The Noise Sub-objective

TAG Unit 3.3.2

April 2011

Department for Transport

Transport Analysis Guidance (TAG)

This Unit is part of a family which can be accessed at www.dft.gov.uk/webtag

Contents

1 The Noise Sub-objective

1.1 Introduction

1.1.1 Noise annoyance is defined by the World Health Organisation (WHO) as 'a feeling of displeasure evoked by noise'. The UK has well established procedures for assessing the nuisance to people caused by road and rail traffic-related noise and vibration. These procedures have been developed from surveys of the impacts of noise from transport on people, including dissatisfaction, annoyance and disturbance. More recently the Department for Transport commissioned a research study aimed at putting a monetary value on the impact of noise. This guidance document incorporates those monetary values in to its existing noise assessment. The inclusion of monetary valuation will enable decision-makers to assess the relative importance of noise impacts of a transport option in relation to other impacts currently measured in monetary terms.

1.1.2 Assessing the noise implications of multi-modal transport plans and strategies presents a particular challenge for two main reasons:

- people exhibit different responses to noise from and within different transport modes, making the determination of cumulative impact difficult; and
- noise is a local impact which depends on the precise geometric relationship of source and receiver - while these will be easily ascertainable at the plan level of assessment, it is unlikely they will be sufficiently well defined at the strategic level.

1.1.3 Research studies both in the UK and other countries in Europe are attempting to address these difficulties. Much of this work has been initiated following the European Commission's green paper in 1996 on Future Noise Policy. The Commission's own work on the relationship between community annoyance and noise exposure levels will be useful in seeking a European consensus.

1.1.4 The assessment involves two steps. The first, based on the concept of noise annoyance, involves calculating the difference in the estimated population who would be annoyed by noise from alternative sources, comparing the do-minimum and do-something scenarios. The second is based on the effect of noise on house prices and involves calculating the present value of households' willingness to pay to avoid transport related noise over the whole appraisal period for each scenario. This valuation is based primarily on the findings of the study: **Valuation of Transport-Related Noise in Birmingham** (Bateman, Day and Lake, 2004)[1]. Reasonably reliable valuations of the annoyance associated with exposure to noise were estimated using a large, state of the art dataset and advanced economic modelling, for a UK city. The hedonic pricing method was used to estimate willingness-to-pay for peace and quiet in the housing market, based on real market behaviour.

1.1.5 In moving from Birmingham-based values to values suitable for transport appraisal elsewhere in the UK, it was necessary to transfer the values both over time and across locations. From 1997, the year of the Birmingham property market data, the values were transferred to 2002. The values were also re-based from Birmingham to

---

[1] This work was subjected to peer review and a range of benchmarking against European evidence.

UK average levels of household income. This work was carried out by Leeds and Loughborough Universities (Nellthorp, Bristow and Mackie, 2005)[2].

1.1.6 The TAG Noise Spreadsheet automates this calculation. This automation now requires the cross-tabulation of households experiencing different noise level bands between the do-minimum and do-something scenarios. Estimates of both these effects can be based on relatively precise data at the plan level; whilst indications at the strategic level will be comparatively broad-brush.

1.1.7 It should be recognised that, in many situations, relatively large changes in traffic flows are required to bring about significant changes in the response to noise levels in the longer term. For freely flowing traffic, a difference of about 3dB in noise level is required before there is a statistically significant change in the average assessment of nuisance. The assessment of nuisance however could still be affected even if there is only a 1dB change in the noise level if the change is associated with changes in the view of traffic, or if the change occurs suddenly. When options of this nature are being appraised, particularly strategies, the analyst will need to exercise judgement about whether the impact on noise should be ignored. Furthermore, care is needed in assessing options which may result in adverse noise impacts during the night. Whilst traffic levels and their resultant noise impacts are lower at night than during the day - by about 10dB on roads - people tend to be more sensitive to night-time noise. As noise during the night (midnight to 6am) is not covered in the 18 hour measures used for assessing the annoyance impacts and monetary values of noise, any significant changes in night-time noise should be reported in the qualitative assessment column of the Appraisal Summary Table (AST).

1.1.8 Research undertaken by the Department has demonstrated the importance of understanding the differences in the impacts of transport interventions between different groups of people. This should include consideration of how noise impacts are distributed amongst different groups, and Section 4 of this Unit sets out an approach to understanding these impacts.

1.2 When to Undertake Valuation

1.2.1 The availability and quality of noise impact data tends to increase as the planning process progresses:

- for a transport ‘Plan’ which contains fully-specified projects, and for fully-developed road and rail schemes (e.g. those at DMRB Stage 3_, noise contour maps should be available, based on a spatially-detailed traffic model representing specific links and nodes in the network[3];
- for a transport ‘Strategy’, or for early-stages road or rail schemes which are represented by ‘broadly defined routes or corridors’ (e.g. those at DMRB Stages 1 & 2), models will be coarser and more approximate methods will be used. For example, TAG recommends calculating average emissions within each model zone using CRTN and CRN, which at the next step are combined with zonal average population densities to approximate noise exposure[4].

1.2.2 In general, noise valuation should always be undertaken at the Plan stage, which includes Local Transport Plans and fully-developed road and rail schemes.

---

[2] This work was subjected to peer review at a seminar held by the DfT in 2005
[3] see TAG Unit 3.3.2, Section 1.5.
[4] see TAG Unit 3.3.2, Section 1.6.

1.2.3 Noise valuation is unlikely to be feasible for Strategies, because the data requirements[5] will often not be met. However, the earlier any piece of evidence can be brought into the planning process, the greater the effect it can have on the choice between options. Therefore appraisers are also encouraged to make use of noise valuation earlier than the Plan stage (or DMRB Stage 3) wherever the data allows. If approximate data on the number of households or people affected by specific noise changes is available at the Strategy stage (or DMRB Stages 1 & 2) then the valuation exercise should be attempted for each option, and the fact that the results are approximate should be noted in the reporting (including in the Assessment column of the AST).

1.3 Community response to transport noise

1.3.1 Although individuals vary widely in their response to the same level of noise, even when it arises from the same source, the average or community response from a large number of people exposed to the same source of noise is relatively stable and a community average degree of annoyance can be associated with long-term average noise exposure. The concept of annoyance is generally recognised as a robust and well-established measure for identifying the long term noise impacts from roads and railways. However as stated, the same level of noise emitted by different sources provokes different responses, when measured as community annoyance.

1.3.2 One approach to overcoming this problem is to apply different impact criteria to each mode. This allows estimates of numbers of people exposed to different noise levels to be made on each mode. However in comparing the noise impact of each mode there is a residual problem in weighing up the significance of the impact against the number of people exposed. This problem is also encountered in single mode assessments, in that it is difficult to compare an option which has a small noise impact for a large population with an option which has a large noise impact for a small population, although the willingness-to-pay and annoyance-response approaches below offer ways of overcoming this.

1.4 Annoyance response relationship

1.4.1 The annoyance response relationship can be used when comparing the noise impacts of different road types as it estimates the numbers of people likely to be annoyed for each option. The relationship shows the percentage of a population annoyed[6] by road traffic noise in the longer term as a function of the noise level. The latter is measured in $L_{A10,\ 18\ hr}$ as set out in the Calculation of Road Traffic Noise (DoT, 1988). As the basis of the relationship is long term, it ignores the immediate impacts of any change. Figure A 3.1 in DMRB presents the relationship in graphical form.

1.4.2 Road noise will need to be adjusted from $L_{A10,\ 18\ hr}$ to $L_{Aeq,\ 18\ hr}$ in order to associate noise levels with the monetary values that are based on $L_{Aeq,\ 18\ hr}$ levels. The conversion of $L_{Aeq,\ 18hr} = L_{A10,\ 18hr} – 2.5$ dB(A) should be applied to all L_{A10} data calculated for the DMRB noise assessment before using the TAG Noise Spreadsheet which calculates both changes in annoyance and money values of noise changes from L_{Aeq} levels.

---

[5] Section 3 below.

[6] DMRB uses the phrase ‘bothered very much or quite a lot’.

1.4.3 Railway noise levels are already calculated in $L_{Aeq,\ 18\ hr}$ (see Calculation of Railway Noise, DoT, 1995). There is no standard annoyance response relationship for railway noise but one has been developed for the purposes of this guidance.

1.4.4 Even when noise levels are measured using the $L_{Aeq,\ 18\ hr}$ scale, research indicates people respond differently to the same level of road and rail noise. For example, the Mitchell Committee's report **Railway Noise and the Insulation of Dwellings** (DoT, 1991) summarises research undertaken up to 1991 on the question of the differential between road and rail noise annoyance response. Although the Committee found no clear consensus, they concluded that at levels of 60 to 70dB(A) most studies found the same degree of annoyance where rail noise exceeded road traffic noise by between 4 and 9dB(A); but for noise levels of 50 to 60dB(A) the differential was very small or zero. In reaching their conclusion on the appropriate criterion for insulation against rail noise, the Committee gave emphasis to UK studies, as it was recognised that social and cultural factors might have a strong influence on the differential response.

1.4.5 Based on the results of this and other research, an annoyance response curve for rail traffic noise has been derived for use in this guidance. The differential between road and rail noise for equal annoyance has been taken as varying between:

- 0 at 55dB $L_{Aeq,\ 18\ hr}$; and
- 6dB at 70dB $L_{Aeq,18\ hr}$.

1.4.6 The annoyance response relationship for road traffic noise was taken from Page 4 of Annex 3 in DMRB, adjusted for noise measured in L_{Aeq}. The response for rail traffic noise was derived from this by applying the differential as above. The two relationships are given in Table 1.

1.4.7 The poorest performing option, in terms of noise, will be that with the largest increase in estimated population annoyed when comparing the do-something scenario with the do-minimum. However the current relationships are based on data gathered in past decades and further research is needed to assess the annoyance response to different sources of transport noise such as: i) high speed rail, which produces a significantly different spectrum of noise than conventional rail; ii) low frequency noise from light rail systems in urban areas; and iii) noise from road traffic which is not free flowing. This needs to be taken into account, and noted in the qualitative column of the AST, when assessing the noise impact of options which involve non-standard types of rail project or dealing with congested road traffic. Very little is also known about the combined effect of noise from different sources, as one source of noise can mask another.

1.4.8 It is also important to be aware that the annoyance response function is uncertain at low noise levels (especially over large distances). Consequently, it is recommended that appraisal is undertaken for noise above a cut-off level below which only a small percentage of the population would be annoyed. Research conducted by the Department suggests a positive willingness to pay to avoid transport related noise from 45dB $L_{Aeq,18\ hr}$, and this level is used as the cut-off for both annoyance and valuation calculations.

1.4.9 Annoyance response functions and monetary valuations of noise are provided for noise levels up to 81dB $L_{Aeq,18\ hr}$. Although noise levels in excess of this may be experienced road- or track-side, it is unlikely that adjacent properties will be affected by such high noise levels. In the rare case where noise levels exceed the upper limit, the highest monetary values and annoyance rates should be used and a comment should be included in the qualitative column in the AST.

1.4.10 For the appraisal process the assessment of noise impacts from multi-modal plans and strategies will compare the change in estimated population annoyed in the longer term for each option in relation to a do-minimum scenario. The assessment should be carried out for fifteen years after the opening of the scheme. The degree of uncertainty in the calculation will depend on the quality and amount of detailed information available, including that for population distribution. It may be necessary to make simplifying assumptions to arrive at estimates of the change in population annoyed for each option. However, the approximate nature of these estimates need not invalidate comparisons between options.

Table 1: Annoyance Response Relationships for Road and Rail Traffic Noise.

Road Noise		Rail Noise	
$L_{Aeq, 18hr}$ dB	% annoyed	$L_{Aeq, 18hr}$ dB	% annoyed
<45	0	<45	0
45	3	45	3
46	4	45	4
47	4	47	4
48	5	48	5
49	5	49	5
50	6	50	6
51	7	51	6
52	7	52	7
53	8	53	8
54	9	54	8
55	10	55	9
56	11	56	10
57	13	57	11
58	14	58	12
59	15	59	13
60	17	60	15
61	19	61	16
62	21	62	17
63	23	63	19
64	25	64	20
65	27	65	22
66	30	66	23
67	32	67	25
68	35	68	27
69	38	69	29
70	41	70	30
71	44	71	32
72	47	72	34
73	50	73	36
74	52	74	38
75	55	75	40
76	58	76	42
77	61	77	44
78	64	78	46
79	67	79	48
80	69	80	50
81	72	81	52
>81	75	>81	55

1.5 Monetary Valuation of Noise

1.5.1 As stated above, monetary valuation is intended to complement the existing noise assessment. It will be used to aid decision-makers when appraising different transport options and raise awareness of the environmental impacts of transport schemes such as noise. Noise valuation should, in general, always be undertaken at the plan stage which includes Local Transport Plans as well as fully-developed road and rail schemes. For strategies, it is understood that data requirements[7] may make it infeasible to undertake noise valuation, however, if approximate data on the number of households or people affected by specific noise changes is available then valuation should be attempted for each option and a note made in the qualitative column of the AST regarding the approximation.

1.5.2 The zero value placed on the impact of noise below 45dB LAeq reflects the finding of the DfT research which showed that below this level the monetary values people placed on noise could not be shown to be different from zero at a 95% confidence level. Similarly the research did not provide evidence on values of the impact of noise above 81dB LAeq, we assume the monetary value placed on a decibel change in noise remains constant above this. The data on the influence of railway noise on property prices did not provide sufficient evidence to make a distinction between road and rail for the monetary values of noise changes comparable with the differences in annoyance.

1.5.3 Table 2 below shows the annual value of the impact of a 1dB change in exposure to noise at noise levels from 45 to 81 dB $L_{Aeq,\ 18\ hr}$. These are the standard appraisal values based on the UK average household income, for general use.. They are also the values applied in the TAG Noise Spreadsheet. They are expressed at 2002 prices and values and are assumed to grow in line with real GDP per household. They should be used with a positive sign to value the benefit of noise reductions and with a negative sign to value the disbenefit of noise increases.

1.5.4 In some specific cases, for example when distributional weights are being used in the cost-benefit analysis, values for higher- or lower-income localities might be required (TAG Unit 2.7.10, Section 1.9). In those cases, a cross-sectional elasticity of 1.0 with respect to household income should be used, combined with household income data provided by the ONS, to estimate the local values for noise change. The formula to use is:

Local value = UK value * $(1+((\mathrm{GDHI}_{local}-100)/100))$

where GDHI_{local} is the Gross Domestic Household Income index as provided by the ONS[8].

---

[7] Section A.1 of the Annex A has more information regarding the data requirements and issues.

[8] See tables at http://www.statistics.gov.uk/articles/economic_trends/regional_sub-regional_local_area_household_income.pdf

Table 2: Monetary valuation of changes in noise level (per household, 2002 prices)

$L_{Aeq, 18hr}$ dB(A)		£ per household per dB change
Low	High	
	<45	0.0
45	46	8.4
46	47	11.1
47	48	13.7
48	49	16.3
49	50	19.0
50	51	21.6
51	52	24.2
52	53	26.9
53	54	29.5
54	55	32.1
55	56	34.8
56	57	37.4
57	58	40.0
58	59	42.7
59	60	45.3
60	61	48.0
61	62	50.6
62	63	53.2
63	64	55.9
64	65	58.5
65	66	61.1
66	67	63.8
67	68	66.4
68	69	69.0
69	70	71.7
70	71	74.3
71	72	76.9
72	73	79.6
73	74	82.2
74	75	84.9
75	76	87.5
76	77	90.1
77	78	92.8
78	79	95.4
79	80	98.0
80	81	98.0

1.6 Growth in Values over Time

1.6.1 In order to apply these values to projects and plans running into the future, information is also needed on the expected growth in these values over time, in real terms. In practice, these value growth factors are applied later in the process. Values for transport-related noise are assumed to grow in line with real GDP per household[9]. TAG unit 3.5.6 **The Values of Time and Operating Costs** contains the appropriate growth factors and provides guidance on the discount rates to be used as recommended by the Green Book.

1.7 Methodology for Plans

1.7.1 At the plan level, where options involve specific interventions, it is likely that a spatially detailed transport model will be available. The output from this type of model will enable an understanding to be gained of differences in road traffic flows on a link by link basis, which in turn will allow differences in noise for specific communities to be predicted. At this level, a detailed understanding of rail movements is also likely to be available.

1.7.2 Both changes in noise annoyance and the monetary value of the change in noise levels can be calculated using the TAG Noise spreadsheet. The following method describes the input data required for the TAG Spreadsheet and an overview of the methodology assumed within this.

1.7.3 Having generated data on road and rail traffic flows, the following four steps are required to calculate the noise impacts of different options. The results should be recorded in the TAG Noise Spreadsheet. The appraiser will also need to specify the opening year of the scheme and whether the scheme is a road or rail scheme. The latter will affect the annoyance levels only. For monetary valuation, noise data is required for both the do-minimum and do-something scenarios in the opening year and 15 years after the opening of the scheme. For annoyance levels only the data for 15 years after the opening of the scheme will be used.

i) Noise levels: the noise spreadsheet requires noise data to be in 3dB(A) bands.[10] These bands are <45, 45-47.9, 48-50.9, 51-53.9, 54-56.9, 57-59.9, 60-62.9, 63-65.9, 66-68.9, 69-71.9, 72-74.9, 75-77.9, 78-80.9,and >81dB in terms of $L_{Aeq\ 18hr}$. The numbers of residential properties within noise bands in 3dB(A) increments along transport alignments should be assessed using simplified standard prediction methodologies, such as the Calculation of Road Traffic Noise and the Calculation of Railway Noise. Noise levels are required for the do-minimum scenario and the do-something scenarios for each transport option in order to reveal the change in noise faced at each residential property. Noise levels should be estimated for all residential properties within 600m of the transport infrastructure concerned in the scheme e.g. a road. More detailed data on properties within 300m and on properties further away from this can provide more accurate estimates of noise levels in given situations. Many factors, such as the type of ground cover, the presence and degree of screening, wind direction and strength, can all influence noise levels and the extent of the noise footprint. Professional judgement is needed to assess the significance of specific factors and to determine which can be disregarded.

ii) For noise annoyance, populations within these noise bands should be estimated. In the TAG Noise Spreadsheet this is calculated automatically once the user inputs an estimate of average household size. Explicit assumptions may need to be made about population densities in order to estimate population exposure, although census data and, where available, building occupancy databases and other sources can also be used. In the absence of more refined information the national average of 2.36 people per household (2001 Census) can be used.

---

[9] Note that this is similar although not identical to the practice for values of working time savings (TAG Unit 3.5.6), since values of noise change are expressed per household, whilst values of time are expressed per person.

[10] For noise data in other band widths see section 1.3 of Annex A.

iii) The annoyance functions and monetary values of changes in noise are presented above. The monetary values are national average values per household per year at 2002 prices. These are increased in line with forecasts of GDP per household and discounted over the appraisal period to give a present value of noise. More details on the process of applying monetary values for noise and the assumptions built into the TAG Noise Spreadsheet can be found in Section 2.4 at the end of this unit.

iv) The incremental impact of each option, expressed in terms of differences in population annoyed, can be derived by subtracting, for each noise band, the population annoyed in the do-minimum scenario from the population annoyed in the do-something scenario and summing over all noise contours. Both this and the present value of the change in noise are automatic outputs of the TAG Noise spreadsheet, but can also be calculated separately for other years or noise profiles[11].

1.7.4 Care is needed where there appears to be the potential for double counting populations exposed to multiple sources of transport noise. As noted above, little is known about annoyance from multiple sources and expert judgement is important in these situations. In some cases, 'double counting' could give the best answer. For example, those disturbed by railway noise may be different from those who would be disturbed by road traffic noise, or, where noise sources are transient in nature, noise from one source might 'fill the gaps' in the varying noise levels arising from another. Furthermore, multiple sources may impact different facades of exposed buildings. For example, a road might affect the front of a property, while a railway line might be to the rear of the same property. Even if the facade noise levels generated by the two sources were similar, there is no reason to assume that the annoyance caused would be identical.

1.7.5 Where the levels of noise from different sources are dissimilar, it may be reasonable to make a simplifying assumption and ignore annoyance from the source giving lower annoyance. However, where there is uncertainty, it is more difficult to make such a simplifying assumption and professional judgement will be needed to reduce the risk of double counting populations.

1.7.6 It is possible that the resident population in the affected properties or the number of properties in the study area will change over time but as a general rule appraisers should assume a constant number of households over time. However, where there are grounds to confidently predict changes in the affected number of households between the Do-Minimum and Do-Something scenarios, it would be appropriate to reflect this in the number of households exposed to transport noise in the forecast year. Consider an example where due to property demolitions or house building contingent on the project or Plan going ahead, the affected number of households in the Do-Minimum and Do-Something scenario differ. In these cases, a nominal noise exposure of $55dB_{Leq}$ should be assumed for the missing scenario, i.e. a demolition will be assumed to lead to the relocated household experiencing $55dB_{Leq}$ elsewhere in the Do-Something, and new homes will be assumed to attract households who would otherwise have experienced $55dB_{Leq}$ in the Do-Minimum.

---

[11] The TAG Noise Spreadsheet assumes a linear change in the base year equivalent value of noise between the opening year and the 15th year. After the 15th year the noise level (and therefore its equivalent value in the base year) is assumed to remain unchanged due to uncertainties in forecasting. All values are then inflated in line with per household GDP and discounted in line with standard treasury discount rates.

Quantitative column

1.7.7 The entries in the quantitative column of the AST should show the estimated numbers of people who are likely to be annoyed in the longer term in the do-minimum scenario and the do-something scenario in the fifteenth year.

Overall assessment score

1.7.8 The entry in the Overall Assessment column should show:

i. The net difference in the estimated population who are likely to be annoyed in the longer term as a result of the option compared to the do-minimum scenario in the fifteenth year;

ii. The estimated present value of the change in noise (at 2002 prices) discounted over the 60 year appraisal period.

These are both calculated as outputs from the TAG Noise Spreadsheet.

Qualitative comment

1.7.9 A qualitative entry in the AST should be used to highlight any factors which cannot be readily understood from the numbers in the Quantitative and Overall Assessment columns. For example, there may be a significant impact on night time noise, or instances of properties experiencing noise levels in excess of 80dB $L_{Aeq\ 18hr}$. For noise insulation issues the number of properties experiencing noise levels above 68dB $L_{Aeq\ 18hr}$ in the Do-Something scenario should be highlighted. Also the appraiser may wish to comment on whether noise impacts on potentially noise sensitive non-residential receptors (for example schools or hospitals) both nearer and further than 600m band from the road/railway are likely to be significant. An indication can be given of the main factors causing any change in noise conditions.

1.8 Methodology for Strategies

1.8.1 For strategies, if the data required for plans is available, this can be used to generate monetary values and annoyance levels as above. However, at the strategic level, it is envisaged that options will generally be assessed using a spatially coarse transport model, given that they are reasonably informative and comparatively quick to run. Spatially coarse models will be likely to provide only a broad indication of changes in transport behaviour arising from strategy options, expressed in such terms as changes in passenger car unit kilometres or vehicle kilometres across a model zone or regional study area. Such model output does not enable noise impacts to be identified at specific receptor sites. Consequently, a more broad-brush, two step assessment must be undertaken, based on determining the **change** in average noise emission and relating this to population data, rather than predicting the expected noise levels. One of the difficulties associated with estimating effects at this level is that the dose response relationship between noise and annoyance is non-linear. In order to estimate average effects the method recommends that these relationships should be linearised. However the analyst should be aware that this may have implications for the range of noise levels which can be assessed with any degree of confidence. The results should be recorded using the Calculation Sheets of the TAG Noise spreadsheet and Worksheet 1 provided at the end of the TAG Unit. As the monetary value of noise impacts depends heavily on the initial levels of noise, monetary valuation is not meaningful for strategies in the absence of this information at a reasonable level of detail.

Step 1

1.8.2 The first stage involves using transport model outputs to estimate the difference in noise emissions between the do-minimum and do-something scenarios for hypothetical sections of the road and rail network within model zones. Average noise emission indicators, such as those in the Calculation of Road Traffic Noise and Calculation of Railway Noise (Basic Noise Level) should be used. For example, for road options, data on zonal flows (vehicle kilometres), speed and traffic composition from a strategic transport model can be used to estimate changes in average zonal noise emission levels in each of the model's zones. When assessing changes in noise under different scenarios, it may not be manageable to predict absolute noise levels over large areas, but it will generally be possible to predict the relative difference between the various options. Provided that total traffic flow, traffic composition (e.g. % heavy goods vehicles for roads and freight movements for rail) and traffic speed are used to calculate the noise emission levels, the method should give realistic comparisons between options. Factors such as road surface, distance to receiver and screening effects can be ignored because they will not vary between options.

Step 2

1.8.3 Comparing options on the strength of the change in zonal noise emission levels alone should be avoided, as it makes no allowance for population distribution and therefore actual noise impacts, which are receptor dependent. For example, an option that moves traffic from local roads to motorways may show increased average noise emission levels because it enables greater traffic speeds. However it may result in a lower total noise impact because motorways tend to be more distant from large communities.

1.8.4 The change in average noise emission levels, between the do-minimum and do-something scenarios, should be related to population data, to enable the change in the estimated population annoyed to be determined. Spatially coarse transport models (and/or their GIS adjuncts) will generally hold data on population levels across model zones. The following steps should be followed:

i) The length of the transport network within each model zone, in

km, should be multiplied by the width of the impact corridors in metres, to estimate the magnitude of the noise impact (in terms of area) for each zone, within the study area).

ii) For each zone the area impacted - expressed in km^2 - should be multiplied by the zonal population densities to derive estimates of the population exposed.

iii) An estimate of the difference in population annoyed by noise in each zone can be derived by multiplying the estimate of the population exposed by the percentage of the population annoyed by the change in the average noise emission level.

iv) These estimates by zone can then be summed to arrive at an indicator of estimated change in population annoyed across the whole study area, for each option.

1.8.5 In determining the area of noise impact, assumptions will need to be made about the areas adjacent to transport links which are likely to be affected. For roads, an appropriate distance should be taken for the first band of properties, say 50m for urban/suburban schemes and then further bands of 100m, 200m, up to maximum corridor width of 400m should be considered, with an attenuation rate of 3dB(A) per band applied. However, this may not be appropriate in all cases and other assumptions may need to be made. For rail, more so than for roads, the area of impact will depend more on local conditions. Rail tends to involve much more variation in horizontal and vertical alignment than roads, which will have a bearing on noise levels and, therefore, the appropriate swathe distance to adopt. Broad assumptions will need to be made about the overall length of the rail network in tunnels, cuttings etc. This may be different for each multi modal study area and it is important that these assumptions are made explicit. For rural schemes there may be justification for increasing the corridor width. Professional judgement is needed to determine the distance of the impacts.

1.8.6 In determining the change in the percentage of the population annoyed, it should be noted that predictions of average noise emission levels, based on outputs from strategic transport models, will often tend to over estimate the actual levels of noise. Where the average noise emission is predicted to be over 65dB LAeq, 18 hr the change in the percentage of the population annoyed should, based on table 1, be assumed to be 3% per dB for road and 2% per dB for rail.

1.8.7 Population densities within zones may vary, particularly between rural and urban zones. In some cases, this may lead to inaccuracies in the estimated population annoyed, which should be noted on Worksheet 1. However the approach is conceptually similar to that applied at the plan level and does identify the benefits or otherwise (in terms of noise impacts on people in buildings) arising from changes in traffic across these zones. The main difference at the strategic level is that vehicle kilometres by zone are used instead of traffic flow data on road/rail links and zonal population densities replace geographic population data.

1.8.8 Worksheet 1 has a row for each study zone and for some studies with numerous zones it may be very large. Therefore in these cases it may be useful to summarise separately the information on Worksheet 1 and show the numbers of zones where population annoyance is increased, decreased or unchanged, as well as the total change in population annoyance over the whole study area.

1.8.9 The change in population for all the zones should also be shown in a graphical or mapped format, depending on the size of the study. For example, for a 20 zone study a simple bar chart showing the change in community annoyance in each zone may give a clear picture of the benefits and dis-benefits of the strategy option. The results of a more complex regional study may be more clearly shown on maps using colour-coded ranges of change in population annoyance for each zone.

Quantitative column

1.8.10 The entries in the Quantitative column should show the estimated numbers of people in the area who are likely to be annoyed in the fifteenth year after opening in the do-minimum scenario and the do-something scenario. As with plans, appraisers should also comment where significant impacts are likely to affect important non-residential receptors e.g. school and hospitals as well as where night time noise levels (not included in the 18 hour measures of noise) are disproportionately affected.

Overall Assessment score

1.8.11 The entry in the Overall Assessment column should show the net difference in the estimated population who are likely to be annoyed in the longer term as a result of the option compared to the do-minimum scenario in the fifteenth year.

Qualitative comment

1.8.12 A qualitative entry in the AST should be used to highlight any factors which cannot be readily understood from the numbers in the Quantitative and Overall Assessment columns. An indication can be given whether there is an overall improvement or worsening of conditions as a result of an option compared to the do-minimum and the main factors causing any change in conditions.

1.9 Quiet Areas

1.9.1 In general, noise assessment from transport is limited to the consideration of effects on people in occupied buildings, so-called noise sensitive receivers (dwellings, schools, hospitals etc). The debate on noise impacts stimulated by developing EC noise policy has raised concern about other spaces, particularly those used for recreation, that currently enjoy a peaceful environment, referred to as 'quiet areas'. Some Member States have become concerned that attempts to improve the noise climate in areas of high exposure may lead to a spreading of noise across areas that are currently almost free from transportation noise. There is a perceived need to protect these quiet or tranquil areas.

1.9.2 However, 'tranquillity' is one of the features defining landscape, and changes in tranquillity will be taken into account in the assessment of impact under the **landscape sub-objective***.* Thus, in order to avoid double counting, the noise impacts of plans and strategies in quiet or tranquil areas should not be assessed under the noise sub-objective.

2 Application of TAG to Highway Schemes

This section provides advice on the links between TAG's treatment of the noise sub-objective and the advice given in Volume 11 of the Design Manual for Roads and Bridges (DMRB), which deals with the environmental assessment of highway projects. An explanation of the correspondence between the advice set out in TAG and DMRB is given in Applying the multi-modal new approach to appraisal to highway schemes, TAG Unit 2.6.

2.1 Methods and Worksheets

2.1.1 TAG requires similar base calculated data on noise levels, noise level changes and people annoyed by noise to that output from the DMRB 11.3.7 ‘Detailed’ assessment, but the noise level data is expressed in terms of LAeq, 18hr. The TAG Noise spreadsheet shows the information that should be reported for this sub-objective. The AST should contain the outputs of the TAG Noise Spreadsheet, i.e. the absolute numbers of people annoyed in year 15 of the scheme, the change in people annoyed and the present value of the change in noise. The completed spreadsheet should then be submitted for reference.

“TAG Noise Spreadsheet.xls”

“Noise Worksheet 1.doc”

“Noise Worksheet 2.doc”

2.2 Data Transformation from DMRB to TAG

Data Requirements	Modify DMRB Output?	Data Source
Worksheet:		
Do-Minimum noise levels, by noise band	Yes	DMRB 11.3.7 and use conversion given in 1.4.2 to express levels in terms of L_{Aeq}
Do-Something noise levels, by noise band	Yes	DMRB 11.3.7 and use conversion given in 1.4.2 to express levels in terms of L_{Aeq}
Population exposed to different noise bands, Do-Minimum & Do-Something	Yes	Factor No. of properties by average household size – 2.36
Population annoyed by noise	Yes	Use Table 1 in this TAG Unit
AST:		
Net population than win/lose	Yes	From TAG Noise Spreadsheet.

2.2.1 Calculated noise levels can be taken direct from the DMRB assessment, and converted to LAeq, 18hr plus a further analysis for Do-Minimum in future. TAG requires noise levels for the opening year of the scheme and a future year of 15 years after scheme opening in the Do-Minimum and Do-Something.

2.2.2 In TAG, the comparison is between Do-Minimum and the Do-Something in the future year, 15 years after opening. There are differences in the basic parameters of assessment used by DMRB and TAG, which require some transformation of the outputs from DMRB.

2.2.3 TAG requires an estimate of the population exposed to noise levels in defined noise bands, based on 3dB(A) and 5dB(A) interval noise contours. DMRB 11.3.7 on the other hand uses an estimate of the number of properties exposed to noise levels and changes. The DMRB property data can be converted to population numbers by assuming an average household size. This should be taken from either population census data for the study area or the national average household size of 2.36 (Census 2001).

2.2.4 TAG requires noise levels in the future year Do-Minimum and Do-Something to be grouped into bands: <45, 45-47.9, 48-50.9, 51-53.9, 54-56.9, 57-59.9, 60-62.9, 63-65.9, 66-68.9, 69-71.9, 72-74.9, 75-77.9, 78-80.9 and >81dB(A) and these can be derived from the DMRB results, adjusted to LAeq, 18hr, and entered into the TAG Noise Spreadsheet.

2.2.5 Nuisance or Annoyance - TAG requires an estimate of the number of people annoyed by noise in the longer term in the Do-Minimum and Do-Something, based on the population exposed to different noise levels (LAeq, 18hr, in 3dB interval bands) multiplied by the Annoyance Response Function (expressed as % highly bothered by noise) given in Table 1 above. This uses the relationship given in DMRB 11.3.7 Figure A3.1 which assesses the current nuisance. However, DMRB assesses the change in nuisance level in the Do-Minimum and Do-Something compared to the current situation expressed as number of properties where the change in % bothered (taken from Figure 3) is grouped: <10%, 10<20%, 20<30%, 30<40%, ≥40%. In this case it is not possible to use the DMRB results; a new assessment will be required for TAG.

2.2.6 Annoyance - TAG uses 'estimated population likely to be annoyed by noise in the longer term' as an indicator of noise effects and calculates the net difference in population likely to be annoyed by noise between Do-Something and Do-Minimum in the 15th year. This indicator was principally selected for TAG as a way of overcoming the difficulty of combining the effects of noise from different sources of transport. By using 'annoyance', it is possible to assess the combined road, rail and air noise effects on the population. The TAG presentation is a simplification of the fuller environmental assessment results. For the purpose of the environmental assessment, the changes in annoyance in the short term must also be recorded.

2.2.7 Monetisation - TAG requires the initial level and change in household exposure to noise for the Do-Minimum and Do-Something scenario in both the opening year of the scheme and 15 years after.

2.2.8 TAG highlights the need to protect quiet or tranquil areas. This is dealt with under the Landscape sub-objective and is not assessed under Noise. If the quantitative assessment does not properly represent the adverse effects on tranquil areas then a comment should be made in the qualitative column.

2.3 DMRB Screening, Scoping and Simple & Detailed Assessment Stages / TAG

2.3.1 Current DMRB guidance introduces the Screening, Scoping Simple & Detailed Assessment processes. Promoters are advised to carryout screening and scoping assessments at all stages (i.e 1,2 and 3) of scheme development. The outcome of the screening and scoping assessments will be to provide an indication of whether a simple or detailed assessment of noise impacts is required.

2.3.2 At the screening and scoping stages, no noise calculations are made, only an estimate of the number of properties within 2 kilometres of existing and new routes, except where sensitive locations are identified. Where it is clearly evident that the project will result in significant noise and vibration impacts, it is advised that a detailed assessment be undertaken. Otherwise a simple assessment should be undertaken. Figure 3.1 of DMRB volume 11.3.7 provides a clear and detailed representation of the main stages of the assessment process.

2.3.3 At both simple and detailed stages of assessment it is advised that a measurement survey be completed where necessary.

2.4 The TAG Noise Spreadsheet

2.4.1 One of the two purposes of the TAG Noise Spreadsheet (“TAG Noise Spreadsheet.xls”) is to automate the noise valuation process described in this document. The other is to calculate the change in population annoyed by transport-related noise. The TAG spreadsheet is incorporated in this unit.

2.4.2 The input screen (as illustrated in Table 2 of Annex A) requires the user to input data on the number of households moving between specific noise bands in the Do-Something versus the Do-Minimum scenarios. The data should be:

- for 3dB noise bands, that is, 45-47.9dB, 48-50.9dB and so on;

- for the opening year (Year 0) and Year 15.

2.4.3 The user is required to input the year which will be defined as the opening year (Year 0) for the project or Plan.

2.4.4 The input screen also asks the user to input the average household size in the study area (for which the default is 2.36, the average across England and Wales) and the project type (road or rail). However, this data is not used in the noise valuation analysis, instead it is used to calculate the change in population annoyed by transport noise – another output of the TAG Noise Spreadsheet. The project type is not used in the valuation analysis because, for the time being, a common noise value is being applied to road and rail noise[12].

2.4.5 Based on these inputs, the spreadsheet makes the calculations described in this document, which are:

- using the monetary values for transport-related noise (Refer Table 2) calculate the benefits in the Opening Year and the Forecast Year;
- using linear interpolation between the Opening Year and Forecast Year, and a flat noise profile after the Forecast Year, produce a stream of benefits over the whole appraisal period;
- apply the expected real growth in values of noise over time;
- discount the benefit stream using Treasury discount rates; and
- derive the Present Value of Benefits (PVB) for transport-related residential noise.

2.4.6 The detailed calculations involved in each of these steps are described in Annex A .

2.4.7 The Present Value of Benefits for transport-related residential noise should be reported in the Appraisal Summary Table (AST) in the assessment column – see Section 1.7.7 and 1.8.10 above.

2.4.8 Sometimes the available data may be slightly incompatible with the TAG spreadsheet. In this case, the analyst should use their judgement about how best to proceed, or consult DfT. However, if the issue is that the noise data is in 3dB bands, but for years other than those required by TAG, then the options are:

(a) conduct further noise analysis to estimate household exposure data for the opening year (Year 0) and Year 15, then enter the data into the TAG spreadsheet; or

(b) calculate the noise benefits using the method set out in this document, which is equivalent to the spreadsheet but allows some extra flexibility over the Years represented in the data.

3 Social and Distributional Impacts of Noise

3.1 Introduction

3.1.1 This section provides additional advice on the technical processes to be considered in the assessment of the potential social and distributional impacts of changes in noise levels resulting from transport interventions. The analyst should, in addition, make reference to **Detailed Guidance on Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17) in undertaking this work.

---

[12] For further information, see the seminar paper.

3.2 Which groups of people are particularly vulnerable to the effects of noise?

3.2.1 The only clearly established evidence of a social impact is the impact of noise on children's concentration when learning. However, there is no quantitative cause-effect relationship. The approach is therefore likely to be focused on the analysis of changes in noise affecting schools, although this is already undertaken in current noise appraisal (in terms of identifying sensitive receptors) through TAG and DMRB. There should, therefore, be no additional burden on the analyst in considering this specific social impact.

3.2.2 Whilst there is no clear evidence of particular impacts on other social groups, it is appropriate to consider the distributional impacts of changes in noise. This could, for example, consider the impacts of changes in noise on households in different income groups.

3.2.3 Similarly there is no clear evidence about distributional impacts of noise outside the home environment, but there exists the possibility that individuals with different levels of income might be exposed to different levels of change in noise levels when away from home. This might arise because of the characteristics of different attractors whose user profiles vary by income levels, and where a transport intervention impacts differently on each attractor.

3.3 Process to be followed

3.3.1 The approach to the assessment of the social and distributional impacts should follow the process described in **Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17). In terms of noise, this follows the following five steps:

- Step 0: initial screening – this will identify if there are likely to be reductions in noise or potential increases in noise that cannot be eliminated through option design / mitigation;
- Step 1: identification of the area impacted by changes in noise;
- Step 2: analysis of the demographic profile in the area impacted by changes in noise;
- Step 3: a screening process, to determine if it is appropriate to undertake further analysis of the changes in noise and the approach to be taken;
- Step 4: the analysis of noise impacts; and
- Step 5: the collation and presentation of the outputs from the noise analysis.

3.3.2 The process to be followed for Steps 0-3 is described in TAG Unit 3.17.

3.3.3 In the event of noise impacts being identified from the screening process, the sections below should be used to guide the technical analyses required in Steps 4 and 5 of this process.

3.3.4 The following section refers to the full appraisal process. TAG Unit 3.17 also notes that alternative approaches can be taken when impacts are neither significant nor concentrated. These are intended to be more proportionate and are more qualitative than the full appraisal. TAG Unit 3.17 sets out the principles that can be applied.

3.3.5 For both the full appraisal and the more proportionate qualitative appraisal, the promoter should develop a specification for the appraisal and agree this with the Department (or equivalent) before proceeding with the appraisal.

3.3.6 It is likely that there will be relatively limited evidence available when undertaking appraisal at the ‘Strategy’ level, described in Section 1.6 above. In this case, the analyst should develop a qualitative approach to identifying the potential social and distributional impacts of noise, and agree this with the Department (or equivalent). In the case of appraisal at the ‘Plan’ level, described in Section 1.5, it is likely that there will be more detailed data available that will facilitate a full SDI appraisal, although the approach should again be agreed.

3.4 Analysis of Social and Distributional Impacts of Noise (Step 4)

3.4.1 The analyst should analyse the noise impacts of the intervention, in accordance with the guidance described in Sections 1 and 2 of this TAG Unit.

3.4.2 The changes in noise levels in the affected area should be mapped, using GIS if possible, which will help present visually the key changes, and will assist in the subsequent analysis of social and/or distributional impacts.

3.4.3 This noise mapping should be overlain with income data to estimate the changes in noise experienced, at a detailed level, by households in different groups. TAG Unit 3.17 provides a discussion of the merits of different income datasets.

3.4.4 The identification of sensitive receptors, including schools, is already required, as described in Sections 1 and 2 above, and hence the analyst should already have examined the changes in noise that are forecast for schools in the affected area and provide comments.

3.4.5 The analysis should be undertaken for the fifteenth year following the opening of the intervention. It is therefore appropriate to ensure that the analysis takes account of any planned new schools (or conversely, closures of schools) in the affected area.

3.5 Outputs from Appraisal of Social and Distributional Impacts (Step 5)

3.5.1 The main outputs and measurements that will be produced from the noise appraisal process will be through statistical and mapping outputs.

3.5.2 In the case of children, the outputs of the noise indicator should be presented in a worksheet showing the change in decibels (dB) that the school(s) would experience as a result of the intervention. This is already undertaken as a core part of the noise analysis, and will not therefore result in additional burden for the analyst.

3.5.3 The analysis of distributional impacts should provide, as an output, the relative numbers of people in different income groups experiencing increases and decreases in noise. This will draw on the spatial analysis of socio- demographic data and changes in noise in the affected area.

3.5.4 Table 3 sets out an example of this analysis for the five quintiles in the income domain of Index of Multiple Deprivation (IMD).

Table 3 – Example of Noise SDI Analysis

	IMD Income Domain Most deprived areas ⟷ Least deprived areas					**Total**
	0-20%	20-40%	40-60%	60-80%	80-100%	
Population in each group with increased noise [A]	2,000	1,000	500	1,000	500	5,000
Population in each group with decreased noise [B]	500	2,000	3,000	2,500	2,000	10,000
Population in each group with no change in noise [C]	500	1,000	1,000	500	1,000	4,000
Net no of Winners / Losers in each group [D] = [B] – [A]	-1500	1,000	2,500	1,500	1,500	-
Total number of Winners / Losers across all groups [E] = ∑[D]	-	-	-	-	-	5,000
Net winners/losers in each area as percentage of total [F] = [D] / [E]	-30%	20%	50%	30%	30%	100%
Share of Total Population in Study Area	22%	25%	15%	28%	10%	100%
Assessment (see Paragraph 3.5.8 below)	×××	✓	✓✓✓	✓✓	✓✓✓	✓✓

(Note: identification of populations with increased / decreased noise should be based on the analytical approach described in Section 1 of this Unit, with changes > 1dB(A)).

3.5.5 This shows the significant negative impacts that are experienced, in noise terms, by the households in the lowest income group (comprising areas with the worst income deprivation). In contrast, 50% of the net numbers benefiting in noise terms are in the middle group, despite only comprising 15% of the population. This group could therefore be considered to have a ‘large beneficial’ impact. Likewise, the least deprived areas, in income terms, experience high benefits in relation to share of the population (this group has 30% of the overall winners in noise terms but only 10% of the total population.

3.5.6 Any proposed noise mitigation needs to ensure the mitigation outcomes are considered and appear alongside the appraisal process, such as increased visual intrusion impacts of screening walls.

3.5.7 The table below presents the approach to the grading of Noise SDIs.

Table 4: System for Grading of Noise SDIs for each of the social groups

Consideration of each IMD group		**Assessment**
Overall noise impact is **beneficial** and the impact for the group as a proportion of the total is…	Beneficial (i.e. reduced noise) and significantly greater than the proportion of the group in the total population	Large Beneficial
	Beneficial (i.e. reduced noise) and in line with the proportion of the group in the total population	Moderate Beneficial
	Beneficial (i.e. reduced noise) and smaller than the proportion of the group in the total population	Slight Beneficial
	A disbenefit (i.e. an increase in noise)	Large Adverse
There are no Noise Benefits or Disbenefits experienced by the group		Neutral
Overall noise Impact is **adverse** and the impact for the group as a proportion of the total is…	Adverse (i.e. increased noise) and smaller than the proportion of the population of the group in the total population	Slight Adverse
	Adverse (i.e. increase noise) that is broadly in line with the proportion of the population of the group in the total population	Moderate Adverse
	Adverse (i.e. increased noise) and significantly greater than the proportion of the population of the group in the total population	Large Adverse
	A benefit (i.e. a reduction in noise)	Large Beneficial

3.5.8 This system should be applied for each of the five income groups. Using the example in Table 3 above, we would derive the following scores:

- The least deprived quintile has a 10% share of the overall population, but 30% of the ‘net winners’ in terms of reduced noise levels. In this case the proportion of net winners significantly exceeds the proportion of the population as a whole, and it is appropriate to give a score of large beneficial.

- The second most deprived quintile has a 25% share of the total population and 20% of the net winners. The proportion of net winners is less than the proportion of the population as a whole, and it is therefore appropriate to give a score of slight beneficial.

- The most deprived quintile has a 22% share of the population, but there are 1,500 ‘net losers’ in this group (30% of the total 5,000 population, which significantly exceeds the 22% proportion of the population as a whole). The noise impacts for this group are therefore large adverse.

- The most deprived quintile has a 22% share of the population, but there are 1,500 ‘net losers’ in this group, despite an overall reduction in noise for the population as a whole. This group suffers in both absolute and relative terms, and it is therefore appropriate to give a score of large adverse.

3.5.9 The analyses described above are based on the noise experienced at people's place of residence. However, the highest levels of noise are generally experienced during the day, when many people are away from the home, at work, school or carrying out personal business. On the other hand, the analyst should also take into account changes in noise levels that could occur at night (refer to Paragraph 1.5.9 for details). The analyst should therefore take into account the nature of the exposure to noise in undertaking the assessment.

3.5.10 In specific cases where analysis is required by attractors, the appraisal should report the impacts by IMD income groups. However, as exposure to noise is at attractors rather than at home, the analysis also needs to indicate the duration of exposure. It is expected that in most cases only a qualitative assessment will be required, although there could be exceptions in the case of attractors with long dwell times and profiles of users that are significantly affected by income.

3.5.11 The scores for each of the groups under consideration should then be reported in the matrix of social and distributional impacts, described in Step 5 of **Detailed Guidance on Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17).

4 Further Information

The following documents provide information that follows on directly from the key topics covered in this Unit.

For information on:	See:	TAG Unit number:
Research on the relationship between community annoyance and noise exposure level	European Commissions Green Paper on noise international links	
The annoyance response curve for road traffic	DMRB Annex 3 Figure A 3.1	
Taking account of changes in tranquillity	The landscape sub-objective	TAG unit 3.3.7
The correspondence between the advice set out in TAG and DMRB	Applying the multi-modal new approach to appraisal to highway schemes	TAG unit 2.6
Appraisal Summary Table (AST)	Transport Appraisal and the New Green Book	TAG unit 2.7
The background and overall approach to the Social and Distributional Impacts of transport interventions	Detailed Guidance on Social and Distributional Impacts of Transport Interventions	TAG Unit 3.17

5 References

Bateman, I.J., Day, B.H., & Lake, I. (2004), **The Valuation of Transport-Related Noise in Birmingham**, DfT. (available at: http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/economics/rdg/birmingham/)

British Medical Association (1997), **Road Transport and Health**

Department of Transport (DoT) (1991), **Railway Noise and Insulation of Dwellings, Report of the Mitchell Committee*,*** HMSO

Department of Transport (DoT) (1988), **Calculation of Road Traffic Noise***,* DoT, Welsh Office, HMSO

Department of Transport (DoT) (1995), **Calculation of Railway Noise**, HMSO

Department of the Environment, Transport and the Regions (DETR), **Design Manual for Roads and Bridges, Environmental Assessment, Volume 11***,* London, The Stationary Office

Highways Agency (HA), Design Manual for Roads and Bridges, Environmental Impact Assessment, Volume 11, Section 3, HA. (Available at: http://www.dft.gov.uk/ha/standards/dmrb/vol11/section3/ha21308.pdf)

Department of Health (1988), **Our Healthier Nation: a contract for health*, CM 3854,*** The Stationary Office

Fletcher, T and McMichael, AJ (1997), **Health at the crossroads, Transport policy and urban health***,* Wiley, Chichester

Hillman, Boyd, Tuxworth (1999), **Promoting Cycling as a Way to a Healthier Life – Proceedings from Velo City** *1999,* Graz, Austria (11th International Bicycle Planning Conference)

Health Education Authority (1998), **Transport and Health: A Brief for Health Professional and Local Authorities**

L M Pearce (TRL), AL Davies (Adrian Davis Associates), Dr HD Crombie (Independent Consultant) and HN Boyd (Allot and Lomax), **Cycling for a Healthier Nation***,* TRL Report 346

Nellthorp, J., Bristow, A., & Mackie, P., (2005) **Developing Guidance on the Valuation of Transport-Related Noise for Inclusion in WebTAG**, DfT. (available at: http://www.defra.gov.uk.)

Parker, DM (1995), **English Nature Science Series No 21**

Transport Research Laboratory (1999), **An examination of the noise index $L_{Aeq,\,T}$ and review of traffic noise prediction models***,* Unpublished

6 Document provenance

This Transport Appraisal Guidance (TAG) Unit is based on Chapters 4, Section 3 (including worksheets 4.1 and 4.2) of Guidance on the Methodology for Multi-Modal

Studies Volume 2 DETR, 2000); together with Section 7.1 of Applying the multi-modal new approach to appraisal to highway schemes (“The Bridging Document”) (DETR, 2001).

This version of the TAG unit merges the ‘Supplementary Guidance’ document into the main body of the unit. The table containing GDP Growth per household forecasts has been removed from this unit. This information can now be found in **TAG 3.5.6 The Value of Time and Operating Costs**. It has also been updated in line with changes in DMRB Guidance Volume 11.3.7 as of August 2008.

This TAG unit has been updated in January 2010 to reflect the guidance on Social and Distributional Impacts.

This TAG Unit is now definitive.

Technical queries and comments on this Unit should be referred to:

Integrated Transport Economic Appraisal (ITEA) Division

Department for Transport
Zone 3/04 Great Minster House
76 Marsham Street
London SW1P 4DR
itea@dft.gsi.gov.uk
Tel 020 7944 6176
Fax 020 7944 2198

Annex A

A.1 Data Requirements

A.1.1 The key input data for noise valuation is the noise exposure of each affected household in the Do-Minimum and Do-Something scenarios, in the opening year (Year 0) and 15 years after the opening of the scheme (Year 15). This data will typically be taken from noise maps of the Study Area.

A.1.2 This TAG unit requires data to be collected in 3dB ranges from $45dB_{Leq}$ to $81dB_{Leq}$ showing how household exposure changes between the do-minimum and the do-something scenarios. This Supplementary Guidance explains how this data is used to derive estimates of benefit, and illustrates how the approach can be adapted according to the amount of detail in the available noise data. More aggregate data may be used, but will lead to only approximate results. Note that noise should always be measured in or approximated to dB_{Leq} as this is the measure on which the noise values are based[13].

A.1.3 We consider four cases:

i. noise levels and changes are recorded to the nearest 1dB;

ii. noise levels and changes are recorded using 3dB bands, as required by this TAG Unit, that is, 45-47.9dB, 48-50.9dB and so on;

iii. noise levels are recorded in 5dB or other bands;

---

[13] TAG Unit 3.3.2, §1.3.2 states that if data measured in $dB_{L10\ 18hr}$ are available, then $dB_{L10\ 18hr}$ – 2.5 can be used as an approximation for $dB_{Leq\ 18hr}$. This will often be useful for road schemes, since DMRB has used $dB_{L10\ 18hr}$ as its standard measure.

iv. no cross-tabulation between the Do-Minimum and Do-Something is available (that is, the number of households in each noise band is recorded for the Do-Minimum and for the Do-Something scenario, but the number of households moving between particular bands is not known).

Case (i): 'High Resolution' Noise Data to the Nearest 1dB

A.1.3.1 In a simple case, with relatively few households affected and good data on the noise impacts on each one, it will be possible to list the households as separate data items. This is illustrated by the real data shown in Table 1a, which is an extract from the data for the proposed A3 Hindhead Improvement. This dataset includes data for the opening year and 15 years after opening (2012 and 2027), for the Do-Minimum and Do-Something scenarios. Since the Hindhead data includes 772 households, there might be advantages in presenting that particular scheme's data in a different format (see Table 1b below)[14].

Table 1a: Noise Data by Household, 1dB resolution, opening year and 15 years after opening (Years 0 and 15)

Household	Do-Minimum noise level, dB(A)$_{\text{Leq 18hr}}$		Do-Something noise level, dB(A)$_{\text{Leq 18hr}}$	
	2012	2027	2012	2027
1	64	64	59	60
2	61	61	57	58
3	61	61	57	58
4	62	62	58	59
5	61	61	58	59
6	61	61	58	59
7	62	62	59	60
8	61	61	58	59
9	64	64	61	62
10	67	67	63	64
11	69	69	66	67
.	.	.	.	.
.	.	.	.	.
74	51	51	53	54
75	53	53	54	55
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
772	54	55	51	52

A.1.3.2 Where the intervention affects noise levels across a wider area, e.g. an LTP or a major road or rail scheme in an urban area, it will be more practical to present this detailed data – if available – as a cross-tabulation of Do-Minimum and Do-Something noise levels, with a count of the number of households affected in each cell (Table 1b). A table in this format would be required for each year of data (e.g. the opening year (Year 0) and Year 15 in this case).

A.1.3.3 In future, it is expected that noise data at this level of detail will increasingly be gathered and held for transport projects and plans, and GIS systems will reduce the burden of doing so. Nevertheless, it is often the case currently that noise data is coarser than this – see Cases (ii)-(iv).

---

[14] For this case study the approximation used for $\text{dBL}_{\text{A10, 18hr}}$ was $\text{dBL}_{\text{Aeq, 18hr}}$ – 3, in accordance with the WebTAG guidance at the time. More recent guidance suggests $\text{dBL}_{\text{Aeq, 18hr}}$ – 2.5 is a more appropriate approximation for $\text{dBL}_{\text{A10, 18hr}}$ (see WebTAG Unit 3.3.2).

Table 1b: Cross-Tabulated Noise Data, 1dB resolution, 15 years after opening (Year 15)

Number of households

Do-Something noise level, dB(A)$_{Leq\ 18hr}$

Do-Minimum noise level, dB(A)$_{Leq\ 18hr}$

	<45	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
<45	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	2	1	4	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	4	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	5	0	0	1	1	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	4	12	2	1	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	18	0	0	0	5	12	2	0	0	9	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	6	7	1	3	1	8	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	2	11	3	11	17	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	3	0	0	26	2	7	4	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	6	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	18	0	9	4	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	1	1	9	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	22	0	1	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	6	0	15	1	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	9	9	4	7	11	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	29	13	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	15	3	4	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	7	19	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	2	2	5	5	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	7	30	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	6	4	13	10	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	25	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	4	2	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	6	0	1	0	0	0	0	0	0	0
73	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Case (ii): New TAG Standard Noise Data using 3dB Bands

A.1.3.4 If noise data are available in 3dB bands as required by TAG Unit 3.3.2, that is, 45-47.9dB, 48-50.9dB and so on, and if the data is for Years 0 and 15, where Year 0 is the opening year, then the new TAG Noise Spreadsheet may be used to calculate the monetary benefits, removing the need for any calculations to be made by the appraiser. This type of input data is illustrated in Table 2, which is taken directly from the input screen of the new TAG spreadsheet. Again the example data is for the proposed A3 Hindhead Improvement.

A.1.3.5 Sections 4 and 5 below explain the calculations which are made within the TAG spreadsheet, and also how the method can be adapted if the noise data are available in 3dB bands as above, but for years other than the opening year (Year 0) and Year 15.

Table 2: TAG Standard Cross-Tabulated Noise Data using 3dB bands, opening year (Year 0) and Year 15

No. of households experiencing 'Do Minimum' & 'Do Something' noise levels (given in dB_{Leq}) in Year 0

	Do Something	<45	45-48	48-51	51-54	54-57	57-60	60-63	63-66	66-69	69-72	72-75	75-78	78-81	81+
Do Minimum															
<45		14													
45-48		3	15	19											
48-51		18	35	32	21			5							
51-54			3	42	43	5			1						
54-57					48	21	5	1							
57-60					2	46	72	21							
60-63						2	25	49	21						
63-66							20	19	77	15					
66-69								1	4	2	2				
69-72				15					2	13	3	1			
72-75			1						2	8	7				
75-78							8				2	1			
78-81															
81+															

No. of households experiencing 'Do Minimum' & 'Do Something' noise levels (given in dB_{Leq}) in Year 15

	Do Something	<45	45-48	48-51	51-54	54-57	57-60	60-63	63-66	66-69	69-72	72-75	75-78	78-81	81+
Do Minimum															
<45		14													
45-48		3	14	21	2										
48-51		18	4	49	20	1			1						
51-54				12	78	13	1	5							
54-57					34	35	5	1							
57-60						42	32	53							
60-63							24	44	21						
63-66							19	19	70	36					
66-69									6	10					
69-72				15					2	15	11				
72-75			1							8	3	2			
75-78							8								
78-81															
81+															

*note that 45-48dB_{Leq} refers to noise levels from 45.0 to 47.9dB_{Leq} and so on

Case (iii): ‘Lower Resolution’ Data using 5dB or Other Bands

A.1.3.6 If the noise levels are recorded in 5dB or other bands, then the data should be gathered in a table such as Table 3. It is fairly straightforward to carry out the valuation exercise using this type of data, assuming that some spreadsheet software is available (see Section 4).

Table 3: Cross-Tabulated Noise Data using 5dB bands, opening year (Year 0) and Year 15

Number of households

2012

Do-Minimum noise level, dB(A)$_{Leq\ 18hr}$	Do-Something noise level, dB(A)$_{Leq\ 18hr}$							
	<45	45-49.9	50-54.9	55-59.9	60-64.9	65-69.9	70-74.9	75-80
<45	14							
45-49.9	8	76	12					
50-54.9	13	25	137	4	6			
55-59.9			40	115	22			
60-64.9				47	123	39		
65-69.9					14	25		
70-74.9		16			2	12	11	
75-80				8		2	1	

2027

Do-Minimum noise level, dB(A)$_{Leq\ 18hr}$	Do-Something noise level, dB(A)$_{Leq\ 18hr}$							
	<45	45-49.9	50-54.9	55-59.9	60-64.9	65-69.9	70-74.9	75-80
<45	14							
45-49.9	8	59	31		1			
50-54.9	13	12	145	6	5			
55-59.9			33	77	54			
60-64.9				43	128	11		
65-69.9					12	69		
70-74.9		1	15			13	14	
75-80				8				

Case (iv): Data without Cross-Tabulations

A.1.3.7 What if the data do not give the change in noise level for each household between the Do-minimum and Do-something scenarios, but instead give only the total number of households in each band for each scenario? This situation is illustrated in Table 4. In this case, **assumptions** should be made – and reported – about the way in which individual properties change noise level. For example, a ‘cascade’ method could be used, assuming:

- minimum movement by individual households between noise bands;
- start by allocating households to the lowest noise band.

A.1.3.8 For example, if there is a decrease by 10 in the number of households experiencing noise levels of <45dB between the Do-Minimum and the Do-Something, then all of these households are assumed to experience 45-47.9dB (the next category up) in the Do-Something. The 45-47.9B category is then assessed and if the number of households under DS is greater than that under DM, then the remainder move to the next category up, and so on.

A.1.3.9 This is the least satisfactory of the data formats, because the assumptions made will not necessarily match the real pattern of noise changes, and potential for errors is introduced when the appraiser ‘reconstructs’ noise change data from noise band data of this type. For these reasons, the emphasis in the new TAG Unit 3.3.2 is on requiring cross-tabulation between the DM and DS scenarios.

A.1.3.10 After the ‘cascade’ method or an alternative has been used, a Table such as 1b, 2 or 3 will be produced, which allows the noise changes to be valued. This approach can be used in valuing noise change, provided that the assumptions made are reported with the appraisal results.

Table 4: Noise Data in 3dB bands without Cross-Tabulation

Number of households

2012

	Do-Minimum noise level, dB(A)$_{\text{Leq 18hr}}$	Do-Something noise level, dB(A)$_{\text{Leq 18hr}}$
<45	14	35
45-48	37	54
48-51	111	108
51-54	94	114
54-57	75	74
57-60	141	130
60-63	97	96
63-66	131	107
66-69	9	38
69-72	34	14
72-75	18	2
75-78	11	0
78-81	0	0

2027

	Do-Minimum noise level, dB(A)$_{\text{Leq 18hr}}$	Do-Something noise level, dB(A)$_{\text{Leq 18hr}}$
<45	14	35
45-48	40	19
48-51	93	97
51-54	109	134
54-57	75	91
57-60	127	89
60-63	89	122
63-66	144	100
66-69	16	69
69-72	43	14
72-75	14	2
75-78	8	0
78-81	0	0

Other Data Issues

A.1.4 In some cases, the noise data may be gathered in terms of **residential properties** rather than households. The DMRB method, for example, initially counts the number of properties. Care should be taken to ensure that where a building such as an apartment block contains many separate housing units, the number of these is counted or estimated, rather than crudely using the number of buildings (in property market terms, the number of households will typically be the number of leasehold or rental properties in a block). It is the number of households which is needed for the noise valuation calculations.

A.1.5 Where the noise data is in terms of the **number of people** affected, appraisers should use the England and Wales average household size of 2.36 to convert between number of people affected and number of households. Alternatively, local data on household size at a local authority level are available through National Statistics online Census 2001 pages[15].

A.1.6 Note that for all of the Cases above, noise predictions will be required for more than one year during the appraisal period, ideally for the opening year and 15 years after opening (e.g. for 2008 and 2023) although other similar pairs of modelled years are acceptable. Noise predictions are rarely made for three separate years, but use should be made of such data when it is available, using linear interpolation between the modelled years (see Section 4). When the TAG spreadsheet is used, it will request comparisons between the do-minimum and do-something scenarios for the opening year (Year 0) and 15 years after the opening of the scheme (Year 15). Noise benefits will then be calculated automatically. If the noise data is in 3dB bands, but for years other than the opening year and Year 15, then the options are:

(a) conduct further noise analysis to derive noise exposure estimates for the opening year and Year 15, then enter the data into the TAG spreadsheet; or

(b) calculate the noise benefits using the method set out below, which is equivalent to the spreadsheet but allows some extra flexibility.

Interpolation and Extrapolation to the Full Appraisal Period

A.1.7 As with other items of benefits and costs in the appraisal, the analysis of noise must address not only a snapshot of future benefits but the stream of benefits over the appraisal period as a whole – typically this is the lifetime of the assets created, or an appraisal period of 60 years for most road and rail infrastructure (TAG Unit 3.5.4).

A.1.8 Noise forecasts will typically be available for:

- the opening year (Year 0) – the year in which the benefits of the intervention come on line; and
- a future ‘forecast year’ (usually 15 years after opening (Year 15) for road schemes, based on standard practice in DMRB).

For Plans which include two or more different components coming on line in different years, more model runs are sometimes undertaken in order to have an understanding of any kinks in the benefit profile over time.

A.1.9 After the future ‘forecast year’, appraisers should make the assumption that the noise profile will be flat. That is, the noise level experienced by each property in the Do-Minimum and the Do-Something scenarios is assumed to be constant, hence the difference between the two is constant. This assumption, which is based on a judgement made by DfT in discussion with noise modellers and the Highways Agency, is justified essentially on the grounds that there are forces acting in both directions in the long term (towards increases in noise and decreases in noise), and the evidence is not sufficient to determine which will prevail.

---

[15] http://www.statistics.gov.uk/census2001/

A.1.10 This is consistent with the approach taken to some other types of benefits – e.g. travel time savings – where it is sometimes assumed that annual benefits will cease to rise after the last modelled year (see TAG Unit 3.5.4, Section 5.4 for further discussion).

A.1.11 In between the Opening Year and the Forecast Year, appraisers should use linear interpolation to predict the profile of growth in noise levels (and hence noise changes) over time. This, too, is judged to be a reasonable approximation in the face of some uncertainty, and is consistent with the general advice given in TAG Unit 3.5.4, Section 5.4.

A.1.12 Finally, note that it is possible that the resident population in the affected properties will change over time, or that the number of properties in the study area will change over time. The direction of change is hard to predict, since the influences of declining household size and increasing urban density (encouraged by the planning system) will pull in opposite directions. Where there is no firm contrary evidence, **as a general rule appraisers should assume a constant exposed number of households over time**. However, where there are grounds to confidently predict changes in the affected number of households – for example, where substantial new housing is planned in the study area during the 15 years after the opening year of the project or Plan – it would be appropriate to reflect this in the number of households exposed to transport noise in the forecast year (usually Year 15). Any change in the number of households in the study area in Year 15 compared with the opening year can simply be included in the calculations for Year 15, or in the inputs to the TAG Noise Spreadsheet for Year 15. These households will appear in both the Do-Minimum and Do-Something scenario for Year 15. In general, an increase in the number of households in Year 15 will lead to an increase in the benefits from any noise reduction (and an increase in the disbenefits from any increases in noise). Beyond Year 15, the uncertainty over any possible change in the number of households will be much greater – and unless there are exceptional reasons to do otherwise, the number of households should be assumed to be constant from Year 15 onwards. Linear interpolation should continue to be used between the opening year and Year 15. Any assumptions and evidence used in relation to household numbers should be reported with the appraisal results.

A.1.13 It is also possible in a few cases that, in the forecast year, the number of households will change between the Do-Minimum and Do-Something scenarios. For example this may be due to property demolitions or house building contingent on the project or Plan going ahead. In these cases, a nominal noise exposure of $55dB_{Leq}$ should be assumed for the missing scenario, i.e. a demolition will be assumed to lead to the relocated household experiencing $55dB_{Leq}$ elsewhere in the Do-Something, and new homes will be assumed to attract households who would otherwise have experienced $55dB_{Leq}$ in the Do-Minimum.

A.2 Worked Example

A.2.1 The A3 Hindhead Improvement scheme has already been mentioned in Sections 3 and above. This is a £240million road widening scheme which would remove a bottleneck, the last single-carriageway section between London and Portsmouth on the A3 trunk road. The scheme includes a tunnel under the Devil's Punch Bowl SSSI (Site of Special Scientific Interest), which is currently divided by the road. Part of the existing road would be returned to nature.

A.2.2 Noise effects on households would result from changing the alignment of the road and from the new patterns of traffic movement and speed. Table 1a gave an extract from the noise data for this scheme. The full dataset includes 772 households, and the data for the year 2027 are summarised in Table 1b. This data is at 1dB resolution, in other words we are dealing with Case (i) of the four types of data listed above.

Case (i): 1dB resolution data

A.2.3 Table 1b shows the number of households experiencing specific noise levels in the Do-Minimum scenario in the year 2027, cross-tabulated with their noise level in the

Do-Something in the same year. For example, eight households that would experience 75dB without the scheme, would experience a reduction to 60dB with the scheme. Three households would experience a reduction from 53dB to 48dB, etc.

A.2.4 An equivalent table could be prepared for the Opening Year, 2012. Alternatively, a table in the style of Table 1a could be prepared for the scheme, including both the 2012 and 2027 data.

A.2.5 The next step is to apply the monetary values to the noise data for the years 2012 and 2027. Whichever form your data is in, a useful tool is a spreadsheet containing values cross-tabulated between DM and DS noise levels from 45 to 80dB(A)$_{\text{Leq 18hr}}$. This can be prepared from first principles using the values in Table 2 of the guidance.

A.2.6 If the data is in the form of Table 1b, then a simple multiplication is needed:

Monetary benefit (2002 prices and values)

= Number of households * Value of noise change per household

For example, for the cell in Table 1b representing a change from 75dB (in the DM) to 60dB (in the DS):

= 8 households * £996.10

= £7,968.80

Remember that this benefit has not yet been increased to account for real growth in noise values between 2002 and 2027. This will be done at a later stage in the process.

A.2.7 If the data is in the form of a list (like Table 1a) then analysts may wish to make use of spreadsheet functions to extract the correct value from the table of values, to apply to each entry in the list.

Sum the benefits across all cells in the Table, to give a net benefit in Year *n*. Do this for the Opening Year and the Forecast Year, giving:

Net Benefit (2012) = £43,925.20

Net Benefit (2027) = £33,974.50

A.2.8 Using the assumptions of linear interpolation up to the Forecast Year and then a flat noise profile thereafter, create the stream of benefits across the whole appraisal period. The expected asset life of the A3 Hindhead Improvement warrants a 60 year appraisal period. The profile of benefits **before increasing the values in line with real GDP growth and before discounting** are shown in Figure 1.

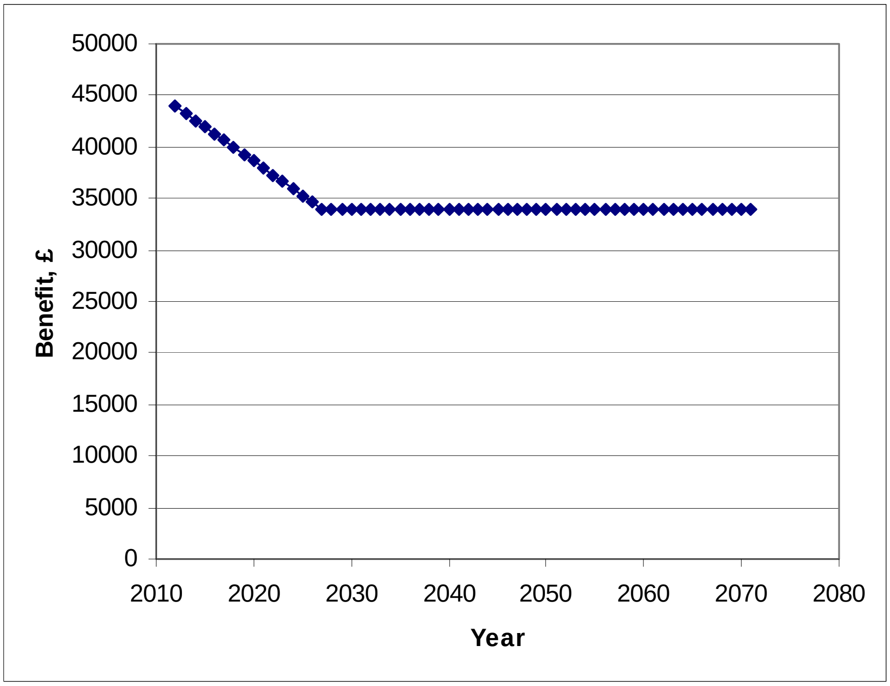


Figure 1: Example Benefit Profile before value growth or discounting

A.2.9 Now apply the value growth and discounting, and sum the results over the appraisal period. These steps and the final Present Value of Benefits for noise are shown in Table 8.

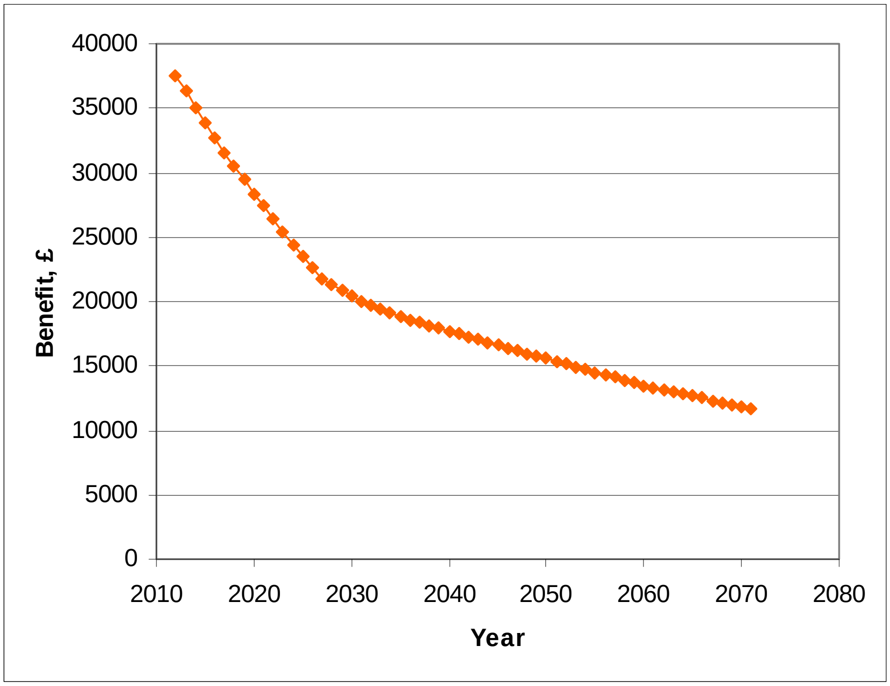
A.2.10 The PVB (Residential Noise) for the A3 Hindhead Improvement is found to be £1.164 million. This is the figure which would usually be exported from the noise valuation analysis into the Appraisal Summary Table (AST) and the Analysis of Monetised Cost and Benefits table – see Section 7 'Reporting'.

Table 8: Example of the Present Value of Benefits (PVB) Calculation

Year	Benefit, £ (pre-growth)	Value growth factor	Discount factor	Discounted Benefit, £ (with value growth)
2012	**43925.2**	**1.206**	**0.709**	**37544.6**
2013	43261.8	1.225	0.685	36287.9
2014	42598.4	1.244	0.662	35064.9
2015	41935.1	1.263	0.639	33875.0
2016	41271.7	1.283	0.618	32717.3
2017	40608.3	1.303	0.597	31591.0
2018	39944.9	1.324	0.577	30495.3
2019	39281.5	1.345	0.557	29429.5
2020	38618.2	1.366	0.538	28392.8
2021	37954.8	1.387	0.520	27384.6
2022	37291.4	1.407	0.503	26364.0
2023	36628.0	1.427	0.486	25373.5
2024	35964.6	1.447	0.469	24412.1
2025	35301.3	1.467	0.453	23479.2
2026	34637.9	1.488	0.438	22573.9
2027	**33974.5**	**1.509**	**0.423**	**21695.6**
2028	33974.5	1.530	0.409	21258.6
2029	33974.5	1.552	0.395	20830.5
2030	33974.5	1.574	0.382	20410.9
2031	33974.5	1.596	0.369	19999.8
2032	33974.5	1.626	0.356	19676.5
2033	33974.5	1.651	0.346	19397.9
2034	33974.5	1.676	0.336	19123.2
2035	33974.5	1.702	0.326	18852.5
2036	33974.5	1.728	0.317	18585.6
2037	33974.5	1.758	0.307	18353.6
2038	33974.5	1.788	0.298	18124.5
2039	33974.5	1.819	0.290	17898.2
2040	33974.5	1.850	0.281	17674.8
2041	33974.5	1.881	0.273	17454.2
2042	33974.5	1.914	0.265	17236.3
2043	33974.5	1.947	0.257	17021.1
2044	33974.5	1.980	0.250	16808.7
2045	33974.5	2.014	0.243	16598.9
2046	33974.5	2.048	0.236	16391.7
2047	33974.5	2.083	0.229	16187.1
2048	33974.5	2.119	0.222	15985.0
2049	33974.5	2.155	0.216	15785.5
2050	33974.5	2.192	0.209	15588.4
2051	33974.5	2.230	0.203	15393.8
2052	33974.5	2.263	0.197	15169.6
2053	33974.5	2.297	0.192	14948.7
2054	33974.5	2.332	0.186	14731.0
2055	33974.5	2.367	0.181	14516.5
2056	33974.5	2.402	0.175	14305.1
2057	33974.5	2.438	0.170	14096.8
2058	33974.5	2.475	0.165	13891.5
2059	33974.5	2.512	0.160	13689.2
2060	33974.5	2.550	0.156	13489.8
2061	33974.5	2.588	0.151	13293.4
2062	33974.5	2.632	0.147	13127.4
2063	33974.5	2.678	0.143	12963.6
2064	33974.5	2.723	0.138	12801.7
2065	33974.5	2.770	0.134	12641.9
2066	33974.5	2.818	0.130	12484.1
2067	33974.5	2.866	0.127	12328.3
2068	33974.5	2.915	0.123	12174.4
2069	33974.5	2.965	0.119	12022.4
2070	33974.5	3.016	0.116	11872.4
2071	33974.5	3.068	0.112	11724.2
			PVB, £ =	1163590.3

A.2.11 For illustration only – and not part of the appraisal outputs – is Figure 2, showing the profile of noise benefits after value growth and discounting have been applied. Compared with Figure 1, this shows that the effect of discounting outweighs the effect of value growth. The net effect is to decrease the magnitude of the benefits, and that effect becomes stronger the further we look into the future.

Figure 2: Example Benefit Profile after value growth and discounting



Case (ii): New TAG Standard Noise Data, 3dB Bands

A.2.12 Suppose that instead of the 1dB resolution data above (Tables 1a or 1b), the appraiser has access to noise data conforming to the standard set out in the new TAG Unit 3.3.2:

- noise levels recorded in 3dB bands from 45dB to 81dB, that is, 45-47.9dB, 48-50.9dB and so on;
- the data is for the opening year (Year 0) and 15 years after the opening year (Year 15);
- the data includes the Do-Minimum and Do-Something scenarios for each year.

A.2.13 In this case, the appraiser can make use of the new TAG Noise Spreadsheet to calculate the monetary benefits, removing the need for any calculations to be made by the appraiser. The data in Table 2 is for the A3 Hindhead Improvement, and is shown as it would appear in the input screen of the new TAG spreadsheet.

A.2.14 The calculations necessary for this type of data – and which are automated by the TAG spreadsheet – are largely the same as for the 1dB resolution data above. The one difference is that the monetary values of noise (Table 2 of the guidance) cannot be applied directly to the noise data because the noise data has been grouped into 3dB bands. Instead, values must be derived for changes between each 3dB band and each other 3dB band.

A.2.15 These values for movements between 3dB bands have been based on the assumption that within each pair of bands, movements from any noise level to any other noise level are equally likely – that is, noise levels are uniformly distributed across each band. This implies that, for example, for a household which moves from the 51.0-53.9dB band to the 45.0-47.9dB band, the mean or expected willingness-to-pay for the noise change is given by

(0.5*£26.90)+£24.20+£21.60+£19.00+£16.30+£13.70+(0.5*£11.10)

=£113.80

A.2.16 The values for movements between 3dB bands across all combinations of bands are given in Table 10. These values are used in the TAG Noise Spreadsheet.

Table 10: Values for movements between 3dB bands

£ per household per annum, 2002 prices and values													
Do-Minimum noise, dB	Do-Something noise, dB												
	<45	45-48	48-51	51-54	54-57	57-60	60-63	63-66	66-69	69-72	72-75	75-78	78-81
<45	0	-14 0	-59.0	-127 8	-220.2	-329.8	-469 8	-633.4	-820.8	1031.8	-1266.6	-1525.1	-1807.4
45-48	14.0	0	-45.1	-113 8	-206.3	-315.9	-455 8	-619 5	-806.8	-1017.9	1252.6	-1511 2	-1793.4
48-51	59.0	45.1	0	-68.8	-161.2	-270.8	-410 8	-574.4	-761.8	-972.8	-1207.6	1466.1	-1748.4
51-54	127.8	113.8	68.8	0	-92.5	-202.1	-342 0	-505.7	-693.0	-904.1	-1138.8	-1397.4	1679.6
54-57	220.2	206.3	161 2	92.5	0	-109.6	-249 6	-413 2	-600.6	-811.6	-1046.4	-1304 9	-1587.2
57-60	329.8	315.9	270 8	202.1	109.6	0	-140 0	-303 6	-491.0	-702.0	-936 8	-1195 3	-1477.6
60-63	469.8	455.8	410 8	342 0	249.6	140.0	0	-163.7	-351.0	-562.1	-796 8	-1055.4	-1337.6
63-66	633.4	619.5	574.4	505.7	413.2	303.6	163.7	0	-187.4	-398.4	-633 2	-891.7	-1174.0
66-69	820.8	806.8	761.8	693 0	600.6	491.0	351 0	187.4	0	-211.1	-445 8	-704.4	-986.6
69-72	1031 8	1017.9	972 8	904.1	811.6	702.0	562.1	398.4	211.1	0	-234 8	-493.3	-775.6
72-75	1266 6	1252.6	1207.6	1138.8	1046.4	936.8	796 8	633.2	445.8	234.8	0	-258.6	-540.8
75-78	1525.1	1511.2	1466.1	1397.4	1304 9	1195.3	1055.4	891.7	704.4	493.3	258 6	0	-282.3
78-81	1807.4	1793.4	1748.4	1679.6	1587 2	1477.6	1337.6	1174 0	986.6	775.6	540 8	282.3	0

A.2.17 When the number of households (Table 2) is multiplied by the values for the 3dB bands (Table 10) and the results summed across all households, the benefits (pre-growth) are estimated to be:

Net Benefit (2012) = £50,779.40

Net Benefit (2027) = £32,062.10

These benefits are, respectively, 15% higher and 6% lower than the benefits obtained using 1dB resolution data.

A.2.18 When the PVB (Residential Noise) is recalculated using the net benefits above, the PVB is estimated to be £1.157 million. This is 0.6% lower than the estimate using 1dB resolution data.

Case (iii): 5dB banded data

A.2.19 If the noise levels are recorded in 5dB bands, as in Table 3, then a similar process is required to Case (ii) (see §5.14-18), however the values must be derived for movements between 5dB bands (see Table 11).

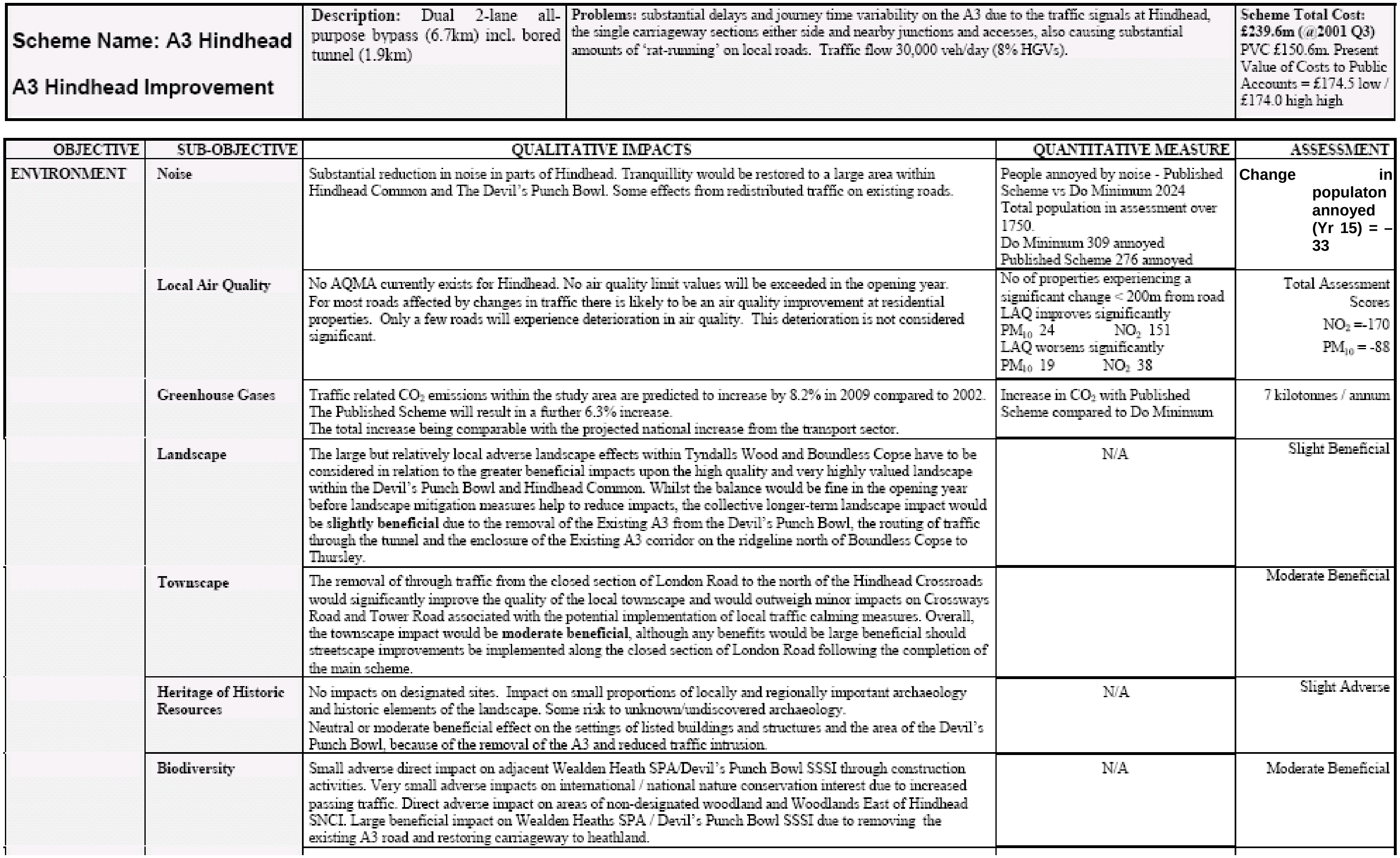
Table 11: Values for movements between 5dB bands

£ per household per annum, 2002 prices and values								
Do-Minimum noise, dB	Do-Something noise, dB							
	<45	45-49.9	50-54.9	55-59.9	60-64.9	65-69.9	70-74.9	75-80
<45	0	-26.4	-127 8	-295.0	-528.2	-827.3	-1192.2	-1623.1
45-49.9	26.4	0	-101.4	-268.7	-501.9	-801.0	-1165.9	-1596.8
50-54.9	127.8	101.4	0	-167.3	-400.5	-699.6	-1064.5	-1495.4
55-59.9	295.0	268.7	167.3	0	-233.2	-532.3	-897.2	-1328.1
60-64.9	528.2	501.9	400.5	233.2	0	-299.1	-664.0	-1094.9
65-69.9	827.3	801.0	699.6	532.3	299.1	0	-364.9	-795.8
70-74.9	1192.2	1165.9	1064.5	897.2	664.0	364.9	0	-430.9
75-80	1623.1	1596.8	1495.4	1328.1	1094.9	795.8	430.9	0

A.2.20 The steps of benefit estimation, interpolation and extrapolation, value growth and discounting are then carried out as for the 1dB or 2dB resolution data.

A.2.21 The annual net benefits (pre-growth) in year 2012 were estimated to be £42,168.30 in year 2027 were £32,191.60.

A.2.22 The Present Value of Benefits for transport-related residential noise was found to be £1.106 million using this data. This result is 5.0% lower than the PVB estimated above using data at 1dB resolution and 4.4% lower than the PVB estimated using the TAG standard data in 3dB bands. Across many applications, the results using 5dB banded data will on average be less accurate than the 3dB banded data which is required by TAG Unit 3.3.2 and the new TAG spreadsheet.



Scheme Name: A3 Hindhead **A3 Hindhead Improvement**	**Description:** Dual 2-lane all-purpose bypass (6.7km) incl. bored tunnel (1.9km)	**Problems:** substantial delays and journey time variability on the A3 due to the traffic signals at Hindhead, the single carriageway sections either side and nearby junctions and accesses, also causing substantial amounts of 'rat-running' on local roads. Traffic flow 30,000 veh/day (8% HGVs).	**Scheme Total Cost: £239.6m (@2001 Q3)** PVC £150.6m. Present Value of Costs to Public Accounts = £174.5 low / £174.0 high high

OBJECTIVE	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE MEASURE	ASSESSMENT
ENVIRONMENT	Noise	Substantial reduction in noise in parts of Hindhead. Tranquillity would be restored to a large area within Hindhead Common and The Devil's Punch Bowl. Some effects from redistributed traffic on existing roads.	People annoyed by noise - Published Scheme vs Do Minimum 2024 Total population in assessment over 1750. Do Minimum 309 annoyed Published Scheme 276 annoyed	**Change in populaton annoyed (Yr 15) = –33**
	Local Air Quality	No AQMA currently exists for Hindhead. No air quality limit values will be exceeded in the opening year. For most roads affected by changes in traffic there is likely to be an air quality improvement at residential properties. Only a few roads will experience deterioration in air quality. This deterioration is not considered significant.	No of properties experiencing a significant change < 200m from road LAQ improves significantly PM_{10} 24 NO_2 151 LAQ worsens significantly PM_{10} 19 NO_2 38	Total Assessment Scores NO_2 =-170 PM_{10} = -88
	Greenhouse Gases	Traffic related CO_2 emissions within the study area are predicted to increase by 8.2% in 2009 compared to 2002. The Published Scheme will result in a further 6.3% increase. The total increase being comparable with the projected national increase from the transport sector.	Increase in CO_2 with Published Scheme compared to Do Minimum	7 kilotonnes / annum
	Landscape	The large but relatively local adverse landscape effects within Tyndalls Wood and Boundless Copse have to be considered in relation to the greater beneficial impacts upon the high quality and very highly valued landscape within the Devil's Punch Bowl and Hindhead Common. Whilst the balance would be fine in the opening year before landscape mitigation measures help to reduce impacts, the collective longer-term landscape impact would be **slightly beneficial** due to the removal of the Existing A3 from the Devil's Punch Bowl, the routing of traffic through the tunnel and the enclosure of the Existing A3 corridor on the ridgeline north of Boundless Copse to Thursley.	N/A	Slight Beneficial
	Townscape	The removal of through traffic from the closed section of London Road to the north of the Hindhead Crossroads would significantly improve the quality of the local townscape and would outweigh minor impacts on Crossways Road and Tower Road associated with the potential implementation of local traffic calming measures. Overall, the townscape impact would be **moderate beneficial**, although any benefits would be large beneficial should streetscape improvements be implemented along the closed section of London Road following the completion of the main scheme.		Moderate Beneficial
	Heritage of Historic Resources	No impacts on designated sites. Impact on small proportions of locally and regionally important archaeology and historic elements of the landscape. Some risk to unknown/undiscovered archaeology. Neutral or moderate beneficial effect on the settings of listed buildings and structures and the area of the Devil's Punch Bowl, because of the removal of the A3 and reduced traffic intrusion.	N/A	Slight Adverse
	Biodiversity	Small adverse direct impact on adjacent Wealden Heath SPA/Devil's Punch Bowl SSSI through construction activities. Very small adverse impacts on international / national nature conservation interest due to increased passing traffic. Direct adverse impact on areas of non-designated woodland and Woodlands East of Hindhead SNCI. Large beneficial impact on Wealden Heaths SPA / Devil's Punch Bowl SSSI due to removing the existing A3 road and restoring carriageway to heathland.	N/A	Moderate Beneficial

-