of Data through SLAT
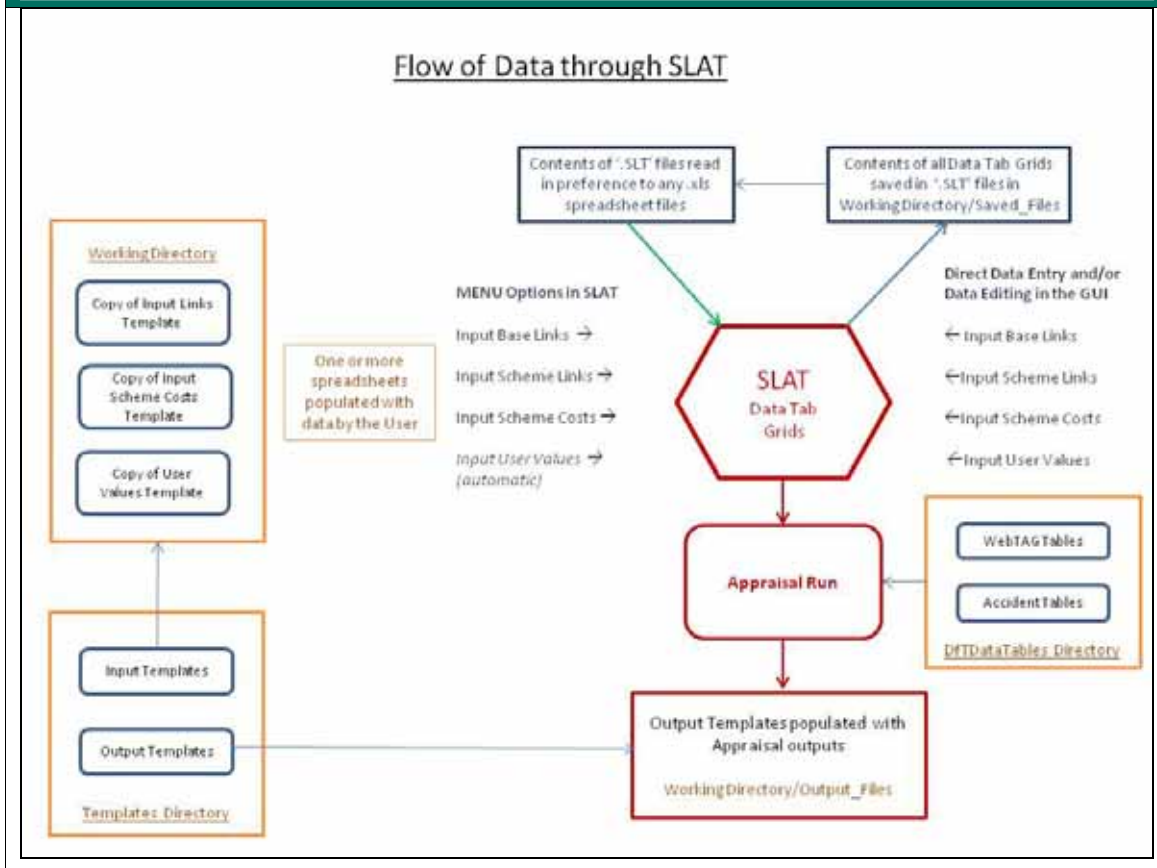
## The Master Folder for Housing SLAT Studies

**5.32**   All new studies will be located by default in the master SLAT study folder:

- *C:\Speed_Limit_Appraisal_Studies*

If required, this location can be changed by running SLAT and selecting the **'STUDY>SYSTEM DEFAULTS'** option and choosing a new folder location from the Menu shown in Figure 5.3.

**Figure 5.3  System Defaults Dialogue**

System Defaults

Default folder for storing Speed Appraisal Studies

Current:  [C:\Speed_Limit_Appraisal_Studies]

Change Folder

Default Base Year for Study          2012

Default Study Region                 England

Area Type                            London

Abandon          Save

- Having selected a new location, close SLAT.

- When you come to start your new Study and run SLAT again, the Study will be stored in the folder of your choice.

**Key Points**

- A large urban is for a population > 250,000

- Defining the region and area type controls the growth factors, which come from Road Traffic Forecasts Table 1.1

- Once a new study has been started, it is not possible to change its location. If necessary, the default folder should be changed as described above, and the study re-initiated.

- When a new study is initiated, a new folder (directory) is created in the default SLAT Study folder (see Figure 6.3)  in which four predefined folders are created along with an 'INI' file, used by SLAT to keep track of data relevant to the study.

# The Standard Study Sub-Directories

**5.33**   The four study folders are shown in Figure 5.4 and are used as described below.

### Figure 5.4  Standard Study Sub-directories
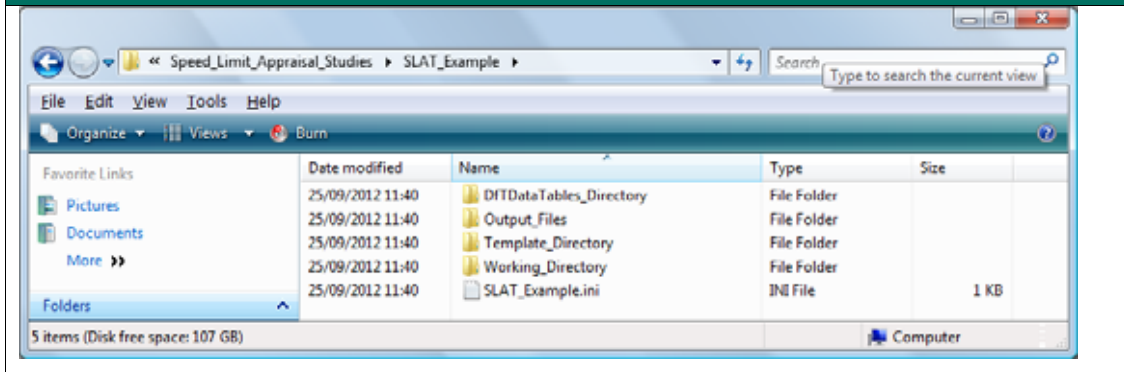


## DfTDataTables_Directory

**5.34**   This contains master DfT WebTAG and Accident tables, as well as other tables taken from COBA, in the form of spreadsheets used by the SLAT Appraisal. These spreadsheets cannot be edited or accessed directly by the user. Figure 5.5 shows the DfTDataTables sub-directory.

### Figure 5.5  DfTDataTables Sub-directory
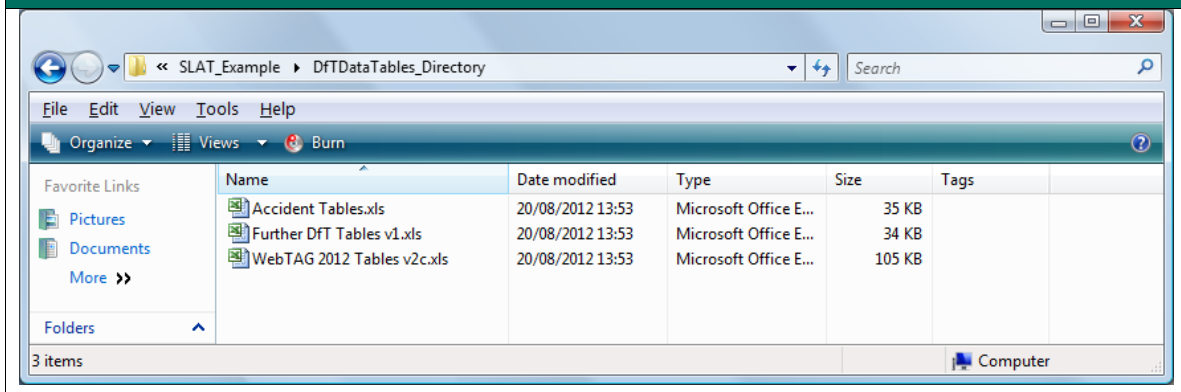


## Template_Directory

**5.35**   This directory contains sets of INPUT and OUTPUT templates for the Excel spreadsheets used by the Study (see Figure 5.6).

• The three INPUT templates are 'masters' which are used for reference; copies of these are put in the **Working_Directory**, with the name of the Study incorporated into the spreadsheet filenames.

- The four OUTPUT templates are used by the tool when generating the associated output analysis spreadsheets.

- The spreadsheets located in the **Template_Directory** should **NOT** be edited directly.

**Figure 5.6  Input and Output Spreadsheet Templates**
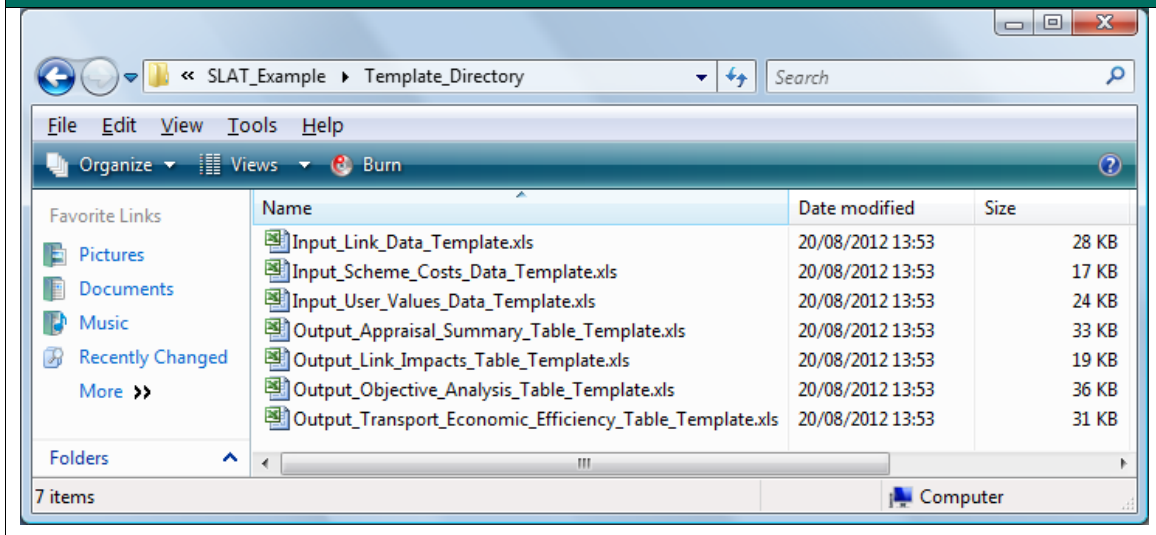


**Working_Directory**

**5.36** This contains copies of the input spreadsheets, appropriately re-named for the study (see Figure 5.7). If you are inputting data using spreadsheets, then it is these spreadsheets that are used.

- This folder will contain other data files as the Study develops.

- The **Saved_Files** sub-folder is used to hold the data in the input tabs (after import and /or manual edit) which are written to the folder when either the menu item **STUDY>SAVE CURRENT DATA SETS** or **STUDY>SAVE AND EXIT** options are activated.

**Figure 5.7 Working Directory - Users' Data Area**
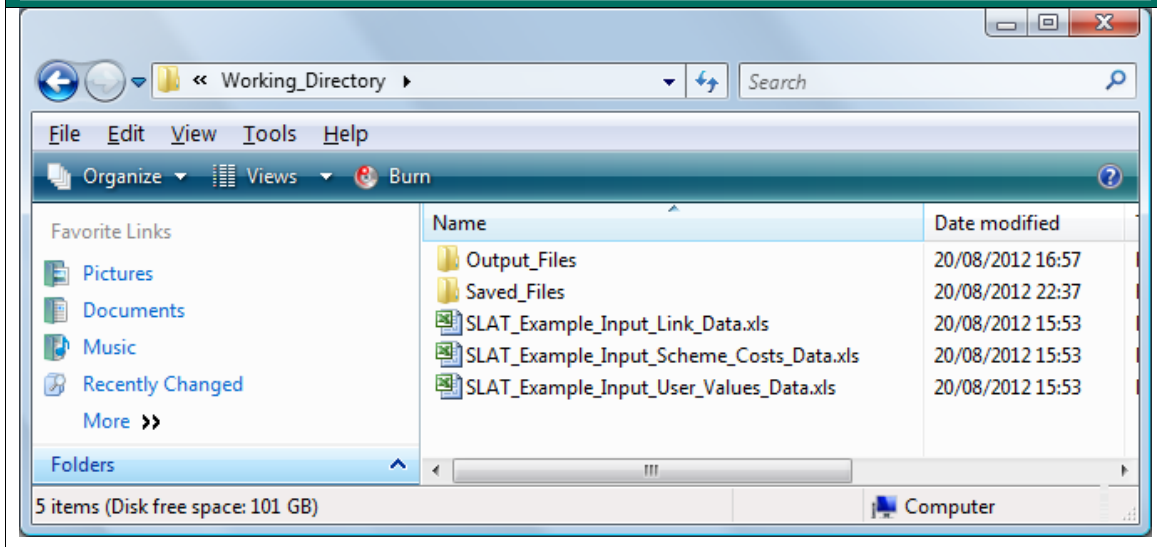


### Output_Files directory

**5.37** This is used to hold the outputs for each Scheme Appraisal. Data from these files are read in preference to reading from the corresponding input spreadsheet, so you will need to re-import the spreadsheets if you have changed data in the input spreadsheets to be used in an appraisal.

## Spreadsheets and Manual Data Entry

**5.38** Study data can be input either using some or all of the spreadsheets located in the **Working_Directory**, or by direct data entry into the appropriate Data Tab grid in the SLAT-GUI. Similarly, data can be input from a spreadsheet and amended or extended directly using the SLAT - GUI. This means that data in the SLAT-GUI may be more up-to-date than that in the input spreadsheet, especially if the validation procedures indicate errors in the input spreadsheet files. In these circumstances, the user may choose to amend the input spreadsheet files and re-import the data. However, an (automatic) facility is provided whereby the contents of each Data Tab grid which has been populated with data is saved to file, and when SLAT is re-started for that Study these files are read in preference to any spreadsheet files (see Figure 5.8).

**Figure 5.8  Saved Data from User's Session**
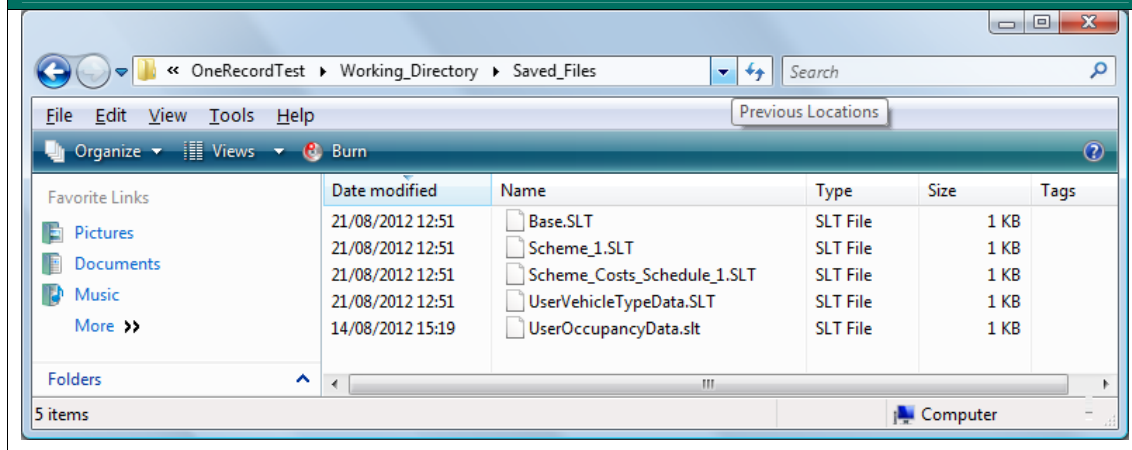


**5.39** These 'saved' files have the file extension .SLT, with the filename relating to the data source. They cannot be edited by the user.

**5.40** If any or all of these files are deleted by the user, which is allowed, the associated data must be re-established in the Study; either by re-importing from a spreadsheet or entering manually.

**5.41** These files are saved using the Study Menu Options (see Figure 5.9):

**SAVE CURRENT DATA SETS**, or
**SAVE DATA AND EXIT**

**Figure 5.9  Study Menu Options**
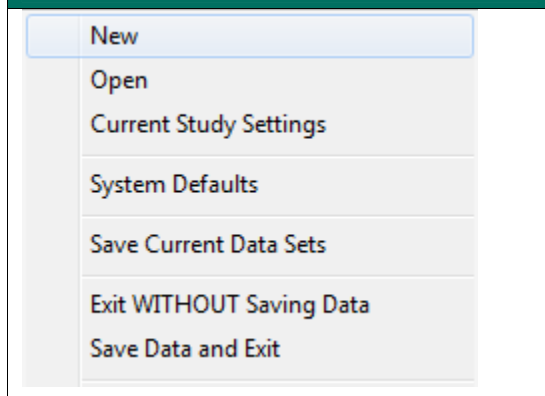


**5.42** There is the option to exit the tool without saving any imported data and/or subsequent changes made to that data in the GUI.

## Overview of the Input Spreadsheets

**5.43** Three input spreadsheets are located in the Working_Directory:

- *'study_name'*_Input_Links_Data.xls

  i. The first worksheet is labelled **'Notes'** and contains information about the content of the following worksheets.

  ii. The second worksheet is called **'Base'** and contains the template for the input data used to describe the Base Scheme. The label given to this worksheet MUST match the name given to the Base Scheme in the Study Scheme Manager (see ' The Study Scheme Manager' below)

  iii. The third worksheet is called **'Scheme 1'** and contains the template for the input data used to describe the first Study (Future) Scheme. If more than one Scheme is to be tested, you create a new worksheet and copy the contents of the 'Scheme_1' worksheet. The label given to each scheme worksheet MUST match the name given to the corresponding  Scheme in the Study Scheme Manager (see ' The Study Scheme Manager' below)

- *'study_name'*_Input_Scheme_Costs_Data.xls

  i. The first worksheet is called **'Scheme Costs 1'** and contains the template for the first Scheme Costs Schedule. If more than one set of Cost Schedules is required, you create a new worksheet and copy the contents of the **'Scheme_Costs_1'** worksheet. The label given to each Cost Schedule  worksheet MUST match the name given to the corresponding  Cost Schedule  in the Study Scheme Manager (see ' The Study Scheme Manager' below)

- *'study_name'*_User_Values_Data.xls

  i. This spreadsheet contains four worksheets which can be used to provide, if appropriate, local values for a limited range of WebTAG parameters. It is expected that you will use local values infrequently, if at all. If this data is not supplied, the default WebTAG values will apply. The four worksheets are:

     1. **U_Vehicle_Type_Shares**. This table allows the proportion of vehicle types for the Study to be varied from the WebTAG defaults, which are shown. The sum of the proportions  must sum to 1.0

     2. **U_Purp_Splits**. This table allows the proportion of trips by purpose, by mode, to be varied from the WebTAG defaults, which are shown.  The sum of the proportions per mode must sum to 1.0

     3. **U_Growth_Indices**. This table contains the percentage change in vehicle type proportions from 2010 and is given in 5-year steps until 2035. The default values are taken from RTF Table 1.1 and are based on Region/Area Type specified in the System Defaults Dialogue (see Figure 6.3).

4. **U_Veh_Occup**. This table allows the vehicle occupancy factors per mode by journey purpose to be varied from the WebTAG defaults, which are shown. No Vehicle Occupancy factor can be less than 1.0

ii. The names of these four worksheets **must not be changed**. In all of these spreadsheets/worksheets, the labels in the first row used to describe the data fields **must not be changed**.

# Running the Tool

**5.44** The procedure for running the tool is described in more detail in the Chapter 6, but the main points are:

- The tool employs the concept of 'Studies' which have corresponding directories under the main directory (default name and location 'C:\Speed_Limit_Appraisal_Studies'), which is placed in a location on the computer that is determined when the software is installed

- There is a natural set up work flow of:

**5.45** Study definition → Base network definition→ Scheme definition → Costs definitions

**5.46** Associate Costs with the Scheme or Schemes (one set of Costs may apply to more than one Scheme)

- Data may be input using supplied spreadsheet templates, or through the tool's Graphic User Interface (GUI), or a combination of the two. Data imported from spreadsheets or entered via the GUI needs to be saved using the 'Study' menu item, to preserve the data when the session is closed.

- Once data has been prepared, you must ensure that the required Scheme is selected, i.e. that its corresponding 'data tab' is selected in the GUI and use the Run Appraisal menu. Appraisal run times are usually quick, but on first use in a session it may take some moments to load the Ruby software engine used by SLAT.

- Results are stored as a set of spreadsheets in a directory of the project called Output_Files. (A corresponding Saved_Files sub-directory stores SLAT data so the GUI is re-populated when a study is re-opened.)

# Using the Result Spreadsheets

**5.47** The set of four output spreadsheets should be considered as a starting point for developing the appraisal into a case that can be readily understood and appreciated by a range of people, and which reflects wider considerations than the quantitative values that the tool provides. In particular, the Appraisal Summary Table (AST) and the Objectives

Analysis (OA) table require the addition of text in their 'Qualitative' and 'Summary' columns. (Cells in the tables that are grey are not relevant.)

5.48 Insights into the result can be gained from the 'Link Impacts' table. Especially when the network has a significant number of links, standard spreadsheet facilities can be used to filter and sort the data so that links and particular results of interest can be highlighted. The Link Impacts table does not replicate all of the input data, but such data is easily appended when link data has been input via a spreadsheet. This allows further bespoke analysis to meet the user's specific requirements.

# 6. Getting Started

## Primary Steps

**6.1** The procedure for using the tool can be summarised as a sequence of six steps:

- **Step 1: Installing the SLAT software**

- This is done via the installation program downloaded from the DfT web site (see Chapter 4: Installing the speed limit appraisal tool). The installation program guides the installation via a wizard that covers locations on the computer where the software is installed, where user information about sessions is stored, and where SLAT 'studies' are stored. The installation process takes a few minutes.

- **Step 2:- Defining a 'Study'**

- This requires a name for the study associated with the road network of interest, together with information on the start and end years for the appraisal period, as well as identifying the 'base' year for which observed data has been collected. (Accident data is entered as PIA per annum, which should be ideally derived from at least 3 years data.)

- **Step 3: Providing a Description of the Study Area Road Network**

- This is provided for the existing ('base') situation, together with information on traffic flows, speeds, and accidents.

- **Step 4: Providing Definitions of the Speed Limit Scheme**

- This is primarily a matter of specifying different speed limits for some or all roads defined in the base case, though additional matters such as traffic calming can be included.

- **Step 5: Running the Appraisal**

- This takes a few minutes or less and generates four output appraisal spreadsheets.

- **Step 6: Reporting the Results**

- This takes the form of an Appraisal Summary Table (AST) and an Objectives Analysis (OA) table with qualitative and summary assessments, for which the tables provide spaces for user-added text.

# Starting a New Study

**6.2**   Once you are satisfied with the location for the storing of your Studies, you can run the Speed Limit Appraisal Tool.

**6.3**   When the tool starts, you will see the following screen (Figure 6.1). Note the state of the 'Study Scheme Manager' which contains one entry saying 'No Active Study'. This view will change once the study has been initiated.

**Figure 6.1  Initial screen**
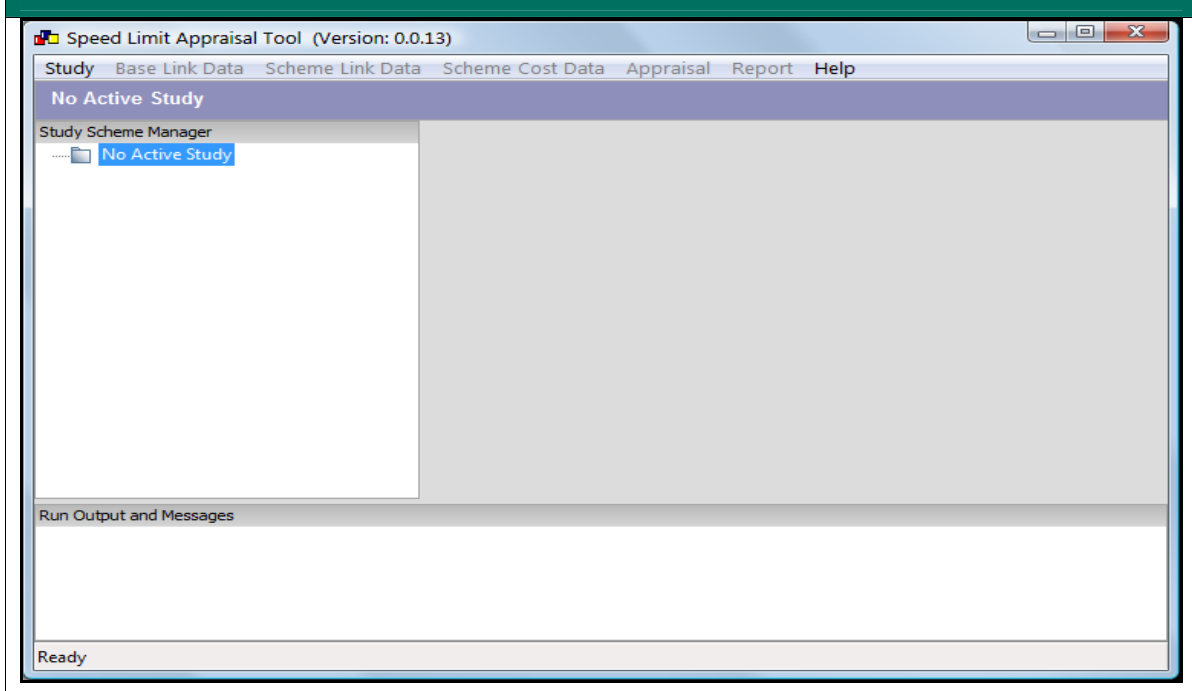


**6.4**   From the Study menu, choose **'NEW'** and make a new folder for your Study under the default SLAT Study folder (see Figure 6.2). You will not be allowed to create a folder elsewhere. *(Note: This dialogue should open showing the current default study directory 'in view' C:\Speed_Limit_Appraisal_Studies. But when using Windows 7, the dialogue initially shows the 'root' directory, but will re-focus on the default directory when the 'Make New Folder' button is pressed).*

**Figure 6.2  Setting a Study Directory under the SLAT Studies Directory**
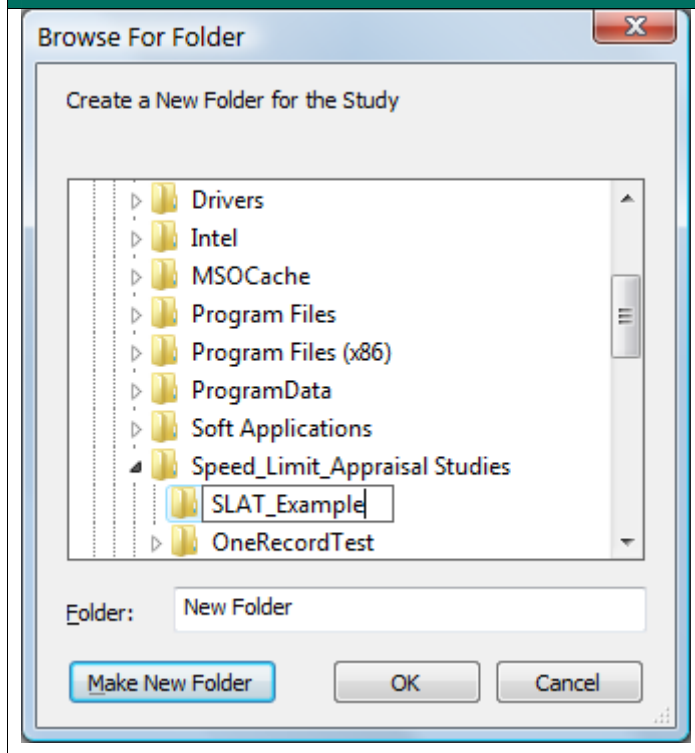
**6.5**    The name you give to the Study is very important as it will be used to label all input and output data files associated with the Study.

**6.6**    You cannot use any special characters that are barred by Windows for specifying a folder name. Use only letter, number, space, and underscore (_) characters.

**6.7**    For the purposes of demonstrating the operation of the tool in this User Guidance, the Study is called **'SLAT_Example'**.

**6.8**    When you have created your new Study Folder, the Study Scheme Manager will be updated (as shown in Figure 6.3).

**Figure 6.3  New Study in SLAT Study Scheme Manager**
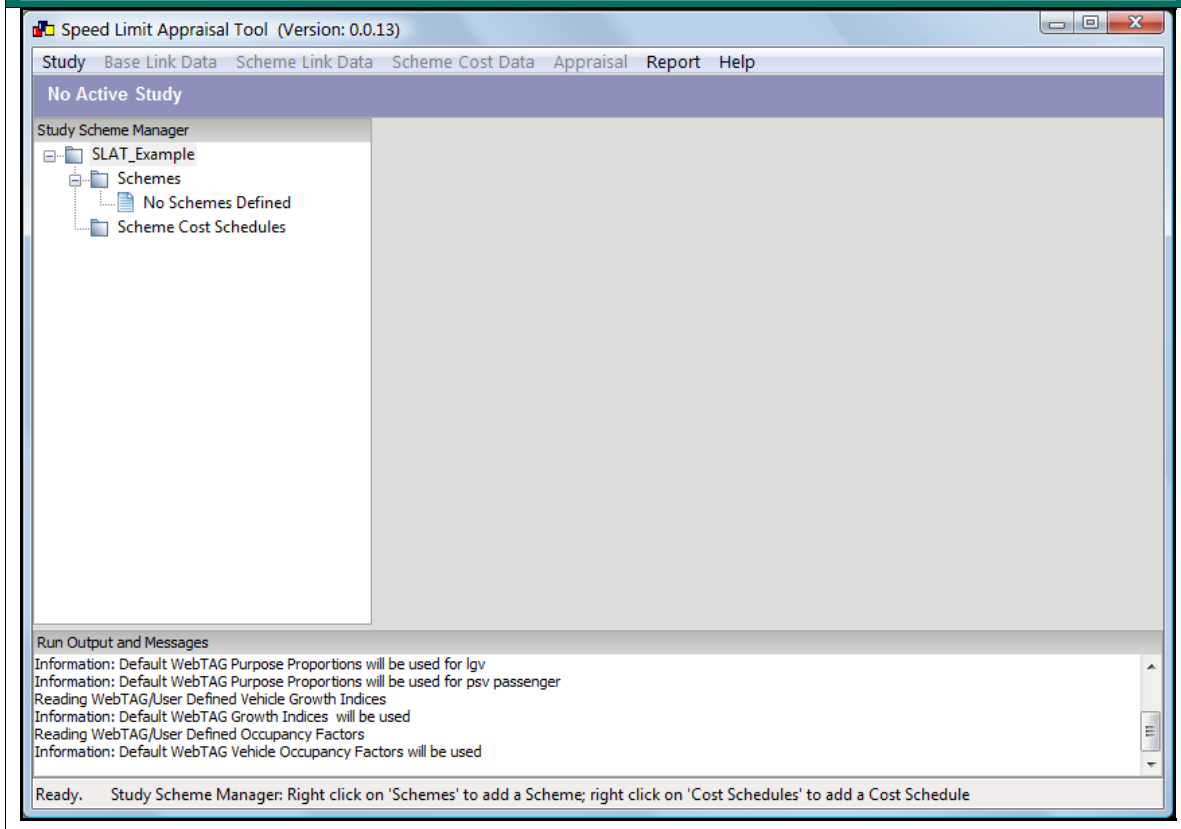


**6.9**     Before proceeding further, a 'New Study Created' dialogue is presented requesting a decision from you on how to proceed (see Figure 6.4). This gives you the choice of providing input data to the analysis either by:

1   Using a set of prescribed spreadsheets, or
2   Direct data entry in the SLAT interface.

**Figure 6.4  Choice of Importing Data or Using Direct Data Entry**



New Study Created

Your new study folders have been created and you now either:

1: Close this program so that you can prepare your input data using the template

   spreadsheets that you will find in folder:

         C:\Speed_Limit_Appraisal_Studies\SLAT_Example\Template_Directory

2: Enter the data directly using the tools provided in SLATS

However, you are strongly recommended to review the Study Setting Parameters first
What would you like to do?

REVIEW STUDY SETTINGS

1: Prepare Spreadsheets - SLATS will close          2: Enter Data Now

**6.10**   How you choose to work is up to you, but if you are using SLAT for the first time it is recommended that you provide data for your Study using the prescribed spreadsheets.

**6.11**   If you choose Option 1 then the tool will close and you would prepare your input data using the spreadsheets found in the **'Working_Directory'**. Before closing, you are presented with a further information dialogue to remind you what you need to do next (Figure 6.5).

**Figure 6.5  Information dialogue**
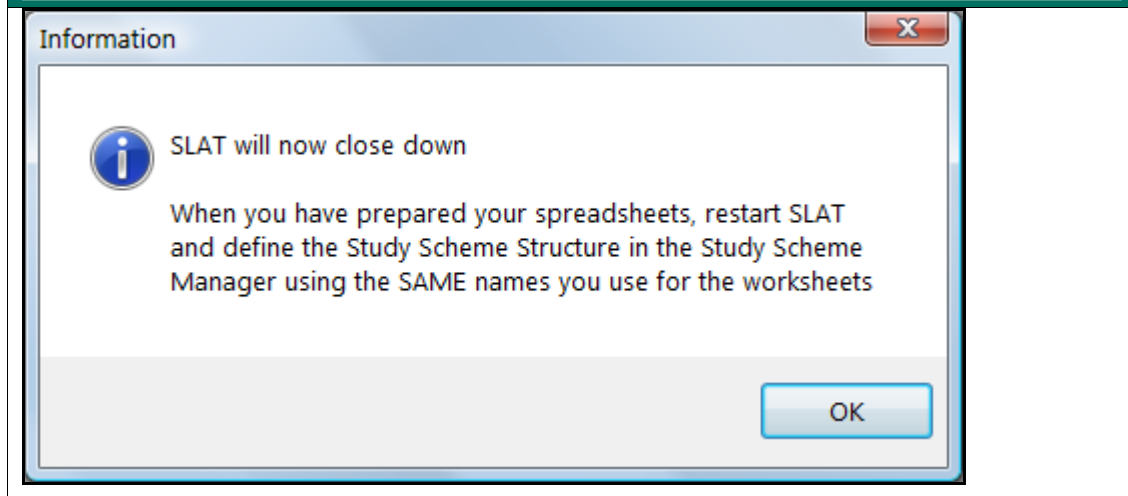


**6.12**   If you choose Option 2, you would enter your data directly using the tools found in SLAT. As you will come to see, the Data Tab 'grids' used to hold the various data components are identical for either mode of operation; it is just a matter of how they are populated with data. It is possible to mix the way in which you provide data to the tool; that is some can come via the spreadsheets and some can be entered directly. This will become evident as you become familiar with the way the tool operates.

**6.13**   Note that there is the possibility to REVIEW STUDY SETTINGS before choosing Options 1 or 2. This is equivalent to choosing the **STUDY>CURRENT STUDY SETTINGS** menu item (see Study Settings below) and you are strongly recommended to review and change these settings to match your Study at this initial point.

## Opening an Existing Study

**6.14**   This is similar to starting a NEW project, with the exception that you choose which study to open using the Browse for Folder dialogue which opens automatically under the default SLAT Studies folder (see Figure 6.6).

**Figure 6.6  Dialogue for Opening an Existing Study**
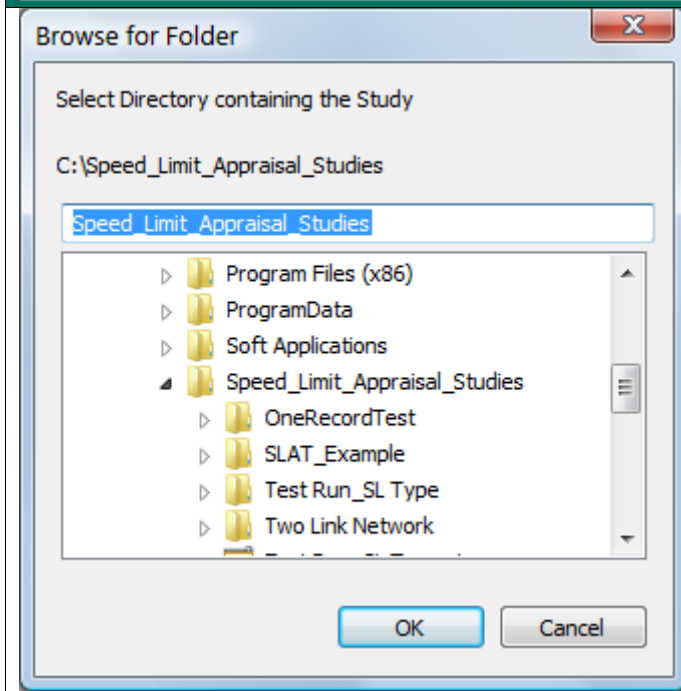


**6.15** When the target folder is selected a check is made to see if the study files exist in the folder; if not you must choose another location.

# Opening a New Study when the Tool is already working with a Study

**6.16** If you choose to open a different study from the one that is currently active, the open study will be closed down with all data saved to .SLT files.

# The Study Scheme Manager

**6.17** The Study Scheme Manager is a primary 'data control' object which is central to how you label and manage your Study Scheme Data. When you first create your Study, the Study Scheme Manager should appear as shown in Figure 6.7

**Figure 6.7 Study Scheme Manager Showing Unpopulated Study**
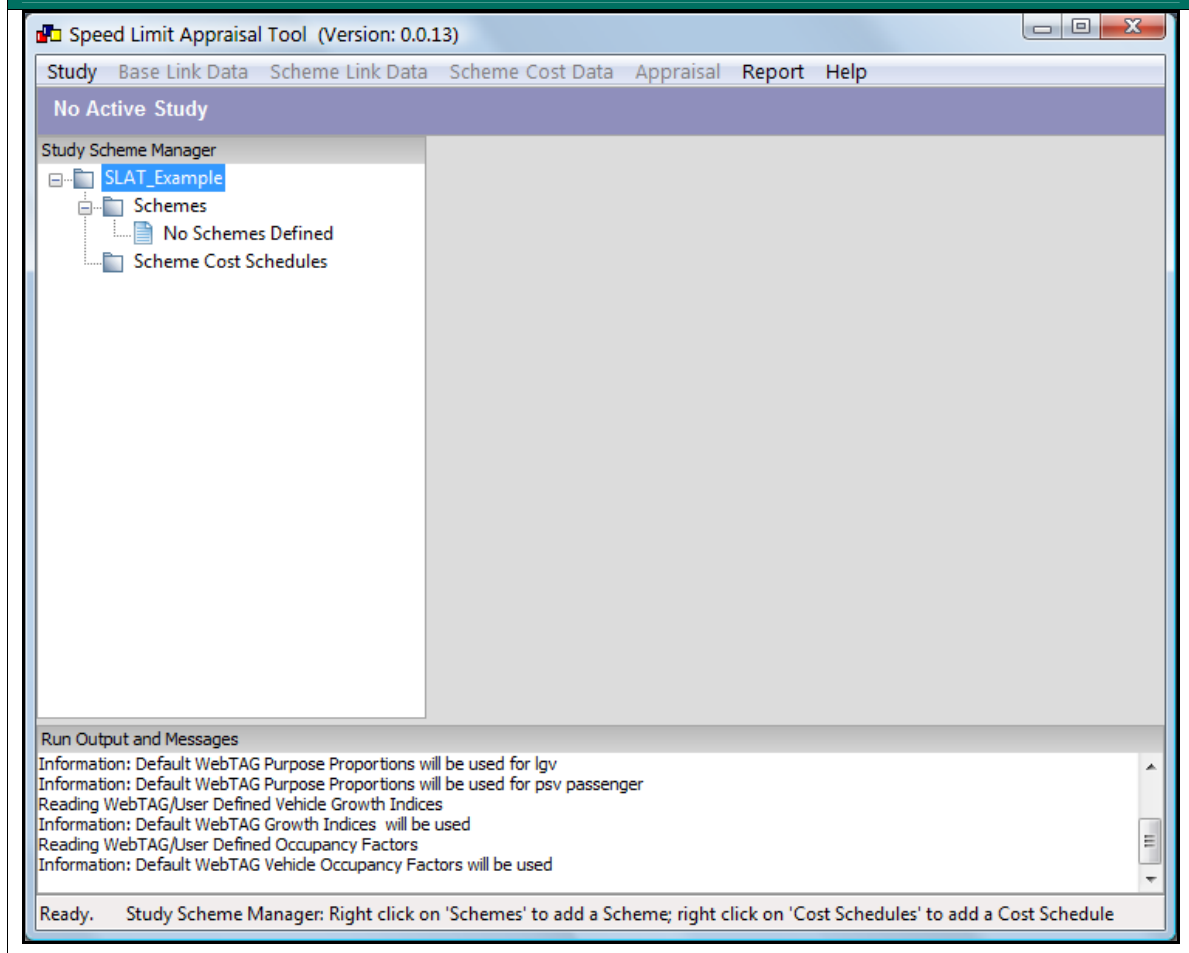


6.18 The first action is to create and name the BASE scheme in your Study. To do this, right click on Schemes and you will see the dialogue presented in Figure 6.8:

**Figure 6.8 Creating the BASE Scheme**
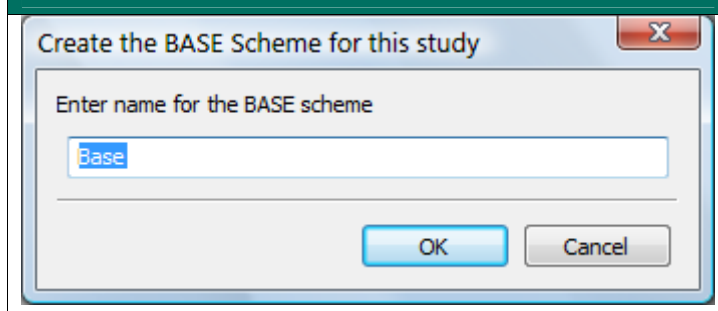


6.19 By default the Base scheme is called 'Base', but you can give it any name you wish (excluding the use of special characters).

**6.20** When you press 'OK', the Base Scheme is added to the Study Scheme Manager. Note that a Data Tab containing a grid is created on the top-right hand side of the interface with the label 'Input Link Data: Base' (see Figure 6.9). As implied, this tab is used to contain data relating to the Base Scheme; this data is either imported from the Input Links spreadsheet or entered manually.



Figure 6.9  Data Tab and Grid for Base
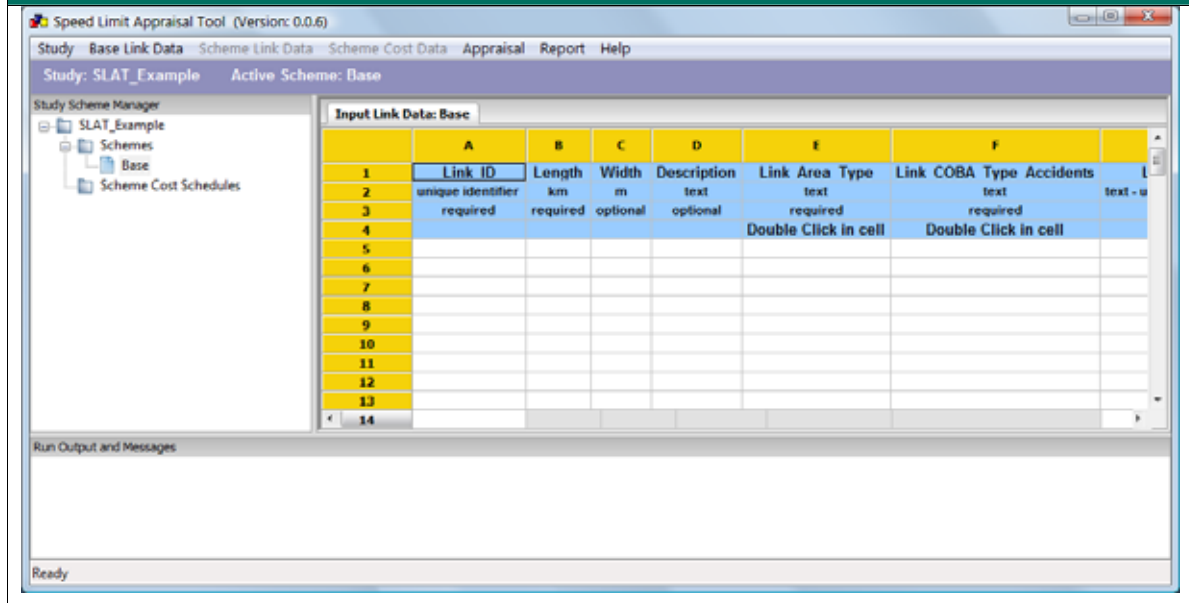
**6.21** You can re-name the scheme if you wish (you will need to left click on the name), but the name given here for the base scheme **MUST BE THE SAME** name as given on the worksheet used to provide the Input Links Data (See **'Your_StudyName'_Input_Link_Data.xls** - part shown in Figure 6.10).



Figure 6.10  Part of ..._Input_Link_Data.xls

**6.22**  Similarly, you must define the one or more future schemes that you are testing in the study[7]. For the purposes of our example, two schemes are created using the default scheme names. As each scheme is created, a corresponding 'tab' and data grid is generated (see Figure 6.11).

**Figure 6.11  Data Tab and Grid for Future Schemes**
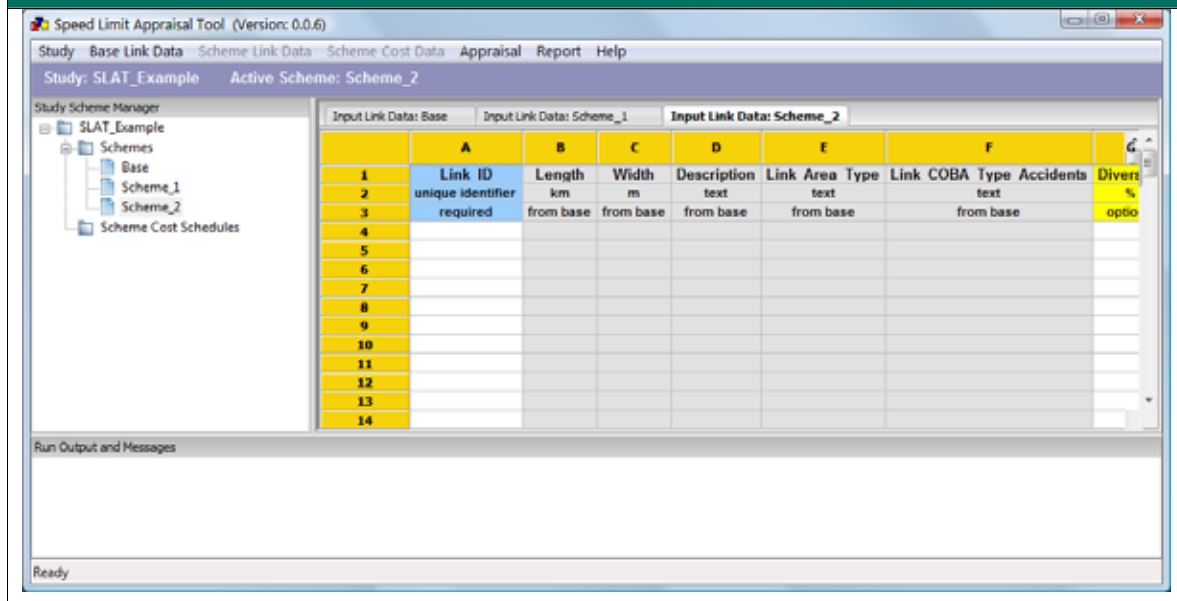


**6.23**  The same rule defining the relationship between the Schemes and the worksheets residing in the Input Links Spreadsheet applies - the name of a scheme and the associated worksheet **MUST BE THE SAME**.

**6.24**  When defining the Study structure in this way, schemes can be deleted by 'right clicking' on them and choosing the 'Delete' option.

**Key Points**

- The Base Scheme cannot be deleted whilst future schemes exist
- Right clicking on the Base Scheme has the only option to delete; right clicking on a Scheme has additional options (described below).

---

[7] There is no limit on the number of schemes that can be defined.

**6.25** Having defined the schemes that are in the study, you must define one or more Scheme Cost Schedules[8]. Each (future) scheme must be associated with a cost schedule, and different schemes can be associated with the same cost schedule.

**6.26** Scheme Cost Schedules are defined by right clicking on the tree item 'Scheme Cost Schedules' and giving the Cost Schedule a name (Figure 6.12).

**Figure 6.12  Naming Scheme Cost Schedules**
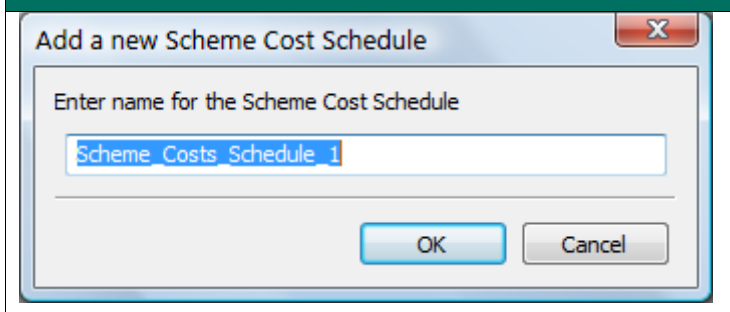


**6.27** The name given here MUST be the same as the corresponding cost schedule worksheet supplied in the **'Your_StudyName'_Input_Cost_Data.xls** spreadsheet (see Figure 6.13).

**Figure 6.13  Part of ..._Input_Scheme_Costs_Data.xls**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Year | Capital_Cost | Operating_Cost | | |
| 2 | 2012 | | | | |
| 3 | 2013 | 30000 | | | |
| 4 | 2014 | 70000 | 5000 | | |
| 5 | 2015 | | 5000 | | |
| 6 | 2016 | | 5000 | | |
| 7 | 2017 | | 5000 | | |
| 8 | 2018 | | 5000 | | |
| 9 | 2019 | | 5000 | | |
| 10 | 2020 | | 5000 | | |
| 11 | 2021 | | 5000 | | |
| 12 | 2022 | | 5000 | | |
| 13 | 2023 | | 5000 | | |

Scheme_Costs_Schedule_1

Ready                    100%

---

[8] There is no limit on the number of cost schedules that can be defined.

**6.28**   As with schemes, a tab/data grid is created for each new Cost Schedule (as in Figure 6.14):

**Figure 6.14   Data Tab and Grid for Scheme Cost Data**
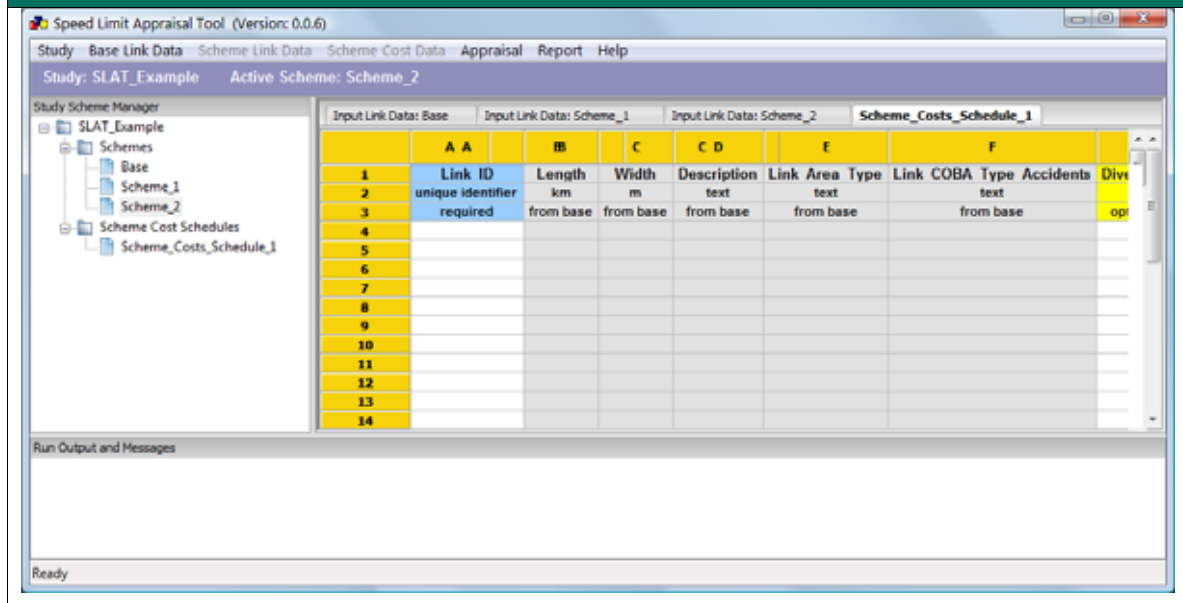


**6.29**   Each Scheme needs to be associated with a cost schedule; this is done by right clicking on the Scheme and choosing the appropriate Cost Schedule (in this example there is only one - see Figure 6.15):

**Figure 6.15   Associating a Scheme with Cost Data**
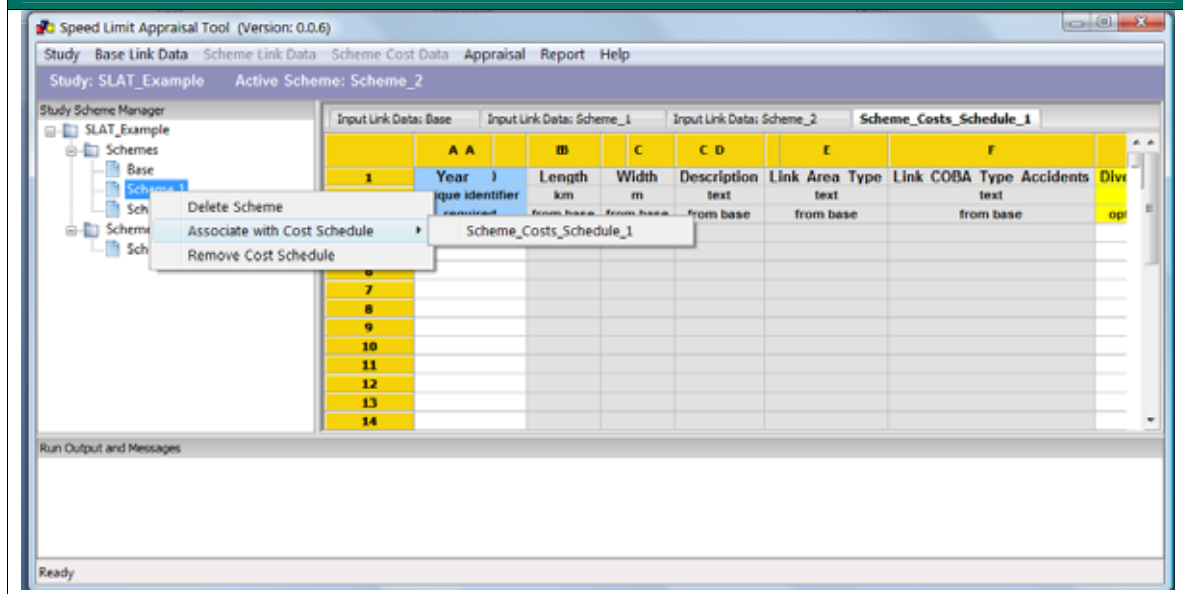
**6.30**   This is repeated for each Scheme, until each scheme is associated with a cost schedule, as in Figure 6.16.

**Figure 6.16  Completed Data Structure for a Study**
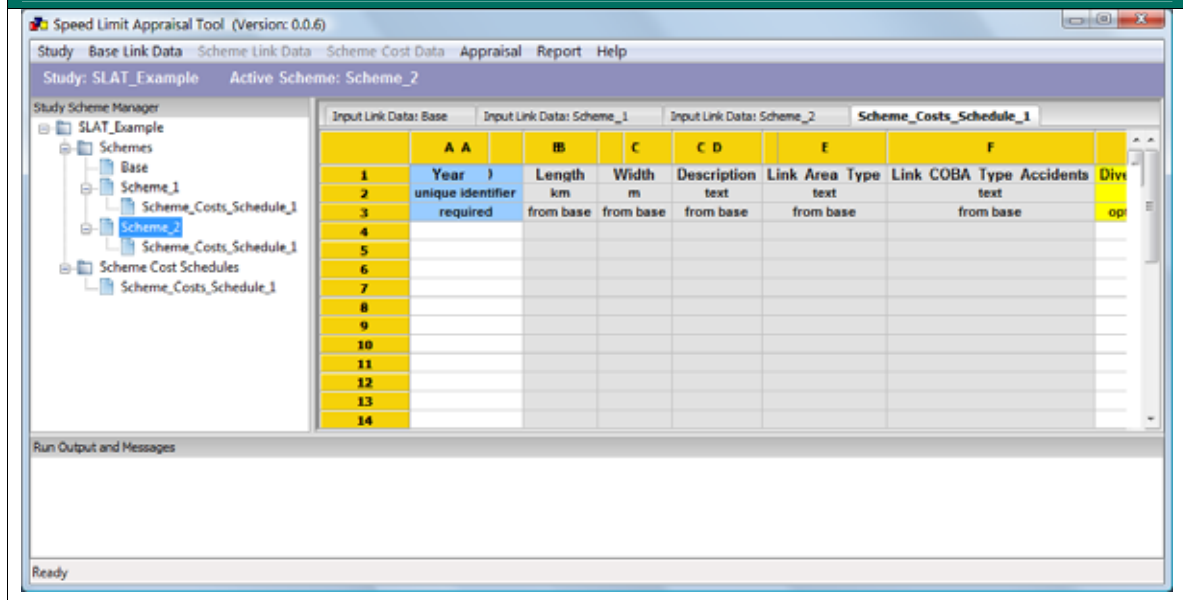


**6.31**   Having completed these steps, the following has been achieved:

- The study 'structure' has been specified
- The names of the various data components have been established
- Places for the various input data sets have been created

---

**Key Points**

The following Main Menu Items are disabled until the appropriate items on the Study Scheme Manager have been added. Further, the Appraisal menu item is not enabled until all three components exist.

- Base Link Data
- Scheme Link Data
- Scheme Cost Data

---

# Study Settings

**6.32** Before importing any data, the Study Setting parameters which can be seen from the Menu item **STUDY>CURRENT STUDY SETTINGS** should be reviewed (see Figure 6.17 and below).

**Figure 6.17  Global Study Settings**



- Study Base Year

This is the start year for the Study; this should match the start of the Capital Cost data stream in ALL Scheme Cost Schedules.

- Study Opening Year

This is the year in which the scheme opens. This year should match the point in all Scheme Cost Schedules when the Capital Costs data stream switches to Operating Costs and should be equal to or later than the Study Base Year.

- Study Final Year

This is the year in which the appraisal period and the Operating Costs data stream finishes.

- Accident Base Year

This the Base Year applicable to accident data averaged over a three-year period.

- Study VOT Multiplier

This is the numeric value to adjust default WebTAG values of time to local values (as determined by local surveys). The default value of the VOT Multiplier is 1.0. This value should only be varied from 1.0 if there is robust evidence to justify and support doing so.

- Study Region

Regional identifier corresponding to RTF (Road Traffic Forecast) regions for traffic growth. Select appropriate value from drop-down list.

- Area Type

This is the characterisation of area. Select appropriate value from drop-down list. Note - Large Urban is for urban areas with a population of over 250,000.

- Speed Change Constraint

This is a 'flag' to determine whether speeds can alter in opposite direction to speed limits change (as observed at certain low-speed studies).

**Key Point**

As can be seen, one set of Base/Opening/Final/Accident years applies to the Study, and all Cost Schedules used in the analysis must conform to this regime. If different years and associated cost regimes apply per scheme, then each 'set' should be treated as a separate Study.

# User Values

6.33 Changing the following set of User Value Tables is optional, and dependent on available, statistically adequate, local data.

**Vehicle Type Proportions**

6.34 The **Vehicle Type Proportions** button provides access to the Vehicle Type Proportions read from the **U_Vehicle_Type_Shares** worksheet, which resides in the **'study_name'_User_Values_Data.xls** spreadsheet (see Figures 6.18 and 6.19).

**Figure 6.18  Table for User-Defined Vehicle Type Proportions**

User Defined - Vehicle Type Proportions

| | Default_WebTAG | User_Defined |
|---|---|---|
| **Car** | 0.816 | 0.3 |
| **LGV** | 0.114 | 0.2 |
| **OGV1** | 0.028 | 0.2 |
| **OGV2** | 0.031 | 0.1 |
| **PSV** | 0.011 | 0.1 |

Proportions must sum to 1.0 not 0.90

| Clear | Abandon | Save |

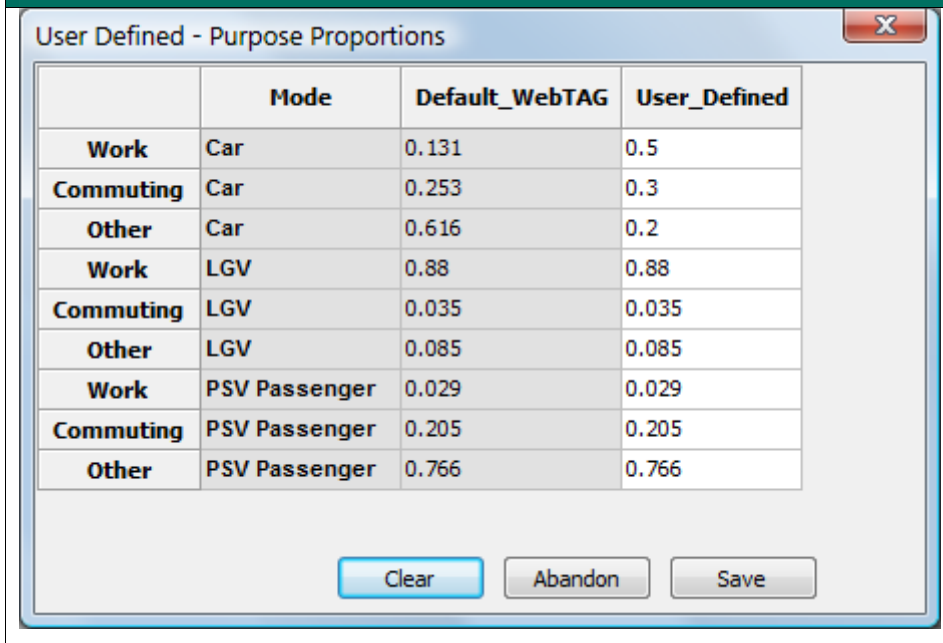**6.35**   In the example above, the sum of the User Defined proportions is not 1.0, so the User Defined column is coloured red. Further, the 'SAVE' button is disabled. The data must therefore either be corrected, the User Defined column cleared, or any changes made abandoned.



**Figure 6.19  Corresponding ..._Input_User_Values_Data.xls Data of Vehicle Type Shares**

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | Vehicle Type | Default_WebTAG | User_Defined | | | | | |
| 2 | Car | 0.816 | 0.8 | | | | | |
| 3 | LGV | 0.114 | 0.14 | | | | | |
| 4 | OGV1 | 0.028 | 0.02 | | | | | |
| 5 | OGV2 | 0.031 | 0.03 | | | | | |
| 6 | PSV | 0.011 | 0.01 | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |

U_Veh_Type_Shares    U_Purp_Splits    U_Growth_Indices

Ready          Average: 0.2     Count: 5    Sum: 1       100%

**Purpose Proportions**

**6.36**  The **Purpose Proportions** button provides access to the Purpose Proportions (see Figure 6.20) read from the **U_Purp_Splits** worksheet which resides in the **'study_name'_User_Values_Data.xls** spreadsheet

**Figure 6.20  User Data for Trip Purpose Proportions by Vehicle Type**

User Defined - Purpose Proportions

| | Mode | Default_WebTAG | User_Defined |
|---|---|---|---|
| **Work** | Car | 0.131 | .5 |
| **Commuting** | Car | 0.253 | .3 |
| **Other** | Car | 0.616 | .3 |
| **Work** | LGV | 0.88 | 0.0 |
| **Commuting** | LGV | 0.035 | 0.0 |
| **Other** | LGV | 0.085 | 0.0 |
| **Work** | PSV Passenger | 0.029 | 0.0 |
| **Commuting** | PSV Passenger | 0.205 | 0.0 |
| **Other** | PSV Passenger | 0.766 | 0.0 |

Clear    Abandon    Save

**6.37**  In the example above, the sum of the User Defined proportions for Car is not 1.0, so that segment of the User Defined column is coloured red. Further, the 'SAVE' button is disabled; the data must either be corrected, the User Defined column cleared, or any changes made abandoned.

**6.38**  If you choose to supply User Defined values for some, but not all, vehicle types, the cells which are left zero-filled will in fact be filled automatically

---

[9] All WebTAG and other DfT data in the User Values section can be found in the 'DfTDataTables_Directory' sub-directory.

with the WebTAG default values when the SAVE button is pressed . This is because it is not allowed to have partially completed User Defined Data.

**Figure 6.21  Completed User Table of Trip Purposes by Vehicle Type**

| | Mode | Default_WebTAG | User_Defined |
|---|---|---|---|
| **Work** | Car | 0.131 | 0.5 |
| **Commuting** | Car | 0.253 | 0.3 |
| **Other** | Car | 0.616 | 0.2 |
| **Work** | LGV | 0.88 | 0.88 |
| **Commuting** | LGV | 0.035 | 0.035 |
| **Other** | LGV | 0.085 | 0.085 |
| **Work** | PSV Passenger | 0.029 | 0.029 |
| **Commuting** | PSV Passenger | 0.205 | 0.205 |
| **Other** | PSV Passenger | 0.766 | 0.766 |

User Defined - Purpose Proportions

Clear   Abandon   Save

**Key Point**

An Appraisal run cannot proceed unless all User Defined Purpose Proportion data has passed all validation tests successfully.

**Vehicle Occupancy**

**6.39**   The **Vehicle Occupancy** button provides access to the Vehicle Occupancy Factors read from the **U_Veh_Occup** worksheet which resides in the **'study_name'_User_Values_Data.xls** spreadsheet (see Figures 6.22 and 6.23).
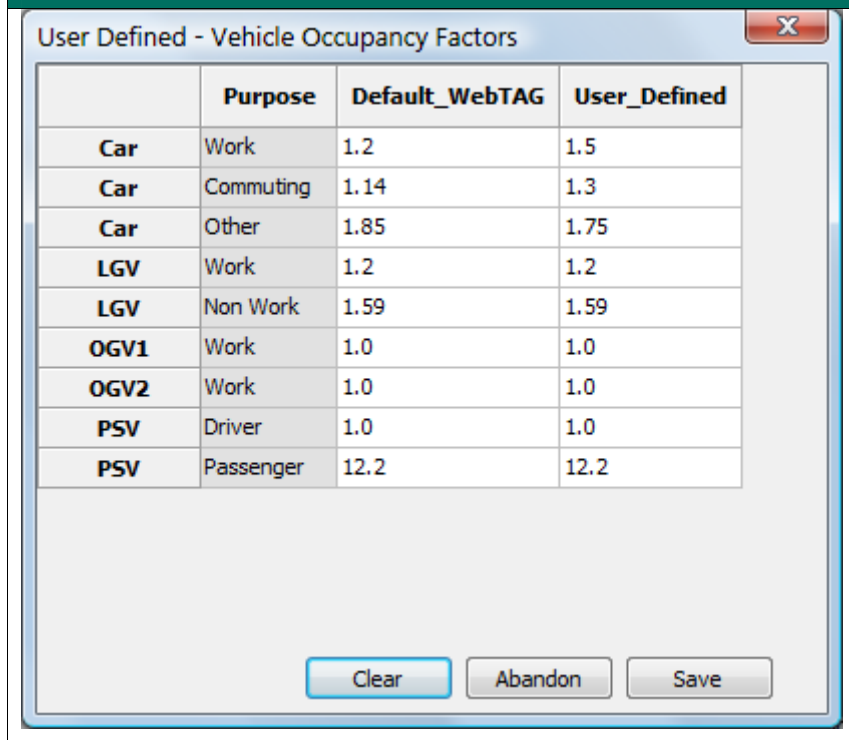
**Figure 6.22  User-Defined Vehicle Occupancy Factors**

User Defined - Vehicle Occupancy Factors

|  | Purpose | Default_WebTAG | User_Defined |
|---|---|---|---|
| Car | Work | 1.2 | 1.5 |
| Car | Commuting | 1.14 | 1.3 |
| Car | Other | 1.85 | 1.75 |
| LGV | Work | 1.2 | 0.0 |
| LGV | Non Work | 1.59 | 0.0 |
| OGV1 | Work | 1.0 | 0.0 |
| OGV2 | Work | 1.0 | 0.0 |
| PSV | Driver | 1.0 | 0.0 |
| PSV | Passenger | 12.2 | 0.0 |

Clear    Abandon    Save

6.40   If you choose to supply User Defined values for some, but not all, mode/purpose combinations, the cells which are left zero-filled will in fact be filled automatically with the WebTAG default values when the SAVE button is pressed. This is because it is not allowed to have partially completed User Defined Data.

**Figure 6.23  Completed Vehicle Occupancy Factors Table**



User Defined - Vehicle Occupancy Factors

| | Purpose | Default_WebTAG | User_Defined |
|---|---|---|---|
| **Car** | Work | 1.2 | 1.5 |
| **Car** | Commuting | 1.14 | 1.3 |
| **Car** | Other | 1.85 | 1.75 |
| **LGV** | Work | 1.2 | 1.2 |
| **LGV** | Non Work | 1.59 | 1.59 |
| **OGV1** | Work | 1.0 | 1.0 |
| **OGV2** | Work | 1.0 | 1.0 |
| **PSV** | Driver | 1.0 | 1.0 |
| **PSV** | Passenger | 12.2 | 12.2 |

Clear    Abandon    Save

**Key Points**

- An Appraisal run cannot proceed unless all User Defined Vehicle Occupancy Factors have passed all validation tests successfully.

- The default values for occupancy are 2000 values; therefore, occupancy trends should be applied between 2000 and the Base Year and to each scheme year. If the user is defining local values, the year for these needs to be defined, so that the WebTAG trends can be applied correctly.

**Growth Indices**

6.41    The **Growth Indices button** provides access to the Growth Factors read from the U_Growth_Indices worksheet, which resides in the 'study_name'_User_Values_Data.xls  spreadsheet (see Figure 6.24). These are percentage changes in growth from 2010 by five-year increments to 2035 by vehicle type.

**Figure 6.24  User-Defined Traffic Composition Changes from 2010**

**User Defined - Growth Indices**

|  | Year | Default_WebTAG_% | User_Defined_% |
|---|---|---|---|
| **Car** | 2010 | -0.2 | 0.0 |
| **LGV** | 2010 | 16.6 | 0.0 |
| **OGV1** | 2010 | -3.7 | 0.0 |
| **OGV2** | 2010 | -10.5 | 0.0 |
| **PSV** | 2010 | -3.9 | 0.0 |
| **Car** | 2015 | 2.9 | 0.0 |
| **LGV** | 2015 | 35.1 | 0.0 |
| **OGV1** | 2015 | 12.9 | 0.0 |
| **OGV2** | 2015 | 5.1 | 0.0 |
| **PSV** | 2015 | -8.3 | 0.0 |
| **Car** | 2020 | 12.2 | 0.0 |
| **LGV** | 2020 | 56.7 | 0.0 |
| **OGV1** | 2020 | 16.5 | 0.0 |
| **OGV2** | 2020 | 17.1 | 0.0 |
| **PSV** | 2020 | -9.9 | 0.0 |
| **Car** | 2025 | 22.1 | 0.0 |
| **LGV** | 2025 | 76.7 | 0.0 |
| **OGV1** | 2025 | 19.8 | 0.0 |
| **OGV2** | 2025 | 31.0 | 0.0 |
| **PSV** | 2025 | -12.5 | 0.0 |
| **Car** | 2030 | 28.6 | 0.0 |
| **LGV** | 2030 | 97.2 | 0.0 |
| **OGV1** | 2030 | 24.2 | 0.0 |
| **OGV2** | 2030 | 41.6 | 0.0 |
| **PSV** | 2030 | -15.0 | 0.0 |
| **Car** | 2035 | 34.9 | 0.0 |
| **LGV** | 2035 | 119.2 | 0.0 |
| **OGV1** | 2035 | 27.3 | 0.0 |
| **OGV2** | 2035 | 59.0 | 0.0 |
| **PSV** | 2035 | -17.4 | 0.0 |

Copy    Clear    Validate    Abandon    Save

**6.42**    You will need to use the COPY button to copy all WebTAG values to the User Defined column and change the indices you wish to amend. Any values which are +/- 10% of the associated WebTAG values are flagged as a warning as data is entered. The 'Validate' button can be used at any time to re-check the entire table.

**Key Point**

With all four of the User tables, if you have supplied any Default Values these will be saved as described under the heading **'Spreadsheets and Manual Data Entry'** above. However, if you CLEAR all values from any table, the saved corresponding '.SLT' file will be deleted and when SLAT is re-opened it will (re-) read input values (if any) from the corresponding table in the **…_Input_User_Values_Data** spreadsheet.

# 7. Inputting Scheme Link Data from the Spreadsheets

## Basic Rules

**7.1** There are some basic rules associated with the data supplied in the input spreadsheets. These are:

- The name of the worksheet must match the name of the scheme (Base or Future) into which the data is being imported. The same is true for Scheme Cost Schedule data[10].

- Each row of data in the base and scheme links worksheet represents one link.

- Each link must have a unique **Link_ID** value (alphanumeric) in the first column.

- If using text in the **Link_ID**, it will be case sensitive

- The end of the data stream for link data is marked in the **LINK_ID** field by a blank or the string 'End'. Therefore, do NOT have blank rows interspersed in the link data as the data after the first blank row will not be recognised.

- You cannot have data for a link without a **Link_ID**. When working in the Data Tab grid, any such data will be removed as entered.

## Base Scheme Links

**7.2** Given that the Base Scheme has been defined in the Study Scheme Manager and has been named (in this example 'Base'), data can be read from the input links spreadsheet which:

- resides in the **Working_Directory**

- is called **'study_name'_Input_Link_data.xls**

- has the link data in the second worksheet, whose label matches the name of the Base Scheme (in this case: 'Base')

---

[10] When importing data from a spreadsheet for either schemes or cost schedules, it is assumed that data sets are in the same sequence as worksheets in the spreadsheets as the data tabs in the GUI. So, for example, the third set of cost schedules will expect to import data from the third worksheet.

**7.3** The Menu item **BASE LINK DATA** is enabled once the Study Scheme Manager has been established, and the data is imported from the spreadsheet using the **'Import link Data for : Base Scheme Name'** option (see Figure 7.1).



**Figure 7.1 Importing Base Link Data**
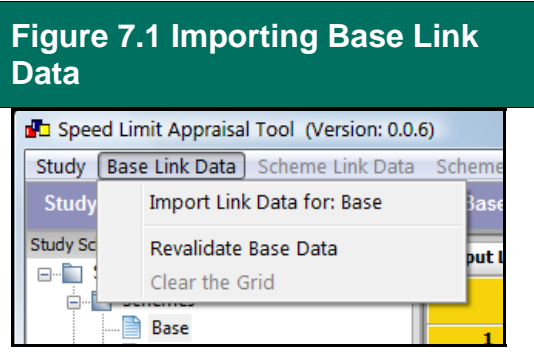
**If you are inputting data directly into the Data Grid, then the following text applies.**

**7.4** The data is validated as it is read in, and errors are reported both in the 'Run Output and Messages' area, as well as the 'error' cells in the grid changing colour.

**7.5** There are different types of error, described as follows:

- **Range error**. Depending on the data item, the supplied value is checked to ensure it is within the specified range. Cells in error are coloured red; when corrected the cell will revert to white.

- **Inter-variable dependency**. Specifically related to the Accident data, you can define accidents in one of two ways. Errors detected in this group of cells are coloured orange as it is not possible to identify uniquely in which cell(s) the problem lies. You must make a judgement as to which cells need to be changed; when all validation checks are passed the group of cells will revert to white.

**7.6** Each row represents data for one link, and each link must have a unique (alphanumeric) id. If duplicate link_ids are found, the relevant **link_id** cells will be coloured red. When made unique, the cells will be coloured white. However, note the relationship with the **link_ids** in the scheme input link Data Tab grids; they must match.

**7.7** As suggested, data can be edited or entered directly in the Data Tab grid, and at any time you can choose to revalidate the base data using the menu item shown above. Note that two fields for the Base Link data are filled by selecting text from a drop-down combo box; these fields are **Link_AREA_Type** and **Link_COBA_Accident_Type.**

**7.8** Only when all Base Link data is 'clean' can an Appraisal run take place.

**7.9**    It is recommended that if you make any changes to the data in the Data Tab grid, you save them by selecting the **STUDY>SAVE CURRENT DATA SETS** option.

# Future Scheme Links

**7.10**    The commentary on inputting Base Scheme Links applies to that for Future Schemes, although there are some specific items to mention, namely:

- The data required for a Scheme Link is, for the most part, an extension of that for the Base Link.

- When importing Scheme Link data, it is imported into the Current Active Scheme.

- The Menu SCHEME LINK DATA item is not enabled until Base Links data has been input (see Figure 7.2).

- An option exists to copy the appropriate sub-set of data from the Base Scheme into the current active scheme.

- The columns coloured in light grey are read-only and contain data copied from the Base Scheme. They are for information only

- Positionally in the rows, the **Link_IDs** must match with those of the Base Scheme.

**Figure 7.2  Importing Scheme Link Data**
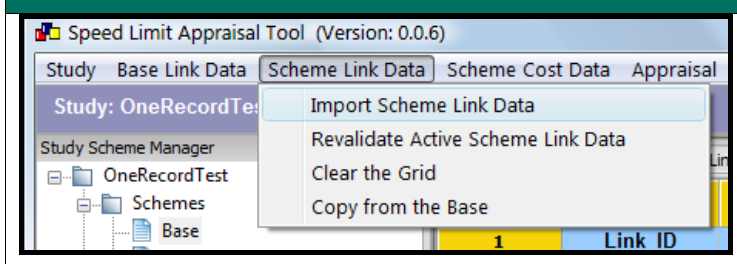


# Inputting Scheme Cost Schedule Data

**7.11**    Scheme Cost Schedule data is imported and validated in a similar fashion to that of link data, noting the following rules:

- The menu item **SCHEME COST DATA** is not enabled until both Base and at least one set of Scheme data has been imported.

- The list of years must contain unique numbers with no numeric breaks.

- The 'start' year of the Capital Costs should match the Study 'Start Year'

- The 'end' year  of the Capital Costs (and start year of Operating Costs) should match the Study 'Opening Year'

- The 'final' year of Operating Costs should match the Study 'Finish Year'

- Warnings are reported if these conditions are not met; they are not regarded as fatal errors.
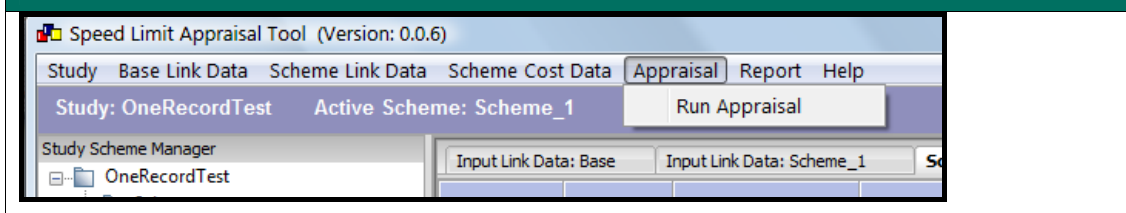


**Figure 7.3  Importing Scheme Cost Data**
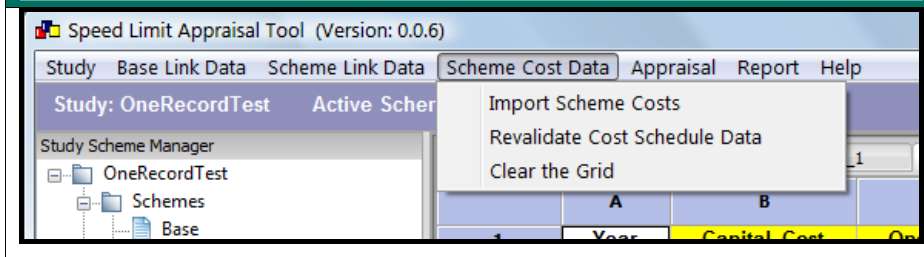
# 8. Running the Appraisal

**8.1**      A scheme appraisal is activated from the menu item **APPRAISAL>RUN APPRAISAL** (see Figure 8.1).



**Figure 8.1  Initiating the Scheme Appraisal**

**8.2**      A Scheme Appraisal can be run only when:

- Base Link data has been imported and passed the validation checks.

- A future Scheme has been selected as the Active Scheme, its data has been imported and passed the validation checks

- The associated Scheme Cost Schedule data has been imported and passed the validation checks.

- If any of the four Study User Data Sets (Vehicle Type, Purpose, Vehicle Occupancy, Growth Indices) has user supplied data and all validation checks have been passed

**8.3**      When **'RUN APPRAISAL'** is activated, all required data is re-validated automatically, and if any errors are detected in the input data, the run is aborted with an appropriate error message. Further, a check is made to ensure that all of the required DfT Data Tables are present in the **DfTDataTables_Directory**.

# 9. Reporting Results

## Output File Structure

**9.1** When the run is complete, four output spreadsheets are written to the study **Output_Files** folder. These files are called:

- Transport_Economic_Efficiency_Table_for_*'study_name'_'timestamp'* .xls

- Appraisal_Summary_Table_for_*'study_name'_'timestamp'*.xls

- Objective_Analysis_Table_*'study_name'_'timestamp'*.xls

- Link_Impacts_Table_for_*'study_name'_'timestamp'*.xls

where:
- 'study_name'  is the name you gave to the study
- 'timestamp' is of the form year_month_day_hour_minute. This allows previous outputs for a scheme's run to be preserved.

**9.2** Each output spreadsheet is a copy of the 'master' template from the **Templates_Directory**, and populated in the appropriate cells with data generated by the appraisal.

**9.3** An audit file of diagnostic information is output as a text file with a name of the form audit_**'timestamp'**.txt. This is mainly of relevance in the case of problems or questions arising relating to the results.

**9.4** Additionally, note that the output to the Messages panel can be saved to a file from the **REPORT** menu.

## The Appraisal Summary Table (AST)

**9.5** An example of an AST output spreadsheet for an example scheme named **'Scheme_1'** is shown in Figure 9.1. SLAT fills certain of the cells in the table with numeric values, in monetary and non-monetary units. Some cells are greyed out as being not relevant. Blank white cells are provided for the user to enter qualitative assessments. (This will be based on various factors, but including assessment of the Link Output Analysis file.)

Figure 9.1 Illustrative Excerpt of the Appraisal Summary Table

# Transport Economic Efficiency Table (TEE Table)

**9.6** An illustrative part of the TEE table is shown in Figure 9.2. In a few cases it may be appropriate to add data relating to Private Sector contributions. The summary total numbers at the bottom of the table, not shown in the figure, will alter as a result.

**Figure 9.2 Illustrative Transport Economic Efficiency Table**

| Transport Economic Efficiency Table (TEE) | | | | | |
|---|---|---|---|---|---|
| **Consumers** | | | | | |
| *User benefits* | **Private Cars and LGVs** | **PSV** | | | |
| Travel time | £9,698,767 | £1,006,258 | | | |
| Vehicle operating costs | £561,759 | | | | |
| User charges | £0 | | | | |
| During Construction & Maintenance | £0 | | | | |
| NET CONSUMER BENEFITS | £11,266,784 | *(1)* | | | |
| **Business** | | | | | |
| *User benefits* | **Total** | **Goods Vehicles** | **Business Cars & LGVs** | **PSV** | |
| Travel time | £10,170,992 | £1,222,047 | £8,620,926 | £328,019 | |
| Vehicle operating costs | £1,137,994 | £710,951 | £264,574 | £162,468 | |
| User charges | 0 | | | | |
| During Construction & Maintenance | 0 | | | | |
| Subtotal | £11,308,986 | £1,932,998 | £8,885,500 | £490,488 | *(2)* |
| *Private sector provider impacts* | | | | | |
| Revenue | 0 | | | | |
| Operating costs | 0 | | | | |
| Investment costs | 0 | | | | |
| Grant/subsidy | 0 | | | | |

Scheme_1

# Objectives Analysis Table

**9.7** The Objective Analysis table provides a convenient summary overview of the schemes benefits (see Figure 9.3).

## Figure 9.3  Illustrative Objectives Analysis Table



# Link Output Analysis File

**9.8**    This file provides details for each link in the network and enables an analysis of the distribution of effects on speeds, accidents, and benefits different categories to be made[11]. The file is shown in two sections below (Figures 9.4 and 9.5), with Figure 9.5 presenting the benefit categories for which values are calculated[12].

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[11] For reasons of consistency of on-screen display in the program and spreadsheet, the precision of some numbers is restricted, which results in small rounding discrepancies with reported totals.

[12] The traded $CO_2$ emissions are actually non-zero as electric vehicles are forecast in the future, but typically appear to be zero as results are only reported to 0.1 of a tonne.

# Figure 9.4  Illustrative Section of the Link Output Analysis File

| Link_ID | Link Length kms | Before Speed Limit | After Speed Limit | Before Flow - AADT | After Flow - ADDT | Before Speed - mph | After Speed - mph | Before Speed 85 Percentile | After Speed 85 Percentile | Before Fatal Acidents | Fatal Accidents | Serious Accidents | Serious Accidents | Slight Accidents | Slight Accidents | Damage Only Accident | Damage Only Accident | Before All Accidents | After All Accidents | Before All PIA Accidents | After All PIA Accidents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 1.6 | 40 | 30 | 2297 | 2297 | 39.4 | 32.8 | 44.7 | 35.6 | 4 | 2.5 | 38 | 28.8 | 201.6 | 167.5 | 4311.4 | 3720.5 | 4555 | 3919.3 | 243.6 | 198.8 |
| 102 | 3.78 | 40 | 30 | 2016 | 2016 | 41.2 | 33.2 | 48 | 37 | 1 | 0.6 | 9.9 | 7.2 | 52.6 | 42.4 | 1125.6 | 947.4 | 1189.2 | 997.5 | 63.6 | 50.2 |
| 103 | 1.75 | 40 | 30 | 1937 | 1937 | 39.1 | 32.7 | 45.9 | 36.7 | 0.4 | 0.2 | 2.4 | 1.8 | 12.8 | 10.7 | 276.1 | 239.3 | 291.7 | 252.1 | 15.6 | 12.8 |
| 104 | 1.85 | 40 | 30 | 5177 | 5177 | 33.5 | 31.3 | 40 | 35.8 | 1.7 | 1.4 | 16.3 | 14.7 | 86.4 | 80.7 | 1847.7 | 1750.8 | 1952.1 | 1847.7 | 104.4 | 96.9 |
| 105 | 2.04 | 40 | 30 | 5233 | 5233 | 34.6 | 31.6 | 40.7 | 35.5 | 0.3 | 0.2 | 2.4 | 2.1 | 12.9 | 11.8 | 276.1 | 258.7 | 291.7 | 270.8 | 15.6 | 14.1 |
| 106 | 1.81 | 40 | 30 | 1911 | 1911 | 36.4 | 34.2 | 43 | 40.4 | 0.2 | 0.2 | 1.5 | 1.6 | 9.9 | 9.3 | 212.4 | 193.6 | 224.4 | 204.6 | 12 | 11 |
| 107 | 1.21 | 40 | 30 | 1831 | 1831 | 36 | 33.9 | 42.4 | 39.9 | 0.7 | 0.5 | 6.6 | 5.6 | 34.8 | 32.5 | 743.3 | 679.8 | 785.3 | 718.5 | 42 | 38.7 |
| 108 | 1.7 | 40 | 30 | 2471 | 2471 | 34.1 | 31.5 | 39.9 | 35.2 | 0.8 | 0.6 | 7.7 | 6.8 | 40.7 | 37.6 | 870.8 | 816.5 | 920 | 861.5 | 49.2 | 45 |
| 109 | 4.21 | 40 | 30 | 2455 | 2455 | 33.6 | 31.3 | 40.1 | 35.8 | 0.7 | 0.6 | 6.7 | 6.1 | 35.8 | 33.3 | 764.6 | 723.2 | 807.8 | 763.2 | 43.2 | 40 |
| 110 | 2.12 | 30 | 20 | 1832 | 1832 | 17 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 2.1 | 2.1 | 2.2 | 2.2 | 0.1 | 0.1 |
| 111 | 1.01 | 30 | 20 | 1201 | 1201 | 20 | 19.9 | 0 | 0 | 0.1 | 0.1 | 1.3 | 1.3 | 10.6 | 10.5 | 212.4 | 210.4 | 224.4 | 222.3 | 12 | 11.9 |
| 112 | 0.78 | 30 | 20 | 899 | 899 | 30 | 27.6 | 0 | 0 | 0.1 | 0.1 | 1.3 | 1.1 | 10.6 | 9.7 | 212.4 | 187.5 | 224.4 | 198.3 | 12 | 10.8 |
| 113 | 1.82 | 30 | 20 | 1527 | 1527 | 21 | 15.1 | 0 | 0 | 0.3 | 0.1 | 5.6 | 2.4 | 44.5 | 30.8 | 892 | 543.3 | 942.4 | 576.6 | 50.4 | 33.3 |
| 114 | 4.24 | 60 | 50 | 4000 | 4000 | 47.7 | 45.8 | 0 | 0 | 0.1 | 0.1 | 0.5 | 0.5 | 3 | 2.8 | 28.1 | 26.4 | 31.7 | 29.8 | 3.6 | 3.4 |
| 115 | 3.24 | 60 | 50 | 4000 | 4000 | 47.9 | 45.9 | 0 | 0 | 2 | 1.7 | 13 | 11.7 | 72.6 | 69.2 | 683.2 | 641.4 | 770.8 | 724 | 87.6 | 82.6 |
| 116 | 2.22 | 60 | 40 | 3000 | 3000 | 34.2 | 34.2 | 0 | 0 | 0.9 | 0.9 | 5.9 | 5.9 | 32.8 | 32.8 | 308.9 | 308.9 | 348.5 | 348.5 | 39.6 | 39.6 |
| 117 | 3.11 | 50 | 40 | 13428 | 13428 | 40 | 38.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.9 | 0.9 | 1.1 | 1 | 0.1 | 0.1 |
| 118 | 1.11 | 60 | 40 | 4227 | 4227 | 41.2 | 39.6 | 0 | 0 | 0.3 | 0.3 | 2.1 | 1.9 | 11.9 | 11.4 | 112.3 | 105.6 | 126.7 | 119.2 | 14.4 | 13.6 |

Scheme_1

# Figure 9.5  Illustrative Section of the Link Output Analysis File (continued)

| After All PIA Accidents | Saved Fatal Accidents | Saved Serious Accidents | Saved Slight Accidents | Damage Only Accident | Saved All Accidents | Saved All PIA Accidents | VOT Benefits (£) | VOC Benefits (£) | Accident Benefits (£) | CO2 Benefits (£) | NOx Benefits (£) | Total PVB 2010 (£) | CO2 Non-Traded (tonnes) | CO2 Traded (tonnes) | Nox (tonnes) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 198.8 | 1.5 | 9.2 | 34.1 | 590.9 | 635.7 | 44.8 | -604661 | -46141 | 5878344 | -2799 | -89 | 5224654 | 60.84 | 0 | 0.117 |
| 50.2 | 0.4 | 2.7 | 10.3 | 178.2 | 191.7 | 13.4 | -1425078 | -98571 | 1750501 | -5490 | -179 | 221182 | 119.35 | 0 | 0.236 |
| 12.8 | 0.1 | 0.6 | 2.1 | 36.8 | 39.6 | 2.8 | -544034 | -42126 | 430159 | -2584 | -82 | -158668 | 56.19 | 0 | 0.108 |
| 96.9 | 0.3 | 1.6 | 5.7 | 97 | 104.5 | 7.5 | -638400 | -60686 | 1015413 | -4252 | -129 | 311944 | 92.43 | 0 | 0.171 |
| 14.1 | 0.1 | 0.3 | 1.1 | 19.4 | 20.9 | 1.5 | -1219753 | -112320 | 200993 | -7733 | -237 | -1139050 | 168.08 | 0 | 0.312 |
| 11 | 0 | 0.3 | 0.7 | 18.8 | 19.7 | 1 | -193576 | -15628 | 169805 | -989 | -31 | -40421 | 21.51 | 0 | 0.041 |
| 38.7 | 0.1 | 0.9 | 2.2 | 63.5 | 66.8 | 3.3 | -120984 | -10007 | 575782 | -644 | -20 | 444125 | 14.01 | 0 | 0.027 |
| 45 | 0.2 | 0.9 | 3.2 | 54.3 | 58.4 | 4.2 | -330518 | -30892 | 564852 | -2144 | -65 | 201231 | 46.62 | 0 | 0.086 |
| 40 | 0.1 | 0.7 | 2.4 | 41.4 | 44.6 | 3.2 | -710046 | -67311 | 433042 | -4710 | -143 | -349168 | 102.37 | 0 | 0.189 |
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11.9 | 0 | 0 | 0.1 | 2 | 2.1 | 0.1 | -12263 | -1419 | 12735 | -108 | -3 | -1058 | 2.36 | 0 | 0.004 |
| 10.8 | 0 | 0.3 | 0.9 | 24.9 | 26.1 | 1.2 | -64827 | -6939 | 153535 | -515 | -15 | 81238 | 11.2 | 0 | 0.02 |
| 33.3 | 0.2 | 3.2 | 13.6 | 348.7 | 365.8 | 17.1 | -1660953 | -190124 | 1978214 | -14420 | -401 | 112315 | 313.18 | 0 | 0.529 |
| 3.4 | 0 | 0.1 | 0.1 | 1.7 | 1.9 | 0.2 | -479796 | 13048 | 40536 | 3199 | 83 | -422928 | -69.53 | 0 | -0.111 |
| 82.6 | 0.3 | 1.3 | 3.4 | 41.8 | 46.8 | 5 | -372463 | 11036 | 1004604 | 2582 | 67 | 645827 | -56.13 | 0 | -0.09 |
| 39.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 726114 | 0 | 0 | 726114 | 0 | 0 | 0 |
| 0.1 | 0 | 0 | 0 | 0 | 0.1 | 0 | -1135698 | -59974 | 3028 | -2354 | -86 | -1195086 | 51.21 | 0 | 0.114 |
| 13.6 | 0.1 | 0.2 | 0.5 | 6.7 | 7.5 | 0.8 | -151923 | -6684 | 404832 | -169 | -7 | 246047 | 3.68 | 0 | 0.01 |

Scheme_1

# Glossary

| | |
|---|---|
| **85th %ile speed** | The speed below which 85% of the traffic is travelling. |
| **AST** | Appraisal Summary Table. The impacts of transport projects are categorised in terms of five high level criteria (economy, safety, environment, accessibility and integration), reflecting the Government's objectives for transport. Each of these criteria is divided into a number of sub-criteria and it is against each of these sub-criteria that the impacts of a proposal are assessed and presented in a 1 page Appraisal Summary Table (AST). |
| **AADT** | Average Annual Daily Traffic. The AADT is a traffic count representing an average 24-hour day in a year i.e. total annual flow divided by 365. |
| **Artic** | Articulated lorry. |
| **BCR** | Benefit to cost ratio. A benefit-cost ratio (BCR) is an indicator used in cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values. |
| **$CO_2$** | Carbon dioxide |
| **COBA** | **CO**st **B**enefit **A**nalysis program COBA is a computer program that estimates the effects of highway improvements, in terms of time, vehicle operating costs and accident costs on the users of the road system. |
| **DfT** | Department for Transport |
| **GDP** | Gross Domestic Product |
| **INCA** | INcident Cost-benefit Assessment. INCA is a spreadsheet-based transport economic appraisal tool, used to estimate the impact of incidents on motorways and high standard dual-carriageway roads. |
| **Journey Time Reliability** | Variation in journey times that drivers are unable to predict. |
| **LGV** | Light Goods Vehicle (up to 1.5 tonne unladen weight). |
| **Link** | A length of road which is considered to have the same flow of traffic along it. Usually, a link is the road from one junction to the next. |
| **Monetised** | Impacts that can be given a monetary value (for example, journey time savings). |
| **Non-monetised** | Impacts that cannot be given a monetary value (for example, |

| | |
|---|---|
| | landscape impacts). |
| **NOx** | Nitrogen oxides |
| **NPV** | Net Present Value.  The NPV is given by subtracting the discounted sum of all future costs from the discounted sum of all future benefits. |
| **NRTF** | National Road Traffic Forecasts. |
| **OGV1** | Goods Vehicle of over 1.5 tonne unladen weight with 2 or 3 axles. |
| **OGV2** | Goods Vehicle with 4 or more axles and/or articulated. |
| **PIA** | Personal Injury Accident |
| **PSV** | Public Service Vehicle |
| **PVB** | Present Values of Benefit.  The PVB is the discounted sum of all future benefits (including increases in indirect tax revenues). |
| **PVC** | Present Values of Costs. PVC is the discounted sum of all future costs (excluding reductions in indirect tax revenues). |
| **Rigid** | Non-articulated lorry |
| **RTF** | Road Traffic Forecasts |
| **Severance** | The separation of people from facilities and services they use, which can be caused by new or improved roads or by changes in traffic flows. |
| **TEE Table** | Transport Economic Efficiency Table. The purpose of the TEE table is to summarise and present transport user benefits. |
| **TEMPRO** | Trip End Model Presentation Program. TEMPRO is a transport planning software tool used to forecast population, employment, households by car ownership, trip ends and trip end traffic growth factors. |
| **VAT** | Value Added Tax |
| **VOC** | Vehicle Operating Costs |
| **VOT** | Values of Time. The opportunity cost of the time that a traveller spends on his/her journey. In essence, this makes it the amount that a traveller would be willing to pay in order to save time, or the amount they would accept as compensation for lost time. |
| **WebTAG** | Web based Transport Analysis Guidance. |

# List of Tables

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# Annex A: Development of Relationships

A.1    This Annex describes the development of relationships used to forecast the monetised content of the Speed Limit Appraisal Tool. For the development of relationships for speed, flow and accidents, data was extracted from the review of evidence and from the data collected in the evidence gathering from local authorities and the call for evidence. NOx relationships were derived from the Emissions Factors 2009 research undertaken for the Department[13].

## Mean Speed Relationships

**Methodology**

A.2    TRL had previously undertaken research to forecast speed changes resulting from speed limits. In report PR58[14] they forecast speed change as a function of speed limit change, but this takes no account of the before speed characteristics of the road and this relationship is therefore considered not to be appropriate.

A.3    In report PPR025[15] for rural roads, TRL developed relationships between before and after speeds. These relationships were of the exponential form. However, testing of these gives implausible results at the upper end of the speed range; therefore, these are also considered not to be appropriate.

A.4    In view of the above, it was decided to explore linear relationships related to before mean speed (BMS) to forecast mean speed change (MSC – after speed minus before speed).

A.5    For each speed limit type, data was segregated into data for individual links and data for areas. Where available, individual link data was used. This proved to be the case for all speed limit types except for urban 20 mph limits with traffic calming.

A.6    Linear regressions were undertaken to forecast MSC from BMS. Also, where appropriate, dummy variables were used to explore the impacts

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[13] Emissions factors 2009: Final Summary Report, TRL, May 2009.
[14] PR58, D.J. Finch, P. Kompfner, C.R. Lockwood and G. Maycock, 'Speed, Speed Limits and Accidents', TRL, 1994
[15] PPR025, D. Lynam, J. Hill, J. Barker, 'Developing a Speed Management Assessment Framework for Rural Single Carriageway Roads', TRL 2004

of features relating to the speed limits. The significance of variables was assessed using the t statistic which for significance at the 5% level should have an absolute value of greater than 2.

**A.7** As all speed data was provided in mph and speed limits are in mph this analysis was based on speeds expressed in mph. Linear equations were developed of the form:

$$MSC = a + b* BMS$$

Where:
- MSC = Mean speed change between before and after in mph
- BMS = Mean speed before the speed limit
- a, b   = Coefficients

## Urban 20 mph Without Traffic Calming

**A.8** This analysis was based on before and after data for 347 link observations supplied by seven authorities spread throughout England.

**A.9** Initial regressions were undertaken to forecast MSC from BMS and dummy variables representing the presence of enforcement, roundels and awareness measures. BMS was significant, but of the dummy variables only the presence of roundels was just significant. This appeared to be a perverse finding as enforcement is more likely to have an impact than roundels. It was considered that the data relating to the presence of these features was not reliable. In view of this it was decided that the effect of these features could not be reliably forecast. Regression using BMS only as the explanatory variable gave the following equation:

$$MSC = 4.4038 - 0.2265* BMS$$

The R2 (coefficient of determination) value was 0.39 and the t statistics for the constant and BMS were 12.6 and 14.8 respectively. The observed BMS range was 13.8 to 32.9 mph. The equation gives zero speed change (the x intercept) at BMS = 19.4 mph.

## Urban 20 mph with Traffic Calming

**A.10** Only area data was available for urban 20 mph speed limits with traffic calming. This data was extracted from TRL Reports 215[16] and PPR243[17]. This data provided 44 area observations covering a wide range of urban areas in England. Regression produced the following speed change equation:

$$MSC = 10.2891 - 0.7714 * BMS$$

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[16] TRL Report 215, D. Webster, A. Mackie, 'Review of Traffic Calming Schemes in 20 mph Zones', TRL, 1996
[17] PPR243 D. Webster, R. Layfield, 'Review of 20 mph Zones in London Boroughs', TRL, 2003

The R2 value was 0.76 and the t statistics for the constant and BMS were 6.0 and 11.5 respectively. The observed BMS range was 14.9 to 34.0 mph. The equation gives zero speed change at BMS = 13.3 mph.

## Urban 40 to 30 mph

A.11    Link data was available for 27 link observations mainly in Buckinghamshire and Warwickshire, but with one site in Cornwall. Regression produced the following speed change equation:

MSC = 23.0694 – 0.7538 * BMS

The R2 value was 0.57 and the t statistics for the constant and BMS were 5.2 and 5.7 respectively.  The observed BMS range was 27.0 to 37.9 mph.  The equation gives zero speed change at BMS = 30.6 mph.

## Rural Village 40 to 30 mph

A.12    Link data was available for 41 links in Buckinghamshire, Cornwall and one from Warwickshire. Initial analysis showed that one site with a very low BMS of 23.5 mph was biasing the analysis with an unexpected speed reduction. This site was removed from the regression. Despite this the regression fit was very poor with R2 = 0.05 and insignificant t statistics for the constant and BMS. Also, the fitted line was implausible.

A.13    It was decided that the best way of developing a plausible relationship was to force the X intercept for BMS to the 27.22 mph intercept found for rural village 60 to 30 mph limits, based on the assumption that both would have similar BMS intercepts, i.e. the intercept is related directly to the new speed limit.  Based on this assumption and using data transformation and origin forcing the following equation was derived:

MSC = 6.4522 – 0.2370 * BMS

The R2 value was 0.69 although this should be treated with caution as the regression was origin forced. The t statistic for BMS was 9.3. There is no t statistic for the intercept as this was origin forced. The observed BMS range was 31.9 to 45.2.

A.14    The difficulties of fitting relationships for these types of road may be due to their variability in nature with roads varying between minor C roads and A roads.  Also the nature of the development adjacent to these roads would vary from dense in large villages to sparse in small villages.

## Rural Village 60 to 30 mph

A.15    Link data was available for 30 sites in Buckinghamshire. Initial observations showed that it was not possible to fit an equation with significant coefficients. This was found to be due to six sites where BMS was below 27 mph and where the limit unexpectedly reduced speeds further. These locations were removed from the analysis and this

allowed an equation which was significant to be fitted which was as follows:

MSC = 7.6608 – 0.2814 * BMS

The R2 value was 0.33 and the t statistics for the constant and BMS were 2.6 and 3.3 respectively. The observed BMS range was 27.2 to 42.7 mph. The equation gives a zero speed change intercept of 27.22 mph. Only two of these sites were on A roads with the remainder being on C or unclassified roads. This sample is therefore likely to be more homogeneous than that for the rural village 40 mph to 30 mph sites. However, this may limit the applications of the function in relation to A and B roads.

### Rural Village 60 to 40

A.16    Link data was available for 18 sites in Buckinghamshire and Warwickshire. These covered B, C and unclassified roads, but no A roads. Regression produced the following speed change equation:

MSC = 10.9042 – 0.3363 * BMS

The R2 value was 0.51 and the t statistics for the constant and BMS were 3.3 and 4.1 respectively.  The observed BMS range was 30.8 to 47.0 mph.  The equation gives a zero speed change intercept at 32.4 mph. As the sample did not include any A roads this may limit the application of the function for these types of road.

### Rural Single Carriageway 60 to 50

A.17    Data was available for 112 links in Buckinghamshire and Warwickshire. These were mainly A and B roads with a small sample of C and unclassified roads. Regression produced the following speed change equation:

MSC = 8.9212 – 0.2274 * BMS

The R2 value was 0.12 and the t statistics for the constant and BMS were 3.23 and 3.94. The observed BMS range was 34.0 to 57.7 mph. The equation gives a zero speed change intercept at 39.2 mph. Although the R2 value is relatively low, the t statistics are significant. This function is therefore considered to be acceptable.

### Rural Single Carriageway 60 to 40

A.18    Data was available for 21 links from Buckinghamshire and Warwickshire. Regression produced the following equation:

MSC = 9.7998 – 0.2778 * BMS

The R2 value was 0.29 and the t statistics for the constant and BMS were 2.4 and 2.8 respectively. The observed BMS range was 33.1 to 45.8 mph. The equation gives a zero speed change at 35.3 mph.

## Rural Dual Carriageway 70 to 40

**A.19**  Data was available for 23 links in Buckinghamshire, Poole and Warwickshire. These are mainly for A roads as would be expected. Regression produced the following equation:

MSC = 21.7359 – 0.4739 * BMS

The R2 value was 0.66 and the t statistics for the intercept and BMS were 5.4 and 5.9 respectively.  The observed BMS range was 38.7 to 63.0 mph.  The equation gives zero speed change at 45.9 mph.

## Part Time Speed Limits

**A.20**  Data was available for three sites in Northern Ireland with part time speed limits. Two of these had a normal speed limit of 60 mph while the other, for which there were different observations for three times of the day, had a normal speed limit of 30 mph. This data is insufficient for the development of reliable relationships for part time speed limits.

## Other Speed Limits

**A.21**  Other speed limits for which insufficient data was available to fit functions were as follows:

- Rural 40 to 50 (1 link)
- Rural 50 to 40 (3 links)
- Dual 70 to 40 (2 links)
- Dual 70 to 60 (3 links)

**A.22**  For dual carriageway 40 and 60 mph links the dual carriageway 70 mph to 50 mph function should be used.  For rural 50 mph to 40 mph the rural village 60 mph to 40 mph function should be used. For Rural 20 mph, no data is available, therefore where this occurs it will be assumed to behave in the same way as Urban 20 mph.

## Increased Speed Limits

**A.23**  There are no functions available that give speed changes with increased speed limits. A pragmatic approach to calculating the effect of these would be to assume that they have an effect which is the exact reverse of the effect of the equivalent speed limit reduction. To take account of this, a and b parameters were calculated for the effect of reversing speed limits.

**A.24** Note that for urban 20 mph with traffic management a reversal would include the removal of the traffic management measures. Where these are to be retained the pragmatic approach would be to use the reversed 20 mph with no traffic management.

**Treatment of Low Before Mean Speeds**

**A.25** There is strong evidence that where the before mean speed is well below the speed limit level imposition of a speed limit increases mean speeds. This could be treated either by applying the above functions in such cases to forecast an increase in speed or by assuming that below the x intercept of the function there is no speed change. In the light of the available evidence we recommend that the functions should be applied where BMS is below the x intercept in which cases the limit will increase the speed.

**Parameter Summary**

**A.26** Speed change function parameters are summarised in Table A.1. Reverse speed change function parameters are summarised in Table A.2.

| Table A.1  Mean Speed Function Parameter Summary for MSC | | |
|---|---|---|
| **Limit Type** | **Constant a** | **BMS Coefficient b** |
| 20 mph no Traffic Calming | 4.4038 | -0.2265 |
| 20 mph with Traffic Calming | 10.2891 | -0.7714 |
| Urban 40 to 30 mph | 23.0694 | -0.7538 |
| Village 40 to 30 mph | 6.4522 | -0.2370 |
| Village 60 to 30 mph | 7.6608 | -0.2814 |
| Village 60 to 40 mph | 10.9042 | -0.3363 |
| Rural Single 60 to 50 mph | 8.9212 | -0.2274 |
| Rural Single 60 to 40 mph | 9.7998 | -0.2778 |
| Rural Dual 70 to 40 mph | 21.7359 | -0.4739 |

| Table A.2  Reverse Mean Speed Function Parameter Summary for MSC | | |
|---|---|---|
| Limit Type to be Reversed | Constant a | BMS Coefficient b |
| 20 mph no Traffic Calming | -5.6930 | 0.2928 |
| 20 mph with Traffic Calming | -45.0139 | 3.3749 |
| Urban 40 to 30 mph | -93.6999 | 3.0616 |
| Village 40 to 30 mph | -8.4567 | 0.3107 |
| Village 60 to 30 mph | -10.6606 | 0.3916 |
| Village 60 to 40 mph | -16.4283 | 0.5066 |
| Rural Single 60 to 50 mph | -11.5476 | 0.2944 |
| Rural Single 60 to 40 mph | -13.5699 | 0.3847 |
| Rural Dual 70 to 40 mph | -41.3128 | 0.9007 |

# 85th Percentile Speed

## Methodology

A.27   The 85th percentile speed at any site will vary as the mean speed varies. This will arise from two components: the change in mean speed; and any change in the distribution of speeds. The effect of speed limits on mean speeds is estimated by the mean speed functions. In consequence, to estimate the effect on 85% speeds it is only necessary to forecast the effect of speed limits on the distribution, i.e. the ratio between 85th percentile speed and mean speed.

A.28   To establish the distribution effects 85th percentile to mean speed ratios were calculated for each link for both before and after speed limits and their coefficients of variation (CV – the ratio of the standard deviation to the mean) were calculated. These ratios were then compared using a t test to identify any significant differences.

## Results

A.29   The results of this analysis are set out in Table A.3. It will be noted that the number of cases with 85th percentile speeds available is less than the total number of links used in the mean speed function development. Also, there was no 85th percentile speed data available for 20 mph limits with traffic calming.

## Table A.3  85th Percentile to Mean Speed Ratios

| Limit Type | Ratios | | | CV | | Cases | t stat |
|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | | 5% sig |
| 20 mph no Traffic Calming | 1.20 | 1.21 | 0.6% | 0.05 | 0.05 | 177 | no |
| 20 mph with Traffic Calming | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Urban 40 to 30 mph | 1.19 | 1.14 | -4.3% | 0.07 | 0.09 | 19 | yes |
| Village 40 to 30 mph | 1.17 | 1.18 | 0.8% | 0.03 | 0.03 | 40 | no |
| Village 60 to 30 mph | 1.20 | 1.22 | 1.6% | 0.04 | 0.04 | 30 | yes |
| Village 60 to 40 mph | 1.16 | 1.15 | -1.2% | 0.02 | 0.02 | 18 | yes |
| Rural Single 60 to 50 mph | 1.15 | 1.13 | -1.4% | 0.03 | 0.03 | 112 | yes |
| Rural Single 60 to 40 mph | 1.16 | 1.15 | -0.9% | 0.03 | 0.03 | 21 | no |
| Rural Dual 70 to 40 mph | 1.15 | 1.13 | -1.6% | 0.02 | 0.02 | 17 | yes |

A.30 It is noteworthy that the CVs for the ratio are generally low which shows that it is relatively stable between links. Also the change between before and after is a maximum of 4.3% for urban 40 mph to 30 mph limits, with all the other changes being by less than 1.6%. The t test shows that for five speed limit groups the changes were significant at the 5% level and for three they were not. However, only two are significant at the 1% level. For five speed limit groups the limit appears to reduce the ratio while for the other three it is increased. The decreases correspond with the higher limits by area type, i.e. urban 30 mph, village 40 mph and all rural roads, while the increases correspond with the lower limits, i.e. urban 20 mph and village 30 mph.

## Function Form

A.31 The above analysis demonstrates that the after speed limit 85th percentile speed can be calculated from the mean speed. For any link this would be based on the ratio between the before mean speed and the before 85th percentile speed.

A.32 The question arises as to whether this ratio should be changed to reflect the change in distribution between the before and after cases. It is assumed that where the observed difference is not significant this change should not be applied. In any event all non-significant changes are less than 1%. However, where the change is significant it should be applied.

**A.33** Assuming that the 20 mph limits with traffic calming behave in a similar manner to those without traffic calming, this gives the change factors as set out in Table A.4.

| Table A.4  85th Percentile Speed Change Factors | |
|---|---|
| **Limit Type** | **Factor** |
| 20 mph no Traffic Calming | 1.0000 |
| 20 mph with Traffic Calming | 1.0000 |
| Urban 40 to 30 mph | 0.9567 |
| Village 40 to 30 mph | 1.0000 |
| Village 60 to 30 mph | 1.0158 |
| Village 60 to 40 mph | 0.9885 |
| Rural Single 60 to 50 mph | 0.9865 |
| Rural Single 60 to 40 mph | 0.9907 |
| Rural Dual 70 to 40 mph | 0.9835 |

**A.34** The formulation for calculating the 85th percentile speed after the speed limit will be as follows:

A85S = AMS*SCFAC*B85S/BMS

Where  A85S = After 85th percentile speed
     B85S = Before 85th percentile speed
     AMS =  After mean speed
     BMS =  Before mean speed
     SCFAC = Speed change factor

# Flow

**Methodology**

**A.35** Flow change should be a function of the change in journey time on a link, for which speed change can be taken as a proxy. Linear relationships were explored between the proportional flow change (FCP) and the proportional mean speed change (MSCP) defined as follows:

FCP = (AFLOW – BFLOW)/BFLOWMSCP = (AMS – BMS)/BMS

Where:  BFLOW = Before flow
    AFLOW = After flow
    BMS = Before mean speed

AMS = After mean speed

Linear regressions were undertaken to forecast FCP from MSCP.

## Results

**A.36** The results of the analysis are summarised in Table A.5. For all speed limit types, except urban 20 mph with no traffic calming, the number of observations of before and after flows was extremely limited.

| Table A.5  Flow Changes | | | |
|---|---|---|---|
| **Limit Type** | **Cases** | **Overall** | **Regression** |
| | | **FCP** | **Significant** |
| 20 mph no Traffic Calming | 76 | -5.3% | no |
| 20 mph with Traffic Calming | 18 | -13.4% | no |
| Urban 40 to 30 mph | 1 | 25.3% | n/a |
| Village 40 to 30 mph | 13 | 0.3% | yes |
| Village 60 to 30 mph | 11 | -0.4% | no |
| Village 60 to 40 mph | 10 | -4.0% | no |
| Rural Single 60 to 50 mph | 12 | 4.3% | no |
| Rural Single 60 to 40 mph | 4 | -11.8% | no |
| Rural Dual 70 to 40 mph | 3 | 0.3% | n/a |

**A.37** The only limit category for which regression gave significant coefficients was village 40 mph to 30 mph. However, the coefficients are perverse predicting an increase in traffic flow as speeds decrease.

**A.38** The overall FCP values for each speed limit type are set out in Table A.5.  For all except 20 mph with traffic calming (for which detailed flow data was not available) these are weighted by before flow. In five of the nine speed limit classifications flow decreased while in the remaining four it increased.

**A.39** Traffic flows are subject to relatively high variability due to measurement errors, variation between days and trends in traffic growth. The absence of any significant logical relationships suggests that traffic diversion caused by speed limits may not be significant. Also this will be very dependent on network characteristics, particularly the availability of diversion routes. In view of these factors, there is no case and no basis for implementing diversion relationships in the Speed Limit Tool.

However, where local information is available, e.g. from a traffic assignment model, users should be allowed to represent this.

# Accidents

**Methodology**

A.40 Data on personal injury accidents (PIA) before and after speed limits was only available for a relatively small number of links as set out in Table A.6. This data was insufficient to develop relationships between speed change and accident change.

| Table A.6  Accident Changes | | | | | |
|---|---|---|---|---|---|
| **Limit Type** | **Cases** | **Before** | **After** | **Elvik** | **Implied** |
| | | **PIA** | **PIA** | **Forecast** | **Trend** |
| 20 mph no Traffic Calming | 15 | 12.33 | 8.33 | 13.26 | -37% |
| 20 mph with Traffic Calming | 0 | n/a | n/a | n/a | |
| Urban 40 to 30 mph | 6 | 37.90 | 26.00 | 30.86 | -16% |
| Village 40 to 30 mph | 1 | 1.00 | 1.00 | 0.87 | 15% |
| Village 60 to 30 mph | 0 | n/a | n/a | n/a | |
| Village 60 to 40 mph | 1 | 0.00 | 0.00 | 0.00 | |
| Rural Single 60 to 50 mph | 57 | 207.50 | 170.20 | 193.46 | -12% |
| Rural Single 60 to 40 mph | 6 | 13.00 | 10.00 | 12.76 | -22% |
| Rural Dual 70 to 40 mph | 4 | 22.33 | 14.72 | 17.18 | -14% |

A.41 Of the accident models reviewed in the report 'Existing Information on Speed Limit Change Relationships'[18], that developed by Rune Elvik[19] of the Norwegian Institute of Transport Economics was the most appropriate for general application to speed limit schemes. This has the major advantages of being incremental, i.e. it adjusts the before observed accidents to forecast after accidents; and taking account of changes in severity. The Elvik model for all PIA was tested on the link data available to this study.

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[18] Existing Information on Speed Limit Change Relationships, Hyder 2013 (project report, available for download from the Department for Transport website)
[19] The Power Model of the Relationship Between Speed and Road Safety, Rune Elvik, TOI Report 1034/2009, Norwegian Institute for Transport Economics

**Results**

**A.42** The results of this analysis are set out above in Table A.6. In all cases, the Elvik model forecasts underestimate the reduction in accidents. However, the observed reductions in accidents appear to be relatively large.

**A.43** The observed data ideally relates to three years before the speed limit scheme and the same period after. Over the period 2003 to 2010 nationally PIA declined by 28%. In consequence, a reduction between the before and after monitoring periods would be expected, independent of the speed limit change.

**A.44** The temporal trends implied, if the Elvik forecasts of change due to speed change are correct, are set out in Table A.6. For most speed limit types these are of the order of magnitude expected between the before and after periods. The exceptions are village 40 mph to 30 mph, for which there is only one observation, and 20 mph with no traffic calming for which the small sample of sites have a small speed increase which is not typical.

**A.45** In view of the above, there is no reason to reject the Elvik methodology for use in the Speed Limits Tool.

# NOx Emissions

**Methodology**

**A.46** $CO_2$ emissions are calculated using the WebTAG 3.3.5D methodology which gives emissions by vehicle type and fuel type per litre of fuel consumed. However, there is no comparable methodology for forecasting NOx based on fuel consumption. It was therefore necessary to develop relationships between NOx and $CO_2$ consumption per litre of fuel consumed.

**A.47** This analysis was undertaken based on the Emission Factors 2009 work by TRL and is summarised in 'Emissions factors 2009: Final Summary Report, TRL, May 2009'. This study produced a spreadsheet model ('regulated.xls') which forecasts $CO_2$ and NOx emissions by 237 motor vehicle types by speed.

**A.48** Using this spreadsheet $CO_2$ and NOx emissions were calculated for 2010 for each of the 237 vehicle types for speeds at 10 kph intervals between 10 kph and 120 kph.

**A.49** Vehicle fleet compositions for 2010 were then calculated using the Emission Factors 2009 study spreadsheet 'emissionsfactorsdemonstrations.xls' and data on annual vehicle kilometres travelled by vehicle type for 2010 as set out in the Road

Traffic Forecasts (RTF) 2011. This gave the following vehicle classifications:

- a. Car Petrol
- b. Car Diesel
- c. LGV Petrol
- d. LGV Diesel
- e. OGV1 – HGV Rigid
- f. OGV2 – HGV Artic
- g. B PSV – Bus/Coach

**A.50** Based on this composition the 237 vehicle types were then aggregated to give forecasts of $CO_2$ and NOx per vehicle kilometre for 2010 for the range of speeds noted above for the seven vehicle classes.

**A.51** Ratios of $CO_2$ to NOx emissions per vehicle kilometre, which apply equally to per litre of fuel consumed, were then calculated for each speed. Analysis of the results showed that the ratio was relatively stable over the speed range 20 kph to 100 kph, which is the order of speed range likely to be encountered in speed limit studies. (The available link data gave no before or after mean speeds outside this range.)

**A.52** Vehicle compositions are forecast to change over time, particularly as older vehicles with less efficient engines are replaced with more efficient vehicles. To represent this effect, the above analysis was repeated for 2015, 2020 and 2025 to give $CO_2$ to NOx relationships for each vehicle type for each year.

**Results**

**A.53** This analysis shows that relative to $CO_2$ the volume of NOx emissions is negligible. For example in 2010 for an average car the amount of $CO_2$ emitted at 30 kph per litre of fuel is 896 times the NOx emissions. This increases to 1307 times in 2025.

**A.54** In view of the above, the change in NOx emissions caused by speed limits is likely to be extremely small.

**A.55** Factors by which the $CO_2$ emissions are to be divided to give NOx emissions by vehicle type by year are set out in Table A.7.

| Table A.7  CO$_2$ to NOx Factors by Year | | | | |
|---|---|---|---|---|
| Vehicle Type | 2010 | 2015 | 2020 | 2025 |
| Car | 587 | 779 | 987 | 1093 |
| Car Petrol | 1029 | 1147 | 1142 | 1127 |
| Car Diesel | 356 | 520 | 821 | 1063 |
| LGV | 373 | 607 | 1032 | 1377 |
| LGV Petrol | 2353 | 4385 | 5517 | 5741 |
| LGV Diesel | 355 | 579 | 985 | 1319 |
| Rigid | 141 | 249 | 611 | 1263 |
| Artic | 145 | 270 | 716 | 1310 |
| PSV | 132 | 204 | 396 | 782 |
| All Petrol | 1039 | 1163 | 1161 | 1147 |
| All Diesel | 221 | 359 | 732 | 1158 |
| HGV | 143 | 260 | 666 | 1290 |
| Non-HGV | 465 | 655 | 923 | 1111 |

# Noise Impacts

A.56    As commented in paragraph 2.57, noise impacts have not been quantified in the tool. This is because the impact is likely to be negligible and the user input required would be onerous. The following explains the basis for this conclusion. If a Noise Assessment is required, guidance for assessing Noise impacts can be found in WebTAG Unit 3.3.2 The Noise Sub-Objective, DMRB 11.3.7 Noise and Vibration, and Calculation of Road Traffic Noise (DfT 1988).

A.57    During the development of the tool, the research team identified over 600 individual speed limit changes. The maximum observed speed change was identified for each speed limit category and a large flow of 10,000 AAWT was then used to calculate the most extreme changes in noise that could be expected based on observed speed changes. These calculations were based on the formulas used in the Calculation of Road Traffic Noise. The results are summarised below (Table A.8).

## Table A.8  Summary of Noise Calculations

| Speed Limit Type | Before mean speed (mph) | After mean speed (mph) | Mean speed change (mph) | Noise Change LA10,T (dBA) | Noise Change LAeq,T (dBA) |
|---|---|---|---|---|---|
| Urban 30 to 20mph signs only | 28 | 22 | -6 | -0.6 | -0.5 |
| Urban 30 to 20mph signs and publicity only | 31.7 | 26.6 | -5.1 | -0.6 | -0.6 |
| Urban 30 to 20mph with other measures | 23.5 | 18.2 | -5.3 | -0.2 | -0.2 |
| Urban 40 to 30mph | 36.6 | 27.3 | -9.3 | -1.2 | -1.2 |
| Rural village 40 to 30mph | 37.5 | 30.7 | -6.8 | -0.9 | -0.9 |
| Rural village 60 to 30mph | 34 | 28.7 | -5.3 | -0.1 | -0.1 |
| Rural village 60 to 40mph | 47 | 40.2 | -6.8 | -0.5 | -0.4 |
| Rural single carriageway 60 to 50mph | 57.7 | 49.9 | -7.8 | -1.1 | -1 |
| Rural minor single carriageway 40 to 30mph | 35.7 | 32.6 | -3.1 | -0.4 | -0.4 |
| Rural minor single carriageway 60 to 40mph | 45.4 | 40.4 | -5 | -0.7 | -0.7 |

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Where:
- Noise Change LA10,T = The change in noise level exceeded for 10% of the 18hr period in dBA
-
- Noise Change LAeq,T = The equivalent continuous change in noise level over an 18hr period in dBA

**A.58**  The table shows that even in the most extreme cases, the change in noise levels as a result of speed limit changes is likely to be negligible (<1dBA)[20]. In reality, the actual change in noise is likely to be much less than 1dBA because:

- The change in speed predicted by the tool is based on averages and will therefore be less than the most extreme cases observed in the real world.

- Traffic flows are likely to be smaller.

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[20] 0dBA is the healthy hearing threshold; 10dBA is the equivalent of hearing a pin dropping.

- Houses are unlikely to be zero distance from the road (as was assumed in our calculations), with noise reducing significantly over distance.

- Other factors such as sound barriers (e.g. trees and hedges) are likely to further reduce noise levels.

A.59 However, if a scheme results in a major diversion of traffic there are likely to be noise benefits at the scheme location and disbenefits elsewhere on the network. In these cases, a traffic model is likely to be needed to assess the noise impacts.