An examination of the monetised benefit of proposed changes to type approved noise limits for tyres

M Muirhead, P G Abbott (TRL) and M Burdett (iSoniq)
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(Robert Falk)

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<table>
<thead>
<tr>
<th>Name</th>
<th>Date Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Manager</strong></td>
<td>Phil Abbott</td>
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Executive summary

In 2001 a European Commission Directive was introduced to establish a test method for assessing rolling noise emissions from tyres and set limit values for different types of tyres. These tests are conducted prior to new vehicles entering the fleet and are referred to as type approval tests. The Directive also set out its intention to introduce more stringent type approval limit values for tyres in the future.

Since the Directive was first introduced, several proposals have been put forward recommending changes to the type approval noise limits for tyres. In readiness for discussions with the European Commission (EC) regarding these proposals, the Department for Transport (DfT) is preparing an initial impact assessment to determine the effect of these proposals on the UK.

A review of the current limit values was carried out by the Forum of European National Highway Research Laboratories (FEHRL) and based on those findings the EC has proposed lower limit values for tyre noise and has produced an impact assessment.

Prior to the EC proposals, TRL was commissioned by DfT to carry out a programme of work to evaluate the extent to which limit values for car tyres could be lowered without compromising safety and the effect these new limits would have on actual traffic noise levels, particularly in the UK. Their report proposes more stringent tyre noise limits for cars than that proposed by the EC for this tyre class.

A third proposal, put forward by the Italian delegation, which includes members from the tyre industry, suggested noise limits that are less stringent than those proposed by the EC Commission.

This project was commissioned to examine the monetised benefits of each of these proposals, with respect to a base year of 2006, up to the year 2025.

The approach adopted was conducted in three stages:

Stage 1: Calculation of traffic noise emissions. A vehicle source model allowing the influence of tyre/road noise to be modelled separately provided a means of evaluating the impact of each tyre noise proposal on future exposure levels for three speed categorised roads; less than 50 km/h, between 50 and 80 km/h and above 80 km/h.

Stage 2: Calculation of noise exposure outside residential properties in the UK. From a selection of noise mapped agglomerations and areas outside the first round agglomerations, the dominant road traffic noise, in terms of the speed categorised roads defined in stage 1, was estimated for all residential dwellings in the UK.

Stage 3: Calculating the monetised benefits for each proposal. Monetised benefits for each proposal were based on an assessment of the reduction in noise using a single rate of 27 Euros per dB(A) per household per year for the baseline year 2006 together with the current Treasury discount rate of 3.5% and converted to pound sterling using an exchange rate of 1.25 Euros to the pound.

Due to limitations in estimating the dominant road traffic noise source for all dwellings, both an ‘optimistic’ and ‘conservative’ estimate of the cumulative monetised benefits for 2015 and 2025 have been provided.

It is recommended for the purposes of informing on policy the following values are used since this represents the conservative estimate of the monetised benefits:

<table>
<thead>
<tr>
<th></th>
<th>2015: £0.1bn</th>
<th>2025: £1.32bn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commission:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRL:</td>
<td>£0.12bn</td>
<td>£1.53bn</td>
</tr>
<tr>
<td>Italian Delegation:</td>
<td>£0.04bn</td>
<td>£0.52bn</td>
</tr>
</tbody>
</table>

It should be noted that in deriving the above estimate a number of assumptions have been made which have been detailed in this report.
1 Introduction

1.1 Background

Noise from road traffic is the most pervasive of all the noise sources that affect people. Prior to the most recent expansion of the European Union (EU), it was estimated that approximately 80 million people in the EU were exposed to unacceptably high noise levels from road traffic (Lambert, 2000). Progressive legislation for reducing vehicle noise emissions related to sources associated with vehicle propulsion, for example the engine and exhaust, have been in place since the early 1970s. However, these measures are only effective in traffic conditions where such sources are dominant, generally at low speeds, particularly when vehicles are accelerating. For moderate and high speed roads the dominant noise source is generated by the interaction of the tyres with the road surface and referred to as rolling noise. Legislation to control this noise source was introduced in 2001 (Commission of the European Communities, 2001). The Directive established a test method for assessing rolling noise emissions from tyres and set limit values for different types of tyres. These tests are conducted prior to new vehicles entering the fleet and are referred to as type approval tests. The Directive also set out its intention to introduce more stringent limit values in the future.

Since the Directive was first introduced, several proposals have been put forward recommending changes to the type approval noise limits for tyres. In readiness for discussions with the European Commission (EC) regarding these proposals, the Department for Transport (DfT) is preparing an initial impact assessment to determine the effect of these proposals on the UK.

A review of the current limit values was carried out by the Forum of European National Highway Research Laboratories (FEHRL) supported by the Transport Research Laboratory (TRL) and SP Technical Research Institute of Sweden, amongst others (FEHRL, 2006). Based on those findings, the EC (Commission of the European Communities, 2008a) has proposed lower limit values for tyre noise, and has produced an impact assessment (Commission of the European Communities, 2008b).

Prior to the EC proposals, TRL was commissioned by DfT to carry out a programme of work to evaluate the extent to which tyre noise limits (for C1 class tyres only, see section 1.2) could be lowered without compromising safety and the effect these new limits would have on actual traffic noise levels, particularly in the UK (Watts et al., 2006). Their report proposed new tyre noise limits which differed from that proposed by FEHRL for this tyre class. These differences are largely due to differences in the type of surfaces traditionally used in the UK compared with other EU members.

A third proposal, put forward by the Italian delegation, which includes members from the tyre industry, suggested noise limits that are less stringent than those proposed by the EC Commission (Commission of the European Communities, 2008c).

This report examines the monetised benefit of each of these proposals, with respect to a base year of 2006, up to the year 2025. Section 1.2 outlines the current and proposed noise limits, Chapter 2 discusses the methodology used to determine the monetised benefit of each approach, Chapter 3 presents the results of this analysis and Chapter 4 provides a summary and conclusions.

1.2 The proposals

Tyre noise limits are defined separately for several different categories of tyre and vehicle. In the first instance tyres are categorised according to the type of vehicle for which they are manufactured. These categories are referred to as C1, C2 and C3 and cover light motor vehicles, medium heavy vehicles and heavy vehicles respectively, see for example (Peeters and van Blokland, 2007). Within each of these categories the tyres
are distinguished according to their purpose (e.g. snow tyres) and, in the case of C1 tyres, their width, see Tables 1.1-1.3.

The type approval tests, to which these limits pertain, consist of a series of measurements taken in order to determine the noise of the vehicle when coasting at a reference speed of 80 km/h in the case of C1 and C2 class tyres and 70 km/h in the case of C3 class tyres. For details of these tests and how the tyre noise levels are calculated see Directive 2001/43/EC (Commission of the European Communities, 2001).

The noise limit values for class C1 tyres are shown in Table 1.1. Columns 1 and 2 show the current tyre classes and nominal section widths, respectively. Columns 3 and 4 show the tyre classes associated with the three proposals under discussion. The proposed limit values are given in columns 9 to 14 where the bracketed numbers represent the corresponding reductions compared with the current limits. The current limit values are shown in columns 5 to 8.

Table 1.2 shows the noise limit values for class C2 tyres proposed by the Commission and the Italy/Industry delegation including the reductions relative to the current limits.

Table 1.3 shows the noise limit values for class C3 tyres proposed by the Commission and the Italy/Industry delegation including the reductions relative to the current limits.

Note that the limits proposed by TRL do not cover class C2 and C3 tyres and therefore the values proposed by the Commission have been used in assessing the benefits of the TRL proposal. Additionally the limits concerning specialised tyres, shown in columns 6-8 and 12-14, are not considered in this study.

The dates of the proposed implementation of the noise limits are:

- 29th October 2012 - for the purposes of type approval of all new vehicles;
- 29th October 2016 - all new vehicle registration and replacement tyres.

The potential benefit of each proposal, with respect to a baseline of keeping the existing limits in place, is examined for years 2006, 2010, 2015 and 2025. This is summarised in Table 1.4 where for four assessment scenarios are defined as follows:

Scenario 1: No change in existing tyre noise limits

Scenario 2: with the Commission’s proposal

Scenario 3: with the TRL proposal - adopting the Commission’s proposal for C2 and C3 tyres in the assessment

Scenario 4: with the Italian proposal.
Table 1.1. Noise limits for Class C1 tyres proposed by the Commission, TRL and the Italy/Industry delegation

<table>
<thead>
<tr>
<th>Scenario</th>
<th>C1-1</th>
<th>C1-2</th>
<th>C1-3</th>
<th>C1-4</th>
<th>C1-5</th>
<th>C1-6</th>
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<tbody>
<tr>
<td>Current</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Italy / industry proposal</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Proposed</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Normal</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Snow</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Reinforced</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Special</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>Commission</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>TRL</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
</tr>
<tr>
<td>All tyres except special</td>
<td>78 (0)</td>
<td>77 (0)</td>
<td>77 (1)</td>
<td>76 (0)</td>
<td>76 (1)</td>
<td>76 (2)</td>
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<table>
<thead>
<tr>
<th>Tyre class</th>
<th>Nominal section width (mm)</th>
<th>Proposed</th>
<th>Current</th>
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<tbody>
<tr>
<td>C1a</td>
<td>≤145</td>
<td>72</td>
<td>72 (2)</td>
</tr>
<tr>
<td></td>
<td>&gt;145</td>
<td>73</td>
<td>73 (0)</td>
</tr>
<tr>
<td>C1b</td>
<td>≤165</td>
<td>73</td>
<td>73 (0)</td>
</tr>
<tr>
<td></td>
<td>&gt;165</td>
<td>74</td>
<td>74 (1)</td>
</tr>
<tr>
<td>C1c</td>
<td>≤185</td>
<td>74</td>
<td>74 (1)</td>
</tr>
<tr>
<td></td>
<td>&gt;185</td>
<td>75</td>
<td>75 (1)</td>
</tr>
<tr>
<td>C1d</td>
<td>≤215</td>
<td>75</td>
<td>75 (1)</td>
</tr>
<tr>
<td></td>
<td>&gt;215</td>
<td>76</td>
<td>76 (1)</td>
</tr>
<tr>
<td>C1e</td>
<td>≤245</td>
<td>76</td>
<td>76 (1)</td>
</tr>
<tr>
<td></td>
<td>&gt;245</td>
<td>76</td>
<td>76 (1)</td>
</tr>
<tr>
<td>C1f</td>
<td>≤275</td>
<td>76</td>
<td>76 (1)</td>
</tr>
<tr>
<td></td>
<td>&gt;275</td>
<td>76</td>
<td>76 (1)</td>
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</table>

Table 1.1. Noise limits for Class C1 tyres proposed by the Commission, TRL and the Italy/Industry delegation.
Table 1.2. Noise limits for Class C2 tyres proposed by the Commission and the Italy/Industry delegation

<table>
<thead>
<tr>
<th>Tyre class</th>
<th>All tyre widths</th>
<th>Current limit values</th>
<th>C2-1 Commission proposal</th>
<th>C2-2 Italy / industry proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limit value dB(A)</td>
<td>Reduction relative to current dB(A)</td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td></td>
<td>75</td>
<td>72</td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td>77</td>
<td>73</td>
</tr>
<tr>
<td>Traction (snow) tyres</td>
<td></td>
<td></td>
<td>78</td>
<td>No category</td>
</tr>
<tr>
<td>Special</td>
<td></td>
<td></td>
<td>78</td>
<td>No category</td>
</tr>
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</table>

Table 1.3. Noise limits for Class C3 tyres proposed by the Commission and the Italy/Industry delegation

<table>
<thead>
<tr>
<th>Tyre class</th>
<th>All tyre widths</th>
<th>Current limit values</th>
<th>C3-1 Commission proposal</th>
<th>C3-2 Italy / industry proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limit value dB(A)</td>
<td>Reduction relative to current dB(A)</td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td></td>
<td>76</td>
<td>73</td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td>78</td>
<td>75</td>
</tr>
<tr>
<td>Traction (snow) tyres</td>
<td></td>
<td></td>
<td>79</td>
<td>No category</td>
</tr>
<tr>
<td>Special</td>
<td></td>
<td></td>
<td>79</td>
<td>No category</td>
</tr>
</tbody>
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Table 1.4: Matrix of test cases to be modelled

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
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<tbody>
<tr>
<td>2006</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2010</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2015</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2025</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
2 Methodology

2.1 Stage 1: Calculation of traffic noise emissions

Calculation of traffic noise emissions are based on the HARMONOISE/IMAGINE source noise model. This was developed as part of a general programme of research to support the EU policy in providing a common approach to the assessment of environmental noise on communities (Peeters and van Blokland, 2007).

An advantage of this method is that it can model propulsion and rolling noise sources for different types of vehicles separately allowing an examination in how changes to the rolling noise component impact overall vehicle noise levels. In order to capture the fact that the relative impact of the rolling noise component increases as vehicle speed increases roads in three different speed categories are considered: low speed roads - up to 50 km/h, medium speed roads - between 50 and 80 km/h and high speed roads - over 80 km/h. The potential effect of the proposed limits in each of these road categories is then assessed by aggregating the noise from all vehicles in the traffic stream to determine the overall traffic noise level for a given traffic flow, composition and mean traffic speed. This is achieved in three stages:

- A sound power level for every vehicle in an assumed hourly traffic flow is calculated using the IMAGINE source model
- The Sound Exposure Level (SEL) for each vehicle is then determined from its sound power level and the mean traffic speed\(^1\)
- These SELs are then summed to determine the overall traffic noise level, \(L_{\text{Aeq,1h}}\).

In implementing the above approach a large number of factors need to be considered. The rest of this section examines these factors, how they have been modelled and what assumptions have been made in obtaining the appropriate input data. The most important parameters affecting the influence of the proposed limits are discussed first.

**The influence of changes in the limit values on the distribution of tyre noise levels within each tyre category**

For the existing tyre limits, it is known that the test values of tyres within a tyre category can vary over a wide range, with a significant percentage of the population being 3 dB(A) or more below the type approval limit. Using data from (FEHRL, 2006) showing what percentage of various class C1 tyres are 3 and 5 dB(A) below the current limits respectively and assuming the current type approval levels form a normal distribution, as indicated in (de Graaff and van Blokland, 2007), an estimated distribution of the actual noise levels of current tyres can be derived. Note that this will include some tyres which do not meet current regulations since these regulations only govern new vehicles as they enter into service.

Acknowledging that there is a technical lower limit to the noise level generated by tyres, it is unlikely that this distribution will simply shift downwards as type approval limits are reduced. The most likely outcome will be that this distribution will become narrower. As such a Rayleigh distribution, see for example (Papoulis, 1984), is assumed for tyres required to meet the new limits.

The overall effect is that the average reduction in tyre noise values within a tyre category from a lowering in the corresponding limit values will be less than the actual change in limit values.

\(^1\) The formula given in (Watts, 2005) is used, noting that the effect of the ground surface should be added and not subtracted. This relative sound pressure is calculated from the solution to the Helmholtz equation for a point source above a ground surface in a non-refracting atmosphere; see for example (Salomons, 2001).
An example of this is given in Appendix A where a proposed reduction of 6 dB(A) in the type approval limit results in only a 3.8 dB(A) reduction in the average type approval level.

It may be argued that as the years go by this new distribution will slowly change, resulting in generally quieter tyres still but given the obvious lack of data on potential tyre noise in the future and the fact that the tyre manufacturers consider further breakthroughs unlikely (Watts et al, 2006) this has not been modelled. Therefore the results presented here may be considered a conservative estimate of the benefit of any new proposals.

The percentage of vehicles with tyres which meet the tyre noise limits

For 2006 and 2010 the distribution of type approval levels for tyres is assumed from the data in (FEHRL, 2006) as described above. In 2015 all vehicles less than 3 years old will have tyres meeting the new regulations. In order to determine what percentage of the fleet this will be, statistics on car ages from the Society of Motor Manufacturers and Traders (SMMT) were used (SMMT, 2008). By 2025 it is assumed that all tyres will meet the new regulations given that new and replacement tyres will have had to meet the regulations for at least 9 years.

The relationship between tyre noise levels on the ISO surface and corresponding levels on typical road surfaces used on the UK road network

The tyre noise levels generated during type approval testing are obtained on a road surface conforming to ISO 10844 (ISO, 1994). This surface was specifically developed for reducing the rolling noise source contribution during whole-vehicle type approval noise testing. It has been shown that changes in tyre noise levels generated on the ISO surface do not correspond to similar changes in tyre noise levels on other surface types (Watts et al, 2006).

In order to quantify this relationship typical road surfaces found in the UK need to be identified. For the purposes of this study three surface types have been considered, which together constitute the vast majority of road surfaces in the UK. They are namely: Hot Rolled Asphalt (HRA), thin surfaces and concrete. Data, from research carried out at TRL (McRobbie et al, 2004), for 2001 and 2003 has been extrapolated to estimate the distribution of these surfaces over the UK road network between 2006 and 2025. The corresponding noise reduction offered by these surfaces relative to the ISO surface has been derived from data given in (FEHRL, 2006) and (Watts et al, 2006). However, no information is available to establish whether these relationships remain constant as surfaces age.

The distribution of tyre sizes in the existing car fleet and how this distribution changes with time

To provide reliable estimates of traffic noise levels from traffic on UK roads, the distribution of tyre sizes within the vehicle category for cars must be established to reflect the influence of different limit values associated with different size tyres on overall traffic noise levels. The current trends regarding UK tyre sales between 1993 and 2004 are shown in (Watts et al, 2006) and these trends have been extrapolated through to 2025².

Changes in traffic conditions and fleet population

Changes in the composition and speed of traffic will influence the impact changes to the rolling noise emissions have on overall noise exposure. For example, the rolling noise component dominates at higher speeds and different limits are proposed for different vehicle categories.

² Over the period 1993-2004 there was a trend towards larger tyre widths, however, given increasing pressure to improve fuel efficiency, it is unlikely that this trend will continue at the same rate. This has been taken into account when extrapolating the data in (Watts, et al, 2006) although, in the absence of any further information, we have not gone as far as reversing any of the trends shown in (Watts, et al, 2006).
Note that typical traffic flows on each road category will only influence the absolute noise level at residential properties and not the relative benefit of the proposed limit changes; as such nominal hourly values have been selected.

Traffic composition, in each of the three road categories, has been estimated from (NAEI, 1999) and mean traffic speeds taken from (DfT, 2005a) and (DfT, 2005b). Note that while cars, light goods vehicles and heavy good vehicles are all considered motorcycles are not.

**Additional parameters**

In addition to assuming vehicle tyres fall into the ‘normal’ category, see Table 1.1, there are numerous other factors that can be accounted for in the IMAGINE source model but since these will have little relative influence on the impact of the proposed tyre noise limits the default values described in (Peeters and van Blokland, 2007) have been used. It is therefore assumed that:

- All vehicles are travelling at a constant speed
- All roads are flat
- The air temperature is 20°C
- The road surfaces are dry
- There are no trucks with doubled mounted axles
- Vehicles with C3 tyres have an average of four axles
- Vans comprise 10.5% of vehicles with C1 tyres
- There are Illegal Replacement Exhaust Silencer Systems (IRESS) on 1% of vehicles with C1 tyres
- No cars have studded tyres.

### 2.2 Stage 2: Calculation of noise exposure outside residential properties representative of the UK

Data collected from the noise mapping projects undertaken by Department for Environment, Food and Rural Affairs (Defra), to meet the requirements of reporting under the Environmental Noise Directive (END), has been utilised to provide indicative analytical statistics. END noise mapping information has been used to assess residential exposure for a small sample of geographical locations across England. Analysis has been undertaken across two types of area covered by the END noise mapping, namely agglomerations and major road sources.

Road noise model input datasets for the three predefined agglomerations were used to determine the geographical location of noise sources as defined during the Defra noise mapping process. In order to facilitate subsequent analysis these datasets were classified into the following three predefined ‘mean traffic speed’ \((V)\) categories by utilising the speed information inherent within the road network dataset:

- Road category 1: \(V \leq 50 \text{ km/h}\)
- Road category 2: \(50 < V \leq 80 \text{ km/h}\)
- Road category 3: \(V > 80 \text{ km/h}\)

In addition to road network information, the project has utilised the strategic population models as used by Defra in carrying out the END population exposure assessment. These

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3 Road input datasets, as used to produce the END mapping (2007). Output maps available to view at www.noisemapping.defra.gov.uk
models have been used to define the spatial location and distribution of residential dwellings across the study areas.

### 2.2.1 Proximity assessment of residential dwellings in first round agglomerations to road traffic noise sources

This project has focussed upon three of the first round agglomerations\(^4\) in England (West Midlands, Portsmouth and Preston). These agglomerations were chosen in order to reflect urban areas of different sizes and in different parts of the country containing all three road categories.

It is important to note that no sampling techniques were applied in the selection of the three agglomerations. The extent to which the three sample agglomerations represent a proxy for the situation across the UK has not been assessed. Therefore the validity of extrapolating any statistical analysis of this sample across the UK is unknown and any attempt to do so should be treated with caution.

Across the UK, there are a total of 28 first round agglomerations. Based upon 2001 Census population statistics, the total population of these three agglomerations is approximately 10% of the total population inside UK first round agglomerations.

Spatial analysis of the Defra road network and population datasets has been carried out to estimate the number of residential properties in the vicinity of the three road speed categories being considered.

It has been determined that each dwelling will be assigned to the speed category of the nearest road source. The results of this analysis are presented in Table 2.1, below.

<table>
<thead>
<tr>
<th>Agglomeration</th>
<th>Estimated number of residential dwellings for which the road speed category is estimated to be the closest source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 50 kph</td>
<td>50 - 80 kph</td>
</tr>
<tr>
<td>Preston</td>
<td>113,812</td>
<td>330</td>
</tr>
<tr>
<td>Portsmouth</td>
<td>190,147</td>
<td>939</td>
</tr>
<tr>
<td>West Midlands</td>
<td>946,408</td>
<td>16,008</td>
</tr>
</tbody>
</table>

It is important to note that the results of the analysis presented here are based upon the inherent input information contained within the noise mapping input datasets. The analysis used to derive the data in Table 2.1 assumes that the dominant noise source at each of the selected dwellings is the nearest road speed category without taking into account the 3D spatial location of the dwelling in relation to its surroundings and noise sources. The extent to which this methodology represents a true proxy has not been fully assessed but has been estimated by keeping track of dwellings for which the distance between the selected speed category and a higher speed category is less than 50m. It was found that this number represented about 3% of the total dwellings modelled.

---

\(^4\) An area having a population in excess of 250,000 persons and a population density equal to or greater than 500 people per km\(^2\), which the Secretary of State considers to be urbanised.
The above analysis was used to estimate the number of residential dwellings for each road speed category for all the other agglomerations in the UK assuming a linear relationship between the number of residential dwellings for each road speed category and the total number of residential dwellings in the agglomerations. The results of this analysis are shown in Table 2.2. As stated in (King and Bush, 2001) this represents approximately 43% of the total number of dwellings in the UK.

Table 2.2: Estimated number of dwellings for the three predefined speed categories across all agglomerations in the UK

<table>
<thead>
<tr>
<th>Source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 kph</td>
<td>10562170</td>
</tr>
<tr>
<td>50 - 80 kph</td>
<td>145626</td>
</tr>
<tr>
<td>&gt; 80 kph</td>
<td>203</td>
</tr>
<tr>
<td>Total</td>
<td>10707999</td>
</tr>
</tbody>
</table>

Further analysis, to represent the remaining dwellings, is described in the next section.

2.2.2 Proximity assessment of residential dwellings outside first round agglomerations to road traffic noise sources

The analysis outside first round agglomerations has been based upon two key datasets used during the noise mapping projects undertaken by Defra; road noise model input information and population model datasets.

Road noise model input datasets for the ‘first round major road’ network were used to determine the geographical location of noise sources and the associated characteristics or attributes for each section of road, as defined during the Defra noise mapping process.

This analysis has focussed upon two Government Office Regions (GORs) in England; the North West and the South East. For areas outside of first round agglomerations, to meet the requirements of the END, it is important to note that not all road traffic noise sources were incorporated. The Directive and Regulations only necessitate that areas in the vicinity of first round major roads were mapped. Based upon 2001 Census population statistics, the total population of the two selected regions is approximately 25% of the total population of England, outside first round agglomerations.

It is important to note that no sampling techniques were applied in the selection of the two GORs; as with the agglomerations they were chosen to represent regions of varying size and geographical location. The extent to which these sample GORs represent a proxy for the situation across the UK has not been assessed. Therefore the validity of extrapolating any statistical analysis of this sample across the UK is unknown and any attempt to do so should be treated with caution.

Spatial analysis of the Defra major road network and population datasets has been carried out to estimate the number of residential properties in the vicinity of the three road speed categories being considered. For each residential dwelling within 200 m of a

5 The total number of dwellings in first round agglomerations has been estimated from data provided in (King and Bush, 2001) together with population figures for mid-2006, available from http://www.statistics.gov.uk
6 First round major roads are those roads with more than 6 million vehicle passages a year, that the Secretary of State considers to be regional national or international.
7 Road input datasets, as used to produce the END mapping (2007). Output maps available to view at www.noisemapping.defra.gov.uk
major road it has been determined that the dwelling will be assigned to the speed category of the nearest road source. The results of this analysis are presented in Table 2.3, below.

**Table 2.3: Dwelling proximity analysis statistics for the three predefined speed categories**

<table>
<thead>
<tr>
<th>Government Office Region (GOR)</th>
<th>Number of residential dwellings (outside first round agglomerations) for which the road speed category is estimated to be the closest source</th>
<th>Estimated total population (outside first round agglomerations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 50 kph</td>
<td>50 - 80 kph</td>
</tr>
<tr>
<td>North East GOR</td>
<td>18,102</td>
<td>8,191</td>
</tr>
<tr>
<td>South East GOR</td>
<td>109,931</td>
<td>85,158</td>
</tr>
</tbody>
</table>

It is important to note that the results of the analysis presented here are based upon the inherent input information contained within the noise mapping input datasets. No validation has been undertaken to assess whether this approach is representative.

As with the first round agglomerations the analysis used to derive the data in Table 2.3 assumes that the dominant noise source at each of the selected dwellings is the nearest road speed category without taking into account the 3D spatial location of the dwelling in relation to its surroundings and noise sources that may or may not be contained in the road network dataset.

From these data we note that approximately 85% of the dwellings in the GORs, outside first round agglomerations, have not been analysed as part of this study. An assumption must therefore be made regarding the speed limit of the road that provides their dominant traffic noise source.

With respect to the road categories from which the unaccounted dwellings receive most of their traffic noise two alternate assumptions are made. The first assumes that these dwellings are distributed in the same manner as the dwellings in the GORs that were mapped. The results of this analysis are shown in Table 2.4.

**Table 2.4: First estimate of the number of dwellings for the three predefined speed categories across all GORs in the UK**

<table>
<thead>
<tr>
<th>Estimated number of residential dwellings for which the road speed category is estimated to be the closest source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 kph</td>
<td>50 - 80 kph</td>
</tr>
<tr>
<td>5433898</td>
<td>3961309</td>
</tr>
</tbody>
</table>

This is likely to underestimate the number of dwellings next to roads with speed limits less than 50 km/h and therefore overestimate the likely benefits of each proposal (given that limit reductions will have the greatest effect on high speed roads where tyre noise is dominant).
The second assumption is that all dwellings not analysed in the above process are impacted most by roads where the speed limit is less than 50 km/h. This method provides a conservative estimate as to the benefits of each proposal. The results of this analysis are shown in Table 2.5.

### Table 2.5: Second estimate of the number of dwellings for the three predefined speed categories across all GORs in the UK

<table>
<thead>
<tr>
<th>Source</th>
<th>Estimated number of residential dwellings for which the road speed category is estimated to be the closest source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 kph</td>
<td>13347793</td>
<td>14536912</td>
</tr>
<tr>
<td>50 - 80 kph</td>
<td>512875</td>
<td></td>
</tr>
<tr>
<td>&gt; 80 kph</td>
<td>667244</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.2.3 Estimated number of dwellings for each road speed category across the UK

The total estimate for the number of dwellings related to each road speed category class is reached by combining the estimates obtained for dwellings inside and outside first round agglomerations. The results for the two assumptions made with regards to the unmapped dwellings are shown in Tables 2.6 and 2.7 respectively. The first assumption is identified as leading to an optimistic estimate of the monetised benefits of each proposal and the second assumption is identified as leading to a conservative estimate.

### Table 2.6: Estimate of the number of dwellings for the three predefined speed categories across the UK - Optimistic

<table>
<thead>
<tr>
<th>Source</th>
<th>Estimated number of residential dwellings for which the road speed category is estimated to be the closest source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 kph</td>
<td>15996068</td>
<td>25244911</td>
</tr>
<tr>
<td>50 - 80 kph</td>
<td>4106935</td>
<td></td>
</tr>
<tr>
<td>&gt; 80 kph</td>
<td>5141909</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2.7: Estimate of the number of dwellings for the three predefined speed categories across the UK - Conservative

<table>
<thead>
<tr>
<th>Source</th>
<th>Estimated number of residential dwellings for which the road speed category is estimated to be the closest source</th>
<th>Total estimated number of residential dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 kph</td>
<td>23909963</td>
<td>25244911</td>
</tr>
<tr>
<td>50 - 80 kph</td>
<td>667501</td>
<td></td>
</tr>
<tr>
<td>&gt; 80 kph</td>
<td>667447</td>
<td></td>
</tr>
</tbody>
</table>
2.3 Stage 3: Calculating the monetised benefits for each proposal

The monetised benefits for each proposal are based on the method described in section 4.3.1.1 of (Commission of the European Communities, 2008b). This method evaluates monetised benefits through an assessment of the reduction in noise using a single rate per dB(A) per household per year and is independent of absolute evaluations of noise levels.

The cumulative monetised benefits of each proposal at 2006 values are discussed in Chapter 3. An initial figure of 27 Euros/dB(A)/household/year has been used for the baseline year of 2006 (FEHRL, 2006) together with the current Treasury discount rate of 3.5%. This figure is converted to pounds sterling using an exchange rate, supplied by DfT, of 1.25 Euros to the pound. All results in sections 3.2 and 3.3 are then presented in pounds at 2006 values.

Given the assumptions made in the noise modelling there will be no benefit from any of the proposals until they have been in force for at least a year. We have not, for example, assumed that the distribution of tyre noise levels will change prior to 2012 as tyre manufactures prepare for the introduction of the new limits.

Given the cumulative nature of the Euros/dB/household/year metric the noise benefit of the proposed limit changes would need to be known every year between 2012 and 2025 in order to calculate its effect accurately but the only years, post 2012, for which the impact of the proposals has been modelled are 2015 and 2025. Therefore these data have been linearly interpolated over the years 2012 to 2025 to provide an estimate of the noise, and therefore monetary, benefit in each year. This is in effect assuming a steady rate of introduction of new and replacement tyres.
3 Results

3.1 Effect of proposals on community noise

From the analysis described in section 2.1 a nominal hourly \( L_{\text{Aeq},1h} \) for observers 50m from the road has been calculated\(^8\). Figure 3.1 shows the effect of each proposal with respect to each road category for a nominal hourly \( L_{\text{Aeq},1h} \) based on 6000 vehicles. The scenarios are as described in section 1.2; therefore the black lines represent predicted levels if no new limits were enforced, the red line reflects the impact of the Commission’s proposal, the blue line reflects the effect of TRL’s proposed limits and the green line the effect of limits proposed by the Italian delegation.

If no new tyre noise limits were introduced it is anticipated that the noise on low speed roads will increase slightly largely because of the trend of tyre widths increasing on cars. When looking at high speed roads however this trend is reversed through the anticipated introduction of more low-noise surfaces and their subsequent influence on noise.

As may be expected the introduction of more stringent tyre noise limits has a greater effect on the community noise. The fact that this effect is more pronounced on the higher speed roads is because the surface types common to these roads better reflect noise benefits seen on an ISO surface, particularly as traditional surfaces such as HRA is replaced with low-noise surfaces.

\(^8\) It is important to note that the results presented in this report are independent of distance since it deals with changes in source noise. The results are also valid for all noise indices which have a 1:1 relationship with \( L_{\text{Aeq}} \) i.e EU noise indices \( L_{\text{den}} \) and \( L_{\text{night}} \) and the UK road traffic noise index \( L_{\text{A10,18h}} \).
The relative noise benefits of each approach in each road category are plotted separately in Appendix B which also provides a brief summary of the relation these data have to the perceived impact of noise.

### 3.2 Optimistic estimate of monetised benefits

In this section the results presented reflect the first of the two assumptions described in section 2.2, namely that all dwellings not mapped should be associated with road speed categories in the same ratio as those mapped as part of the GORs.

Figure 3.2 shows the monetised benefit per annum for each year between 2006 and 2025.

![Figure 3.2: Optimistic monetised benefit of each proposal per annum](image)

Note that no benefit has been assumed until the proposed limits are introduced in 2012. The rate of increase in the yearly benefits of each proposal is initially kept constant as replacement tyres become affected and more low noise surfaces are introduced. Eventually this rate of increase tails off as the effect of the discounting, discussed in section 2.3, is seen.

The cumulative benefit, between the baseline year of 2006 and each modelled year 2015 and 2025, is shown in Figure 3.3. These numbers reflect the total benefit seen up to the years 2015 and 2025 respectively. Note that no bar appears for scenario 1 since benefits are measured with respect to this case.

The bars illustrated for 2015 show the benefit of having had lower noise tyres on new cars for a period of three years where as the relatively large numbers shown for 2025

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reflect the fact that by this time nearly all vehicles will have been fitted with new or replacement lower noise tyres for many years.

![Figure 3.3: Optimistic cumulative monetised benefit of each proposal in 2015 and 2025](image)

**Figure 3.3: Optimistic cumulative monetised benefit of each proposal in 2015 and 2025**

### 3.3 Conservative estimate of monetised benefits

In this section the results presented reflect the second of the two assumptions described in section 2.2, namely that all dwellings not mapped should be associated with low speed roads.

Figure 3.4 shows the monetised benefit per annum for each year between 2006 and 2025 as in Figure 3.2 but under this new assumption. Given that tyre noise is less dominant with respect to the propulsion noise of vehicles at lower speeds it is anticipated that Figure 3.4 will show less of a benefit than Figure 3.2 and this can indeed be seen to be the case.
Figure 3.4: Conservative monetised benefit of each proposal per annum

The cumulative summation of the benefits shown in Figure 3.4, for the years 2015 and 2025, are shown in Figure 3.5. This chart can be read in conjunction with Figure 3.3 to represent a band within which the cumulative benefits are expected to lie. It can be seen that the anticipated benefits are about 75% of those presented in section 3.2. The ratio of the size of the monetised benefit of each proposal is not affected however with the more stringent limits proposed by TRL still leading to a benefit nearly three times that expected if the limits from the Italian delegation are taken forward.
The cumulative benefits of each proposal are summarised in Table 3.1. The upper and lower limits of the values shown for each scenario reflect the values presented in sections 3.2 and 3.3 respectively.

Table 3.1: Cumulative monetised benefits of each proposal

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Monetised benefit (£bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>2 (Commission)</td>
<td>0.10-0.13</td>
</tr>
<tr>
<td>3 (TRL)</td>
<td>0.12-0.14</td>
</tr>
<tr>
<td>4 (Italian)</td>
<td>0.04-0.05</td>
</tr>
</tbody>
</table>

The cumulative monetised benefits of each proposal without any discounting applied are given in Appendix C.
4 Summary and Conclusions

This project was commissioned to examine the monetised benefits following the introduction of proposed changes to type approval noise limits of vehicle tyres. Three different proposals have been considered; the Commission, TRL and the Italian delegation.

Due to time constraints, a simplified approach was adopted, in particular in estimating the change in traffic noise levels outside dwellings in the UK as a result of changes in type approved limits for tyres.

To provide a robust estimate a range in the monetised benefits for each proposal for both 2015 and 2025 is given. The lower estimate assumes a smaller proportion of dwellings are exposed to noise from medium and high speed roads compared with the higher estimate.

It is recommended for the purposes of informing on policy the lower estimates are used since this represents a conservative estimate of the monetised benefits.

The cumulative monetised benefits for each proposal are as follows:

Commission: 2015: £0.1bn  2025: £1.32bn
TRL: 2015: £0.12bn  2025: £1.53bn
Italian Delegation: 2015: £0.04bn  2015: £0.52bn

Clearly, the TRL proposal which was the most stringent in proposing lower limit values provided the greatest monetised benefit, whilst the least stringent proposal, offered by the Italian delegation, is expected to result in a monetised benefit about 1/3rd of the size compared with TRL’s. This relative difference in monetised benefit between proposals was found to be the same when assuming the higher estimate of the proportion of dwellings exposed to medium and high speed roads.

It should be noted that in deriving the above estimate a number of assumptions have been made which have been detailed in this report.
Acknowledgements

The work described in this report was carried out by the Noise and Vibration Group in the Centre for Sustainability Division of the Transport Research Laboratory and iSoniq. The authors are grateful to Phil Sivell who carried out the technical review and auditing of this report.

References


Appendix A  Tyre noise distribution

In this example, the existing tyre noise limit is assumed to be 76 dB(A) and the existing distribution of tyre noise levels is derived from statistics in (FEHRL, 2006) and shown in Figure A1 as the blue line. Note that this is a normal distribution which contains tyres not meeting the current limits; this is because the current regulations only cover tyres on new vehicles and not replacement tyres.

The proposed limit, shown as the vertical dashed line, of 70 dB(A) will require all new tyres to be below this level. Note, from the blue line, that some existing tyres will already meet this limit and, without assuming a major breakthrough in tyre technology, it is assumed that these tyres will make up most of the new tyre population. This results in a new distribution of tyre noise levels, shown as the red line in Figure A1.

The mean of each distribution is used when modelling the impact of the proposed limits and by noting that this is approximately the peak of each distribution it can be seen that the proposed reduction of 6 dB(A) will only result in an average noise reduction of about 4 dB(A) for new tyres.

![Figure A1: Tyre noise level distributions before and after the introduction of new noise limits](image-url)
Appendix B  Relative noise benefits

The relative noise benefits of each proposal, for low, medium and high speed road categories, are shown in Figures B1-B3 respectively. Note that these figures are based on the modelled years of 2010, 2015 and 2025. Hence, for example, the kink in the slopes in the plots is a result of the introduction of the regulations to replacement tyres in 2016 but appears at 2015 in the graphs since the lines are joining the data calculated in 2015 to the data calculated in 2025.

![Figure B1: The relative noise benefits of each proposal for low speed roads](image)
Figure B2: The relative noise benefits of each proposal for medium speed roads
Figure B3: The relative noise benefits of each proposal for high speed roads

To provide some guidance on the magnitude of the impact of these proposals Table B.1 provides a method for classifying impacts according to changes in road traffic noise.

Table B.1. Classification of noise impacts (Department for Transport, 2008)

<table>
<thead>
<tr>
<th>Noise change dB(A)</th>
<th>Magnitude of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No change</td>
</tr>
<tr>
<td>0.1 to 0.9</td>
<td>Negligible</td>
</tr>
<tr>
<td>1.0 to 2.9</td>
<td>Minor</td>
</tr>
<tr>
<td>3.0 to 4.9</td>
<td>Moderate</td>
</tr>
<tr>
<td>5+</td>
<td>Major</td>
</tr>
</tbody>
</table>

According to the above classification, the Italian proposal will provide a negligible impact on people’s perception in their homes by 2025.

Both the Commission and TRL proposals will provide a minor change in impact on people’s perception of noise in their homes where the dominant noise is from medium and high speed roads but negligible impact where the noise is from low speed roads.

However, it should be stressed that these changes in impacts can only be regarded as tentative and may be influenced by other factors such as absolute noise levels and spectral content.
Appendix C  Non-discounted benefits

Figure C1 shows the calculated upper limit for the cumulative benefit of each proposal (cf. Figure 3.3) but without discounting the benefit in future years. Figure C2 shows the corresponding lower limit on the cumulative benefits without discounting (cf. Figure 3.5). Both data sets are summarised in Table C1.

![Figure C1: Optimistic non-discounted monetised benefits for each proposal](image-url)
Figure C2: Conservative non-discounted monetised benefits for each proposal

Table C1: Cumulative non-discounted monetised benefits of each proposal

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Monetised benefit (£bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>2 (Commission)</td>
<td>0.13-0.17</td>
</tr>
<tr>
<td>3 (TRL)</td>
<td>0.15-0.19</td>
</tr>
<tr>
<td>4 (Italian)</td>
<td>0.06-0.07</td>
</tr>
</tbody>
</table>
An examination of the monetised benefit of proposed changes to type approved noise limits for tyres

In 2001 a European Commission Directive was introduced to establish a test method for assessing rolling noise emissions from tyres and set limit values for different types of tyres. These tests are conducted prior to new vehicles entering the fleet and are referred to as type approval tests. The Directive also set out its intention to introduce more stringent type approval limit values for tyres in the future.

Since the Directive was first introduced, several proposals have been put forward recommending changes to the type approval noise limits for tyres. In readiness for discussions with the European Commission (EC) regarding these proposals, the Department for Transport (DfT) is preparing an initial impact assessment to determine the effect of these proposals on the UK.

This project was commissioned to examine the monetised benefits of each of these proposals, with respect to a base year of 2006, up to the year 2025.

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